March 24, 2017

Los Angeles Regional Water Quality Control Board
Attn: Dr. L.B. Nye, Dr. Jun Zhu, and Mr. Kangshi Wang
320 W 4th St., Suite 200
Los Angeles, CA 90013
LB.Nye@waterboards.ca.gov; Jun.Zhu@waterboards.ca.gov;
Kangshi.Wang@waterboards.ca.go

VIA EMAIL

Re: Comments on the 2016 Clean Water Act Sections 303(d) and 305(b) Integrated Report for the Los Angeles Region, Public Review Draft

Dear Dr. Nye, Dr. Zhu, Mr. Wang, and to Whom it May Concern with the Los Angeles Regional Water Quality Control Board:

On behalf of Wishtoyo Foundation and our Ventura Coastkeeper Program, please accept the following comments on the 2016 Clean Water Act Sections 303(d) and 305(b) Integrated Report for the Los Angeles Region, Public Review Draft ("Draft 303(d)/305(b) List").

In reviewing the Draft 303(d)/305(b) List and in corresponding with Los Angeles Regional Water Quality Control Board ("Los Angeles Regional Board") staff, it has come to our attention that almost all of the proposed 303(d)/305(b) listings (See Attachment A) and accompanying supporting data timely submitted on August 30, 2010 by Wishtoyo Foundation's Ventura Coastkeeper Program ("VCK") were not assessed for inclusion in the Draft 303(d)/305(b) List[1].

We thus respectfully request the Los Angeles Regional Board assess all of VCK's proposed 303(d)/305(b) listings and accompanying data submitted in 2010, and ensure VCK's proposed listings are included in the 2016 303(d)/305(b) List. All of VCK's proposed listings meet the requirements for listing in the State Water Resources Control Board's Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. Notably, as demonstrated by VCK August 30, 2010 proposed listing submission, VCK's watershed monitoring data supporting the proposed listings were collected and analyzed in accordance with VCK's Quality Assurance Project Plan (QAPP) approved by the Los Angeles Regional Water Quality Control Board.

Furthermore, we ask the Board to include on the list, the dissolved oxygen ("DO") data submitted by VCK that supports the Santa Clara River Estuary ("Estuary") being

[1] See Attachment B for Los Angeles Regional Board staff worksheet detailing some of the VCK proposed listings and accompanying data improperly not assessed to date for the Draft 2016 303(d)/305(b) List.

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included on the 2016 Draft 303(d)/305(b) list for DO impairment. Even one event where DO levels drops below Basin Plan thresholds can be catastrophic for native and endangered aquatic life, including the Southern California Steelhead[2] and Tidewater Goby that use the Estuary as habitat and that need healthy and suitable water quality in the Estuary to survive and recover. It only takes one event of low DO for these species to perish, and the Los Angeles Regional Board was provided over 200 separate data entries indicating that DO fell in the Estuary below Basin Plan thresholds and non-harmful levels for aquatic life. Attached to this letter is are two studies by a Regional Board Scientist (Carter 2005 and 2008) that further details the harms of low DO on aquatic life and native and endangered species, including Southern California Steelhead.

VCK's mission is to protect, preserve, and restore the ecological integrity and water quality of Ventura County's inland and coastal waterways. In 2009 and 2010, VCK, in coordination with the Los Angeles Regional Water Quality Control Board and State Water Resources Control Board Clean Water Team, dedicated a tremendous amount of resources to its watershed monitoring program that resulted in VCK's proposed 303(d)/305(b) listings. These resources include VCK running volunteer stream teams, utilizing staff time to collect and analyze water quality data, purchasing and maintaining field equipment, and running a laboratory. It would be a shame, and detrimental to Ventura County's inland and coastal waterways and their beneficial uses, if the water quality impairments discovered, rigorously documented by VCK, and provided to the state did not result in 2016 303(d)/305(b) listings, especially on the account that they were not assessed. It is without second thought that the Los Angeles Regional Board assessing our proposed 303(d)/305(b) listings and accompanying data from August 30, 2010, and ensuring these proposed listings are included in the 2016 303(d)/305(b) List, is critical to the protection of Ventura County's waters for all the people, wildlife, communities, and the Chumash Native American Peoples that depend upon clean and healthy waters to sustain their health, wellbeing, and life ways.

Thank you for considering our comments. Please feel free to contact me with any questions.

Sincerely,

Jason Weiner
General Counsel, Water Initiative Director
Wishtoyo Foundation and its Ventura Coastkeeper Program
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(805) 823-3301

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[2] Juvenile Southern California Steelhead utilize estuaries as over-summering and rearing habitat for extended periods of time. (See attached Hayes, et. al (2008); See attached Bond (2006).) The National Marine Fisheries Service ("NMFS") has designated the Estuary as critical habitat under the federal Endangered Species Act, and the NMFS Steelhead Recovery Plan (January 2012) prioritizes Santa Clara River Estuary habitat restoration and protection as a critical action for the survival and recovery of the species. For NMFS Steelhead Recovery Plan visit: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/south_central_southern_california_coast/south_central_southern_california_coast_recovery_publications.html (last visited March 24, 2017).

ATTACHMENT A

VENTURA COASTKEEPER® 3875-A Telegraph Road #423, Ventura, California 93003
Phone (805) 658-1120 • Fax (805) 258-5135 • www.wishtoyo.org

August 30, 2010

Jeffrey Shu, State Water Resources Control Board
Division of Water Quality
P.O. Box 100
Sacramento, CA 95812-0100
VIA ELECTRONIC MAIL: jshu@waterboards.ca.gov

RE: **Region 4, Notice of Public Solicitation of Water Quality Data and Information for 2012 California Integrated Report [Clean Water Act Sections 305(b) and 303(d)]**

Dear Mr. Shu:

Wishtoyo Foundation's Ventura Coastkeeper Program (VCK), which represents over 700 Ventura County residents, appreciates the opportunity to submit water quality data and information for the 2012 California Integrated Report for Los Angeles Region 4 pursuant to Clean Water Act Sections 305(b) and 303(d).

VCK's Watershed Monitoring Program has conducted water quality monitoring throughout the Santa Clara River, Ormond Beach, Calleguas Creek, and Nicholas Canyon Creek watersheds from June 2009 to August 2010. After reviewing VCK's monitoring data collected and analyzed in accordance with VCK's Quality Assurance Project Plan (QAPP) approved by the Los Angeles Regional Water Quality Control Board, and after analyzing additional water quality parameters collected by local and state agencies, VCK requests that the following waterbodies[1] are incorporated into the 2012 California Integrated Report for the Los Angeles Region (Region 4) and added to the 2012 Clean Water Act 303(d) impaired waterbody list (List of Water Quality Limited Sections) for the following impairments:

1.) **Nicholas Canyon Creek**

[1] The locations and description of all waterbodies are included in the attached Wishtoyo Foundation's Ventura Coastkeeper Program's Watershed Monitoring Data Spreadsheet unless otherwise noted. VCK's watershed monitoring locations are part of VCK's watershed monitoring routes, and were chosen based on varying upstream land uses, accessibility, and the need for baseline and real time data to assess the water quality and ecological integrity of Ventura County's inland and coastal waterbodies, and to help pinpoint water quality impairments.

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a. **<u>Trash[2]:</u>** VCK's attached watershed monitoring program data indicates that on 5 out of 7 VCK monitoring events on Nicholas Canyon Creek downstream of PCH, the presence of trash pollution exceeded the numeric target for trash as derived in the Los Angeles River Trash TMDL.

2.) San Jon Barranca / Creek

a. **<u>Trash:</u>** VCK's attached watershed monitoring program data indicates that on 8 out of 8 VCK monitoring events on San Jon Barranca downstream of Harbor Boulevard , the presence of trash pollution in San Jon Barranca exceeded the numeric target for trash as derived in the Los Angeles River Trash TMDL.

b. **<u>E. Coli</u>**: VCK's attached watershed monitoring program data indicates that on 5 out of 8 VCK monitoring events on San Jon Barranca downstream of Harbor Boulevard, the presence of E. Coli exceeded the Water Quality Control Plan for the Los Angeles Region ("Basin Plan") single sample numeric water quality standard for E. Coli density of 235/100ml for Fresh Waters Designated for Water Contact Recreation (REC-1).

Pictured below, a child plays in the trash lined San Jon Barranca in the presence of E. Coli pollution.

[2] For monitoring of trash at all of VCK's watershed monitoring locations, if the length of the reach monitored for trash is not listed, trash was counted at the sampling location only.

3.) Ormond Beach Lagoon[3]

a. **<u>Trash:</u>** VCK's attached watershed monitoring program data indicates that on 9 out of 9 VCK monitoring events in the Ormond Beach Lagoon, the presence of trash pollution in the Ormond Beach Wetlands Lagoon exceeded the numeric target for trash as derived in the Los Angeles River Trash TMDL.

b. **<u>E. Coli</u>**: VCK's attached watershed monitoring program data indicates that on 6 out of 32 VCK monitoring events on the Ormond Beach Lagoon, the presence of E. Coli exceeded the Basin Plan single sample numeric water quality standard for E. Coli density of 235/100ml for Fresh Waters Designated for Water Contact Recreation (REC-1).

c. **<u>pH:</u>** VCK's attached watershed monitoring program data indicates that on 6 out of 8 VCK monitoring events in the Ormond Beach Wetlands Lagoon, pH levels in the Ormond Beach Wetlands Lagoon water column exceeded the Basin Plan single sample numeric water quality standard of 8.5 for Fresh Waters Designated for Water Contact Recreation (REC-1).

d. **<u>Nitrate</u>:** VCK's attached watershed monitoring program data indicates that on 11 out of 14 VCK monitoring events in the Ormond Beach Lagoon, the concentration of Nitrate in the Ormond Beach Wetland Lagoon water column exceeded the numeric targets for Nitrate at 1 mg/l as derived in the Los Angeles Regional Water Quality Control Board's Machado Lake TMDL[4] and the Nutrient TMDL for Malibu Creek, adopted by USEPA in 2003[5]. In addition, it should be noted that the USEPA guidance value for CWA section 304(a) nutrient criteria specific to the Los Angeles Region (Ecoregion III) is 0.38 mg/l total nitrogen and 0.022 mg/l total phosphorus for protection of aquatic life and recreation.[6]

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[3] Samping Locations OB-1, OB-5, OB-3(b), OB-4(b) are all 200 meters apart from one another.

[4] Resolution NO. R08-006, Amendment to the Water Quality Control Plan for the Los Angeles Region to Incorporate a Total Maximum Daily Load for Eutrophic, Algea, Ammonia, and Odors (Nutrient) for Machado Lake, California Regional Water Quality Control Board, Los Angeles Region. The Regional Board appropriately included a numeric target for total phosphorus of .1mg/l that was based of the EPA Nutrient Criteria Technical Guidance Manual Lakes and Reservoirs (2000), which does not recommend setting a numeric target for total phosphorus greater than 0.1 mg/L. Additionally, to maintain a balance of nutrients for biomass growth and prevent limitation by one nutrient or another, a ratio of total nitrogen to total phosphorus of 10 is used to derive the total nitrogen numeric target of 1.0 mg/L as a monthly average concentration (Thomann, Mueller, 1987)." (Regional Board Staff Report for Machado Lake TMDL at 35.)

[5] The Nutrient TMDL for Malibu Creek, adopted by USEPA in 2003, provides summer season water quality objectives of 1.0 mg/l total nitrogen and 0.1 mg/l total phosphorous. Other established nitrogen criteria for protection of aquatic life are significantly lower.

[6] See: USEPA, *Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion III* (2000) (EPA 822-B-00-016).

While, the Basin Plan's water quality objective for nitrogen is that "Waters shall not exceed 10 mg/l nitrogen as nitrate-nitrogen plus nitrite-nitrogen, 45 mg/l as nitrate, 10 mg/l as nitrate-nitrogen, or 1 mg/l as nitrite-nitrogen or as otherwise designated in Table 3-8," during the promulgation of the Machado Lake TMDL, the Regional Board determined that the Basin Plan's water quality objective for nitrogen as applied to aquatic life:

> "is not supportive of the narrative biostimulatory substance water quality objective. The nitrogen objective (10 mg/L) in the Basin Plan is based on criteria acceptable for drinking water and not appropriate to address eutrophic conditions in the lake. A review of available data and scientific literature demonstrates that the numeric objective of 10 mg/L for nitrogen is not sufficiently protective for controlling excessive algal/macrophyte growth and the symptoms of eutrophication in the lake. Therefore, the numeric target for total nitrogen will be more stringent than the existing numeric nitrogen objective in the Basin Plan to ensure attainment of the narrative biostimulatory substances water quality objective. The TMDL and its numeric targets must be developed to ensure protection of all the beneficial uses and attainment of nutrient related water quality objectives specified in the Basin Plan."[7]

The Regional Board Staff, in its 2008 update of the Los Angeles Regional Integrated Report for Clean Water Act Section 305(b) Report and Section 303(d) List of Impaired Waters, verified its determinations in their comment for the Machado Lake TMDL by stating:

> "The Basin Plan contains a specific nitrogen (nitrate nitrite) water quality objective, which is established at 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen. This objective is specifically set to protect drinking water beneficial uses and is consistent with the California Department Public Health nitrate drinking water standard. This nitrogen water quality objective does not protect waterbodies from impairments related to biostimulatory substances and eutrophication."

4.) Bubbling Springs

a. **<u>Trash:</u>** VCK's attached watershed monitoring program data indicates that on 9 out of 9 VCK monitoring events at Bubbling Springs, the presence of trash pollution in Bubbling Springs exceeded the numeric target for trash as derived in the Los Angeles River Trash TMDL

[7] Regional Board Staff Report for Machado Lake TMDL at 32, emphasis added.

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b. **E. Coli**: VCK's attached watershed monitoring program data indicates that on 5 out of 11 VCK monitoring events at Bubbling Springs, the presence of E. Coli exceeded the Basin Plan single sample numeric water quality standard for E. Coli density of 235/100ml for Fresh Waters Designated for Water Contact Recreation (REC-1).

5.) J-Street Drain[8]

a. **Trash:** VCK's attached watershed monitoring program data indicates that on 9 out of 9 VCK monitoring events at J St. Drain, the presence of trash pollution in the J. Street Drain exceeded the numeric target for trash as derived in the Los Angeles River Trash TMDL.

6.) Oxnard Industrial Drain (OID)[9]

a. **Trash:** VCK's attached watershed monitoring program data indicates that on 8 out of 8 VCK monitoring events at the OID, the presence of trash pollution in the OID exceeded the numeric target for trash as derived in the Los Angeles River Trash TMDL.

b. **E. Coli**: VCK's attached watershed monitoring program data indicates that on 5 out of 11 VCK monitoring events at the OID, the presence of E. Coli exceeded the Basin Plan single sample numeric water quality standard for E. Coli density of 235/100ml for Fresh Waters Designated for Water Contact Recreation (REC-1).

c. **pH:** VCK's attached watershed monitoring program data indicates that on 6 out of 7 VCK monitoring events in the OID, pH levels in the OID water column exceeded the Basin Plan single sample numeric water quality standard of 8.5 for Fresh Waters Designated for Water Contact Recreation (REC-1).

d. **Nitrate:** VCK's attached watershed monitoring program data indicates that on 8 out of 8 VCK monitoring events at the OID, the concentration of Nitrate in the OID water column exceeded the numeric targets for Nitrate at 1 mg/l as derived in the Los Angeles Regional Water Quality Control Board's Machado Lake TMDL[10] and the Nutrient TMDL for Malibu

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[8] J-Street Drain is visually depicted and labeled as an inland waterbody in Basin Plan Figure 2-1 :"Miscellaneous Streams and Coastal Features, Ventura County".

[9] The OID is visually depicted and labeled as an inland waterbody in Basin Plan Figure 2-1:"Miscellaneous Streams and Coastal Features, Ventura County".

[10] Resolution NO. R08-006, Amendment to the Water Quality Control Plan for the Los Angeles Region to Incorporate a Total Maximum Daily Load for Eutrophic, Algea, Ammonia, and Odors (Nutrient) for Machado Lake, California Regional Water Quality Control Board, Los Angeles Region. The Regional Board appropriately included a numeric target for total phosphorus of .1mg/l that was based of the EPA Nutrient Criteria Technical Guidance Manual Lakes and Reservoirs (2000), which does not recommend setting a numeric target for total phosphorus greater than 0.1 mg/L. Additionally, to maintain a balance of nutrients for biomass growth and prevent limitation by one nutrient or another, a ratio of total nitrogen to

Creek, adopted by USEPA in 2003[11]. In addition, it should be noted that the USEPA guidance value for CWA section 304(a) nutrient criteria specific to the Los Angeles Region (Ecoregion III) is 0.38 mg/l total nitrogen and 0.022 mg/l total phosphorus for protection of aquatic life and recreation.[12]

7.) Santa Clara River Estuary

a. **Trash:** VCK's attached watershed monitoring program data indicates that on 8 out of 8 VCK monitoring events at the Santa Clara River Estuary, the presence of trash pollution in the Santa Clara River Estuary exceeded the numeric target for trash as derived in the Los Angeles River Trash TMDL.

b. **Dissolved Oxygen:** The City of Ventura's Dissolved Oxygen recordings recorded for 24 hour periods by the City's North Sonde (SCR Sonde #1) and South Sonde (SCR Sonde #2)[13] stationed in the Santa Clara River Estuary, when converted to mg/l from % saturation based on additional water quality parameter recordings obtained by the City's sondes, violated the Basin Plan numeric water quality standard for Dissolved Oxygen of 5 mg/l for surface waters designated as WARM and 6mg/l for surface waters designated as COLD on over 40 days between 2009 and 2010.

c. **Nitrate:** VCK's attached watershed monitoring program data indicates that on 8 out of 10 VCK monitoring events at the Santa Clara River Estuary, the concentration of Nitrate in the Santa Clara River Estuary water column exceeded the numeric targets for Nitrate at 1 mg/l as derived in the Los Angeles Regional Water Quality Control Board's Machado Lake TMDL and the Nutrient TMDL for Malibu Creek, adopted by USEPA in 2003. In addition, it should be noted that the USEPA guidance value for CWA section 304(a) nutrient criteria specific to the Los Angeles Region (Ecoregion III) is 0.38 mg/l total nitrogen and 0.022 mg/l total phosphorus for protection of aquatic life and recreation.[14]

d. **Phosphate:** VCK's attached watershed monitoring program data indicates that on 10 out of 10 VCK monitoring events at the Santa Clara River Estuary, the concentration of Phosphate in the Santa Clara River Estuary water column exceeded the numeric targets for Phosphate at .1 mg/l as

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total phosphorus of 10 is used to derive the total nitrogen numeric target of 1.0 mg/L as a monthly average concentration (Thomann, Mueller, 1987)." (Regional Board Staff Report for Machado Lake TMDL at 35.)

[11] The Nutrient TMDL for Malibu Creek, adopted by USEPA in 2003, provides summer season water quality objectives of 1.0 mg/l total nitrogen and 0.1 mg/l total phosphorous. Other established nitrogen criteria for protection of aquatic life are significantly lower.

[12] See: USEPA, *Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion III* (2000) (EPA 822-B-00-016).

[13] Data from City of Ventura included in email and attachments Labeled: City of Ventura Data

[14] See: USEPA, *Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion III* (2000) (EPA 822-B-00-016).

derived in the Los Angeles Regional Water Quality Control Board's Machado Lake TMDL and the Nutrient TMDL for Malibu Creek, adopted by USEPA in 2003. In addition, it should be noted that the USEPA guidance value for CWA section 304(a) nutrient criteria specific to the Los Angeles Region (Ecoregion III) is 0.38 mg/l total nitrogen and 0.022 mg/l total phosphorus for protection of aquatic life and recreation.[15]

e. **pH:** VCK's attached watershed monitoring program data indicates that on 2 VCK monitoring events, and on greater than 60 City of Ventura[16] pH recordings taken on separate days in the Santa Clara River Estuary via the City's North and South Sondes, pH levels in the Santa Clara River Estuary water column exceeded the Basin Plan single sample numeric water quality standard of 8.5 for Fresh Waters Designated for Water Contact Recreation (REC-1).

f. **Low Flows:** As discussed in the City of Ventura Estuary Special Studies One Year Assessment (attached) and the July 23, 2008, National Marine Fisheries Service, Southwest Region Final Biological Opinion (BIOP) concerning the operation of the Vern Freeman Diversion and Fish-Passage Facility (attached), due to diversions at the Vern Freeman Diversion Dam by United Water Conservation District, the Santa Clara River Estuary, Santa Clara River Reach 1, and Santa Clara River Reach 2 are deprived of sufficient flows during the wet season for Southern California Steelhead smolt and migrating adults to migrate up and down the Santa Clara River, and the Estuary does not receive sufficient flows during the dry season when the Estuary is closed as a lagoon to sustain aquatic life. Additionally, flow data indicates that reduced flows below the Vern Freeman Diversion Dam alters the natural flow regime needed to sustain aquatic life and vegetation that evolved with the River's natural flows. Attached daily flow data obtained from United Water Conservation District from 1993-2010, and monthly flow dating back to the 1956, above and below the Vern Freeman Diversion Dam, with the quantity of flows diverted by United included, demonstrates the flow impairments in the Santa Clara River Estuary, Santa Clara River Reach 1, and Santa Clara River Reach 2.

8.) Santa Clara River Reach 1

a. **Low Flows:** As discussed in the City of Ventura Estuary Special Studies One Year Assessment (attached) and the July 23, 2008, National Marine Fisheries Service, Southwest Region Final Biological Opinion (BIOP) concerning the operation of the Vern Freeman Diversion and Fish-Passage Facility (attached), due to diversions at the Vern Freeman Diversion Dam by United Water Conservation District, the Santa Clara River Estuary,

[15] See: USEPA, *Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion III* (2000) (EPA 822-B-00-016).

[16] Data from City of Ventura included in email and attachments Labeled: City of Ventura Data

Santa Clara River Reach 1, and Santa Clara River Reach 2 are deprived of sufficient flows during the wet season for Southern California Steelhead smolt and migrating adults to migrate up and down the Santa Clara River, and the Estuary does not receive sufficient flows during the dry season when the Estuary is closed as a lagoon to sustain aquatic life. Additionally, flow data indicates that reduced flows below the Vern Freeman Diversion Dam alters the natural flow regime needed to sustain aquatic life and vegetation that evolved with the River's natural flows. Attached daily flow data obtained from United Water Conservation District from 1993-2010, and monthly flow dating back to the 1956, above and below the Vern Freeman Diversion Dam, with the quantity of flows diverted by United included, demonstrates the flow impairments in the Santa Clara River Estuary, Santa Clara River Reach 1, and Santa Clara River Reach 2. Additionally, VCK attached watershed monitoring program data indicates no flow or trickle flow in the Santa Clara River at SC-02 below Highway 101, which would other wise be of greater magnitude or sufficient magnitude to support aquatic life absent a diversion at the Vern Freeman Diversion Dam.

b. **Trash:** VCK's attached watershed monitoring program data indicates that on 9 out of 9 VCK monitoring events at Santa Clara Reach 1, the presence of trash pollution in the Santa Clara River Reach 1 exceeded the numeric target for trash as derived in the Los Angeles River Trash TMDL.

9.) Santa Clara River Reach 2

a. **Low Flows:** As discussed in the City of Ventura Estuary Special Studies One Year Assessment (attached) and the July 23, 2008, National Marine Fisheries Service, Southwest Region Final Biological Opinion (BIOP) concerning the operation of the Vern Freeman Diversion and Fish-Passage Facility (attached), due to diversions at the Vern Freeman Diversion Dam by United Water Conservation District, the Santa Clara River Estuary, Santa Clara River Reach 1, and Santa Clara River Reach 2 are deprived of sufficient flows during the wet season for Southern California Steelhead smolt and migrating adults to migrate up and down the Santa Clara River, and the Estuary does not receive sufficient flows during the dry season when the Estuary is closed as a lagoon to sustain aquatic life. Additionally, flow data indicates that reduced flows below the Vern Freeman Diversion Dam alters the natural flow regime needed to sustain aquatic life and vegetation that evolved with the River's natural flows. Attached daily flow data obtained from United Water Conservation District from 1993-2010, and monthly flow dating back to the 1956, above and below the Vern Freeman Diversion Dam, with the quantity of flows diverted by United included, demonstrates the flow impairments in the Santa Clara River Estuary, Santa Clara River Reach 1, and Santa Clara River Reach 2.

b. **<u>Fish Passage:</u>** As discussed in the July 23, 2008, National Marine Fisheries Service, Southwest Region Final Biological Opinion (BIOP) concerning the operation of the Vern Freeman Diversion and Fish-Passage Facility (attached), the Vern Freeman Diversion Dam with its current fish ladder are a fish barrier to migrating Southern California Steelhead in Santa Clara River Reach 2 and 3.

10.) Santa Clara River Reach 3

a. **<u>E. Coli</u>**: VCK's attached watershed monitoring program data indicates that on 5 out of 27 VCK monitoring events at Santa Clara River Reach 3 on the Santa Clara River below the Santa Paula Creek confluence, on the Santa Clara River below the Sespe Creek Confluence, and on the lower segments of Sespe Creek and Santa Paula Creek, the presence of E. Coli in the water column of these waterbodies exceeded the Basin Plan single sample numeric water quality standard for E. Coli density of 235/100ml for Fresh Waters Designated for Water Contact Recreation (REC-1). Additionally, water monitoring on 11/26/08, 12/15/08, 2/6/2009, and 3/5/2009 at ME-SCR (attached), the mass emissions station sampling station operated by the Ventura County Watershed Protection District just above the Vern Freeman Diversion Dam, indicated E.Coli concentrations of 820/100ml, 4884/100ml, 12033/100ml, and 3873/100ml respectively (attached). All of these samples exceeding Basin Plan numeric water quality standards were taken by the county during wet weather events (see Ventura Annual Stormwater Report Appendix F starting at PDF pg 108).

b. **<u>Trash:</u>** VCK's attached watershed monitoring program data indicates that on 26 out of 31 VCK monitoring events at the Santa Clara River Reach 3 on the Santa Clara River below the Santa Paula Creek confluence, on the Santa Clara River below the Sespe Creek confluence, and on the lower segments of Sespe Creek and Santa Paula Creek, the presence of trash pollution in these waterbodies exceeded the numeric target for trash as derived in the Los Angeles River Trash TMDL.

c. **<u>Fish Passage:</u>** As discussed in the July 23, 2008, National Marine Fisheries Service, Southwest Region Final Biological Opinion (BIOP) concerning the operation of the Vern Freeman Diversion and Fish-Passage Facility (attached), the Vern Freeman Diversion Dam with its current fish ladder are a fish barrier to migrating Southern California Steelhead in Santa Clara River Reach 2 and 3.

11.) Santa Clara River Reach 4a

a. **<u>Trash:</u>** VCK's attached watershed monitoring program data indicates that on 7 out of 8 VCK monitoring events in the Santa Clara River Reach 4 below the Santa Clara River's confluence with Piru Creek, the presence of trash pollution exceeded the numeric target for trash in Santa Clara Reach 4 as derived in the Los Angeles River Trash TMDL.

12.) Santa Clara River Reach 5 or 6

a. **Trash:** VCK's attached watershed monitoring program data indicates that on 5out of 7 VCK monitoring events at the Santa Clara River Reach 5 or 6 in Santa Clarita (see attached long lat coordinates), the presence of trash pollution exceeded the numeric target for trash in Santa Clara River Reach 5 or 6 as derived in the Los Angeles River Trash TMDL.

Thank you for considering our data and agency data, and the incorporation of the above mentioned waterbodies as impaired for the above specified constituents into the 2012 California Integrated Report as Clean Water Act 303(d) impaired waterbodies. The ecological integrity and water quality of Ventura County's inland and coastal waterbodies would benefit greatly from these 303(d) listings for all of our communities.

Please feel free to contact us with any questions.

Sincerely,

Jason Weiner, M.E.M.
Associate Director & Staff Attorney
Ventura Coastkeeper
jweiner.venturacoastkeeper@wishtoyo.org
805-823-3301

Wishtoyo

ATTACHMENT B

These are the listings VCK specifically asked for listing in VCK's submission letter dated 8/30/2010
Date: March 23, 2017

Reach	**Pollutant**	**Data Source**	**RB Action**
Nicholas Canyon Creek (San Nicolas Canyon Ck)	Trash	VCK data	Data not assessed (5/7)
San Jon Barranca Creek (Sanjon Barranca Creek)	Trash	VCK data	Data not assessed (8/8)
	E coli	VCK data	Data not assessed (5/8)
Ormond Beach Lagoon (Ormond Beach Wetlands)	Trash	VCK data	Data not assessed (9/9)
	E coli	VCK data	**Do Not Delist (DI 42278) Data is not assessed.**
	pH (>8.5)	VCK data	Data not assessed (6/8)
	Nitrate(>1 mg/L or >10 mg/L)	VCK data	Data not assessed (VKC (11/14), RB(0/10))
Bubbling Springs (Hueneme Drain)	Trash	VCK data	Data not assessed (9/9)
	E coli	VCK data	Data not assessed (5/11)
J Street Drain	Trash	VCK data	List (DI 63443)
Oxnard Industrial Drain (Oxnard Drain)	Trash	VCK data	Data not assessed (8/8)
	Ecoli	VCK data	Data not assessed (VKC(5/11), RB(3/7))
	pH (>8.5)	VCK data	Data not assessed (VKC(6/7), RB(5/7)) **Do Not List (DI62330) Data is not assessed.**
	Nitrate(>1 mg/L or >10 mg/L)	VCK data	Data not assessed (VKC (8/8), RB(3/8))
Santa Clara River Estuary	Trash	VCK data	**Do Not List (DI66592) Data (2009) is used** Data not assessed (8/8)
	DO	City of Ventura Sonde data	**Do Not List (DI66590)** Problems QAQC
	Nitrate	VCK data	**List (DI35380)** Data not assessed (8/10)
	Phosphate	VCK data	Data not assessed (10/10)
	pH	VCK data	**List (DI66591)** Data not assessed
	Low flows	City of Ventura estuary special study	Flow, see below
Santa Clara Reach 1	Low flows	City of Ventura estuary special study	Flow, see below
	Trash	VCK data	**List (DI66631)**

			Data not assessed (9/9)
Santa Clara Reach 2	Low flows	City of Ventura estuary special study	Flow, see below
	Fish passage	NMFS BO	Flow, see below
Santa Clara Reach 3	E coli	VCK data	Data not assessed (5/27)
	Trash	VCK data	Data not assessed (26/31)
	Fish passage	NMFS BO	Flow, see below
Santa Clara Reach 4a	Trash	VCK data	Data not assessed (7/8)
Santa Clara Reach 5or6	Trash	VCK data	Data not assessed (5/7)

FRANK V. ZERUNYAN
Mayor
BRITT HUFF
Mayor Pro Tem
JUDY MITCHELL
Council Member
VELVETH SCHMITZ
Council Member
STEVEN ZUCKERMAN
Council Member
DOUGLAS R. PRICHARD
City Manager

CITY OF
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March 27, 2017

Samuel Unger, P.E., Executive Officer
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013
Via email: losangeles@waterboards.ca.gov

Attn: Jun Zhu, Environmental Scientist (jzhu@waterboards.ca.gov)

Subject: Comment Letter—Revisions to the Los Angeles Region 303(d) list

Dear Mr. Unger:

On February 8, 2017, the Los Angeles Regional Water Quality Control Board (Regional Board) issued a 30-day Notice of Public Hearing and Opportunity to Comment on the Proposed Revisions to the Clean Water Act Section 303(d) List for the Los Angeles Region and the 2016 Integrated Report. On February 24, 2017, the Regional Board issued a Notice of Extension of Comment Deadline with a revised comment deadline of March 30, 2017 and the public hearing scheduled for May 4, 2017. The City of Rolling Hills Estates respectfully submits the attached pollutant/water body-specific comments on the proposed revisions to the 2016 Section 303(d) and 305(b) Integrated Report for consideration by the Regional Board.

The City is pleased that that Palos Verdes Peninsula beaches are being proposed for delisting for indicator bacteria. This is also consistent with Regional Board Resolution No. 2006-008 reviewing the Implementation Plan submitted by Jurisdictional Group 7 for the Santa Monica Bay Beaches Bacteria Wet Weather TMDL which noted that "Palos Verdes Peninsula have had historically fewer exceedances than the reference beach". and " . . . existing water quality is equivalent to compliance with the Santa Monica Bay Beaches Wet Weather TMDL."[1]

Thank you for your consideration of our comments.

Sincerely,

Greg Grammer
Assistant City Manager

Attachment
Copies: Dr. L.B. Nye (LB.Nye@waterboards.ca.gov)

[1] California Regional Water Quality Control Board – Los Angeles Region, Resolution No. 2006-008

City of Rolling Hills Estates Comments on Proposed Revisions to 303(d) List

Water Body/Pollutant	Comment	Recommendation
Los Angeles-Long Beach Inner Harbor/Zinc	We are in agreement with Decision ID 33644 LARWCB staff recommendation to delist the water body both due to flaws in the original listing and because applicable water quality standards are not being exceeded this recommendation, however Appendix A does not reflect this proposed change.	Add a "Y" in the New Delistings column in Appendix A for Zinc in Los Angeles-Long Beach Inner Harbor.
Wilmington Drain/Lead	We are in agreement with Appendix G Decision ID 35085 to delist the Wilmington Drain for lead based on the weight of evidence. Additionally, the weight of evidence is stronger than indicated because data was included in this fact sheet from Compton Creek. LOE 90133 included in Fact Sheet 35085 describes data collected in Compton Creek which is unrelated to the Wilmington Drain.	Remove LOE 90133 from Fact Sheet 35085 and revise the supporting evidence statement to the Regional Board Staff Conclusion to state that "0 of 33 samples exceeded the CRITERIA."
Wilmington Drain/Copper	The Appendix G Decision ID 44676 regarding copper in Wilmington Drain includes a data set that should not have been included: LOE ID 90473 describes data collected in Compton Creek which is unrelated to Wilmington Drain. Removal of this data set from Decision ID 44676 would still leave LOE ID 90131 which is described as 33 samples, only two (2) of which exceeded the criteria for copper. This revised data set now meets the SWRCB Delisting criteria because the number of exceedances is 2 or less in a data set size of 28-36 samples.	Remove LOE ID data set 90473 from Decision ID 44676 and revise the recommendation to Delist from 303(d) List.
Machado Lake/Algae, Ammonia, ChemA, Eutrophic, Odor, Trash	These listings for Machado Lake are included in Appendix B Category 5 (a water segment where standards are not met and a TMDL is required but not yet completed) however all of these	These listings should be moved to Category 4a in Appendix C. An explanation that "TMDL status changed from TMDL still required to Being Addressed by Completed TMDL" should be

Water Body/Pollutant	Comment	Recommendation
	pollutant listings are being addressed by USEPA-approved TMDLs.	included in Appendix A under the "Other Revisions" column for each of these pollutants in Machado Lake.
Los Angeles-Long Beach Outer Harbor (inside breakwater)/DDT, PCBs and Toxicity; Los Angeles Harbor Inner Cabrillo Beach/DDT, PCBs; San Pedro Bay Near-Off Shore/Chlordane, PCBs, Total DDT, and Toxicity	These are included in Appendix B Category 5 (a water segment where standards are not met and a TMDL is required but not yet completed) however all of these listings are being addressed by the USEPA approved TMDL for Dominguez Channel and Greater Los Angeles and Long Beach Harbors. These changes are explained in Appendix A summary under "other revisions".	These listings for DDT, PCBs and Toxicity should be moved to Category 4a in Appendix C.
San Pedro Bay Near-Off Shore Zones/Zinc	Appendix G Decision ID 42798 to Delist San Pedro Bay Near/Off Shore Zones for Zinc because applicable water quality standards are not being exceeded. This recommendation is not reflected in Appendix A summary of recommended changes.	Insert a "Y" in the New Delistings column of Appendix A for San Pedro Bay Near/Off Shore Zones for zinc.
San Pedro Bay Near-Off Shore Zones/Chromium	Appendix G Decision ID 42525 restates and does not revise the original recommendation to delist San Pedro Bay Near/Off Shore Zones for Chromium, however delisting does not seem to have occurred since the pollutant-waterbody combination still appears in Appendix A.	Insert a "Y" in the New Delistings column of Appendix A for San Pedro Bay Near/Off Shore Zones for PAHs and remove the "Y" from the Pollutant Name Changes column since there does not appear to have been any name change made for this pollutant.
San Pedro Bay Near-Off Shore Zones/Copper	Appendix G Decision ID 44434 to Delist San Pedro Bay Near/Off Shore Zones for Copper based on flaws in the original listing. This recommendation is not reflected in Appendix A summary of recommended changes.	Insert a "Y" in the New Delistings column of Appendix A for San Pedro Bay Near/Off Shore Zones for copper.
San Pedro Bay Near-Off Shore Zones/Polycyclic Aromatic Hydrocarbons (PAHs)	Appendix G Decision ID 43259 to Delist San Pedro Bay Near/Off Shore Zones for PAHs because applicable water quality standards are not being exceeded. This recommendation is not	Insert a "Y" in the New Delistings column of Appendix A for San Pedro Bay Near/Off Shore Zones for PAHs.

Water Body/Pollutant	Comment	Recommendation
	reflected in Appendix A summary of recommended changes.	
Santa Monica Bay Offshore-Nearshore/Chordane	The revised Appendix G Fact Sheet associated with Decision ID 37492 recommending delisting Santa Monica Bay Offshore-Nearshore waters for chlordane is not reflected in the Appendix A summary of recommended changes.	Revise Appendix A to place a "Y" in the New Delisting column for Santa Monica Bay Offshore/Nearshore line for Chlordane.
Santa Monica Bay Offshore-Nearshore/Polycyclic Aromatic Hydrocarbons (PAHs)	The revised Appendix G Fact Sheet associated with Decision ID 32656 recommending delisting Santa Monica Bay Offshore-Nearshore waters for PAHs is not reflected in the Appendix A summary of recommended changes.	Revise Appendix A to place a "Y" in the New Delisting column for Santa Monica Bay Offshore/Nearshore line for PAHs.
Santa Monica Bay Offshore-Nearshore/Arsenic	Santa Monica Bay Offshore-Nearshore areas are being proposed for listing for Arsenic based on sampling conducted for the City of Los Angeles Hyperion Wastewater Treatment Plant NPDES Permit. Samples were collected during August 2006, October and November 2007, and August through September of 2007 from nearfield and from Zones 4 & 5—these sampling areas are north of Redondo Beach Pier.	This listing should be narrowed in geographic scope and should exclude Offshore-Nearshore waters of the Palos Verdes Peninsula because the data supporting the listing is not spatially representative of the Palos Verdes Peninsula waters since there is little to no influence from the Hyperion Wastewater Treatment Plant discharge on these waters. The fact sheet (Decision ID 67208) should be revised to discuss the spatial extent of this listing in relation to the data supporting the listing and to exclude areas south of Redondo Beach Pier which are outside of Zones 4 and 5.
Santa Monica Bay Offshore-Nearshore/Mercury	Santa Monica Bay Offshore-Nearshore areas are being proposed for listing for Mercury based on sampling conducted for the City of Los Angeles Hyperion Wastewater Treatment Plant NPDES Permit. Samples were collected during August 2006, October and November 2007, and August through September of 2007 from nearfield and from Zones 4 & 5.	This listing should be narrowed in geographic scope and should exclude Offshore-Nearshore waters of the Palos Verdes Peninsula because the data supporting the listing is not spatially representative of the Palos Verdes Peninsula waters since there is little to no influence from the Hyperion Wastewater Treatment Plant discharge on these waters. The fact sheet should

Water Body/Pollutant	Comment	Recommendation
		be revised to (Decision ID 67209) discuss the spatial extent of this listing in relation to the data supporting the listing and to exclude areas south of Redondo Beach Pier which are outside of Zones 4 and 5.

City of Rosemead

8838 E. VALLEY BOULEVARD P.O BOX 399
ROSEMEAD, CALIFORNIA 91770
TELEPHONE (626) 569-2100
FAX (626) 307-9218

March 28, 2017

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Email: losangeles@waterboards.ca.gov

Subject: Comment Letter – Revisions to the Los Angeles Region (303(d))

Dear Mr. Zhu:

The City of Rosemead (City) is pleased to submit for your consideration the attached comments regarding the Regional Board's propose 2016 303(d) list revisions.

We note significant changes to this list, they include: Rosemead is located in Reach 3 of the Rio Hondo (R3-RH), upstream of the spreading grounds and Whittier Narrows Dam. According to the 2016 303(d) list, all of the metals subject to the Los Angeles River Metals TMDL have been placed on the "**do not list**" for Rio Hondo. This validates the 2010 303(d) list, which did not list any of the metals for R3-RH.

This is good news for our City and once the Los Angeles Basin Plan is amended, Rosemead's MS4 Permit compliance burden will be significantly reduced.

In closing, the City of Rosemead appreciates the opportunity to comment on this matter. Should you have questions or require additional information, please do not hesitate to contact me.

Sincerely,

Kathy Garcia
Director of Public Works
City of Rosemead
(626) 569-2118

cc: Bill R. Manis, City Manager
Rafael Fajardo, City Engineer

I. Summary

The 2016 303(d) revisions for the several reaches (water quality segments) of the Los Angeles River and tributaries[1] propose to ***de-list***, ***do not de-list***, and ***do not list*** metals-related pollutants including copper, lead, selenium and zinc. These pollutants are the subject of the *Total Maximum Daily Loads for Metals for the Los Angeles River (LAR-TMDL)* adopted by Regional Board in 2007. This TMDL has been incorporated into the current Los Angeles County MS4 Permit MS4 Permit (MS4 Permit). The MS4 Permit enables compliance with TMDL waste load allocations (WLAs) -- also referred to as numeric targets. The numeric targets are translated into water quality based effluent limitations (WQBELs) which are applied to MS4 outfall discharges and to receiving waters as limitations. To comply with both, the MS4 Permit coercively encourages compliance through Watershed Management Programs (E/WMPs).

Although many metals have either been placed on the "de-list" and "do not list" categories for Los Angeles River water quality segments, many also have been placed on the "list" and do not de-list categories. Nevertheless, these listings should be voided because:

1. although the LAR-MTMDL claims to have developed water quality standards (includes TMDLs) in accordance with the federal California Toxic Rule (CTR) adopted in 2000, it actually has not; and

2. the LAR-MTMDL is based on water quality samples that were conducted before the Water *Quality Control Policy for California's Clean Water Act Section 303(d) List* (Listing Policy), which was adopted in 2004.

- **California Toxic Rule**

CTR was adopted to provide a mathematical method for establishing ambient (dry weather) water quality standards for toxics necessary to protect beneficial uses of receiving waters. The LAR-MTMDL, however, along with other TMDLs, does not comply with CTR in two significant respects.

First, the TMDL calculates numeric water quality standards/TMDLs for both wet weather and ambient receiving water conditions instead of only on ambient. The LAR-TMDL misinterprets CTR here by claiming that EPA did not differentiate between wet and dry weather conditions when establishing metals and toxics limitations. There is nothing in CTR that supports that view. CTR makes it clear that its purpose is to establish ambient water quality standards: *This final rule establishes ambient water quality for priority toxic pollutants.* USEPA defines ambient as:

[1]Includes but is not limited to the Estuary (Queens Bay); Los Angeles/Long Beach Harbor, Estuary to Reach 1, Reaches 2, 3, 4, 5, and 6; Alhambra Wash, Arroyo Seco, Reaches 1 and 2 (tributaries); Compton Creek (tributary); Monrovia Canyon, Rio Hondo Reach 1; Reach 1 (tributary); Sawpit Wash, and Tujunga Wash.

Natural concentration of water quality constituents prior to mixing of either point or nonpoint source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact to human health.

In other words, ambient is the normal reference condition of a receiving water. This is also the clear understanding of the Regional Board's Surface Water Ambient Monitoring Program (SWAMP). MS4 and other point source stormwater (wet weather) outfall discharges, using sampling and analysis results, are measured against the ambient target for a pollutant established by CTR. For example, suppose a copper limitation is set at 37 micrograms per liter for a given water body. This limit is required to protect fish. Persistent exceedances of the limit based on outfall monitoring would necessitate a revision to the MS4 Permittee's stormwater management program.

Second, CTR requires a hardness parameter (calcium carbonate) to make chemical water quality analysis of toxics more accurate. Generally, the higher the hardness value the higher the toxic pollutant expressed as a numeric limit. The LAR-MTMDL calculates CTR for toxics using a hardness value of 100 milligrams per liter (mg/l). It contends that this is the hardness value required by CTR. This is false. CTR requires actual hardness to be determined by water quality sampling and analysis at the same time a toxic pollutant is sampled. The Regional Board's SWAMP abides by this requirement. Therefore, the LAR-MTMDL establishes limitations for metals and toxics that are more stringent than necessary. This provides another reason for voiding the LAR-TMDL and revising it with a recalculated limitation for each metal by using an actual hardness value based on ambient water quality sampling and analysis.

- **California 303(d) Listing Policy (Listing Policy)**

The Listing Policy was adopted to provide a statistical method to determine how many water quality samples that exceed a water quality standard are required to place a pollutant on a 303(d). That method is a binomial distribution based on the rejection of a null hypothesis measured against sample sizes (see attachment #1). A review of the 2016 303(d) list fact sheets reveals that the metals placed on previous 303(d) lists did not conform to the Listing Policy. In fact, the LAR-MTMDL is based on water quality data that was developed prior to the adoption of the Listing Policy in 2004. According to the LAR-MTMDL, the metals numeric targets were based on data that was limited to 2002. Based on this fact alone the LAR-MTMDL should be voided.

MS4 Permittees located in Reach 2 of the Rio Hondo will be pleased to know that the 2016 303(d) list does not propose to list it for any of the metals covered by the LAR-MTDL. This makes sense given that this reach was not listed for metals impairment on the 2010 303(d) list. Further, LAR-MTMDL makes no mention of Reach 2 of the Rio Hondo. As result, the following cities should not be subject to this TMDL: Alhambra (partially); Arcadia; Bradbury; Duarte; El Monte; Irwindale (partially); Montebello (partially); Monterey Park; Pasadena (partially); Rosemead; San Gabriel; San Marino; South El Monte; Irwindale (partially); and South Pasadena (partially).

However, it is noted that Reaches 1 and 2 of the Arroyo Seco was not placed on the "do not list" for metals. It should have been for the same reason Reach 2 of the Rio Hondo was. Neither Reach 1 nor Reach 2 of the Arroyo Seco appears on the 2010, 2006, or 2002 303(d) list for metals. The Regional Board may wish to update the 2016 303(d) list to place the Arroyo Seco on the "do not list" category.

Attachment #1

TABLE 3.1: MINIMUM NUMBER OF MEASURED EXCEEDANCES NEEDED TO PLACE A WATER SEGMENT ON THE SECTION 303(D) LIST FOR TOXICANTS. *Null Hypothesis: Actual exceedance proportion < 3 percent. Alternate Hypothesis: Actual exceedance proportion > 18 percent. The minimum effect size is 15 percent.*	
Sample Size	List if the number of exceedances equal or is greater than
2 – 24	2*
25– 36	3
37– 47	4
48– 59	5
60– 71	6
72– 82	7
83– 94	8
95– 106	9
107– 117	10
118– 129	11

*Application of the binomial test requires a minimum sample size of 16. The number of exceedances required using the binomial test at a sample size of 16 is extended to smaller sample sizes.

For sample sizes greater than 129, the minimum number of measured exceedances is established where α and f3 < 0.2 and where $|\alpha - f3|$ is minimized.

α = Excel® Function BINOMDIST(n-k, n, 1 – 0.03, TRUE)
f3 = Excel® Function BINOMDIST(k-1, n, 0.18, TRUE)
where n = the number of samples,
k = minimum number of measured exceedances to place a water on the section 303(d) list,
0.03 = acceptable exceedance proportion, and
0.18 = unacceptable exceedance proportion

City of Compton
Public Works/Municipal Utilities
205 South Willowbrook Avenue
Compton, CA 90220

Office: (310) 605-5505
Fax: (310) 605-6326

Jun Zhu
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th St. Suite 200
Los Angeles, CA 90013

RE: SWMP/I-WMP Submittal

Dear Mr. Zhu:

The **City of Compton** is pleased to submit for your consideration the attached comments regarding the Regional Board's proposed 2016 303(d) list revisions.

We note that the Regional Board has proposed excluding many metals (copper, lead, selenium, and zinc. This is good news for the City. Once the Los Angeles Basin Plan is amended, the City's MS4 Permit compliance burden will be significantly reduced.

In closing, the City appreciates the opportunity to comment on this matter. Should you have questions are require additional information please do not hesitate to contact me.

Sincerely,

Glen W. C. Kau
Director of Public Works

Cc: Cecil Rhambo, City Manager
Craig Cornwell, City Attorney
Hien Nguyen, Asst. City Engineer
Ray Tahir, TECS Environmental

City of Compton Comments In Re: Los Angeles Regional Board's Proposed 2016 303(d) List Revisions Affecting Los Angeles River Metals

I. Summary

The 2016 303(d) revisions for the several reaches (water quality segments) of the Los Angeles River and tributaries[1] propose to ***de-list***, ***do not de-list***, and ***do not list*** metals-related pollutants including copper, lead, selenium and zinc. These pollutants are the subject of the *Total Maximum Daily Loads for Metals for the Los Angeles River (LAR-MTMDL)* adopted by Regional Board in 2007. This TMDL has been incorporated into the current Los Angeles County MS4 Permit MS4 Permit (MS4 Permit). The MS4 Permit enables compliance with TMDL waste load allocations (WLAs) -- also referred to as numeric targets. The numeric targets are translated into water quality based effluent limitations (WQBELs) which are applied to MS4 outfall discharges and to receiving waters as limitations. To comply with both, the MS4 Permit coercively encourages compliance through Watershed Management Programs (E WMPs).

Although many metals have either been placed on the "de-list" or "do not list" categories for Los Angeles River water quality segments, many also have been placed on the "list" and do not de-list categories. These listings should be voided because:

1. Although the LAR-MTMDL claims to have developed water quality standards (includes TMDLs) in accordance with the federal California Toxic Rule (CTR) adopted in 2000, it actually has not; and

2. The LAR-MTMDL is based on water quality samples that were conducted before the *Water Quality Control Policy for California's Clean Water Act Section 303(d) List* (Listing Policy), which was adopted in 2004.

- **California Toxic Rule**

CTR was adopted to provide a mathematical method for establishing ambient (dry weather) water quality standards for toxics necessary to protect beneficial uses of receiving waters. The LAR-MTMDL, however, along with other TMDLs, does not comply with CTR in two significant respects.

First, the TMDL calculates numeric water quality standards TMDLs for both wet weather and ambient receiving water conditions instead of only on ambient. The LAR-MTMDL misinterprets CTR by claiming EPA did not differentiate between wet and dry weather conditions when establishing metals and toxics limitations. There is nothing in CTR that supports that view. CTR makes it clear that its purpose is to establish ambient water

[1]Includes but is not limited to the Estuary (Queens Bay); Los Angeles/Long Beach Harbor, Estuary to Reach 1, Reaches 2, 3, 4, 5, and 6; Alhambra Wash, Arroyo Seco, Reaches 1 and 2 (tributaries); Compton Creek (tributary); Monrovia Canyon, Rio Hondo Reach 1; Reach 1 (tributary); Sawpit Wash, and Tujunga Wash.

quality standards: *This final rule establishes ambient water quality for priority toxic pollutants.* USEPA defines ambient as:

> *Natural concentration of water quality constituents prior to mixing of either point or nonpoint source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact to human health.*

In other words, ambient is the normal reference condition of a receiving water. This is also the clear understanding of the Regional Board's Surface Water Ambient Monitoring Program (SWAMP). MS4 and other point source stormwater (wet weather) outfall discharges, using sampling and analysis results, are measured against the ambient target for a pollutant established by CTR. For example, suppose a copper limitation is set at 37 micrograms per liter for a given water body. This limit is required to protect fish. Persistent exceedances of the limit based on outfall monitoring would necessitate a revision to the MS4 Permittee's stormwater management program.

Second, CTR requires a hardness parameter (calcium carbonate) to make chemical water quality analysis of toxics more accurate. Generally, the higher the hardness value the higher the toxic pollutant expressed as a numeric limit. The LAR-MTMDL calculates CTR for metals/toxics using a hardness value of 100 milligrams per liter (mg/l). It contends that this is the hardness value required by CTR. This is false. CTR requires actual hardness to be determined by water quality sampling and analysis at the same time a toxic pollutant is sampled. The Regional Board's SWAMP abides by this requirement. Therefore, the LAR-MTMDL establishes limitations for metals and toxics that are more stringent than necessary. This provides another reason for voiding the LAR-MTMDL and revising it with a recalculated limitation for each metal by using an actual hardness value based on future ambient water quality sampling and analysis.

- **California 303(d) Listing Policy (Listing Policy)**

The Listing Policy was adopted to provide a statistical method to determine how many water quality samples that exceed a water quality standard are required to place a pollutant on the 303(d) list. That method is a binomial distribution based on the rejection of a null hypothesis measured against sample sizes (see attachment #1). A review of the 2016 303(d) list fact sheets reveals that the metals placed on previous 303(d) lists did not conform to the Listing Policy. In fact, the LAR-MTMDL is based on water quality data that was developed prior to the adoption of the Listing Policy in 2004. According to the LAR-MTMDL, the metals numeric targets were based on data that was limited to 2002. Based on this fact alone the LAR-MTMDL should be voided.

II. Los Angeles River Reach/Tributary Specific Comments

Presented below are specific justifications for removing metals that fall under either the "list" or "do not list" categories because they do not conform to CTR or the Listing Policy. Almost all of them fall into these categories.

1. **Compton Creek**

Of the 4 subject LAR-MTMDL metals, the 2016 303(d) list only places selenium on the "do not list" for the Creek.

According to the fact sheet, copper is placed on the "do not de-list" based on 1 of 15 samples that exceeded dissolved copper. This result, however, does not meet the 3.1 Listing Policy's binomial test requirement. The policy explains that the application of the binomial test requires a minimum sample size between 2 and 24, with at least 2 exceedances required for 303(d) listing placement. But, the Listing Policy also mentions that a sample size less than 16 is insufficient to meet the listing test.

Lead is also placed under the "do not de-list" category. This appears to be in error. According to the fact sheet, *1 of 15 samples and 0 of 3 samples exceeded the criteria for this sample size to determine the applicable beneficial use.* However, 1 exceedance out of 15 and 0 out of 3 samples do not meet the Listing Policy for 303(d) list placement. Not only is the exceedance frequency insufficient, but the sample size is too small.

The same is true of zinc, which was placed on the "list" category because 2 of the 15 samples exceeded the allowable frequency. That cannot be. Once again, a sample size of 15 is too small. Further, it is not clear whether the samples were taken from the Creek during a storm event or during an ambient water body condition.

It should also be noted that according Regional Board SWAMP data taken in June of 2005, no exceedances were reported for copper, lead, or zinc.

Based on the foregoing, it is recommended that copper, lead, and zinc be placed on the **"do not list"** category.

Table I. Compton Creek

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes No
Copper	x	-	-	-	x	x	Yes
Lead	x	-	-	-	x	x	Yes
Selenium	-	-	-	x	-		Yes
Zinc	-	x	-	-	-	x	Yes

2. **Los Angeles River Reach 1 (Estuary to Carson)**

Copper, lead, and zinc were listed, while selenium was not. The justification for their listing is questionable. The listing fact sheet indicates 7 out of 18 samples exceeded CTR criteria. Because the LAR-MTMDL asserts that CTR limitations can be based on both wet weather and dry weather (ambient) sampling, the Regional Board needs to provide data that shows which samples were based on wet weather and dry weather.

As mentioned above, CTR limitations are exclusively expressed as ambient standards. Wet weather samples should be excluded. If the number of excluded samples does not meet the Listing Policy requirement for minimum sample size, then the sampling data is invalid. Further, it is not clear when the samples were taken, nor whether the actual hardness value was applied.

Based on this information, copper, lead, and zinc should be de-listed.

Table II. LAR Reach 1

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don’t List	Don’t De-list	Should De-List	Yes No
Copper	x	-	-	x	x	x	Yes
Lead	x	-	-	x	x	x	Yes
Selenium	-	-	-	-	-	-	Yes
Zinc	-	x	-	-	-	x	Yes

3. **Los Angeles River Reach 2 (Carson to Figueroa)**

Copper and lead are carried-over from the 2010 303(d) list and placed in the “do not de-list” category. Selenium and zinc were not listed. Copper and lead should be de-listed because according to the 303(d) listing fact sheet, 0 samples were taken.

Based on this information copper and lead should be should be de-listed.

Table III. LAR Reach 2

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don’t List	Don’t De-list	Should De-List	Yes No
Copper	x	-	-	-	x	x	Yes
Lead	x	-	-	-	x	x	Yes
Selenium	-	-	-	-	-	-	Yes
Zinc	-	-	-	-	-	-	Yes

Attachment #1

TABLE 3.1: MINIMUM NUMBER OF MEASURED EXCEEDANCES NEEDED TO PLACE A WATER SEGMENT ON THE SECTION 303(D) LIST FOR TOXICANTS. *Null Hypothesis: Actual exceedance proportion < 3 percent.* *Alternate Hypothesis: Actual exceedance proportion > 18 percent. The minimum effect size is 15 percent.*	
Sample Size	List if the number of exceedances equal or is greater than
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72– 82	7
83– 94	8
95– 106	9
107– 117	10
118– 129	11

*Application of the binomial test requires a minimum sample size of 16. The number of exceedances required using the binomial test at a sample size of 16 is extended to smaller sample sizes.

For sample sizes greater than 129, the minimum number of measured exceedances is established where α and f3 < 0.2 and where |α - f3| is minimized.

α = Excel® Function BINOMDIST(n-k, n, 1 – 0.03, TRUE)
f3 = Excel® Function BINOMDIST(k-1, n, 0.18, TRUE)
where n = the number of samples,

k = minimum number of measured exceedances to place a water on the section 303(d) list,
0.03 = acceptable exceedance proportion, and
0.18 = unacceptable exceedance proportion.

More To Sea
redondo
BEACH

Public Works Department
Engineering Services Division

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fax: 310 374-4828

March 29, 2017

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 W 4th Street, Suite 200
Los Angeles, CA 90013
Electronic Submission: losangeles@waterboards.ca.gov

Subject: Comment Letter – Revisions to the Los Angeles Region 303(d) List

Dear Dr. Zhu:

The City of Redondo Beach (City) appreciates the opportunity to provide comments on the proposed revisions to the Clean Water Act Section 303(d) list of impaired waterbodies in the Los Angeles Region (303(d) List), which was distributed for public review on February 8, 2017.

The Los Angeles Regional Water Quality Control Board (Water Board) has stated, within the Staff Report, that it is proposing a total of 200 new waterbody segment-pollutant combination 303(d) listings, of which 43 modifications fall within the City's two watersheds – Santa Monica Bay and Dominguez Channel. The City is committed to implementing management programs that assist in achieving the shared goal of improving water quality within the Los Angeles region. The City participates in the implementation of several total maximum daily loads (TMDLs), including the Santa Monica Bay Bacteria[1] and DDT/PCBs[2], which have resulted in a reduction of exceedances and are reflected in the Water Board's reclassification of indicator bacteria, PCBs, and DDT to Category 4A[3]. These TMDLs are listed as the highest priority pollutant combinations in the Beach Cities Enhanced Watershed Management Program, to which the City is a party. The City fully endorses the proposed re-categorizations and looks forward to continued collaboration with the Water Board to protect beneficial uses.

However, after reviewing the proposed changes to the 303(d) List, the City remains concerned about a number of specific issues, which are detailed below. The City's comments are generally grouped within two categories:

- Segment specific comments on the proposed 303(d) List; and
- Inconsistencies within the 303(d) List.

[1] Santa Monica Bay Bacteria TMDL. Resolution R12-007. Approved by LARWQCB April 6, 2006. Pending USEPA approval.
[2] Santa Monica Bay TMDL for DDT and PCBs. Approved by USEPA March 26, 2012.
[3] Category 4A is defined as "*A TMDL has been developed and approved by USEPA for any waterbody-pollutant combination and the approved implementation plan is expected to result in full attainment of the water quality standard within a specified time frame.*"

I. Segment Specific Comments on the Proposed 303(d) List

A. Dominguez Channel (lined portion above Vermont)

Comment 1: The benthic community effects listing (Decision ID 66165) appears to be flawed and should be removed.

The listing for benthic community effects should be removed because it is based on flawed data and/or analyses. The basis for this comment is as follows:

- The sample size did not meet the minimum criteria pursuant to the Listing Policy. According to Section 3.9 Degradation of Biological Populations and Communities of the Listing Policy[4], *The analysis should rely on measurements from at least two stations*. The Appendix G Fact Sheets list only one sample site, however it treats the data from the one site as three separate samples, which is incorrect. As a result, there are not enough data to justify a listing.
- The benthic community effects listing for the lined portion of Dominguez Channel lacks a sufficient reference site. Since this section of the Dominguez channel is lined, it does not have a traditional bed structure or substrates found in a typical stream. The classic Index of Biotic Integrity (IBI) stream assessment score does not take into consideration that lined channels naturally have lower IBI scores as noted in the recently released SCCWRP Special Study on Engineered Channels[5]. In order to make a robust assessment, the reference site should also be a lined channel that has not been subject to anthropogenic influences, however such a reference site was not used in the analysis.
- The IBI is not the assessment tool that should be used to determine benthic community effects. As acknowledged in the Appendix G Fact Sheets: *The CSCI is applicable statewide, accounts for a much wider range of natural variability, and provides equivalent scoring thresholds in all regions of the state. The CSCI will be used in the future for water quality assessment purposes statewide over the regional indices of biologic integrity (IBIs).* We agree with this statement and also note that some IBI scores are especially skewed when utilized for hardened channels since they heavily rely on macroinvertebrates, which are inherently more common in natural bottom stream beds. Other assessment tools such as the diatom IBI may also be used to assess the benthic community of a hardened channel as demonstrated by the SCCWRP Study on Engineered Channels referenced earlier. Therefore, the IBI assessment tool should not be used as the sole basis for a listing in this lined channel.
- The benthic community effects exceedance should not be linked to diazinon as a way to establish a causal effect since this pollutant has been delisted with respect to the Dominguez Channel (lined portion above Vermont) (Decision ID 33061).

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[4] State Water Resources Control Board. *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List*, as amended Feb. 3, 2015. [Referred to hereinafter as the Listing Policy]

[5] Pages 5-7 of Southern California Stormwater Monitoring Coalition. 2017. *2015 Report on the Stormwater Monitoring Coalition Regional Stream Survey: Special Study on Engineered Channels*. SCCWRP Technical Report 963. Southern California Coastal Water Research Project. Costa Mesa, CA.

Requested Action:

- *Remove the benthic community effects listing for Dominguez Channel since the sample size does not meet the minimum criteria, this section of channel lacks a proper reference site, and is based on an inappropriate assessment tool.*
- *If the listing is not removed, the diazinon linkage to benthic community effects should be removed since this pollutant has been delisted.*

Comment 2: The ammonia listing (Decision ID 35134) should be updated to consider all readily available data.

Ammonia was not delisted based on the existence of 2 exceedances out of 21 samples collected from 7/1/2009 to 8/13/2009 at Western Ave., Manhattan Beach Blvd, and El Segundo Blvd. Additional samples were also collected at a sample site just across Vermont Ave. (33° 52' 16" N, 118° 17' 23" W), however these samples were not included in the analysis. The Basin Plan lists Vermont Ave. as the reach break between the Dominguez Channel and Dominguez Channel Estuary and, therefore, it appears a decision was made to include the Vermont Ave. samples in the downstream segment - the Dominguez Channel Estuary (unlined portion below Vermont Ave.) (see map in **Attachment A**).

The City maintains that the Vermont Ave. samples should be considered in the Dominguez Channel (lined portion above Vermont) based on their direct proximity to the end of the reach, offering optimal spatial representation of the water body segment. Furthermore, the sample site is located less than 100 meters from the lined portion of Dominguez Channel and according to the Listing Policy, a sample collected 200 meters upstream, in the lined portion of the Channel, would be considered the same station location[6].

If the additional 8 samples from the Vermont Ave. station are included in the Dominguez Channel (lined portion above Vermont) analysis, the total samples in exceedance would be 2 out of 29. These data would then meet the requirement to delist ammonia as stated in Section 4.1 of the California Delisting Factors set in the Listing Policy – i.e., these samples support rejection of the null hypothesis using the binomial distribution and the sample size is greater than 28. Specifically, Table 4.1 at page 14 of the Listing Policy demonstrates that where 2 or less exceedances are identified in a sample size of 28-36 samples, such as here, then the water segment shall be removed from the 303(d) List. Therefore, based on the updated and appropriate sample size, which includes Vermont Ave. samples, and number of exceedances, ammonia should be delisted for this reach.

Requested Action:

Include the Vermont Ave. sampling data in the analysis of the ammonia listing for Dominguez Channel (lined portion above Vermont).

Delist ammonia based on the updated analysis.

B. Dominguez Channel Estuary (unlined portion below Vermont Ave)

Comment 3: Delist Ammonia (unionized) due to lack of exceedances.

A listing for ammonia was shown in the Appendix G Fact Sheets, however none of the cited lines of evidence (LOE) shows evidence of an exceedance. One LOE is an unspecified

[6] Page 22 of the SWRCB Listing Policy "*Samples collected within 200 meters of each other should be considered samples from the same station or location.*"

placeholder for a listing decision made prior to 2006, however the other two LOE show 0 out of 28 and 0 out of 7 exceedances. Based on the data, this pollutant meets the Section 4 California Delisting Factors set in the Listing Policy.

Requested Action:

- *Delist ammonia (unionized) (Decision ID 34669) based on lack of evidence and exceedances.*

C. Santa Monica Bay Offshore/Nearshore

<u>Comment 4: The arsenic and mercury fish tissue listings are not based on all readily available data, are not spatially representative of the water body, and samples were not treated as temporally independent.</u>

The samples used for the proposed 5A Arsenic and Mercury fish tissue listings (Decision ID: 67208 and 67209) are not spatially representative of the water body. Samples used for these listings were collected for the City of Los Angeles Hyperion Treatment Plant NPDES Permit (NO. CA0109991). The permit designates 5 different sampling zones along the coast of the Santa Monica Bay[7] of which the City falls along the border of zones 4 and 3 (see map in **Attachment B**). All of the samples used for these listings were collected from zones 4 and 5 - no representative samples were collected from zone 3, which includes the southern end of Santa Monica Bay and a substantial portion of the City's drainage area. Therefore, using current samples to list the entire Santa Monica Bay Offshore/Nearshore would incorrectly list zone 3 of the bay despite a lack of representative samples from this area. This would contradict the Listing Policy which states that "*samples should represent statistically or in a consistent targeted manner the segment of the water body*"[8]. The spatial coverage of the samples should be considered and the listing reassessed by either segmenting the water body or using samples from all representative zones of Santa Monica Bay.

In addition, sampling data beyond the 19 samples collected in 2006-2007 should be available from the City of Los Angeles' Hyperion Treatment Plant NPDES permit. It is unclear why only the 2006-2007 samples were used when there are presumably more samples available from the Hyperion Treatment Plant NPDES monitoring program. The City requests that the Water Board review all available data for fish tissue before making a listing for Arsenic and/or Mercury.

Finally, the fish tissue assessment for arsenic and mercury did not properly categorize the data in a way that is temporally independent. The Listing Policy states that samples should be *temporally independent*[9]; however, in some cases fish collected on the same day were treated as unique data points. In addition, the samples collected were from August 2006, October 2007- November 2007, and August - September 2007. Because both arsenic and mercury bioaccumulate over the lifetime of the individual species an averaging period of at least a year should be considered. Therefore, instead of considering 19 individual samples these data should only be considered representative of 2 years thus supporting the need for additional data as previously requested.

[7] Page T-55 of City of Los Angeles Hyperion Treatment Plant. Order NO. R4-2005-0020. NPDES Permit NO. CA0109991, as revised April 7, 2005.
[8] Page 22 of the Listing Policy.
[9] Page 23 of the Listing Policy.

Requested Action:

Either (1) segment the Santa Monica Bay listing since the data used to list arsenic and mercury are not representative of the entire water body as required by the Listing Policy, or (2) seek additional data from all zones of Santa Monica Bay to ensure proper spatial representation of the data prior to listing.

Seek and reanalyze additional sample data from the City of Los Angeles beyond the 19 samples from 2006 and 2007 that were originally used for the analysis.

The mercury and arsenic fish tissue data should be aggregated based on a more reasonable temporal resolution.

Comment 5: Sediment toxicity should be delisted; no justification was provided for the name change in the Fact Sheets.

The Santa Monica Bay Offshore/Nearshore toxicity listing (Decision ID 34120) was marked only as a name change in Appendix A. However, a TMDL for DDTs and PCBs was developed and approved by USEPA in 2012[10] which evaluated sediment toxicity resulting in a recommendation for delisting:

"Our evaluation of the data showed only 3 out of 116 samples exhibited toxicity. Following the California listing policy, Santa Monica Bay is meeting the toxicity objective and there is sufficient evidence to delist sediment toxicity. We therefore make a finding that there is no significant toxicity in Santa Monica Bay and recommend that Santa Monica Bay not be identified as impaired by toxicity in the California's next 303(d) list."

Based on the statement above and data summarized on pages 19 and 20 of the TMDL there is sufficient evidence to delist sediment toxicity for Santa Monica Bay Offshore/Nearshore.

The listed name change appears to be a change from "sediment toxicity" to "toxicity" based on the Appendix G Fact Sheets. We assume that this name change is the result of the Water Board's acknowledged systems and clerical errors in Appendix A. In the event that it is not a mere error that will be corrected by the Water Board, the City requests that justification be provided to support the name change. This name change should only occur if new data is used to support the observation of toxicity in the water column as outlined in section 3.6 of the Listing Policy, however no new data was presented and a reason for this name change was not discussed in the staff report.

Requested Action:

Delist sediment toxicity for Santa Monica Bay based on the data analysis performed in the 2012 DDTs and PCBs TMDL.

- *Correct the name change error.*

II. Inconsistencies within the 303(d) List

As noted by Water Board staff, the Appendices of the proposed 303(d) List have a number of inconsistencies. The inconsistencies listed below are a few examples and should not be considered an exhaustive list. We request that the Water Board do a thorough review of all of the Appendices to ensure that they are internally consistent with the changes listed in the Appendix G Fact Sheets.

[10] Santa Monica Bay Total Maximum Daily Loads for DDTs and PCBs. Approved by USEPA March 26, 2012.

Table 1. Inconsistencies in the Proposed 303(d) List Appendices		
Waterbody Segment	**Pollutant(s)**	**Comment/Requested Action**
Dominguez Channel (lined portion above Vermont)	Diazinon	This pollutant is shown as "delisted" in Appendix A with a note "*TMDL status changed from TMDL still required to Being Addressed by Completed TMDL*". In Appendix G the same pollutant is listed as "*Delist from 303(d) list (being addressed by USEPA approved TMDL)*". **The City would like clarification that this listing will be entirely removed from the 303(d) list and not categorized as 4A as indicated by the note in Appendix A.**
	Aldrin, Chem A, Chlordane, Chromium, DDT, Dieldrin, PAHs, and PCBs	These pollutants are shown as delisted in the Appendix G factsheets, however they are not listed as changed in Appendix A. **All of these pollutants should be delisted due to flaws in the original listing (as noted within the factsheets).**
	Chromium and Dieldrin	These pollutants are shown as "name changes" in Appendix A, however we could find no evidence of a name change throughout the rest of the document. **Any name change should be supported by a reason detailing the need for the change in the Fact Sheets. Furthermore both of these listing should be delisted based on the comment above.**
Dominguez Channel Estuary (unlined portion below Vermont Ave)	Aldrin, ChemA, Chromium (total), and PAHs	These pollutants are not listed as a change in Appendix A, but shown as "delisted" in Appendix G. **All listings should be delisted either because of flaws in the original listing or lack of an exceedance.**
	DDT	This listing is missing from Appendix B or C and has not been listed as changed in Appendix A, however the Appendix G factsheets lists DDT as being addressed with a USEPA approved TMDL and therefore **should be categorized as 5B or 4A.**
	Dieldrin	Listed in Appendix A as "*TMDL status changed from TMDL still required to Being Addressed by Completed TMDL*", however the pollutant does not appear in Appendix B or C and is listed as "*List on*

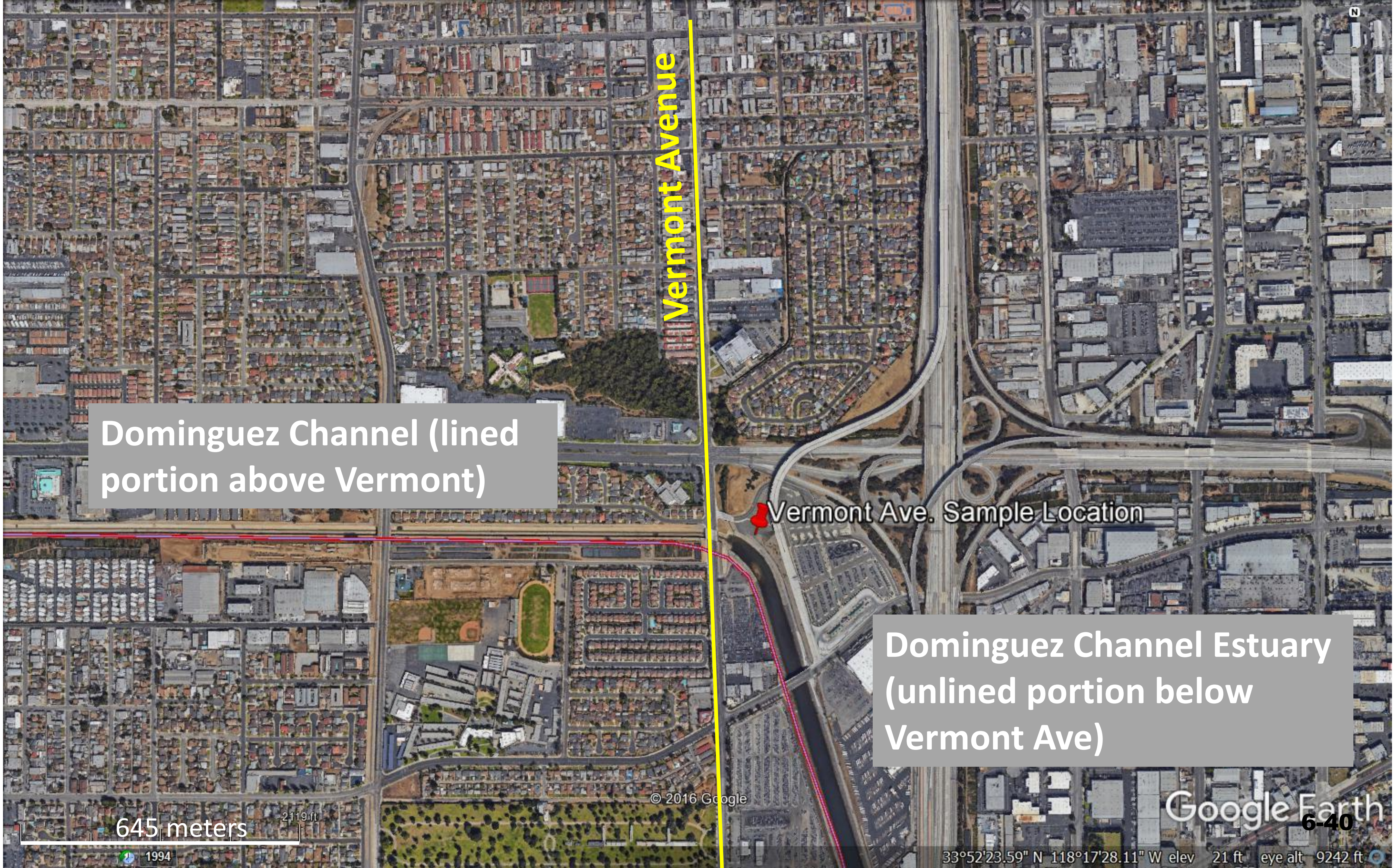
		303(d) list (being addressed by USEPA approved TMDL)" in Appendix G. **This pollutant should be listed as 4A or delisted.**
	Chlordane(tissue)	Listed in Appendix A as unchanged but not found in Appendix B or C. The Appendix G Fact Sheets list this pollutant as "*Do not delist (being addressed with USEPA approved TMDL)*". **The City would like clarification if this pollutant has been delisted or recategorized as 5B.**
The Santa Monica Bay Offshore/Nearshore	Chlordane and PAHs	Not listed as a change in Appendix A but shown as "delisted" in Appendix G. **These pollutants should be delisted.**
Redondo Beach	DDT	Listed in Appendix A only as a 'name change', however Appendix G lists this as "*TMDL status changed from TMDL still required to Being Addressed by Completed TMDL*". The 2010 303(d) list shows Redondo Beach DDT listing was Category 5A however in the newly proposed 303(d) list the pollutant is listed as 4A in Appendix C. Category 4A is the correct category for this pollutant since a USEPA-approved TMDL does exist to manage DDT which is expected to result in full attainment of the water quality standard within a specified time frame. **The City would like Appendix A edited to reflect new 4A listing.** Furthermore if this is in fact a name change, as stated in Appendix A, **an explanation including supporting data for the name change should be included in the Appendix G Fact Sheets.**

The City thanks the Water Board for the substantial time invested in developing the proposed 303(d) List and appreciates the opportunity to comment and consideration of these comments. If you have questions, please do not hesitate to contact me at 310-318-0661.

Sincerely,

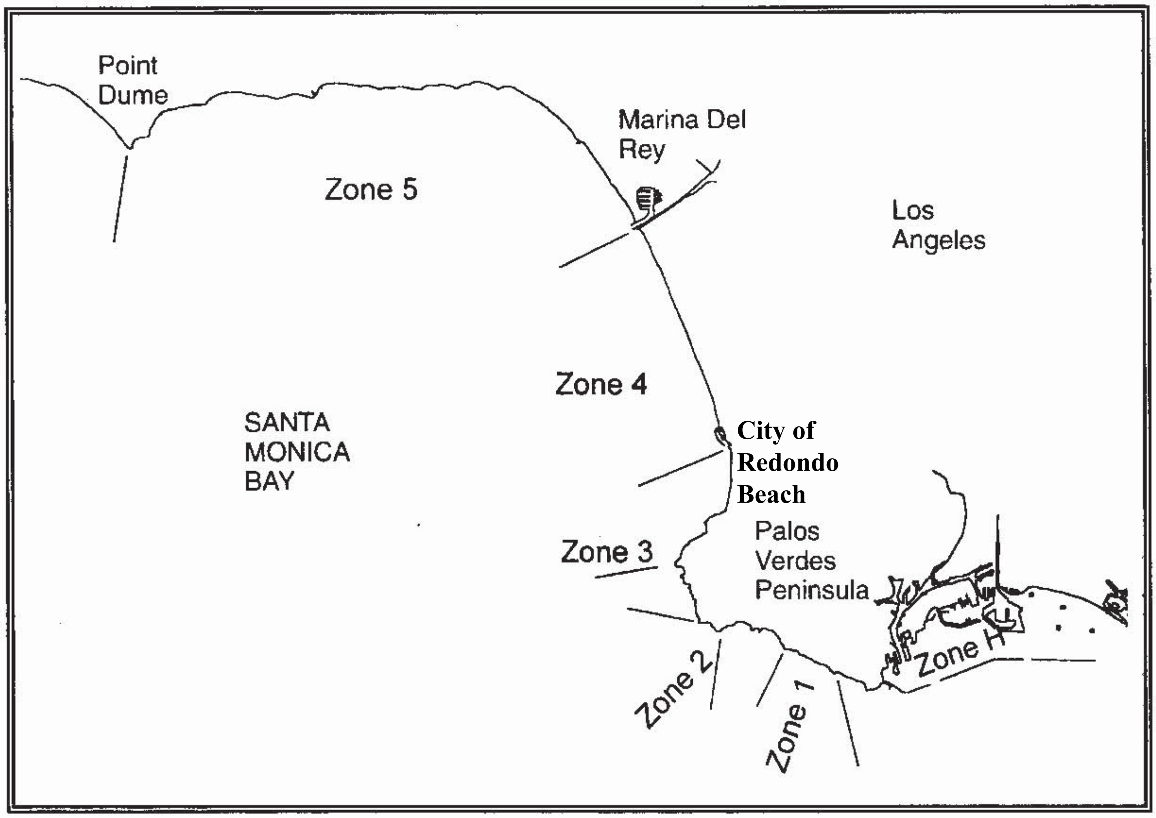
Andrew S. Winje, PE
City Engineer

Attachment A: Map of Vermont Ave. Sampling Location
Attachment B: Map of Hyperion NPDES Santa Monica Bay Sampling Zones



Vermont Avenue
Dominguez Channel (lined portion above Vermont)
Vermont Ave. Sample Location
Dominguez Channel Estuary (unlined portion below Vermont Ave)
© 2016 Google
645 meters
2119 ft
1994
Google Earth
33°52'23.59" N 118°17'28.11" W elev 21 ft eye alt 9242 ft

Figure 5. Local seafood survey zones as defined by SMBRP seafood tissue monitoring design.



City of
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March 28, 2017

Dr. Jun Zhu
California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles CA 90013

Dear Dr. Zhu:

Subject: Comment Letter – Revisions to the Los Angeles Region 303(d) List

This letter is regarding the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) public hearing on May 4, 2017, to consider revisions to the Clean Water Act Section 303(d) list of impaired water bodies. At this meeting, the Regional Board is expected to hear information and take formal action on the proposed revisions to water quality assessments in the Los Angeles Region.

The City of Santa Clarita (City), County of Los Angeles, and the Los Angeles County Flood Control District worked collaboratively to develop the Enhanced Watershed Management Program (EWMP) for the Upper Santa Clara River Watershed to comply with requirements of the Municipal National Pollutant Discharge Elimination System (NPDES) Permit (R4-2012-0175). The EWMP was developed to meet the Permit requirements and also address pollutants specific to the Upper Santa Clara River watershed.

In developing the EWMP for the Upper Santa Clara River, an extensive pollutant prioritization process was performed based on all available data. The characterization process consisted of the following steps:

1. Data from multiple sources, including the 303(d) list, Water Quality Based Effluent Limitations (WQBELs), Receiving Water Limitations (RWLs), the Surface Water Ambient Monitoring Program (SWAMP), annual reports, established Total Maximum Daily Loads (TMDLs), the Los Angeles Department of Public Works, and Los Angeles County Sanitation Districts;
2. Identifying water bodies affected by discharges from the EWMP area;
3. Data analysis to identify constituents with exceedances of water quality objectives;
4. Water body-pollutant combinations identified;
5. Compiling 303(d) listings from the 2010 303(d) List; and

6. Comparing the data analysis to the State of California's (State) Listing Policy.

A wide-ranging watershed model analysis was performed for the entire Upper Santa Clara River Watershed Valley area taking into account pollutant loading, unique characteristics of the area, and control measure performance. The EWMP proposed a detailed path to implementing the stormwater program through programmatic and structural best management practices (BMPs) to effectively address pollutants in the storm drain system and the receiving waters. The EWMP plan prescribes long term strategies, such as regional BMPs, green streets, and other types of infiltration BMPs. After years of studies, modeling, and review, the Regional Board-approved EWMP demonstrates that the selected water quality control measures will result in compliance with applicable WQBELs and RWLs. The City, County of Los Angeles, and the Los Angeles County Flood Control District are just now beginning to implement the EWMP.

Change All Listings to "Being Addressed by Action Other Than a TMDL"

Due to the extensive studies and long term implementation efforts contained in the EWMP, the City requests all pollutants remaining on the 303(d) list without a developed TMDL should be changed to the Category 4B for the Clean Water Act as "Being Addressed by Action Other Than a TMDL." More specifically, the pollutants will be addressed through the long-term implementation of the EWMP. In addition, the City requests a focus be placed on "Delisting" pollutants by the Regional Board so that limited resources can be better applied to applying long-term strategies of the approved EWMP.

The City requests the following amendments for the 2017 303(d) List. The affected water quality objectives are listed below.

Affected Waterbodies, Water Quality Objectives, and Suggested Revisions

Santa Clara River Reach 5 (Blue Cut Gauging Station to West Pier Highway 99 Bridge)

Ammonia should be revised to "Being Addressed by Completed TMDL." The Nitrogen and Effects TMDL for the Santa Clara River was completed in 2004. The Los Angeles County Sanitation Districts revised their operations at the Saugus Water Reclamation Plant and the Valencia Water Reclamation Plant and installed a Nitrification-Denitrification (NDN) process in 2004. The applicable water quality standards for nitrate, nitrite, and ammonia are not being exceeded. Decision ID 34352 states that no discharges exceeded limits.

Benthic Community Effects should be revised to "Being Addressed by Action Other Than a TMDL." Decision ID 44468 states that the water body is impaired with multiple pollutants, including zinc, iron, bacteria, and chloride. However, Line of Evidence 88732 states that 0 out of 153 samples had any exceedance for zinc. Although iron is naturally occurring in the Santa Clara River watershed, Line of Evidence 88656 found 6 of 81 samples exceeded and Line of Evidence 88648 found 0 of 2 samples exceeding water quality limits. There were no samples taken for coliform bacteria, and therefore, no exceedances recorded as per Line of Evidence 4156. Line of Evidence 88792 states that none of the two samples taken exceeded the criterion for chloride. Further, the listing was based on the Southern Coastal California Index of Biotic Integrity (SCIBI). However, the SCIBI-based analysis is inadequate for use in low-gradient and low-elevation waters, such as the Upper Santa Clara River. Through the implementation of the EWMP, the benthic community should rebound to its natural populations as the EWMP addresses toxicity, metals, pesticides, and other metrics that affect benthic communities.

Chloride should be revised to "Being Addressed by Completed TMDL." The Santa Clara River chloride TMDL was approved by the United States Environmental Protection Agency (USEPA) on April 28, 2005. The site-specific water quality objective for Santa Clara River Reach 5 is 100 mg/L. The primary source of chloride was determined to be potable water derived from a blend of the State Water Project and local groundwater. Santa Clarita Valley residents have relinquished over 8,200 salt-based water softeners that had previously contributed to excessive chloride levels found in the Santa Clara River. The Los Angeles County Sanitation Districts has proposed to install reverse-osmosis technology at their Valencia Water Reclamation Plant and Saugus Water Reclamation Plant, as part of an overall chloride reduction plan.

Indicator bacteria should be revised to "Being Addressed by Action Other Than a TMDL." Through the implementation of the EWMP, indicator bacteria should fall to levels found in ambient waters.

Iron should be revised to "Being Addressed by Action Other Than a TMDL." Iron was modeled and will be addressed by the implementation of the EWMP for the Upper Santa Clara River.

Nitrate and nitrite should be revised to "Being Addressed by Completed TMDL." The Nitrogen and Effects TMDL for the Santa Clara River was approved by the USEPA in 2004. The original listing was made in 1998. Since then, the Los Angeles County Sanitation Districts underwent significant upgrades to their operations including incorporation of nitrification/de-nitrification treatment at the Valencia Water Reclamation Plant in 2003, specifically aimed at addressing nitrogen in the Upper Santa Clara River. Decision ID 32484 states that the decision to delist from 303(d) list was previously approved by the State Water Resources Control Board and the USEPA. Toxicity should be revised to "Being Addressed by Action Other Than a TMDL."

Toxicity was modeled and will be addressed by the implementation of the EWMP for the Upper Santa Clara River.

Santa Clara River Reach 6 (West Pier Highway 99 to Bouquet Canyon Road)

Ammonia should be revised to "Being Addressed by Completed TMDL" or "Delist from 303(d) list." The Nitrogen and Effects TMDL for the Santa Clara River was approved by the USEPA in 2004. The original listing was made in 1998. Since then, the Los Angeles County Sanitation Districts underwent significant upgrades to their operations, including incorporation of nitrification/de-nitrification treatment at the Valencia Water Reclamation Plant in 2003, specifically aimed at addressing nitrogen in the Upper Santa Clara River. Decision ID 32462 states that the decision to delist from 303(d) list was previously approved by the State Water Resources Control Board and the USEPA.

Chloride should be revised to "Being Addressed by Completed TMDL" or "Delist from 303(d) list." The Santa Clara River chloride TMDL was approved by the USEPA on April 28, 2005. The site-specific water quality objective for Santa Clara River Reach 5 is 100 mg/L. The primary source of chloride was determined to be potable water derived from a blend of the State Water Project and local groundwater. Santa Clarita Valley residents have relinquished over 8,200 salt-based water softeners that had previously contributed to excessive chloride levels found in the Santa Clara River. The Los Angeles County Sanitation Districts has proposed to install reverse-osmosis technology at their Valencia Water Reclamation Plant and Saugus Water Reclamation Plant, as part of an overall chloride reduction plan.

For chlorpyrifos, Decision ID 33024 states samples were collected from August 2002 through April 2003. It should be noted that USEPA phased out all residential use of chlorpyrifos products since 2004. Since the samples were taken prior to being phased out and no further positive results are presented, this information is no longer relevant. Due to the long term implementation efforts contained in the EWMP, this pollutant should be changed to "Being Addressed by Action Other Than a TMDL."

Copper was modeled for and will be addressed by the implementation of the EWMP for the Upper Santa Clara River. Copper should be revised to "Being Addressed by Action Other Than a TMDL."

Decision ID 44805 states samples for diazinon were collected from August 2002 through April 2003. It should be noted that USEPA phased out all residential use of diazinon products since 2004. Only data generated from after the ban should be considered. For a sample size of 28-36, Table 4.1 of the State's Listing Policy recommends delisting a previously listed pollutant if the numbers of exceedances are less than two. Since no other samples show an exceedance, diazinon should be delisted. In addition, due to the implementation of the EWMP, this pollutant could also be changed to "Being Addressed by Action Other Than a TMDL."

Iron is abundant in the natural soils in the Santa Clarita Valley. In addition, iron was modeled for and will be addressed by the implementation of the EWMP for the Upper Santa Clara River. Iron should be revised to "Being Addressed by Action Other Than a TMDL."

According to the National Weather Service, ambient air temperature for Santa Clarita during the summer months regularly exceeds 100 degrees Fahrenheit due to a semi-arid climate. The Santa Clara River is an ephemeral stream with water flow quickly subsiding into the natural sandy, soft- bottom riverbed. It is noted that all samples registering over 80 degrees Fahrenheit occurred between the months of May and August. It is reasonable that hot and dry air temperatures correlate to warmer water temperatures in shallow, sandy soils. Receiving waters in the Santa Clara River registering above 80 degrees Fahrenheit are the result of natural, ambient conditions and should not be considered as a result of storm drain or treatment discharge.

In Line of Evidence 88683, it is noted that toxicity data was not reported with a control, and therefore anything reported as <100% (chronic) or <100% survival (acute) was considered an exceedance. In addition, toxicity was modeled for and will be addressed by the implementation of the EWMP for the Upper Santa Clara River. Toxicity should be revised to "Being Addressed by Action Other Than a TMDL."

The attached supporting information is the section of the Upper Santa Clara River EWMP that includes a Water Quality Priorities section that summarized the pollutants and findings included in the approved Upper Santa Clara River EWMP. Please contact me if you have any questions about the information provided at (661) 255-4337 or by e-mail at tlange@santa-clarita.com.

Sincerely,

Travis Lange
Environmental Services Manager

TL:OC:ll
S:\ENVSRVCS\NPDES2\303(d) List\2016\303d Response 3-9-17 (Rev).doc

Enclosure

cc: Darren Hernández, Deputy City Manager

4.3 WATER BODY POLLUTANT CLASSIFICATION

The classification process categorizes the WBPCs to focus subsequent EWMP components including the Source Assessment, Prioritization, and the selection of Watershed Control Measures. Based on the water quality characterization, water body-pollutant combinations were classified in one of the three Permit categories as presented in **Table 4-4.**

Table 4-4. Water Body-Pollutant Classification Categories

Category	Water Body-Pollutant Combinations (WBPCs) Included
1 Highest Priority	WBPCs for which TMDL WQBELs and/or RWLs are established in Part VI.E and Attachments L and O of the MS4 Permit.
2 High Priority	WBPCs for which data indicate water quality impairment in the receiving water according to the State's Listing Policy, regardless of whether the pollutant is currently on the 303(d) List, and for which MS4 discharges may be causing or contributing.
3 Medium Priority	WBPCs for which there are insufficient data to indicate impairment in the receiving water according to the State's Listing Policy, but which exceed applicable receiving water limitations contained in the MS4 Permit and for which MS4 discharges may be causing or contributing to the exceedance.

The categories were further subdivided to provide more support for the prioritization and sequencing in the EWMP. Additionally the subcategorization was utilized to provide a better link to the methods for demonstrating compliance with RWL exceedances as outlined in Parts VI.C.2-C.3. The water body-pollutant combination subcategories are shown in **Table 4-5.**

Table 4-5. Categorization for Water Body Pollutant Combinations

Category	Water Body-Pollutant Combinations (WBPCs)
1	**Category 1A:** WBPCs with past due or current Permit term TMDL deadlines with exceedances in the past 5 years.
	Category 1B: WBPCs with TMDL deadlines beyond the Permit term and with exceedances in the past 5 years.
	Category 1C: WBPCs addressed in USEPA TMDL without a Regional Board Adopted Implementation Plan.
	Category 1D: WBPCs with past due, current, or future Permit term TMDL deadlines without exceedances in the past 5 years.
	Category 1E: WBPCs with TMDLs for which MS4 discharges are not causing or contributing. [2]
2	**Category 2A:** 303(d) Listed WBPCs or WBPCs that meet 303(d) Listing requirements with exceedances in the past 5 years.
	Category 2B: 303(d) Listed WBPCs or WBPCs that meet 303(d) Listing requirements that are not a "pollutant"[1] (i.e., toxicity).
	Category 2C: 303(d) Listed WBPCs or WBPCs that meet 303(d) Listing requirements without exceedances in past 5 years or that could be delisted.
	Category 2D: 303(d) Listed WBPCs for which MS4 discharges are not causing or contributing. [3]
3	**Category 3A:** All other WBPCs with exceedances in the past 5 years.
	Category 3B: All other WBPCs that are not a "pollutant"[1] (i.e., toxicity).
	Category 3C: All other WBPCs that have exceeded in the past 10 years, but not in past 5 years.
	Category 3D: WBPCs identified by the USCR EWMP Group Members.

1. While pollutants may be contributing to the impairment, it currently is not possible to identify the specific pollutant/stressor.
2. The Permit requires prioritization of all constituents with established WQBELs or RWLs, regardless of source. WBPCs in this category are for reaches without MS4 discharges. While urban areas may be within the drainage area, no point source MS4 discharges to the waterbody.
3. The Permit does not require prioritization of constituents for which data indicate water quality impairment in the receiving water, but where MS4 discharges are not causing or contributing to the impairment. Pollutants in this category are in reaches within the EWMP area that do not receive MS4 discharges.

In addition to defining the categories for the WBPCs identified, the constituents were assigned a class. As defined in the permit, pollutants are considered in a similar class if they have similar fate and transport mechanisms, can be addressed via the same types of control measures, and within the same timeline already contemplated as part of the Watershed Management Program for the TMDL. The classes assigned as part of the analysis were utilized in developing the scheduling and milestones for the EWMP.

The categorization of WBPCs developed based on the receiving water data characterization is shown in **Table 4-6.** The Santa Clara River reaches are shown in **Figure 4-1.**

Table 4-6. WBPC Categorization

Class[(1)]	Constituent	Santa Clara River Reach				Bouquet Canyon	Lake Elizabeth	Mint Canyon	Piru Creek	Munz Lake	Lake Hughes	Castaic Lake	Pyramid Lake	Los Angeles River
		4B[2]	5	6	7									
Category 1A: WBPCs with past due or current term TMDL deadlines <u>with</u> exceedances in the past 5 years.														
Bacteria	*E. Coli* (dry) [3]	I	I		I									
Salts	Chloride	F	F	F										
Category 1B: WBPCs with TMDL deadlines beyond the current Permit term and <u>with</u> exceedances in the past 5 years.														
Bacteria	*E. Coli* (wet and dry) [3]	F	F		F									
Category 1D: WBPCs with past due, current term, or future deadlines <u>without</u> exceedances in the past 5 years.														
Nutrients	Ammonia	F	F											
	Nitrate and Nitrite	F	F											
Trash	Trash						F							
Bacteria	*E. Coli* (wet and dry) [3]			I/F										
Category 1E: WBPCs with TMDLs for which MS4 discharges are not causing or contributing														
Trash	Trash									TMDL	TMDL			F
Nutrients	Ammonia													F
Nutrients	Nitrate and Nitrite							TMDL[4]						F
Bacteria	*E. Coli*													I
Metals	Cadmium													I
Metals	Copper													I
Metals	Lead													I
Selenium	Selenium													I
Metals	Zinc													I

Class(1)	Constituent	Santa Clara River Reach				Bouquet Canyon	Lake Elizabeth	Mint Canyon	Piru Creek	Munz Lake	Lake Hughes	Castaic Lake	Pyramid Lake	Los Angeles River
		4B[2]	5	6	7									
Category 2A: 303(d) Listed WBPCs with exceedances in the past 5 years.														
Metals	Copper			303 (d)										
	Iron		D	303 (d)										
Cyanide	Cyanide			L										
Category 2B: 303(d) Listed WBPCs that are not a "pollutant" (i.e., toxicity).														
Toxicity	Toxicity			303 (d)										
Other	pH				L		303(d)							
Other	Eutrophic						303(d)							
Other	Organic Enrichment/Low DO						303(d)							
Category 2C: 303(d) Listed WBPCs without exceedances in past 5 years or that could be delisted.														
Pesticides	Chlorpyrifos			D										
Pesticides	Diazinon			D										
Category 2D: 303(d) Listed WBPCs for which MS4 discharges are not causing or contributing.														
Metals	Mercury											303(d)	303(d)	
Other	Eutrophic									303(d)	303(d)			
Other	Fish Kills										303(d)			
Other	Odor										303(d)			
Other	Algae										303(d)			
Other	pH								303(d)					
Salts	Chloride								303(d)					

Class[1]	Constituent	Santa Clara River Reach				Bouquet Canyon	Lake Elizabeth	Mint Canyon	Piru Creek	Munz Lake	Lake Hughes	Castaic Lake	Pyramid Lake	Los Angeles River
		4B[2]	5	6	7									
Category 3A: All other WBPCs with exceedances in the past 5 years.														
Metals	Copper		X		X									
	Mercury		X	X	X									
	Selenium			X										
	Zinc			X										
Cyanide	Cyanide				X									
Salts	TDS		X											
Category 3C: All other WBPCs with exceedances in the past 10 years, but without exceedances in past 5 years.														
Phthalates	Bis-2 Ethylhexyl phthalate			X										
Category 3D: Other EWMP Priorities														
Pesticides	Pyrethroids					X								

1. Pollutants are considered in a similar class if they have similar fate and transport mechanisms, can be addressed via the same types of control measures, and within the same timeline already contemplated as part of the Watershed Management Program for the TMDL.
2. Reach 4B is located in Ventura County but was considered for the purposes of understanding downstream water quality
3. Interim limits for dry *E. Coli* during permit term, interim limits for wet *E. Coli* past permit term, final limits for dry and wet past permit term.
4. Mint Canyon is included in the Nutrients TMDL, but no WLAs for MS4 discharges are assigned for the reach in the TMDL.

I=Interim TMDL WQBEL or Receiving Water Limit
F=Final TMDL WQBEL or Receiving Water Limit
D=303(d) listing that could now be delisted
303(d)=Confirmed 303(d) Listing
L=WBPC that meets the listing criteria, but is not currently on the 303(d) list
TMDL=TMDL that does not contain MS4 allocations for the reach
Other= Used for conditions (pH and dissolved oxygen) that are not pollutants, per se, or constituents where the linkage to another type of constituent will be further investigated.

4.4 SOURCE ASSESSMENT

To complement the water quality prioritization process, permittees must identify known and suspected storm water and non-storm water sources influencing MS4 discharges by utilizing existing information for the water body-pollutant combinations in Categories 1-3. The intent of the Source Assessment is to identify potential sources within the watershed for the water body-pollutant combinations and to support prioritization and sequencing of management actions.

In order to identify potential sources for water quality priorities from MS4 discharges, a review of available data and information was conducted, including the following sources:

1. Findings from Illicit Connections and Illicit Discharge Eliminations Programs;
2. Findings from Industrial/Commercial Facilities Programs;
3. Findings from Development Construction Programs;
4. Findings from Public Agency Activities Programs;
5. TMDL source investigations;
6. Watershed model results;
7. Findings from the Permittees' monitoring programs, including but not limited to TMDL compliance monitoring and receiving water monitoring; and
8. Any other pertinent data, information, or studies related to constituent sources and conditions that contribute to the highest water quality priorities.

The City, County, and County Flood Control District submit Individual Annual Report Forms (Annual Report) to the Regional Board for each fiscal year. The submitted Annual Reports contain details pertaining to their activities under the Industrial/Commercial Facilities Program, Development Construction Program, Public Agency Activities Program and Illicit Connection and Illicit Discharge (IC/ID) Elimination program (items 1-4 in the list above), as well as other MS4 permit requirements. The annual reports include details on inspections and enforcement activities, as well as findings on BMP implementation. As part of the IC/ID program, the City of Santa Clarita produces annual maps showing the locations and type of illicit connections and illicit discharges found during the fiscal year. Available Annual Reports and IC/ID maps were reviewed for the source assessment.

Four TMDLs are pertinent to MS4s in the Upper Santa Clara River watershed: The Upper Santa Clara River Chloride TMDL, Santa Clara River Nitrogen Compounds TMDL, Lake Elizabeth, Munz Lake, and Lake Hughes Trash TMDL, and Santa Clara River Estuary and Reaches 3, 5, 6, and 7 Indicator Bacteria TMDL. Findings from source assessments from each TMDL were incorporated into the source assessment.

Data from the Permittee's monitoring programs mostly consist of receiving water monitoring, and little data is available to characterize MS4 discharges. However, these data were used to evaluate the location and timing of exceedances to inform the source assessment. Additional information and data reviewed included POTW effluent data, other TMDL source assessments from watersheds in the Los Angeles Region, and other studies and reports pertaining to the EWMP area or water quality priorities.

Finally, information from the model developed for the Reasonable Assurance Analysis (RAA) was utilized as part of the source assessment. Summaries of the relative loading estimated from the model for sediment, total zinc, total copper, total lead, and bacteria by land use are provided in Appendix A-1.

The results of source assessments for WBPCs in Categories 1-3 are shown below in **Table 4-7** and described in detail in Appendix A-1. Given the lack of watershed specific information, the source assessment provides a list of potential MS4 sources that are likely to be present in the USCR EWMP area and could be contributing to any exceedances observed in the receiving waters. A source assessment for category 2B constituents, 303(d) Listed WBPCs that are not a "pollutant", could not be developed because the constituents contributing to the condition have not yet been identified. However, source assessments have been provided for other constituents that are potentially contributing to the condition. For example, eutrophic conditions, low dissolved oxygen and changes in pH are all potentially the result of excess algae growth which could be influenced by elevated nutrient levels and pesticides may contribute to toxicity.

Table 4-7. MS4 Sources of Water Quality Priorities

Class	Constituent	Reaches/ Waterbodies	MS4 Potential Sources

Bacteria[1,5]	*E. coli*	4B[2], 5, 6, 7	- Dry- and wet- weather urban runoff
			  - Animal wastes, including those from pets, wildlife and birds
			  - Trash
			- Direct human discharges
			- Sanitary sewer overflows
			- Leaking septic systems
			- Illicit discharge of sewage and wastewater

Nitrogen Compounds[5]	Ammonia, Nitrate/ Nitrite	4B[2], 5, 6, 7	- Atmospheric deposition
			- Leaf litter and debris
			- Runoff from over-fertilized landscaping
			- Improper storage or disposal of fertilizers and ammonia
			- Soil concentrations
			- Leaking septic systems
			- Groundwater concentrations
			- Industrial and commercial sources including:
			  - Landscaping businesses
			  - Nurseries

Salts	Chloride, TDS	4B[2], 5, 6, 7	- Naturally occurring salts in water supply - Saltwater swimming pool discharges
Pesticides	Pyrethroids	Bouquet Canyon	- Residential and professional use of pyrethroids as an insecticide, often to control Argentine ants[3]
	Diazinon and chlopyrifos	6	- Professional pesticide applications

Class	Constituent	Reaches/ Waterbodies	MS4 Potential Sources

Metals[2,5]	All (Copper, Iron, Mercury, Selenium, Zinc)	5,6,7	- Atmospheric deposition
			- Water supply
			- Commercial and municipal vehicle sources
			  - Gas stations, service stations and car washes
			  - Dealerships
			  - Municipal maintenance and storage yards
			- Soil concentrations, release of sediment during:
			  - Construction activities
			  - Gravel mining

	Copper	5,6,7	- Automotive sources
			  - Brake pad debris
			  - Vehicle fluids
			  - Wear on vehicle exterior and engine
			  - Tailpipe emissions
			- Architectural copper
			- Corrosion of copper pipes
			- Runoff of atmospheric deposition
			- Copper-containing pesticides and algaecides
			- Industrial uses including electroplating, metal finishing and semiconductor manufacturing

	Mercury	5,6,7	- Runoff of atmospheric deposition - Mercury containing products including batteries, dental amalgam, fluorescent lamps, jewelry, paint, thermometers and thermostats - Vehicle sources such as mercury switches and emissions that contribute to atmospheric deposition - Industrial uses including semiconductor manufacturing
	Selenium	6	- Nursery runoff - Groundwater concentrations - Mining and oil extraction
	Zinc	6	- Galvanized metal[4] - Vehicle sources such as tires
Other	Cyanide[6]	7	- Industrial uses including metal finishing, electroplating, plastics manufacturing, animal control and fumigation
Trash	Trash	Lake Elizabeth	- Litter from adjacent areas and roadways - Direct dumping

1. Los Angeles Regional Water Quality Control Board (RWQCB), 2010. Los Angeles River Watershed Bacterial TMDL. Adopted by the RWQCB on July 9, 2010.
2. Reach 4B is located in Ventura County but was considered for the purposes of understanding downstream water quality.
3. Castaic Lake Water Agency (CWLA), 2013. The Santa Clarita Valley 2013 Water Quality Report.
4. Larry Walker Associates (LWA), 2009. Urban Water Quality Management Plan for Copper, Mercury, Nickel, and Selenium in Calleguas Creek Watershed. March 25, 2009.
5. California Stormwater Quality Association (CASQA), 2014. Draft Effectiveness Assessment Guidance. May 2014.
6. California Regional Water Quality Control Board, San Francisco Bay Region, 2006. Staff Report on Proposed Site-Specific Water Quality Objectives for Cyanide for San Francisco Bay. December 4, 2006.

The Appendix A-1 includes a map of the major MS4 outfalls as part of the source assessment. No major structural controls were identified in the EWMP area.

The source assessment also identified that MS4s are not the primary source of several of the water quality priorities. As noted in both the Chloride and Nitrogen TMDLs, the primary sources of these constituents in the USCR are the wastewater treatment plants. Additionally, cyanide can be a laboratory contaminant and not many potential MS4 sources exist in the USCR EWMP area.

4.5 PRIORITIZATION

Based on the WBPC categorization and the source analysis, water quality priorities were identified. The prioritization was used to structure the process of identifying watershed control measures, conducting the RAA, and defining the adaptive management process for the EWMP.

Section VI.C.5.a.iv of the Permit identifies the minimum priorities to be considered for the first permit term (2012 to 2017) covered by the EWMP. The minimum priorities are:

- **Priority 1 (TMDLs):** TMDLs for which there are WQBELs and/or RWLs with interim or final compliance deadlines within the Permit term, or TMDL compliance deadlines that have already passed and limitations have not been achieved. This priority corresponds to WBPC categories 1A.
- **Priority 2 (Other Receiving Water Considerations):** WBPCs where data indicate impairment or exceedances of RWLs in the receiving water and the findings from the source assessment implicate discharges from the MS4. This priority corresponds to WBPC categories 2A and 3A.

In addition to the two priorities identified in the permit, Category 1B, TMDLs with deadlines beyond the current permit term were determined to be a priority for the USCR EWMP group and are considered Priority 1. The prioritized WBPCs are shown in **Table 4-8.** The prioritized constituents were utilized to direct the development of the EWMP towards the constituents of highest concern. The prioritized constituents were used to define the RAA approach and analysis and are the drivers for identification of control measures. Further discussion of how the prioritized constituents were utilized in the RAA is described in Section 6.

Table 4-8. Prioritized WBPCs

Class	Constituent	Santa Clara River Reach				Lake Elizabeth
		4B[1]	5	6	7	
Priority 1: TMDLs[2]						
Bacteria	*E. Coli* (wet and dry)	X	X	X	X	
Salts	Chloride	X	X	X		
Trash	Trash					X
Priority 2: Other Receiving Water Considerations[2,3]						
Metals	Copper		X[4]	X	X[6]	
	Iron		X	X		
	Mercury		X[4]	X[5]	X[6]	
	Zinc			X[5]		
Selenium	Selenium			X[5]		
Cyanide	Cyanide			X[5]	X[6]	
Salts	TDS		X[4]			

1. Reach 4B is in Ventura County but was considered for the purposes of understanding downstream water quality.
2. Constituents with no exceedances within the past 5 years and WBPCs located in areas where MS4s are not a source contributing to the exceedances (categories 1D, 1E, 2C, 2D, 3C) are not considered to be priorities for the EWMP. Nitrogen compounds for SCR Reach 5, and chlorpyrifos and diazinon for Reach 6 are not prioritized for this reason.
3. Constituents contributing to impairments in Category 2B (e.g. toxicity, organic enrichment, etc.) are not yet identified and therefore cannot be specifically evaluated in the RAA analysis, and are not prioritized at this time.
4. Copper, mercury and TDS have been observed as exceeding applicable water quality objectives in Reach 5, and are prioritized as "other receiving water considerations" per Permit Provision 5.a.iv.2.a.
5. Mercury, zinc, selenium and cyanide have been observed as exceeding applicable water quality objectives in Reach 6, and are prioritized as "other receiving water considerations" per Permit Provision 5.a.iv.2.a.
6. Copper, mercury and cyanide have been observed as exceeding applicable water quality objectives in Reach 7, and are prioritized as "other receiving water considerations" per Permit Provision 5.a.iv.2.a.

Categories without recent exceedances and WBPCs located in areas where MS4s are not a source contributing to the exceedances (categories 1D, 1E, 2C, 2D, 3C) are not considered to be priorities for the EWMP. Constituents within these categories have not had exceedances within the past 5 years, and are considered to be no longer exceeding water quality objectives, or MS4s were determined to not be the source because the exceedances occur in areas where there is no MS4 infrastructure. However, the RAA analysis addresses all of the WBPCs for which MS4s are contributing (1D, 2C, 3C and 3D) and demonstrates they will likely be addressed by the control measures identified for the prioritized constituents. Additionally, the constituents contributing to the impairments in Category 2B (e.g. toxicity, organic enrichment, etc.) are not yet identified and therefore cannot be specifically evaluated in the RAA analysis. As noted in the source assessment, controlling constituents identified as water quality priorities, such as pesticides and nutrients, may also contribute to reducing the Category 2B impairments and the EWMP is focused on addressing the constituents identified in the other categories. If the impairments continue after the other water quality priorities are addressed, further investigation will be conducted to identify control measures to address the remaining impairment(s).

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March 29, 2017

ATTN: Jun Zhu
Los Angeles Regional Water Quality Control Board
320 W 4th Street, Suite 200
Los Angeles, CA 90013

Submitted via email

Re: Comment Letter – Revisions to the Los Angeles Region 303(d) List

Dear Dr. Zhu,

Farm Bureau of Ventura County (FBVC) appreciates the opportunity to provide comments on the proposed revisions to the Clean Water Act Section 303(d) list of impaired waterbodies in the Los Angeles Region [hereinafter referred to as the 303(d) list], which was distributed for public review on February 8, 2017.

Farm Bureau manages the Ventura County Agricultural Irrigated Lands Group (VCAILG), which acts as a unified discharger group for Ventura County farmers complying with the *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Agricultural Lands within the Los Angeles Region* (Order No. R4-2016-0143). This order, also known as the Conditional Waiver, incorporates requirements that provide for agriculture's compliance with total maximum daily load (TMDL) allocations. Farm Bureau also serves as a stakeholder representative in watershed groups within Ventura County and collaborates on TMDL development and implementation.

Approximately 98 of the new 303(d) listings being proposed by the Los Angeles Regional Water Quality Control Board (Regional Board) are in Ventura County, and many are apparently driven by data collected through VCAILG's Conditional Waiver monitoring program. We have reviewed these proposed listings, and found numerous factual and legal errors that must be corrected. In some cases, the errors or ambiguities in the proposed listings are such that we and our technical consultants found it impossible to properly analyze them.

The development and implementation of TMDLs represents a significant investment of our members' resources, and compliance imposes a significant burden on agricultural operators, so it is critical that the 303(d) list be based on sound science and methodologies. We therefore ask that the issues identified in this letter be addressed, and that the proposed 303(d) list be revised and released for another 60-day comment period before adoption.

The requested modifications fall into four general categories:

1. New Category 4 and 5 listings that should not be listed due to incorrect thresholds being applied for the beneficial use and incorrect interpretation of the data (e.g. mismatched units, incorrectly assigned sample locations). This comment category also addresses the issue of

agricultural drains and ditches — which are not legally recognized as waterbodies — being inappropriately included in the listings.
2. Potential delistings that may be justified if all watershed data were evaluated (e.g. TMDL monitoring program and all wastewater treatment plant NPDES monitoring).
3. New Category 5A listings that should be categorized as Category 5B because TMDLs already exist to address the pollutants.
4. Errors in the listing information that make it difficult to fully evaluate the listings. Examples include inconsistencies between the Category 5 list (Appendix B) and the Proposed updates to the 303(d) list (Appendix A), incorrect HUC/Calwater designations, incorrect beneficial uses listed for the applicable water quality objectives, and inconsistent use of thresholds for interpreting narrative objectives.

The remaining sections of this letter provide the detailed list of requested changes to the 303(d) list and the rationale for the requests. In summary, FBVC requests that all waterbody pollutant combinations in **Table 1** not be listed on the 303(d) list, that waterbody pollutant combinations in **Table 3** and **Table 4** be designated as being addressed by a TMDL if they remain on the 303(d) list after the reassessment, and the errors and inconsistencies identified in Comment IV be addressed for all waterbodies. Furthermore, FBVC supports the 303(d) list comment letter submitted by the Stakeholders Implementing TMDLs in the Calleguas Creek Watershed.

I. REQUESTED MODIFICATIONS TO THE LISTING STATUS

Based on a review of the proposed Category 4 and 5 waterbody pollutant combinations, FBVC has identified a number of waterbodies that we feel should either be delisted based on available data, or which should not be listed based on errors in the evaluation. The requested modifications are shown in **Table 1**, below, with a summary of the justifications for the requested change. A detailed discussion of each of the justifications follows the table.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody segment	Pollutant	Justification
Boulder Creek (Ventura County)	Chlordane	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. • J-flagged data incorrectly used in assessment (WARM).
Boulder Creek (Ventura County)	Nitrogen, Nitrate	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Boulder Creek (Ventura County)	Specific Conductivity	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Boulder Creek (Ventura County)	Toxicity	• Listed based on toxicity observed during a single sampling event (6/4/07). According to the Listing Policy, a larger number of samples is required to justify this listing.

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody segment	**Pollutant**	**Justification**
McGrath Lake Agricultural Drain	Bifenthrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
McGrath Lake Agricultural Drain	Chlordane	• Data from agricultural drain rather than waterbody used as basis for listing decision. • This pollutant is already covered by the McGrath Lake PCBs, Pesticides and Sediment Toxicity TMDL.
McGrath Lake Agricultural Drain	Chlorpyrifos	• Data from agricultural drain rather than waterbody used as basis for listing decision.
McGrath Lake Agricultural Drain	DDT	• Data from agricultural drain rather than waterbody used as basis for listing decision. • This pollutant is already covered by the McGrath Lake PCBs, Pesticides and Sediment Toxicity TMDL.
McGrath Lake Agricultural Drain	Toxaphene	• Data from agricultural drain rather than waterbody used as basis for listing decision. • This pollutant is already covered by the McGrath Lake PCBs, Pesticides and Sediment Toxicity TMDL.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	DDD	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	DDE	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Dimethoate	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Nitrogen, Nitrate	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Specific Conductivity	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody segment	**Pollutant**	**Justification**
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Total Dissolved Solids	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. • Salts criteria do not apply below Potrero Rd.
Calleguas Creek Reach 3 (Potrero Road upstream to Conejo Creek confluence)	Mercury	• Data and objectives have different units (ng/L vs. µg/L); data do not exceed objectives.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Ammonia	• Data from agricultural drain rather than waterbody used as basis for listing decision. • TMDL data demonstrates delisting possible.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Bifenthrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Chloride	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Cyfluthrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Cypermethrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Malathion	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Mercury	• Data and objectives have different units (ng/L vs. µg/L); data do not exceed objectives.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Nitrogen, Nitrate	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Permethrin	• Data from agricultural drain rather than waterbody used as basis for listing decision. • This pollutant is already covered by the Calleguas Toxicity TMDL.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Specific Conductivity	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Sulfates	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody segment	**Pollutant**	**Justification**
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Total Dissolved Solids	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Chlorpyrifos	• Data does not appear to be from a station in Reach 12.
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Diazinon	• Data does not appear to be from a station in Reach 12.
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Malathion	• Data does not appear to be from a station in Reach 12.
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Temperature, water	• Inappropriately applied beneficial use criteria (see temperature comment below)
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Nitrogen, Nitrate	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. *
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Nitrogen	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. *
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Sulfate	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. *
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Specific Conductivity	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Total Dissolved Solids	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No. 2	Toxaphene	• J-flagged data incorrectly used in assessment.

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody segment	**Pollutant**	**Justification**
Ellsworth Barranca	DDE	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. • J-flagged data incorrectly used in assessment.
Fox Barranca	DDE	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Honda Barranca[1]	DDD	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Honda Barranca[1]	DDE	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Rio De Santa Clara/Oxnard Drain No. 3	Nitrogen, Nitrate	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Rio De Santa Clara/Oxnard Drain No. 3	Nitrogen	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Rio De Santa Clara/Oxnard Drain No. 3	Sulfate	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Rio De Santa Clara/Oxnard Drain No. 3	Specific Conductivity	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Rio De Santa Clara/Oxnard Drain No. 3	Total Dissolved Solids	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Rio De Santa Clara/Oxnard Drain No. 3	Toxicity	• Insufficient exceedances to warrant listing.
La Vista Drain (Ventura County)	Chlordane	• Data from agricultural drain rather than waterbody used as basis for listing decision. • J-flagged data incorrectly used in assessment.
La Vista Drain (Ventura County)	Chlorpyrifos	• Data from agricultural drain rather than waterbody used as basis for listing decision.

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody segment	**Pollutant**	**Justification**
La Vista Drain (Ventura County)	Copper	• Data from agricultural drain rather than waterbody used as basis for listing decision.
La Vista Drain (Ventura County)	DDD	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody
La Vista Drain (Ventura County)	DDE	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody
La Vista Drain (Ventura County)	DDT	• Data from agricultural drain rather than waterbody used as basis for listing decision.
La Vista Drain (Ventura County)	Indicator Bacteria	• Data from agricultural drain rather than waterbody used as basis for listing decision.
La Vista Drain (Ventura County)	Mercury	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Data and objectives have different units (ng/L vs. µg/L); data do not exceed objectives.
Santa Clara Drain	Chlordane	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara Drain	Chlorpyrifos	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara Drain	Cypermethrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara Drain	DDD	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using COMM criteria; public access is prohibited by chain link fencing and locked gates.
Santa Clara Drain	DDE	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using COMM criteria; public access is prohibited by chain link fencing and locked gates.
Santa Clara Drain	DDT	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using COMM criteria; public access is prohibited with chain link fencing and locked gates.

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody segment	**Pollutant**	**Justification**
Santa Clara Drain	Nitrogen, Nitrate	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Santa Clara Drain	Specific Conductivity	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Santa Clara Drain	Sulfates	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara Drain	Total Dissolved Solids	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Santa Clara Drain	Toxaphene	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara River Reach 3	Chlordane	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara River Reach 3	Chlorpyrifos	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara River Reach 3	Cyfluthrin	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Criterion listed is for 2,4,5-TP, not cyfluthrin.
Santa Clara River Reach 3	Cypermethrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara River Reach 3	DDD	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Santa Clara River Reach 3	DDE	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Santa Clara River Reach 3	DDT	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara River Reach 3	Mercury	• Data and objectives have different units (ng/L vs. µg/L); data do not exceed objectives.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody segment	Pollutant	Justification
Tapo Canyon	Chlordane	• Includes LOE for toxicity to support the chlordane listing. This LOE should be removed since there is a separate LOE specifically for toxicity.
Tapo Canyon	DDD	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. • Includes LOE for toxicity to support the DDD listing. This LOE should be removed since there is a separate LOE specifically for toxicity.
Tapo Canyon	DDE	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. • Includes LOE for toxicity to support the DDE listing. This LOE should be removed since there is a separate LOE specifically for toxicity.
Tapo Canyon	Nitrogen, Nitrate	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Tapo Canyon	Specific Conductivity	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Wheeler Canyon/Todd Barranca	Chlordane	• J-flagged data incorrectly used in assessment. • Includes LOE for toxicity to support the chlordane listing. This LOE should be removed since there is a separate LOE specifically for toxicity.
Wheeler Canyon/Todd Barranca	Specific Conductivity	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Ventura River Reach 3	Mercury	• Data and objectives have different units (ng/L vs. μg/L); data do not exceed objectives.

*Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2 and Rio De Santa Clara/Oxnard Drain No. 3 are not listed in the Basin Plan and therefore do not have assigned beneficial uses but they are tributaries to Mugu Lagoon which does not have a MUN beneficial use and are brackish waterbodies that would not support the MUN beneficial use.
1. Please review the name of this waterbody, our understanding is that it is Hondo Barranca.

1. Agricultural Drain monitoring data incorrectly used as basis for listing decisions.

There are multiple instances where VCAILG monitoring data from agricultural drains that discharge to waterbody reaches were used to list these waterbody reaches. The drains are not listed tributaries or waterbodies in the Basin Plan and are not located within the waterbody that is being listed. As a result, the data should not be used for the listing decisions for these waterbodies. Calleguas Creek Reach 2 and Reach 4 were listed using data from the VCAILG monitoring sites 02D_BROOM (Reach 2) and 04D_ETTG and 04D_LAS (Reach 4), which are the locations of agricultural drains which drain to Reach 2 and 4. Santa Clara River Reach 3 was listed using data from the VCAILG sampling location S03D_BARDS, which is located on an agricultural drain that ultimately discharges into Santa Clara River Reach 3. These agricultural monitoring sites were selected to be representative of agricultural discharges to Calleguas Creek Reaches 2 and 4 and Santa Clara River Reach 3, and are not representative of receiving water conditions. Therefore, data collected from these sites cannot be used to list the downstream Calleguas Creek or Santa Clara River Reaches. All listings should be evaluated to ensure that the monitoring locations were in receiving waters rather than agricultural drains.

In addition, La Vista Drain and Santa Clara Drain were listed as new waterbodies never before included in the previous 303(d) list, even though data has been collected on both agricultural drains by the MS4 program since the early 1990s. These waterbodies are not designated in the Basin Plan or listed as tributaries in the Basin Plan appendices. The La Vista Drain is an agricultural drain designed to convey excess agricultural irrigation water from agricultural lands, and as such, it is predominantly an open ditch that flows alongside W. Los Angeles Avenue and then along Santa Clara Avenue where it becomes the Santa Clara Drain.

Additionally, inclusion of the COMM beneficial use for the Santa Clara Drain is inappropriate, as public access is prohibited because of fencing and locked gates maintained by the Ventura County Watershed Protection District. It is inappropriate to apply the MAR and EST beneficial uses to the Santa Clara Drain because the drain is located upstream of Highway 101 and is not tidally influenced. The monitoring location on each drain was selected to represent agricultural discharges for the Agricultural Waiver and was not designed to characterize receiving waters. Because these are agricultural drains and not tributaries, they should be removed from the Draft Category 5 list.

McGrath Lake Agricultural Drain is also an agricultural drain comprised of a small open ditch that conveys water from surrounding agricultural lands. A monitoring site was selected on this drain for VCAILG Conditional Waiver monitoring to represent agricultural discharges and was not designed to characterize receiving waters. Moreover, discharges from this drain are already being addressed under the McGrath Lake PCBs, Pesticides and Sediment Toxicity TMDL, which has identified this drain as the "Central Ditch" (the Monitoring Program for the Conditional Waiver also identifies this monitoring site as the Central Ditch). Implementation activities that reduce loadings of chlorinated pesticides and PCBs will also reduce loadings of toxaphene, bifenthrin and chlorpyrifos. For the foregoing reasons, McGrath Lake Agricultural Drain should be removed from the Draft Category 5 list.

Requested Action:

- **Remove all listings shown in Table 1 that were based on VCAILG Conditional Waiver monitoring data from agricultural drains not representative of the listed waterbody, and evaluate remaining listings to ensure no other listings are based on agricultural drain monitoring rather than receiving water monitoring.**
- **Remove La Vista Drain and Santa Clara drain from the list as they are agricultural drains and not waterbodies that fall under the jurisdiction of the 303(d) list.**

- **Remove the McGrath Lake Agricultural Drain because it is not a waterbody that falls under the jurisdiction of the 303(d) list, and because there is an effective TMDL that addresses discharges from this agricultural drain ("Central Ditch") to McGrath Lake.**

2. Remove any pollutant listing based on municipal drinking water objectives where the MUN beneficial use does not apply.

Numerous listings were based on water quality objectives for the protection of municipal drinking water for waterbodies that do not have applicable municipal drinking water beneficial uses. Many of the waterbodies listed are brackish waterbodies for which no beneficial uses are designated, or waterbodies designated for the municipal beneficial use with an asterisk (i.e., P*) in the Basin Plan. The asterisked MUN beneficial use should not be used to propose new 303(d) listings. Fact sheets for previous 303(d) listing cycles have clearly noted that the asterisked MUN beneficial uses should not be used for 303(d) listing purposes.

State Board Resolution No. 88-63 (Sources of Drinking Water) and Regional Board Resolution 89-03 Incorporation of Sources of Drinking Water Policy into the Water Quality Control Plans) state, "All surface and ground waters of the State are considered to be suitable, or potentially suitable, for municipal or domestic waters supply and should be so designated by Regional Boards… (with certain exceptions which must be adopted by the Regional Board)." The Regional Board adopted a Water Quality Control Plan for the Los Angeles Region (Basin Plan) on June 4, 1994, that included provisions to implement State Water Board Resolution 88-63.

On May 26, 2000, the USEPA approved the revised Basin Plan, except for the implementation plan for potential MUN-designated water bodies. On August 22, 2000, the City of Los Angeles, City of Burbank, City of Simi Valley, and the County Sanitation Districts of Los Angeles County challenged USEPA's water quality standards action in the U.S. District Court. On December 18, 2001, the court issued an order remanding the matter to USEPA to take further action on the 1994 Basin Plan consistent with the court's decision. On February 15, 2002, USEPA revised its decision and approved the 1994 Basin Plan in whole. In its February 15, 2002 letter, USEPA stated:

> *"EPA bases its approval on the court's finding that the Regional Board's identification of waters with an asterisk ("*") in conjunction with the implementation language at page 2-4 of the 1994 Basin Plan, was intended "to only conditionally designate and not finally designate as MUN those water bodies identified by an ('*') for the MUN use in Table 2-1 of the Basin Plan, without further action." Court Order at p. 4. Thus, the waters identified with an ("*") in Table 2-1 do not have MUN as a designated use until such time as the State undertakes additional study and modifies its Basin Plan. Because this conditional use designation has no legal effect, it does not constitute a new water*

quality standard subject to EPA review under section 303(c)(3) of the Clean Water Act ("CWA"). 33 U.S.C. § 1313(c)(3)."[1]

In addition to the above decision, the Basin Plan states that until the additional study is undertaken and the Basin Plan is modified, "no new effluent limitations will be placed in Waste Discharge Requirements as a result of these designations". The Regional Board has also determined that water quality objectives applicable to the MUN beneficial use will not be used to assess impairments under the 303(d) listing programs. For constituents that only have objectives that are applicable to the MUN beneficial use, the decision fact sheets for the 303(d) listing process state that there are no applicable water quality objectives in waterbodies designated with an asterisk ("*"). In the 2010 listing cycle, a number of 303(d) listings were actually removed based on this determination. Below is an example of the language from a listing decision for Los Angeles River Reach 1:

"The listing for aluminum in this water body was originally based on data assessed using the MCL for aluminum. Since MUN is a "potential" beneficial use, it is not appropriate to use the MCL to evaluate aluminum data from this reach. Thus, there is no aluminum objective for this reach and the original listing is faulty."

Based on this evidence, it is clear that for waterbodies with a MUN designation that includes an asterisk ("*"), water quality objectives specific to the MUN beneficial use are not applicable. As such, water quality data collected in these receiving waters should not be compared to water quality objectives applicable to the MUN beneficial use.

The listings of total dissolved solids, sulfates, and conductivity are all based on secondary maximum contaminant levels applied to protect the MUN beneficial use. In addition, Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2 and Rio De Santa Clara/Oxnard Drain No. 3 are maintained as fresh/brackish water via tide gates on both drains and do not have designated MUN beneficial uses. Therefore, the listing of TDS, sulfate, and specific conductivity is inappropriate, as naturally occurring levels of these three constituents in groundwater entering both drains within the footprint of Naval Base Ventura County far exceed the secondary MCLs upon which these listings are based.

USEPA validated this reasoning in its "TMDLs for Pesticides, PCBs and Sediment Toxicity for Oxnard Drain 3",[2] where the MUN beneficial use was not considered to be "relevant to the impairments" addressed by the TMDL and so was not included in the TMDL. Additionally, Calleguas Creek Reach 2 and Reach 4 are considered brackish waterbodies according to the California Toxics Rule thresholds and are designated with an asterisked MUN beneficial use. Due to the brackish nature of these waterbodies, other Basin Plan objectives for TDS and sulfate are not considered to be applicable to Reach 2 or Reach 4 below Laguna Road. For all of these reasons, these proposed listings summarized in **Table 1** should be removed.

[1] Language adapted from the 2014 National Pollutant Discharge Elimination System permit findings for wastewater treatment plants in the Calleguas Creek Watershed.
[2] Total Maximum Daily Loads for Pesticides, PCBs, and Sediment Toxicity in Oxnard Drain 3. Approved by USEPA on October 6, 2011.

The proposed Calleguas Creek Reach 2 dimethoate listing was based on three lines of evidence, which the Fact Sheet states all show no exceedances (this appears to be a typo). However, it appears that the only line of evidence that shows an exceedance is based on the potential (P*) MUN, which, as described above, cannot be used to justify a listing. Furthermore, the fact sheet cites a guideline from the California Department of Health Services Notification Levels (1 µg/L) which has not yet gone through the formal MCL regulatory process, and it is not clear that this threshold would meet the Listing Policy requirements.

Requested Action:

- **Revise all of the new listings in the fact sheets to ensure that none are based on municipal drinking water objectives when the MUN beneficial use does not apply.**
- **Remove the segment-pollutant combinations for total dissolved solids, specific conductivity, sulfates, nitrogen, nitrate, dimethoate, and other MUN-based pollutants listed in Table 1 above from the 303(d) list.**

3. Reassess mercury listings using correct objective and correct units.

The data used to assess mercury for Calleguas Creek Reach 3, Reach 4, La Vista Drain, Santa Clara Reach 3, and Ventura River Reach 3 are in ng/L and the objective is in µg/L. The data have to be converted to the same units as the objective before an exceedance can be determined. Our consultants believe that after this calculation has been performed, the waterbodies will no longer meet the listing guidelines for mercury. Additionally, although a California Toxics Rule objective exists for mercury, an EPA nationally recommended criterion was used for the assessment. Regional Board staff should explain why they used a recommended criterion instead of an established water quality objective.

Requested Action:

- **Repeat the mercury analysis after correcting the units error.**

4. Remove toxicity Lines of Evidence (LOE) from pollutant fact sheets when an LOE specifically for toxicity already exists.

Numerous pollutants listed for Calleguas Creek Reach 3, Tapo Canyon and Wheeler Canyon/Todd Barranca include an LOE to support the pollutant listing, when a toxicity LOE already exists for the waterbody. These pollutant-specific toxicity LOEs include no scientific evidence that the specific pollutant was the cause of observed toxicity and so should be removed from the fact sheet. The toxicity LOE listed for the waterbody is sufficient as it is intended to identify the cause of observed toxicity through established and accepted methodologies.

5. Incorrect location and data were used for listings in Reach 12.

The name of the monitoring site presented in the fact sheet for chlorpyrifos, diazinon and malathion listings in Calleguas Creek Reach 12 is unclear. The University site is in Reach 3, not 12, and TO1 is an MS4 discharge characterization site, not a receiving water monitoring location. Therefore, TO1 should not be used for a 303(d) listing decision, and University data are not from Reach 12. A review of the datasets provided in the link on the fact sheet only show data from University (ME-CC) and the number of samples appears to match up with the sample numbers shown in the fact sheet. As a result, it appears that the chlorpyrifos, diazinon and malathion listings do not apply to Reach 12.

In addition, FBVC requests that only data collected after applicable pesticide-use restrictions were in place for these pesticides be considered in the listing decisions. Data from the Calleguas Creek TMDL watershed monitoring program that were not used in the assessment (see Comment II) demonstrate a marked reduction in these pesticides in receiving water since the use restrictions were implemented (approximately 2009 to present), particularly for receiving waters downstream of urban areas (e.g., Reach 12). Given the changed condition resulting from the pesticide-use restrictions, monitoring data collected prior to 2009 are not representative of current waterbody conditions for these constituents. Therefore, these constituents should not be listed unless data collected after the use restrictions were implemented demonstrates continued impairment.

Requested Action:

- **Remove listings for Reach 12 that are not based on receiving water data from that reach.**
- **Remove listings for chlorpyrifos, diazinon, and malathion based on historic data that are not representative of conditions after implementation of pesticide-use restrictions.**

6. Ensure no J-flagged data were used in the assessment.

The listing policy specifically prohibits the use of J-flagged ("estimated") data that fall below the quantitation limit but above the water quality standard. Section 6.1.5.5 of the Listing Policy specifically states:

> "*When the sample value is less than the quantitation limit and the quantitation limit is greater than the water quality standard, objective, criterion, or evaluation guideline, the result shall not be used in the analysis. The quantitation limit includes the minimum level, practical quantitation level, or reporting limit.*"

All listings based on the use of J-flagged data should therefore be removed from the draft 303(d) list. Specific instances are included in **Table 1** and further explained in **Table 2** below, but this list is by no means inclusive; this significant error will have to be addressed by a thorough review of all listing data to confirm that no J-flagged data were used to justify listings.

Table 2. Incorrect use of J-flagged data		
Segment	**Pollutant**	**Comment**
Boulder Creek (Ventura County)	Chlordane	The LOE for Chlordane erroneously states that three out of five samples exceed the objectives. A review of the data shows that only 1 out of 5 samples exceed indicated criteria. The remaining 4 results were (1) not detected and (2) "estimated" (J-flagged) by the laboratory because results were below the reporting limit. Because only 1 sample showed an exceedance, this listing should be removed as it does not meet the binomial test limits set forth in the Listing Policy.
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No. 2	Toxaphene	The Lines of Evidence (LOE) for Toxaphene lists the number of exceedances incorrectly at two. However, only one of six samples exceeded the indicated criterion. The other sample was reported by the laboratory as "estimated" (J-flagged). Because only one of six samples showed an exceedance, this listing should be removed as it does not meet the binomial test limits set forth in the Listing Policy.
Rio de Santa Clara/Oxnard Drain No. 3	Chlordane	The LOE for Chlordane erroneously states that four out of five samples exceed the objectives. A review of the data shows that only 3 out of 5 samples exceed indicated criteria. The remaining 2 results were (1) not detected and (2) "estimated" (J-flagged) by the laboratory because results were below the reporting limit.
La Vista Drain	Chlordane	The LOE for chlordane shows that one of the samples used to justify the listing is based solely on estimated (J-flagged) data because results were below the reporting limit. Because Chlordane has only one detected value for two sampling events, more monitoring data are needed to justify the listing and the proposed listing should be removed. Additionally, refer to comment 1 regarding the inappropriateness of this drain being a listed waterbody.

Requested Action:

- **Review all fact sheets and LOEs for the use of J-flagged data and remove any instances where J-flagged data were used.**
- **Delist toxaphene for Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No. 2, chlordane for La Vista Drain (though we also disagree with the listing of this as a waterbody to begin with), and any other pollutants listed in Tables 1 and 2 that lack the minimum number of exceedances required to justify a listing.**

7. Remove listings where a waterbody assessment does not meet listing thresholds based on data provided.

Finally, the toxicity listing for Rio De Santa Clara/Oxnard Drain No. 3 does not meet the minimum requirements to be listed according to the Listing Policy (pg. 9). According to the Listing Policy, a waterbody can be listed only when the number of exceedances meets the binomial test; in the case of this waterbody, four samples were collected and only one sample showed an exceedance. However, two exceedances would be required for the waterbody to be added to the 303(d) list. Therefore, toxicity was incorrectly listed for this waterbody and should be removed entirely from the 303(d) list.

Requested Action:

- **Remove the toxicity listing for Rio De Santa Clara/Oxnard Drain No. 3, based on failure to meet listing threshold requirements in the Listing Policy.**

II. REQUESTED REASSESSMENTS USING COMPLETE DATA SET

As manager of the VCAILG program, FBVC is a stakeholder in the Calleguas Creek Watershed TMDL monitoring program and represents the agricultural responsible parties listed in the TMDLs. As such, FBVC supports the comments made by the Stakeholders Implementing TMDLs in the Calleguas Creek Watershed regarding the use of all appropriate monitoring data for the 303(d) listing process.

The assessments for the Calleguas Creek watershed do not appear to include any of the submitted Calleguas Creek Watershed TMDL monitoring data, monitoring data from the Camarillo Sanitary District, or monitoring data from the Simi Valley Wastewater Treatment Plant. All of this monitoring data has been provided to the Regional Board in annual monitoring reports and all data were collected using approved QAPPs. As a result, there is no reason why this data should not be included in the 303(d) listing process. Please refer to the letter submitted by the Calleguas Creek Watershed Stakeholders for details regarding the waterbody/pollutant combinations eligible for delisting. While this comment is specific to knowledge regarding monitoring programs in the Calleguas Creek Watershed, it should be applied to the other watersheds in Ventura County.

Requested Action:

- **Reassess all Ventura County waterbodies using all available data.**

III. REQUESTED CATEGORY ASSIGNMENT CHANGES

8. Correct pollutants listed as Category 5A that should be 5B based on coverage by an existing TMDL.

There are number of proposed new listings for pollutants that are already covered by an existing TMDL and are incorrectly categorized as 5A. Although we contend that all of these listings should be removed entirely because of the issues detailed in Comment I**,** if they are not removed they should, at a minimum, be changed from 5A to 5B as applicable.

Because discharges from the McGrath Lake Agricultural Drain (i.e., "Central Ditch") are already being addressed by the McGrath Lake PCBs, Pesticides and Sediment Toxicity TMDL (effective June 30, 2011), toxaphene should be changed from Category 5A to Category 5B. A Calleguas Creek nutrient TMDL addressing nitrogen has been in effect since 2003, including for Reach 9A where a new 5A listing for nitrite is proposed. In 2006, the Toxicity and OC Pesticide and PCBs TMDLs for the Calleguas Creek watershed were established to address chlordane, chlorpyrifos, DDT, DDE, DDD, dieldrin, PCBs, sediment toxicity, and toxaphene.

The La Vista Drain and Santa Clara Drain ultimately flow into Calleguas Creek Reach 4 (was Revolon Slough Main Branch), and although we oppose the inclusion of these listings on the grounds that they are not waterbodies, the actual receiving waters are already addressed by an OC Pesticides and PCBs TMDL, the Toxicity TMDL, the Salts TMDL, the Nitrogen TMDL, and the Metals TMDL, and therefore all of these proposed listings should be Category 5B. Furthermore, two other segments were listed for chlorpyrifos – Honda Barranca and Duck Pond Agricultural Drains – but were correctly listed as Category 5B, citing the 2006 Toxicity TMDL.

The nitrogen, nitrate listings on Boulder Creek and Tapo Canyon are being addressed under the Santa Clara River TMDL, in effect since 2004.

- We request that any listings in **Table 3** and **Table 4** that are maintained after addressing the issues in Comment I also be corrected to be designated in Category 5B.

Table 3. 303(d) Category 5A listings which should be changed to 5B listings

Segment	Pollutant	Proposed 303(d) Category	Requested 303(d) Category	Existing TMDL
McGrath Lake Agricultural Drain	Toxaphene	5A	5B	PCBs, Pesticides and Sediment Toxicity TMDL[1]
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Specific Conductivity	5A	5B	CCW Salts TMDL[2]
	Total Dissolved Solids	5A	5B	CCW Salts TMDL[2]
Calleguas Creek Reach 3 (Potrero Road upstream to Conejo Creek)	Mercury	5A	5B	CCW Metals TMDL[3]
Calleguas Creek Reach 4	Mercury	5A	5B	CCW Metals TMDL[3]
	Specific Conductivity	5A	5B	CCW Salts TMDL[2]
	Total Dissolved Solids	5A	5B	CCW Salts TMDL[2]
	Sulfates	5A	5B	CCW Salts TMDL[2]
Calleguas Creek Reach 9A	Nitrogen, Nitrite	5A	5B	CCW Nitrogen TMDL[4]
Calleguas Creek Reach 12	Chlorpyrifos	5A	5B	CCW Toxicity TMDL[5]
	Diazinon	5A	5B	CCW Toxicity TMDL[5]
Honda Barranca	DDT	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
Fox Barranca	DDE	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
Rio De Santa Clara/Oxnard Drain No. 3	Toxicity	5A	5B	Oxnard Drain #3 Pesticides, PCBs, Sediment Toxicity TMDL[7]
La Vista Drain (Ventura County)	Chlorpyrifos	5A	5B	CCW Toxicity TMDL[5]
	Chlordane	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
	DDT	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
	DDE	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
	DDD	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
	Copper	5A	5B	CCW Metals TMDL[3]
	Mercury	5A	5B	CCW Metals TMDL[3]

Segment	Pollutant	Proposed 303(d) Category	Requested 303(d) Category	Existing TMDL
Santa Clara Drain	Chlordane	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
	Chlorpyrifos			CCW Toxicity TMDL[5]
	DDD	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
	DDE	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
	DDT	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
	Nitrogen, Nitrate	5A	5B	CCW Nutrients TMDL[4]
	Specific Conductivity	5A	5B	CCW Salts TMDL[2]
	Sulfates	5A	5B	CCW Salts TMDL[2]
	Total Dissolved Solids	5A	5B	CCW Salts TMDL[2]
	Toxaphene	5A	5B	CCW OC Pesticides and PCBs TMDL[6]
Tapo Canyon	Nitrogen, Nitrate	5A	5B	Santa Clara River Nitrogen TMDL[8]
Boulder Creek (Ventura County)	Nitrogen, Nitrate	5A	5B	Santa Clara River Nitrogen TMDL[8]

1. The McGrath Lake PCBs, Pesticides and Sediment Toxicity TMDL. RS 2009-006. Approved by USEPA on June 30, 2011.
2. The Calleguas Creek Watershed Salts TMDL. RS 2007-016. Approved by USEPA on December 2, 2008.
3. The Calleguas Creek Watershed Metals TMDL. RS 2006-012. Approved by USEPA on March 26, 2007.
4. The Calleguas Creek Nitrogen TMDL. RS 2002-017. Approved by USEPA on June 20, 2003.
5. The Calleguas Creek, Its Tributaries, and Mugu Lagoon Toxicity, Chlorpyrifos and Diazinon TMDL. RS 2005-009. Approved by USEPA on March 24, 2006.
6. Total Maximum Daily Load for Organochlorine Pesticides, Polychlorinated Biphenyls, and Siltation in Calleguas Creek, its Tributaries and Mugu Lagoon. RS 2005-010. Approved by USEPA on March 24, 2006.
7. Total Maximum Daily Loads for Pesticides, PCBs, and Sediment Toxicity in Oxnard Drain 3. Approved by USEPA on October 6, 2011.
8. Santa Clara River Nitrogen Compounds TMDL RS 2003-011. Effective on March 23, 2004.

In addition, we believe the Calleguas Creek Watershed Toxicity TMDL should cover all new listings in the watershed for pyrethroids and organophosphate pesticides (e.g., malathion), if they are not removed as requested in the first comment. The Toxicity TMDL includes a trigger for additional investigation if ongoing toxicity is identified in the watershed. The toxicity trigger has resulted in the identification of pyrethroids as a potential cause of toxicity, and the Conditional Waiver includes a bifenthrin water quality benchmark triggering management practice implementation in response to exceedances, in addition to the organophosphate pesticides included in the TMDL. Additionally, the structure of the TMDL is designed to proactively prevent toxicity and therefore it is not necessary to develop another TMDL for these constituents. As a result, if the waterbodies are placed on the 303(d) list as new listings, we request that the waterbodies in **Table 4** be moved from 5A to 5B.

Table 4. Pyrethroid and Organophosphate listings covered by the existing Toxicity TMDL[1]

Segment	Pollutant	Proposed 303(d) Listing Category	Requested 303(d) Listing Category
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Bifenthrin	5A	5B
	Cyfluthrin	5A	5B
	Cypermethrin	5A	5B
	Malathion	5A	5B
	Permethrin	5A	5B
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Malathion	5A	5B
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Bifenthrin	5A	5B
Honda Barranca	Bifenthrin	5A	5B
Santa Clara Drain	Cypermethrin	5A	5B

1. The Calleguas Creek, Its Tributaries, and Mugu Lagoon Toxicity, Chlorpyrifos and Diazinon TMDL. RS 2005-009. Approved by USEPA on March 24, 2006.

Requested Action:

- **Change all pollutant-waterbody segment combinations in Table 3 and Table 4 from 5A to 5B or 4A based on coverage by an existing USEPA approved TMDL.**

9. Remove waterbody-pollutant combinations for agricultural drains listed as Category 2.

Two new agricultural drains were included inappropriately on the Category 2 list (i.e., assessed for listing) and should be removed: Drain Along Gerry Road to Calleguas Creek Reach 9, and Oxnard Drain.

The Gerry Road agricultural drain is a small drainage ditch with intermittent flows that exists solely to collect non-potable water from the adjacent agricultural lands before it drains into Calleguas Creek Reach 9; it is not a tributary to Calleguas Creek Reach 9. A VCAILG monitoring site was selected on this drain to be representative of agricultural discharges to Calleguas Creek Reach 9 and is not representative of receiving water conditions. Accordingly, neither the MUN beneficial use nor the MAR beneficial uses apply to this agricultural drain.

The new listing for Oxnard Drain also should be removed from the Draft Category 2 list. The monitoring site indicated for this drain is located in the Ormond Beach Wetlands area where flows from the Hueneme Drain, the J St. Drain (now "Chumash Creek")[3], and the Oxnard Industrial Drain (formerly known as the Oxnard Drain but now known as the "Ormond Lagoon Waterway") commingle. In order to list the "Ormond Lagoon Waterway" (formerly the Oxnard Industrial Drain), a monitoring station would have to be established on that channel upstream of the wetlands area to ascertain water quality in that waterbody.

IV. ADDRESS ALL OTHER INCONSISTENCIES AND ERRORS IN LIST

FBVC's staff and consultants have identified a large number of inconsistencies and issues in the list that should all be addressed prior to adoption. The summary below provides examples of issues identified. The list is not comprehensive, because in many cases the information provided made it difficult or impossible to conduct a proper analysis.

10. Correct Appendix G fact sheets.

The Appendix G fact sheets often include incorrect information and discussion. While most of the identified issues do not appear to impact the listing decisions, they make the review of information difficult. Examples of errors found include:

- Incorrect Evaluation Guideline and Guideline Reference. For example, the Evaluation Guideline (i.e., criterion) provided for cyfluthrin (a pyrethroid) in LOEs 84065, 83200 and 88712 actually is for the chlorinated herbicide 2,4,5-TP. The stated criterion (29 mg/L) was not found in the cited Guideline Reference. Many additional instances were noted in LOEs for phorate, dimethoate, disulfoton, endosulfan sulfate, and many other LOEs. Because the numeric guidelines (and reference documents from which these are obtained) form the basis for any listing, it is critical that these be carefully reviewed and verified prior to issuing the final fact sheets and 303(d) list.
- Incorrect beneficial uses assigned to objectives. For example, MUN beneficial uses listed when aquatic life objectives are presented in the fact sheet.
- Incorrect beneficial uses assigned to a waterbody. For example, MUN beneficial uses assigned to a tidally influenced waterbody (e.g., Duck Ponds Agricultural Drain), and MAR and EST beneficial uses assigned to a waterbody that is too far upstream to be tidally influenced (e.g., Wheeler Canyon/Todd Barranca).
- Incorrect TMDLs assigned to a pollutant. For example, for chlordane in Calleguas Creek Reach 2, the applicable TMDL is listed as the Calleguas Creek Metals TMDL. It should be the Organochlorine Pesticides, PCBs, and Siltation TMDL.
- Incorrect QAPPs identified. For example, the VCAILG QAPP is often referenced for the Ventura County MS4 monitoring data set.
- Incorrect number of samples evaluated and incorrect number of criteria exceedances. For example, the number of samples evaluated for toxaphene on the Rio de Santa Clara/Oxnard Drain No. 3 and on Wheeler Canyon/Todd Barranca is identified as 2 samples, whereas data files obtained from the Regional Board website contain 5 samples for the date range indicated in fact sheets, including 3 samples with results of "ND". Stating in fact sheets that a pollutant exceeds criteria in 100% of samples, instead of the

[3] On November 2, 2015, Ventura County Watershed Protection District renamed two drains in Oxnard: The Oxnard Industrial Drain ("Oxnard Drain") was renamed "Ormond Lagoon Waterway", and the J St. Drain was renamed "Chumash Creek". Regional Board staff should update their records accordingly.

true figure of 40%, conveys an inflated impression of the degree of impairment by that pollutant in a waterbody. The inclusion of J-flagged data when enumerating exceedances (e.g., for chlordane in the same waterbodies) further exacerbates these numbering inaccuracies.

Requested Action:

- **Correct the Appendix G fact sheets for errors such as incorrectly assigned beneficial uses, existing TMDLs, QAPPs, and number of samples / number of exceedances.**

11. Correct the Appendices and Fact Sheet Categories.

Appendix A, Appendix B, Appendix C, and Appendix G are inconsistent, which makes the analysis of new additions very difficult since it is unclear which segment-pollutant combinations actually are new listings. Following are examples of a number of identified issues that need to be corrected to allow FBVC to fully vet and understand the proposed listings.

A number of proposed "name changes" in Appendix A are not shown in Appendix B and there are no associated fact sheets describing the name change (e.g., Reach 4 listings for chlorpyrifos and total DDT). This makes it very challenging to assess the validity or basis for the name change. In other instances, listed name changes are found in Appendix B or C but not supported by an explanation for the name change in Appendix G. The fact sheets for the following name changes should provide justification or explanation for the name change, as many appear to be switching tissue or sediment listings to water listings. If this is in fact the change being made, justification for the water listing needs to be provided in the fact sheet. It is not appropriate to characterize changing the medium that is the basis for the listing as a name change.

Table 5. Listed as Name Changes in Appendix A

CCW Segment	Pollutants
Reach 1	Toxicity
Reach 2	Chlordane, endosulfan, toxaphene
Reach 4	Chlorpyrifos (tissue), fecal coliform, total DDT
Reach 12	DDT (tissue), ammonia
Rio De Santa Clara/Oxnard Drain No. 3	Toxicity
Duck Pond	ChemA

There are a number of inconsistencies where Appendix A does not include all of the new 2014 listings found in Appendix B. Below are a few examples of such inconsistencies.

Table 6. Incorrectly listed waterbody segment-pollutant combinations

Segment	Pollutant	Issue
La Vista Drain	DDT	Not included as a new change in Appendix A but listed as a new 2014 5A listing in Appendix B.
Honda Barranca	Bifenthrin	Not included as a new change in Appendix A but listed as a new 2014 5A listing in Appendix B.
Rio De Santa Clara/Oxnard Drain No. 3	Total Dissolved Solids	Not included as a new change in Appendix A but listed as a new 2014 5A listing in Appendix B.
	Toxicity	Listed only as a “name change” in Appendix A but listed as a new 2014 5A listing in Appendix B.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Indicator Bacteria	Not included as a new change or “name change” in Appendix A but listed as a new 2014 5A listing in Appendix B. Please clarify if this is a new listing or a “coliform bacteria” name change as described for Calleguas Reaches 6, 9A, 10, and 11.
	PCBs	Not included as a new change in Appendix A but listed as a new 2014 5B listing in Appendix B.
	Toxicity	Not included as a new change in Appendix A but listed as a new 2014 5B listing in Appendix B.
	ChemA	Not included as a new change in Appendix A but listed as a new 2014 5B listing in Appendix B despite cited as a historical use of pesticides and lubricants.
Calleguas Creek Reach 4	Cyfluthrin	Not included as a new change in Appendix A but listed as a new 2014 5A listing in Appendix B.

There are also a number of instances where existing waterbody-pollutant listings from the 2010 303(d) list were not stated as delisted in Appendix A and do not appear in Appendix B, C, or G under the waterbodies to delist. We request clarification as to whether these waterbody-pollutant combinations are, in fact, being delisted, as some align with the assessment provided by the Stakeholders Implementing TMDLs in the Calleguas Creek Watershed.

Table 7. Not described as delisted in Appendix A but not found Appendix B or C	
Segment	**Pollutants**
Reach 2	Ammonia
Reach 3	Ammonia
Reach 4	Chlordane (tissue & sediment), DDT (tissue & sediment), PCBs (tissue), Toxaphene (tissue & sediment)
Reach 5	Chlordane (tissue & sediment), Chlorpyrifos (tissue), DDT (tissue & sediment), Dieldrin (tissue), Endosulfan (tissue & sediment), Nitrogen, PCBs (tissue), Toxaphene (tissue & sediment)
Reach 6	DDT (sediment)
Reach 9A	Chlorpyrifos, DDT (tissue), Dieldrin (tissue), Endosulfan (tissue), PCBs (tissue), Toxaphene (tissue & sediment)
Reach 9B	Endosulfan (tissue), Toxaphene (tissue & sediment)
Reach 10	DDT (tissue)
Reach 11	DDT (tissue), Endosulfan (tissue), Toxaphene (tissue & sediment)
Rio de Santa Clara / Oxnard Drain #3	Chlordane (tissue), DDT (tissue), Toxaphene (tissue)

Requested Action:

- **Correct the numerous inconsistencies described above in Table 5, Table 6, and Table 7 and ensure that all of the proposed 303(d) list appendices are internally consistent.**

12. Correct the waterbody assigned Hydrologic Unit (HUCs) and Calwater numbers to reflect those listed in the Basin Plan.

There are multiple instances of what appear to be incorrect Hydrologic Unit numbers (HUCs) and Calwater numbers assigned to the various waterways. For instance, a comparison of the 8 digit HUCs listed in Appendix B of the 303(d) list to the 12 digit HUCs listed in Appendix I of the Basin Plan indicate a number of inconsistencies such that waterbodies present in the Santa Clara River Watershed (e.g., Santa Clara River Reach 1, 2, and 3) are listed with a Calleguas watershed HUC (18070103) while the same reaches are listed as 18070102 in the Basin Plan. This makes identifying the location of unknown waterbodies not previously listed or described in the Basin Plan to assess if they are receiving waters that should be assessed especially difficult. A full review of the 303(d) List HUCs should be completed to correct all errors.

Requested Action:

- **Perform a full review of HUCs and Calwater numbers listed in Appendix B through F and correct any inconsistencies with the Basin Plan.**

13. Correct or clarify inconsistencies in the staff report.

There is inconsistent discussion about some proposed listings in the staff report, which should be clarified to avoid confusion. For instance, on page 10 of the Staff Report there is a discussion about existing TMDLs covering newly proposed pollutants: "*For example, the proposed new listings for DDE and DDD in Calleguas Creek Reach 3 … are being* *addressed by the Calleguas Creek Organochlorine Pesticides, PCBs and Siltation TMDL … and would then be in Category 4A.*" However, we could find no listings of DDE and DDD for Reach 3 in any Appendix of the report including Appendix C – Category 4A Waterbody Segments. Furthermore, the Fact Sheets in Appendix G state that DDE and DDD should *not* be listed for Reach 3. We ask the RWQCB to either clarify or remove the above referenced statement, and clarify any other inconsistencies between the staff report and the list.

Requested Action:

- **Correct or remove language cited on page 10 of the staff report regarding DDE and DDD listing of Calleguas Creek Reach 3 and clarify any other identified inconsistencies within the staff report.**

14. Ensure that all thresholds being used for assessment are consistent and valid under the Listing Policy.

In many cases, the same pollutant is assessed using different thresholds without any explanation for the basis of the threshold. Additionally, in several cases, an LC50 or threshold for individual species were used for the assessment. This is inconsistent with the Listing Policy, which states that it must be demonstrated that an evaluation guideline is *"applicable to the beneficial use, protective of the beneficial use, scientifically based and peer reviewed, and well described."* Because it has not been demonstrated that the individual species' response to these pollutants is applicable and protective of the beneficial use, these guidelines should not be used to make a listing. The Regional Board should review all assessments for consistency, especially for the pesticides (bifenthrin, cyfluthrin, cypermethrin, malathion, permethrin), as well as applicability to the beneficial use as described in the listing policy.

Table 8. 303(d) Pollutants Using Thresholds for Interpreting Narrative Objectives

Pollutant	Segment	Objective Used
Bifenthrin	Boulder Creek (Ventura County)	0.0006µg/L (4-day average) from UC Davis[1]
	CCW Reach 4	0.0006µg/L (4-day average) from UC Davis[1]
	Honda Barranca	0.0006µg/L (4-day average) from UC Davis[1]
	Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	0.00397µg/L mean acute value for mysid from Cal Dept. of Fish and Game[2]
Cyfluthrin	CCW Reach 4	LC50: 29000µg/L from the USEPA OPP Pesticide Ecotox database. LOE states that this applies to 2,4,5-TP, not cyfluthrin.
	Santa Clara River Reach 3	LC50: 29000µg/L from the USEPA OPP Pesticide Ecotox database. LOE states that this applies to 2,4,5-TP, not cyfluthrin.
Cypermethrin	CCW Reach 4	0.002µg/L from the Cal Dep of Fish and Game[2]
	Santa Clara River Reach 3	0.002µg/L from the Cal Dep of Fish and Game[2]
	Santa Clara Drain	0.002µg/L from the Cal Dep of Fish and Game[2]
	Wheeler Canyon/Todd Barranca	0.002µg/L from the Cal Dep of Fish and Game[2]
Malathion	CCW Reach 4	0.28µg/L (4-day average) from UC Davis[1]
	CCW Reach 12	0.1µg/L USEPA[3]
	Tapo Canyon	0.28µg/L (4-day average) from UC Davis[1]
Permethrin	CCW Reach 4	0.0002µg/L from UC Davis[1]

1. Aquatic life water quality criteria derived via the UC Davis method: II. Pyrethroid insecticides. Reviews of Environmental Contamination and Toxicology 216:51-103.
2. Hazard Assessment of the Synthetic Pyrethroid Insecticides Bifenthrin, Cypermethrin, Esfenvalerate, and Permethrin to Aquatic Organisms in the Sacramento-San Joaquin River System; 2000. Cal Dept. of Fish and Game. Report 00-6.
3. National Recommended Water Quality Criteria (Red Book). 1976. United States Environmental Protection Agency. Office of Water. Office of Science and Technology.

The 303(d) list includes new listings for bifenthrin, cyfluthrin, cypermethrin, malathion, and permethrin in Ventura County watersheds. Currently no water quality objectives have been promulgated by USEPA or the State of California for these pollutants and so the criteria listed are from a variety of studies. Some issues with these criteria include the following (this list is by no means inclusive; a thorough review of all listings for these pollutants should be undertaken):

- The criterion used for listing bifenthrin on Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2 is 0.00397 µg/L based on the CDFG criteria. The selective use of a saltwater genus mean acute value is inappropriate when the CDFG study clearly states in the "Conclusions and Recommendations" section that "insufficient freshwater and saltwater acute toxicity data were available to calculate CMC values for bifenthrin." The same use of a criterion unsupported by the study author(s) applies to cypermethrin on the Santa Clara Drain.
- Use of LC50 for listing of cyfluthrin for CCW Reach 4 and Santa Clara River Reach 3 is inappropriate. LC50s do not meet the standard set forth in the listing policy as stated on page 20: " *the evaluation guideline… identifies a range above which impacts occur and below which no or few impacts are predicted*." By definition an

LC50 is simply the concentration at which half of the population of the tested species has died. The LC50 should not be used as the evaluation guideline.

- The criterion used for listing permethrin for Calleguas Creek Reach 4 is 0.0002µg/L based on the UC Davis[4] criteria. However, upon reviewing the UC Davis source, we found the listed chronic standard for permethrin is 2 ng/L (page 92), which is 0.002µg/L not 0.0002µg/L as listed in the 303(d) list.

Requested Action:

- **Review the guidelines used for interpreting narrative objectives and ensure that they are consistently applied and use correct unit conversions.**
- **Remove all guidelines that do not comply with the stated listing policy as described above.**

Farm Bureau appreciates the opportunity to comment on the 303(d) list and looks forward to continuing to work with the Regional Board to address these concerns. Thank you for your time and consideration of these comments. If you have any questions, please contact me at (805) 289-0155.

Sincerely,

John Krist, CEO
Farm Bureau of Ventura County

cc: Edgar Terry, chairman, VCAILG Steering Committee
Nancy Broschart, Farm Bureau of Ventura County
Christ Scheuring, Legal Affairs Division, California Farm Bureau Federation

[4] Aquatic life water quality criteria derived via the UC Davis method: ll. Pyrethroid insecticides. Reviews of Environmental Contamination and Toxicology 216:51-103.

CASTAIC LAKE WATER AGENCY

March 30, 2017

Dr. Jun Zhu
California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles CA 90013

Subject: Comment Letter – Revisions to the Los Angeles Region 303(d) list

Dear Dr. Zhu:

CLWA is a water wholesaler that treats and delivers State Water Project water from Castaic Lake to four water retailers.

This letter regards the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) public hearing on April 6, 2017, to consider revisions to the Clean Water Act Section 303(d) list of impaired water bodies. At this meeting, the Regional Board is expected to hear information and take formal action on the proposed revisions to water quality assessments in the Los Angeles Region, including Castaic Lake.

One of the subject proposed revisions would add polychlorinated biphenyls (PCBs) to the 303(d) listing for Castaic Lake and Lagoon. The data referenced in the proposed PCB listing is from a relatively small number of fish tissue samples analyzed in 2007.

The Agency samples and analyzes water from the lake prior to treatment. Our data does not indicate that PCBs are present in the lake water. Because of this, and the limited data described above, we believe additional study should be conducted to look at longer term trends in PCB concentrations in fish tissue, and PCB source determination.

If you have any questions please call me at (661) 513-1281, or email me at rviergutz@clwa.org.

Sincerely,

Rick Viergutz
Principal Water Resources Planner

"A PUBLIC AGENCY PROVIDING RELIABLE, QUALITY WATER AT A REASONABLE COST TO THE SANTA CLARITA VALLEY"
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website address: www.clwa.org

March 30, 2017

Sent via USPS and email

California Regional Water Quality Control Board
Los Angeles Region
Attn: Dr. Jun Zhu
320 West 4th Street, Suite 200
Los Angeles, CA 90013

RE: COMMENT LETTER – REVISIONS TO THE LOS ANGELES REGION 303(d) LIST

The City of Azusa appreciates the opportunity to provide comments on the Los Angeles Regional Water Quality Control Board's proposed revisions to the Clean Water Act Section 303(d) list of impaired waterbodies in the Los Angeles Region. Enclosed are our comments for your review and consideration.

If you have any questions, please contact Daniel Bobadilla, Director of Public Works/City Engineer, at (626) 812-5264 or dbobadilla@ci.azusa.ca.us.

Sincerely,

Troy L. Butzlaff, ICMA-CM
City Manager

Attachment – As Stated

cc: Azusa City Council
Daniel Bobadilla, PE, Director of Public Works/City Engineer, City of Azusa

Troy L. Butzlaff, ICMA-CM, City Manager
213 E. Foothill Blvd., Azusa, CA 91702
626-812-5238 -- tbutzlaff@ci.azusa.ca.us

City of Azusa Comments on the Los Angeles Regional Water Quality Control Board's Proposed Revision to the Clean Water Act Section 303(d) List of Impaired Waterbodies in the Los Angeles Region, San Gabriel River

Summary

The City of Azusa ("City") appreciates the opportunity to comment upon the proposed revisions to the Clean Water Act Section 303(d) List of Impaired Waterbodies in the Los Angeles Region (San Gabriel Valley). Of the 22 metals reported for all San Gabriel River water quality segments, 19 (84.3%) of them fall under the "de-list" and "do not list" categories.[1] The City believes that 3 additional metals (15.7%) should be de-listed[2], which would raise the total to 22 (100%), for reasons more particularly described below. Based on the de-listing of these metals, the City contends that the Regional Board should remove the San Gabriel Metals TMDL from the Los Angeles Basin Plan.

I. San Gabriel River: Estuary

As the table below illustrates, copper for the estuary is listed on the 2010 303(d) list but was not carried over to the 2016 303(d) list. It must be assumed that the Regional Board did not intend to place copper on this list. Whether or not this was an oversight on the part of the Regional Board, there is ample justification for not listing copper for the estuary. As is the case with most metals and toxics referenced in TMDLs and in the MS4 Permit, the Regional Board did not comply with the federal California Toxic Rule (CTR) to the following extent:

1. The Regional Board did not calculate the numeric limitation for lead properly. CTR establishes water quality standards (including TMDLs), based only on ambient (dry) weather sampling and analysis. However, the Regional Board calculated a wet weather numeric limitation for lead based on stormwater sampled from receiving waters. Further, CTR requires a "real time" hardness parameter (using calcium carbonate) as an adjustment factor in establishing water quality standards for metals and toxics. The Regional Board apparently used a default hardness factor of 100 mg/l. CTR states clearly that the 100 mg/l for hardness is only intended to be an example in calculating CTR water quality standards. It is important that the actual hardness value be applied (which must be sampled and analyzed as the same toxics and metals are sampled). Too low of a hardness value will set a lower numeric limit. The higher the limit is, the less difficult it is to meet it.

[1]copper = 4 (21%); lead = 5 (26.3%); zinc = 6 (31.6%); and selenium = 4 (21%).
[2]copper = 2 (SGR Estuary and Coyote Creek); lead = 1 (SGR R2).

2. Regional Board also did not follow the *Water Quality Control Policy for California's Clean Water Act Section 303(d) List* (Listing Policy). The Listing Policy requires a binomial distribution based on a null hypothesis) to determine if the number of the samples that resulted in exceedances (of CTR) are statistically sufficient to warrant placement on lead on the 303(d) list. There is no evidence that this task was completed. It is possible that it was not completed because the Listing Policy was not adopted until 2004. The copper was added to the 303(d) list in 1998 and carried-over to the 2000 303(d) list. Based on the San Gabriel River Metals TMDL, it appears that the copper data was based on water quality samples conducted in 1998.

3. The Regional Board's Surface Water Ambient Monitoring Program (SWAMP) performed water quality samples for metals in the estuary in June of 2005. Copper, after properly adjusted for hardness, resulted in 3.23 micrograms per liter (ug/l). The limit is 9.4 ug/l. In other words, no exceedance was detected.

Table I. San Gabriel River: Estuary

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	X	-	-	-	-	x	Yes
Lead	-	-	-	x	-	-	Yes
Selenium	-	-	-	x	-	-	Yes
Zinc	-	-	-	x	-	-	Yes

Placing copper on the 2016 303(d) list "do not list" category should effectively eliminate the need for impacted MS4 Permittees to comply with the estuary's copper limitation of 3.7 ug/l (see Table I(a) below).

Table I(a) from Attachment P of the Los Angeles MS4 Permit

Water Body	WLA Daily Maximum	
	Copper	Selenium
San Gabriel Reach 1	18 µg/L	---
Coyote Creek	0.941 kg/day*	---
San Gabriel River Estuary	3.7 µg/L	---
San Jose Creek Reach 1 and 2	---	5 µg/L

Recommendation to Regional Board: (1) approve staff's recommendation not to list lead, selenium, and zinc for the estuary; (2) grant the City's request to de-list copper for the estuary; and (3) use the de-list and do not list justification for this and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

II. San Gabriel River: Reach 1 (Estuary to Firestone)

Metals for San Gabriel River, Reach 1 from the Estuary to Firestone were not placed on the 2010 303(d) List and not placed on the "do not list" category of the 2016 303(d) List. It is unclear, however, why the MS4 Permit requires compliance with the copper limitation of 18 ug/l (shown above in Table I(a), despite the fact that copper was not listed on the 2010 303(d) list in the first place.

Table II. San Gabriel River: Reach 1 (Estuary to Firestone)

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-	-	-	x	-	-	Yes
Lead	-	-	-	x	-	-	Yes
Selenium	-	-	-	x	-	-	Yes
Zinc	-	-	-	x		-	Yes

Recommendation to Regional Board: (1) approve staff's recommendation not to list copper, lead, selenium, and zinc for Reach 1; and (2) use the do not list justification for this and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan

III. San Gabriel River: Reach 2 (Firestone to Whitter Narrows Dam)

As shown on Table III below, the 2016 303(d) list rolls-over lead from the 2010 303(d) list. Lead, however, should be de-listed for the following reasons:

1. Lead is a legacy pollutant (lead content in fuels have been significantly reduced).

2. The 303(d) lists for 1998 and 2000 placed lead on the "list" category, but failed to comply with the California Toxic Rule (CTR) as explained above.

3. The Regional Board did not follow the State's 303(d) Listing Policy. More specifically, according to the San Gabriel River Metals TMDL (Table 2-7), Reach 2 was sampled during dry weather (ambient) for dissolved lead by the Los Angeles County Department of Public Works (LACDPW), in accordance with CTR using the correct hardness adjustment. The 10 samples taken resulted in zero exceedances. If this result were applied to the 303(d) Listing Policy, it would not be sufficient to place lead on the 303(d) List. For a sample size between 2 and 24, 2 exceedances are required for 303(d) list placement.

4. Regional Board's Surface Water Ambient Monitoring Program (SWAMP) performed water quality samples for metals in the estuary in June of 2005. Lead, after properly adjusted for hardness, resulted in 0.81 micrograms per liter (ug/l). The limit is 3.8 ug/l. In other words, no exceedance was detected.

Table III. San Gabriel River: Reach 2 (Firestone to Whittier Narrows Dam)

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-	-	x	-	-	-	Yes
Lead	x	-	-	-	x	X	Yes
Selenium	-	-	-	-	-	-	Yes
Zinc	-	-	x	-	-	-	Yes

Recommendation to Regional Board: (1) do not approve staff's recommendation not to de-list lead; and (2) use the do not list justification for this and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

IV. San Gabriel River: Reach 3 (Whittier Narrows Dam to Ramona)

As shown on Table IV below, San Gabriel River Reach 3 was not placed on the 2010 303(d) list and, therefore, it is easy to see why it is placed on the 2016 303(d) "do not list" category. What is difficult to understand is why the Los Angeles MS4 Permit requires compliance with copper, lead, and zinc. The answer lies on MS4 Permit *Attachment P: TMDLs in San Gabriel River Watershed Management Area.* It states: *Permittees shall comply with grouped wet WLAs … expressed as total recoverable metals discharged to all upstream reaches and tributaries of the San Gabriel River Reach 2 and Coyote Creek* (see Table I(b) below). In other words, even though San Gabriel River Reach 3 is not on the 2010 303(d) list for metals, the MS4 Permit requires compliance with them nevertheless. It does this by applying TMDL numeric targets for copper, lead, and zinc because: (1) San Gabriel River Reach 2 lists a lead TMDL number target of 81.34 ug/l; and (2) Coyote Creek lists copper target of 24.71 ug/l and zinc at 144.57 ug/l. The rationale for applying downstream numeric targets for copper, lead, and zinc is at best murky. How can metals as pollutants associated with downstream reaches be applied to upstream Reach 3 of the San Gabriel River? Pollutants cannot travel upstream against gravity.

Table IV. San Gabriel River: Reach 3 (Whittier Narrows to Ramona)

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-	-	-	x	-	-	Yes
Lead	-	-	-	x	-	-	Yes
Selenium	-	-	-	x	-	-	Yes
Zinc	-	-	-	x	-	-	Yes

Table I(b) from Attachment P of the Los Angeles MS4 Permit

Water Body	WLA Daily Maximum (kg/day)		
	Copper	Lead	Zinc
San Gabriel Reach 2	---	81.34 µg/L x daily storm volume (L)	---
Coyote Creek	24.71 µg/L x daily storm volume (L)	96.99 µg/L x daily storm volume (L)	144.57 µg/L x daily storm volume (L)

Recommendation to Regional Board: (1) approve staff's recommendation not to list copper, lead, and zinc; and (2) use the de-list for these metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

V. San Gabriel River: Coyote Creek

The 2016 303(d) List correctly de-lists lead and zinc but does not de-list copper. Copper should be de-listed for the following reasons:

1. The San Gabriel River Metals TMDL contains ambient sample data for Coyote Creek correctly applying CTR. Under Table 2-7, 8 samples are listed with 0 exceedances. If this result were applied to the 303(d) listing policy, it would not qualify for 303(d) placement. A sample size between 2 and 24 would require exceedances equal to and greater than 2.

2. Wet weather water quality data was used to justify placing copper on the 303(d) list. Listing support information cites that CTR relative to copper was applied to wet weather. As mentioned above, wet weather and CTR requirements are mutually exclusive. Wet weather limitations for San Gabriel River and other receiving water bodies in Los Angeles County are intended to be applied – incorrectly -- to MS4s and other NPDES permittees.

Table V. Coyote Creek

(San Gabriel River Tributary)2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	x	-	-	-	x	x	Yes
Lead	x	-	x	-	-	-	Yes
Selenium	-	-	-	-	-	-	Yes
Zinc	x	-	x	-	-	-	Yes

Recommendation to Regional Board: (1) approve staff's recommendation not to list lead and zinc; (2) approve the City's request to de-list copper; and (3) use the de-list and do not list justification for this and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

VI. **San Jose Creek Reach 1 (SG Confluence to Temple St.)**

Regional Board staff recommends that: (1) selenium be de-listed; and (2) copper, lead, and zinc not be listed (see Table VI below).

Table VI: San Jose Creek Reach 1

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-			x			Yes
Lead	-			x			Yes
Selenium	-		x				Yes
Zinc	-			x			Yes

Recommendation to Regional Board: (1) approve staff's recommendation to de-list selenium and not list copper, lead, and zinc; and (2) use the de-list and do not list justification for these and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

VII. **South San Jose Creek (Los Angeles County)**[3]

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-			x			Yes
Lead	-			x			Yes
Selenium	-			x			Yes
Zinc	-			x			Yes

Recommendation to Regional Board: (1) approve staff's recommendation not list to selenium copper, lead, and zinc; and (2) use the de-list and do not list justification for these and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

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[3]This is Reach is a new listing under the 2016 303(d) List.

TASHA CERDA, *Mayor*
MARK E. HENDERSON, *Mayor Pro Tem*
ART KASKANIAN, *Councilmember*
DAN MEDINA, *Councilmember*
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CITY of GARDENA
ELECTED and ADMINISTRATIVE OFFICES – CITY MANAGER

MINA SEMENZA, *City Clerk*
J. INGRID TSUKIYAMA, *City Treasurer*
MITCHELL G. LANSDELL, *City Manager*
PETER L. WALLIN, *City Attorney*

March 29, 2017

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Email: losangeles@waterboards.ca.gov

Subject: Comment Letter – Revisions to the Los Angeles Region (303(d)

The City of Gardena (City) appreciates the opportunity to comment on the revised 2016 303(d) Integrated Report for the Dominguez Channel. The City also welcomes the proposed "de-list" and "do not list" of pollutants, particularly metals and toxics. These pollutants are the basis for the Dominguez Channel Harbor Toxics TMDL (DCHT-TMDL), which is derived from the 2010 303(d) list. The elimination of these pollutants should effectively eliminate the need for the DCHT-TMDL, which the Dominguez Channel Watershed Management Program was created to comply with.

I. 2010 303(d)/2016 303(d) List Dominguez Channel, Reaches 1 and 2

This list, on which the DCHT-TMDL was developed, contains the following toxics for Reach 1 and 2 as shown in the tables presented below. The tables also show the status of toxic pollutants, including metals, which the 2016 303(d) list revises in terms of the following categories: (1) list; (2) de-list; and (3) don't de-list.

II. Reach 1 Dominguez Channel (unlined portion below Vermont)

2010 303(d) List Toxics/Metals	List Status	2016 303(d) List Toxics/Metals	List Status
1. Benzo(a)pyrene (PAH[1])	List	1. Benzo(a)pyrene (PAH)	Don't de-list
2. Benzo(a)anthracene (PAH)	List	2. Benzo(a)anthracene (PAH)	Don't de-list
3. Chlordane (tissue)	List	3. Chlordane (tissue)	Don't de-list
4. Chryslene (PAH)	List	4. Chryslene (PAH)	Don't de-list
5. Copper (not listed)[2]	?	5. Copper	Don't de-list
6. DDT(tissue and sediment)	List	6. DDT(tissue and sediment)	Don't de-list
7. Dieldren (tissue)	List	7. Dieldren (tissue)	List

[1]This pollutant is a polyaromatic hydrocarbon (PAH), along with benzo(a)anthracene, chryslene, phenathrene, and pyrene (total of 6).
[2]Copper for Reach 1 of the Dominguez Channel was not listed on the 2010 303(d) List. However, according to the 2012 303(d) List, copper is not to be de-listed. There is a disconnect between the listings that requires resolution.

8. Lead (tissue)	List	8. Lead (tissue)	Don't de-list
9. Methylnaphthlene 2	List	9. Methylnaphthlene 2	**Don't list**
10. Polychlorinated Bi-phenyls (PCBs)	List	10. Polychlorinated Bi-phenyls (PCBs)	Don't de-list
11. Polyaromatic Hydrocarbons (PAHs)	Not listed	11. Polyaromatic-Hydrocarbons (PAHs)	**De-list**
12. Phenanthrene (PAH)	List	12. Phenanthrene (PAH)	Unknown
13. Pyrene (PAH)	List	13. Pyrene (PAH)	Don't de-list
14. Sediment Toxicity	List	14. Sediment Toxicity	Unknown
15. Toxicity	List	15. Toxicity	Don't de-list
16. Zinc (sediment)	List	16. Zinc (sediment)	**De-list**

In sum, the 2016 303(d) list for toxics and metals proposes to de-list PAHs and zinc (in sediment) and not list Methylnaphthalene 2. However, because PAHs are to be de-listed, Chryslene, Phenanthrene, and Pyrene must also be de-listed because they are specific types of PAHs. Thus, the total number of toxics to be eliminated from the 2016 303(d) list is 8. Copper should be de-listed as well because: (1) it was not listed on the 2010 303(d) Integrated Report for toxics and metals for Reach 1 of the Dominguez Channel; (2) the 2012 303(d) list recommended that copper not be listed;" and (4) SWAMP data (2003) for all reaches of the Dominguez Channel resulted in only a few slight exceedances for dissolved copper (but not for total recoverable copper, which is the California Toxics Rule (CTR) compliance standard). Should the Regional Board insist on retaining copper on the 2016 303(d) list, it should provide sampling data based on the CTR for establishing ambient water quality standards.

Excluding the aforementioned metals and toxics from the 2016 303(d) list eliminates 9 of them – 56% of the total. On this basis alone, the DCHT-TMDL should be voided. As discussed below the metals and toxics on the proposed 2016 303(d) list that have not been de-listed for Reach 1 of the Dominguez Channel should be de-listed.

1. *Chlordane*

This toxic should be de-listed for the following reasons: (1) no justificaCTRtion to list chlordane was provided in Decision ID 20199 of the proposed 2016 303(d) Integrated Report in keeping with 303(d) Listing Policy; (2) the 2016 303(d) list proposes that chlordane be de-listed for Reach 2 of the Dominguez Channel (); and (3) SWAMP data (2003), based on multiple grab samples for both reaches, resulted in non-detects for chlordane.

2. *DDT (tissue/sediment)*

This toxic should be de-listed for the following reasons: (1) no justification was provided in Decision ID 19790 of the proposed 2016 303(d) list to list DDT in keeping with 303(d) Listing Policy; (2) DDT is de-listed for Reach 2 of the Dominguez Channel; (3) SWAMP data (2003), based on multiple grab samples for both reaches, resulted in non-detects for DDT; and (4) DDT is a legacy pollutant that has been banned for several decades.

3. *Dieldrin (tissue)*

Dieldrin (tissue) should be de-listed for the following reasons: (1) no 303(d) listing policy justification for was provided in Decision ID 34645 of the proposed 2016 303(d) list to list dieldrin; (2) the proposed 2016 303(d) list recommends that dieldren be de-listed for Reach 2 of the Dominguez Channel (despite the fact that the two reaches are connected); (3) dieldrin is a legacy pollutant; and (4) SWAMP data (2003) based on multiple grab samples for both Dominguez Channel reaches resulted in non-detects for dieldrin.

4. *Lead (including tissue)*

Lead (tissue) should be de-listed for the following reasons: (1) no justification to list lead was provided in Decision ID 34645 of the proposed 2016 303(d) Integrated Report in keeping with 303(d) Listing Policy; (2) SWAMP data (2003), based on multiple grab samples for both reaches, resulted in no exceedances for dissolved lead in Reach 1 of the Dominguez Channel; (3) according to the DCHT-TMDL, the samples taken for lead do not comply with the federal California Toxic Rule (CTR), in that they were not based exclusively on ambient samples and incorrectly used a hardness default value of 49 mg/l[3]); and (4) lead as legacy pollutant has been significantly reduced in the environment as a result of de-leaded fuels).

5. *Polychlorinated Bi-phenyls (PCBs*

PCBs should be de-listed for the following reasons: (1) no justification to list was provided in Decision ID 33063 of the proposed 2016 303(d) Integrated Report in keeping with 303(d) Listing Policy (does not conform to the binomial distribution requirement contained in Section 3.1 of the policy); (2) PCBs are de-listed for Reach 2 of the Dominguez Channel; (3) PCBs are legacy pollutants that have been banned for decades; and (4) SWAMP data (2003) based on multiple grab samples for both reaches resulted in non-detects for PCBs.

6. *Toxicity*

Toxicity should be de-listed for the following reasons: (1) no justification to list was provided in Decision ID 43000 of the proposed 2016 303(d) Integrated Report in keeping with 303(d) Listing Policy (does not conform to the binomial distribution requirement contained in Section 3.1 of the

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[3]CTR sets ambient (dry weather) receiving water quality standards. Nevertheless, the DCHT-TMDL mentions that wet weather standards were set in accordance with CTR. Any wet weather standard based on this misinterpretation of CTR should be voided. Further, the hardness value that was used (according to the DC/Harbor Toxics TMDL) was 49 mg/l, which is an average based on samples taken from 2002-2010 (presumably during storm events from Dominguez Channel). This value is too low and is inconsonant with CTR. Hardness influences calculating CTR standards. The higher the hardness value, the higher the target for a toxic or metal. The higher the number, the less difficult it is to comply with. CTR specifically requires an actual hardness a value (using calcium carbonate as an adjustment parameter) to be determined by sampling and analysis at the same time samples are taken for toxics and most metals. CTR cautioned that the use of the 100 mg/l hardness value is intended only as an illustrative factor for calculating CTR standards using a required formula. The Regional Board's SWAMP abides by this requirement when it conducts ambient water quality monitoring.

policy)[4]; (2) SWAMP data (2003) based on multiple grab samples for both reaches resulted in non-detects for most toxics (both Dominguez Channel reaches); and a few detects but no exceedances; and a very few exceedances for metals; and (3) the 2016 303(d) list proposes to de-list toxics affecting Dominguez Channel R1 and R2 that contribute to toxicity[5] (there can be no toxicity if many of the toxics are to be de-listed).

7. *Sediment Toxicity*

Sediment toxicity cannot be commented on because it is not addressed in the 2016 303(d) listing report, although it is listed in both the 2010 and 2012 303(d) reports. It is not certain if the Regional Board intended to de-list sediment toxicity or to carry it over.

Against this background it is recommended the all of following toxics and metals be eliminated from the proposed 2016 303(d) Integrated Report for Reach 1 of the Dominguez Channel:

1. Benzo(a)pyrene (PAH)
2. Benzo(a)anthracene (PAH)
3. Chlordane (tissue)
4. Chryslene (PAH)
5. Copper
6. DDT(tissue and sediment)
7. Dieldren (tissue)
8. Lead (tissue)
9. Methylnaphthlene 2
10. Polychlorinated Bi-phenyls (PCBs)
11. Polyaromatic-Hydrocarbons (PAHs)
12. Phenanthrene (PAH)
13. Pyrene (PAH)
14. Sediment Toxicity
15. Toxicity
16. Zinc (sediment)

Eliminating all of these toxics/metals should be sufficient justification for eliminating or significantly revising the DCHT-TMDL.

III. Reach 2 Dominguez Channel (lined portion above Vermont)

2010 303(d) List Toxics/Metals	List Status	2016 303(d) List Toxics/Metals	List Status

[4]The DCHT-TMDL appears to replace CTR-derived toxics standards with a TUc (toxic unit chronic). According to the DCHT-TMDL, this numeric toxicity objective was created because the Basin Plan's narrative toxicity objective does not allow acute or chronic toxicity in any receiving waters. However, CTR resolves this problem by providing a formula that translates acute or chronic toxicity in dissolved and total recoverable values. Further, other TMDLs adopted by the Regional Board do not resort to a TUc. If the TUc standard is used to meet the binomial distribution requirement under 303(d) Listing Policy Section 3.1 that data, along with the null hypothesis, should be made available.

[5]Chlordane, dieldren, diazinon, DDT, PCBs, and PAHs with the justification that copper, lead, and zinc should also be de-listed.

1. Copper	List	1. Copper	Don't de-list
2. Diazinon	List	2. Diazinon	**De-list**
3. Lead	List	3. Lead	Don't de-list
4. Toxicity	List	4. Toxicity	Don't de-list
5. Zinc	List	5. Zinc	Don't de-list
		6. Benthic-Macroinvertebrate Bioassessment	**List (new)**

The 2016 303(d) list proposes to carry-over from the 2010 303(d) all of the toxics except diazinon, which is de-listed. Copper, lead, zinc, and toxicity should be de-listed for the same reasons for de-listing Dominguez Channel R1 metals and toxics.

The 2016 (303d) list also adds "Benthic-Macroinvertebrate Bioassessment" (BMB), which should not be listed for the following reasons:

- BMB is not a pollutant.

- BMB is used to evaluate the health of wadeable streams using a scoring system. Reach 1 of the Dominguez Channel is not wadeable. The Los Angeles County Flood Control District forbids entry into this and other flood control channels.

- The Index of Biotic Integrity (IBI) score of 40, on which the BMB is justified, is considered to be on the edge of "poor" to "fair." But it was based only on 3 samples, taken in 2006, 2007, and 2008. Not only is the sample size not statistically significant, and therefore not in keeping with the 303(d) Listing Policy, but the data is not current.

- BMB decision ID, 83960, also uses as lines of evidence toxicity, which is associated with copper, lead, zinc, and diazinon. However, copper, lead, zinc, and toxicity should not be listed on the proposed 2016 303(d) list for the same reasons they should not be listed for Reach 2 of the Dominguez Channel. Further, the 2016 303(d) list proposes to de-list diazinon, a toxic.

- According to the Southern California Coastal Water Research Project (SCCWRP), Technical Report 88, which is a bioassessment study concluded in 2015, metals, toxicity, and pyrethroids were only weakly or rarely associated with poor stream health in the Southern region.

- Biota, including fish, located in Reach 1 or Reach 2 of the Dominguez Channel has not been specifically identified as being impaired by metals or toxics. The Regional Board has not been able to demonstrate that fish and other wildlife have been impaired. Admittedly, this would be difficult given that Dominguez Channel is a non-perennial stream; it only flows when it rains. There are no studies that have identified the number and species of fish in the Dominguez Channel during storm events. If there were any fish in the channel traveling from up-stream they would probably perish when moving from a freshwater to a saltwater environment.

III. Conclusions

In the final analysis, each of the metals and toxic pollutants on the proposed 2016 303(d) list for Reaches 1 and 2 of the Dominguez Channel should be de-listed. The bases for the de-listings are, in the aggregate, defective because:

1. The data supporting the listings are out-dated (in some cases by almost 15 years). It is unclear why more current water quality data is not available, especially given that each MS4 in the State is required to pay an annual SWAMP surcharge along with its regular annual MS4 Permit fee to the State. Unlike most non-SWAMP monitoring (sampling and analysis), the Regional Board's SWAMP unit conducts monitoring in accordance with USEPA guidance and State policy. The data SWAMP generates is accurate, objective, and extremely useful. Had SWAMP been allowed to conduct monitoring on a regular basis, the DCHT-TMDL may not have been necessary.

2. Over the past two decades, water quality undoubtedly has improved. Many toxic pollutants are no longer in the environment (e.g., DDT, various pesticides, cleaning solvents, lead in gasoline, etc.). Substantial credit should also be given to municipalities. Since the Los Angeles County MS4 program began in the nineties, cities have dutifully implemented best management practices (BMPs) that have been effective in source-controlling pollutants and reducing them from outfalls through post-construction runoff pollution mitigation controls. Community sensitivity to mitigating runoff pollution is another factor attributable to MS4 public education and outreach programs.

3. The pollutant listings claim to be based on water quality standards developed in conformance with CTR, but they are not. CTR standards for metals and toxics are intended to be ambient standards, derived from dry weather sampling and analysis from receiving water. Instead, they were derived from wet weather conditions. Further, CTR requires an actual hardness value to calculate water quality standards. Many of the 303(d) pollutants were CTR calculated using average hardness values or in some cases the hardness factor of 100 mg/l. According to CTR, this factor was intended only to be used for illustrative purposes when calculating ambient standards for metals and toxics.

4. The pollutant listings, with the exception of those based on the Regional Board's Surface Water Ambient Monitoring Program (SWAMP), do not comply with the State's 303(d) Listing Policy's requirement of meeting the statistical frequency test using a binomial distribution in accordance with a null hypothesis.

It should be noted that the DCHT-TMDL was based on faulty 303(d) metals and toxic pollutant listings. What is regrettable is that the costly Dominguez Channel EWMP is based on the DCHT-TMDL.

In closing, the City once again appreciates the opportunity to comment on this important proposition. Should you have any questions, please feel free to contact me.

Best Regards,

Mitchell G. Lansdell

MITCHELL G. LANSDELL
City Manager

MGL:nw

c: Ray Tahir, TECS Environmental
Joseph Cruz, Director - General Services Dept.

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March 30, 2017

ELECTRONIC MAIL

Dr. Jun Zhu
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

Dear Dr. Zhu:

COMMENT LETTER – REVISIONS TO THE LOS ANGELES REGION 303(D) LIST

The City of Los Angeles LA Sanitation (LASAN) appreciates the opportunity to provide comments on the Proposed Revisions to the Clean Water Act Section 303(d) List for the Los Angeles Region and the 2016 Integrated Report. The decisions related to the 303(d) List have the potential to direct resources to new or changing water quality priorities in all of the City's watersheds and development of new or revised TMDLs that require significant investment of both public agency and State resources. It is crucial that the 303(d) List be revised based on sound science and methodologies following the requirements of the State's Listing Policy. Revisions to the 303(d) List may result in changes to our Enhanced Watershed Management Programs, Coordinated Integrated Monitoring Programs, as well as affecting requirements for the four Water Reclamation Plants operated by LASAN. As such, we feel it is imperative that the listings reflect our understanding of the watersheds to the best of our abilities given the available data.

Attachment 1 to this letter contains a table presenting detailed technical comments. If you have any questions related to comments #1 through 23, please contact Shahram Kharaghani, Watershed Protection Program Division Manager at Shahram.Kharaghani@lacity.org or at (213) 485-0587. For questions related to comments #24 through 28, please contact Hassan Rad, Regulatory Affairs Division Manager at Hassan.Rad@lacity.org or at (213) 847-5186.

We welcome the opportunity for our Division Managers and staff to meet with you to discuss our comments and look forward to continuing our collaborative efforts to collect quality data for use in evaluating the attainment of water quality standards.

Sincerely,

ENRIQUE C. ZALDIVAR, Director
LA Sanitation

ECZ:SK:JLC:HR:es

Attachment

c: Samuel Unger, Regional Water Quality Control Board
Deborah J. Smith, Regional Water Quality Control Board
Renee Purdy, Regional Water Quality Control Board
L.B. Nye, Regional Water Quality Control Board
Traci Minamide, LA Sanitation/EXEC
Adel Hagekhalil, LA Sanitation/EXEC
Mas Dojiri, LA Sanitation/EXEC
Shahram Kharaghani, Bureau of Sanitation/WPD
Hassan Rad, Bureau of Sanitation/RAD

Attachment 1: Detailed Technical Comments on the 2016 Revisions to the Los Angeles Region 303(d) List

	Water Body Pollutant	Technical Comment
1.	Wilmington Drain Zinc	The Fact Sheet for Decision ID 63330 states that one line of evidence is available to assess zinc in Wilmington Drain (90159). LOE 90159 includes data collected by Heal the Bay's, "Compton Creek Monitoring Program" where 3 of 5 samples exceeded the evaluation guideline (i.e., the CTR). However, data collected by Heal the Bay's, "Compton Creek Monitoring Program", were collected from Compton Creek in the Los Angeles River watershed, not in Wilmington Drain. It appears as if the source of confusion is that the samples were collected from a site located at Cressy Street Drain—Williamington Drain (note the difference between <u>Williami</u>ngton and <u>Wil</u>mington). As such, LOE 90159 consists of data that should not be included when assessing whether or not a zinc impairment exists in Wilmington Drain. Excluding LOE 90159 results in no data available to assess the waterbody pollutant combination. ***Requested Action: Remove Decision ID 63330 for the zinc listing for Wilmington Drain as there are no data to assess the waterbody pollutant combination.***
2.	Wilmington Drain Copper	Although the Fact Sheet for Decision ID 44676 states that only two lines of evidence are available in the administrative record to assess the pollutant, Appendix G shows three distinct lines of evidence (4280, 90131, and 90473). LOE 4280 is a placeholder LOE to support a 303(d) listing decision made prior to 2006. As such, no data are included within this LOE. LOE 90131 includes data collected by the City of Los Angeles where 2 of 33 samples exceeded the evaluation guideline (i.e., the CTR). LOE 90473 includes data collected by Heal the Bay's, "Compton Creek Monitoring Program" where 2 of 5 samples exceeded the evaluation guideline (i.e., the CTR). The Fact Sheet for Decision ID 44676 combines these three LOEs to state that 4 of 38 samples exceed the CRITERIA and this exceeds the allowable frequency listed in Table 4.1 of the Listing Policy. However, as previously noted, the third LOE includes data collected by Heal the Bay's, "Compton Creek Monitoring Program", which was focused on Compton Creek in the Los Angeles River watershed, not in Wilmington Drain. It appears as if the source of confusion is that the samples were collected from a site located at Cressy Street Drain—Williamington Drain (note the difference between <u>Williami</u>ngton and <u>Wil</u>mington). As such, LOE 90473 consists of data that should not be included when assessing whether or not a copper impairment exists in Wilmington Drain. Excluding LOE 90473 results in the sample exceedance frequency being 2 of 33 samples, which meets the allowable frequency listed in Table 4.1 of the Listing Policy. ***Requested Action: Revise Decision ID 44676 for the copper listing for Wilmington Drain to Delist from 303(d) list and remove from Category 5 (Appendix B) because the total number of exceedances is equal to or less than the number of exceedances allowed to delist per the Listing Policy.***
3.	Los Angeles River Estuary (Queensway Bay) Copper	The Fact Sheet for Decision ID 64264 presents one line of evidence related to copper in the Los Angeles River Estuary (85965). LOE 85965 presents information from a State of California program that sampled marinas throughout California and assess the data provided as follows: *"A total of six grab samples were collected during each sampling event. Four separate grab samples were collected from inside the marina basin (Sites 1, 2, 3, & 4) and two separate grab samples were collected from outside the marina basin (Sites 5 & 6). Sample results for sites inside the marina basin and sites outside the marina basin were averaged per sample event, resulting in two sample results per sampling event."*

		Per the LOE, the Regional Board utilized data collected from inside the Downtown Shoreline Marina (Sites 1, 2, 3, & 4) and data collected outside the marina basin (Sites 5 & 6) to make a determination that 3 of 6 samples exceeded the copper criterion. No site location information is provided specific to these sites (GPS locations are provided in the associated documents, but no sites are specifically named Sites 1, 2, 3, 4, 5, & 6) so it is not possible to verify the locations. Regardless, data from inside the Marina should not be combined with data from the Estuary to assess the Estuary. These are two distinct bodies of water with differing inputs and water quality conditions. Dissolved copper data collected inside the Marina shows an average concentration of 7 ug/L and represents three of the three exceedances identified in the Fact Sheet. Dissolved copper data collected outside of the Marina (presumably in the Estuary) shows an average concentration of 0.72 ug/L and represents zero of three exceedances. The dissolved copper data collected from inside and outside of the Marina are significantly different from one another, as is to be expected, given that they are separate waterbodies and one is a marina and the other is an estuary. ***Requested Action: Either 1) remove Decision ID 64264 and the corresponding 303(d) listing in Attachment B or 2) revise Decision ID 64264 to reflect the waterbody is the Downtown Shoreline Marina rather than the Los Angeles River Estuary and remove the copper listing for the Los Angeles River Estuary from the 303(d) list (Attachment B).***
4.	Ballona Creek Toxicity	The Fact Sheet for Decision ID 34253 presents two lines of evidence that indicate the presence of sediment toxicity (83019 and 83020). LOE 83019 references a Statewide Stream Pollution Trends Study 2008 and LOE 83020 references Statewide Project Urban Pyrethroid Status Monitoring. When reviewing the station locations (404SUP093 and 404BLNAxx) associated with these two LOEs in an August 2012 Surface Water Ambient Monitoring (SWAMP) report titled “Toxicity in California Waters: Los Angeles Region”, the sampling locations are identified as (page 11) “approximately one kilometer downstream from the confluence with Sepulveda Channel.” In a 2014 SWAMP report titled “Trends in Chemical Contamination, Toxicity and Land Use in California Watersheds: Stream Pollution Trends (SPoT) Monitoring Program Third Report - Five-Year Trends 2008-2012”, the site 404BLNAxx is identified as Ballona Creek Downstream of Centinela (33.986 -118.417). In the Ballona Creek Toxics TMDL Staff Report, Ballona Creek Reach 2 and Estuary are defined as follows (page 5): Ballona Creek to Estuary (Reach 2) is the longest segment of the creek (approximately 4 miles) continuing on from National Boulevard and ending at Centinela Avenue where the Estuary begins. As such, the sites identified in LOEs 83019 and 83020 are in the Ballona Creek Estuary rather than in Ballona Creek and the Estuary already has a toxics TMDL. ***Requested Action: Remove Decision ID 34253 for toxicity for Ballona Creek as there are no data to assess the waterbody pollutant combination.***
5.	Dominguez Channel (lined portion above Vermont Ave) Ammonia	The Fact Sheet for Decision ID 35134 states that two lines of evidence are available in the administrative record to assess pollutant (4098 and 83962). LOE 4098 is a placeholder to support a 303(d) listing decision made prior to 2006. As such, no data are included within this LOE. LOE 83962 includes data collected by the City of Los Angeles (City) and states that samples were collected at 3 locations: Artesia Blvd. & Western Ave., Manhattan Beach Blvd., and El Segundo Blvd. where 2 of the 21 samples exceeded the Water Quality Objective/Criterion. However, the data included within the Data Reference for LOE 83962 includes eight additional results that did not exceed the Water Quality Objective/Criterion (including samples collected at Vermont Ave., which was not identified within the LOE Spatial Representation). Given that the Basin Plan indicates that Vermont Ave. represents the reach break between Dominguez Channel and the Dominguez Channel Estuary, samples collected at Vermont Ave. are representative of the upstream water body (i.e., Dominguez Channel lined portion above Vermont Ave). Including all of the applicable data included within the Data Reference for LOE 83962 results in the sample exceedance frequency

being 2 of 29 samples, which meets the allowable frequency listed in Table 4.1 of the Listing Policy.

Requested Action: Revise Decision ID 35134 for the ammonia listing for Dominguez Channel to Delist from 303(d) list and remove from Category 5 (Appendix B) because the total number of exceedances is equal to or less than the number of exceedances allowed to delist per the Listing Policy.

6. Dominguez Channel Estuary (unlined portion below Vermont Ave) Ammonia

As presented in LOE 83995, ammonia, pH, and temperature data were collected by the City of Los Angeles at four stations in Dominguez Channel Estuary during July 2009 and August 2009. The following table summarizes the number of samples and exceedances.

Summary of data for Dominguez Channel Estuary (unlined portion below Vermont Ave)

Waterbody	□ of Samples	□ of Exceedances of 4-Day Criteria	Delist if the □ of exceedances equal or is less than[1]
Dominguez Channel Estuary (unlined portion below Vermont Ave)	28	0	2

1 For toxicants, the maximum number of exceedances allowed for delisting is shown in Table 4.1 (Page 14) of the Listing Policy.

COMPARISON OF EXCEEDANCES TO LISTING POLICY

As shown in the table above, the total number of exceedances is below the maximum number of exceedances allowed to delist per the Listing Policy. As a result, the available data demonstrates that Dominguez Channel Estuary meets the water quality objectives for ammonia (un-ionized) and should be delisted from the 303(d) list. This decision would be consistent with Decision ID 62240 (which treated the listing as a new listing despite an existing listing being present), which finds that ammonia in the Dominguez Channel Estuary should not be listed and states the following (emphasis added): "Based on the readily available data and information, the weight of evidence indicates that *there is sufficient justification against placing this water segment-pollutant combination on the CWA section 303(d) List in the Water Quality Limited Segments category*. This conclusion is based on the staff findings that:

1. The data used satisfies the data quality requirements of section 6.1.4 of the Policy.
2. The data used satisfies the data quantity requirements of section 6.1.5 of the Policy.
3. 0 of 28 samples exceeded the CRITERIA and this does not exceed the allowable frequency listed in Table 3.1 of the Listing Policy.
4. Pursuant to section 3.11 of the Listing Policy, no additional data and information are available indicating that standards are not met.

Regional Board Staff Decision Recommendation: After review of the available data and information, *RWQCB staff concludes that the water body-pollutant combination should not be placed on the section 303(d) list* because applicable water quality standards are not being exceeded."

Requested Action: Revise Decision ID 34669 for the ammonia listing for Dominguez Channel Estuary to Delist from

		303(d) list and remove from Category 5 (Appendix B) based on Decision ID 62240 (for the ammonia [un-ionized] listing for Dominguez Channel Estuary) and the data reference provided in LOE 83995.
7.	Compton Creek Iron	The Fact Sheet for Decision ID 62052 states that one LOE (83798) is available in the administrative record to assess iron in Compton Creek. LOE 83798 lists the following as the Evaluation Guideline used as the basis for the listing: "National Recommended Water Quality Criteria Continuous Concentrations are intended to protect freshwater aquatic organisms from chronic exposures and are expressed as 4-day average concentrations. The City has several concerns with this listing: • The only two exceedances are associated with wet-weather samples collected on October 13, 2009. The Evaluation Guideline used as the basis is **Criteria Continuous Concentrations** (i.e., chronic criterion). It is inappropriate to use a chronic criterion as it is meant to protect aquatic life against chronic exposure and the samples were taken during a wet-weather event not representative of chronic conditions. USEPA does not recommend a Criteria Maximum Concentration (acute criterion) for iron within its National Recommended Water Quality Criteria. • The National Recommended Water Quality Criteria Continuous Concentration for iron does not specify whether the criterion applies to the total recoverable or dissolved fraction. None of the dissolved iron results associated with the samples used to assess the water body exceeded the criterion. • Section 6.1.5.3 of the Listing Policy states that "Samples used in the assessment must be temporally independent. If the majority of samples were collected on a single day or during a single short-term natural event (e.g., a storm, flood, or wildfire), the data shall not be used as the primary data set supporting the listing decision." However, multiple samples were collected on the same day during the same storms and each was considered separately. Samples collected on the same day during the same storm (as was the case with the two exceedances) should not be considered independently from one another as they are clearly not temporally independent and do not meet the Listing Policy requirements. Averaging samples collected on the same day results in 1 of 5 exceedances, which does not meet the requirements of the Listing Policy for placing a water body segment on the 303(d) list. ***Requested Action: Revise the decision for Decision ID 62052 for the iron listing for Compton Creek to Do Not List on 303(d) list (TMDL required list) and remove from Category 5 (Appendix B) due to an inappropriate evaluation guideline being used as the basis for the listing, the observed exceedances were not temporally independent, and none of the dissolved results exceeded the evaluation guideline.***
8.	Ballona Creek Estuary Silver	The Fact Sheet for Decision ID 34520 states "Silver has not been specifically listed on the 303(d) list." Furthermore, the single Line of Evidence (LOE) does not indicate that any data were analyzed (i.e., the number of samples listed is zero). As such, the listing should be removed. ***Requested Action: Revise Decision ID 34520 for the silver listing for Ballona Creek Estuary to Delist from 303(d) list and remove from Category 4 (Appendix C) to be consistent with the Fact Sheet.***
9.	Dominguez Channel Estuary (unlined portion below	The Fact Sheet for Decision ID 33751 states that five LOEs are available to assess copper in the Dominguez Channel Estuary, four of which correspond to sediment and one of which corresponds to water. The sole LOE that presents water data states that 3 of 3 samples exceeded the dissolved California Toxics Rule (CTR) saltwater chronic criterion. However, these sample results were all collected on the same day and appear to be for total copper associated with a wet-weather event. When using the total copper CTR acute criterion (rather than the dissolved CTR chronic criterion), the samples do

	Vermont Ave) Copper	not exceed. As such, all LOEs that support a listing correspond to the sediment matrix. ***Requested Action: Revise the pollutant for Decision ID 33751 for the copper listing for Dominguez Channel Estuary to "Copper (sediment)" given that the LOEs supporting a listing correspond to the sediment matrix and move the listing to Category 4a (Appendix C).***
10.	Various waterbodies Various pollutants	For a number of existing listings, it appears as if a significant number of readily available data were not considered when making the Final Listing Decision. These data are from NPDES Permit monitoring programs (both wastewater and stormwater). When these data are considered, the number of measured exceedances supports rejection of the null hypothesis as presented in Table 4.1 of the *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (Listing Policy). As such, these listings should be removed from the section 303(d) list. Furthermore, with regards to the cyanide listing for Ballona Creek, it appears as if Los Angeles (LA) Regional Water Quality Control Board (Regional Board or LARWQCB) staff applied the chronic CTR criterion to the entire dataset instead of applying the chronic CTR criterion during dry-weather and the acute CTR criterion during wet-weather.

Water Body	Pollutant	Listing Category	Date Range		□of Samples	□of Exceedances	Max □of Exceedances to Delist
			Start	End			
Ballona Creek	Cyanide	5	10□2000	12□2010	66	5	5
Burbank Western Channel	Selenium	5	10□2003	12□2010	201	15	17
Los Angeles River Reach 1 (Estuary to Carson Street)	Diazinon	5	10□2002	12□2010	56	1	4
	Lead	5	02□2001	12□2010	173	4	14
Los Angeles River Reach 2 (Carson to Figueroa Street)	Lead	5	01□2001	12□2010	241	4	20
Los Angeles River Reach 5 (within Sepulveda Basin)	Lead	5	02□2002	11□2010	78	0	6
Sepulveda Canyon	Lead	4	10□2004	12□2010	98	4	8
	Selenium	4	10□2004	12□2010	98	4	8

Requested Action: Revise the decision for the segments listed in the preceding table to Delist from 303(d) list and remove from Category 5 (Appendix B) or Category 4 (Appendix C), whichever is applicable.

11.	Burbank Western	The Fact Sheet for Decision ID 32882 finds that lead in the Burbank Western Channel should not be listed and states (emphasis added): "One line of evidence is available in the administrative record to assess this pollutant. None of the

	Channel Lead	samples exceed the water quality objective. Based on the readily available data and information, the weight of evidence indicates that *there is sufficient justification against placing this water segment-pollutant combination on the section 303(d) list in the Water Quality Limited Segments category*." In addition, the analysis conducted as part of the Upper Los Angeles River (ULAR) Enhanced Watershed Management Program (EWMP) did not identify any exceedances from October 2003 through December 2010. ***Requested Action: Revise Decision ID 32882 for the lead listing for Burbank Western Channel to Delist from 303(d) list and remove from Category 5 (Appendix B) to be consistent with the Fact Sheet and because there have not been any observed exceedances since 2003.***
12.	Los Angeles River Reach 1 (Estuary to Carson Street) Cadmium	The Fact Sheet for Decision ID 32639 finds that cadmium in the Los Angeles River Reach 1 should not be listed and states (emphasis added): "Three lines of evidence are available in the administrative record to assess this pollutant. The CTR criterion for cadmium for the protection of aquatic life was exceeded three out of forty-two samples from data collected between 1996 and 2002 and no samples exceeded CCR Title 22 MCL guidelines for the protection of MUN beneficial uses in data collected between 2000 and 2003. Based on the readily available data and information, the weight of evidence indicates that *there is sufficient justification for removing this water segment pollutant combination from the section 303(d) list.*" In addition, the analysis conducted as part of the ULAR EWMP did not identify any exceedances from February 2001 through December 2010. ***Requested Action: Revise Decision ID 32639 for the cadmium listing for Los Angeles River Reach 1 to Delist from 303(d) list and remove from Category 5 (Appendix B) to be consistent with the Fact Sheet and because there have not been any observed exceedances since 2001.***
13.	Echo Park Lake Ammonia	Decision ID 34696 proposes to change the ammonia listing for Echo Park Lake from List on 303(d) list (TMDL required list) to list on the 303(d) list (being addressed by United States Environmental Protection Agency [USEPA] approved TMDL). However, the TMDL report made a finding of nonimpairment for ammonia, as outlined in the following excerpt from Section 6.2.3.2 of the TMDL report (emphasis added): "Echo Park Lake was listed as impaired for ammonia in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB, 1996). Consistent with project plan recommendations provided in California's Impaired Waters Guidance (SWRCB, 2005), EPA and local agencies collected 35 additional samples (7 wet-weather) between May 2003 and February 2010 to evaluate current water quality conditions. There was one ammonia exceedance in 35 samples (Appendix G, Monitoring Data). Therefore, Echo Park Lake meets ammonia water quality standards and USEPA concludes that preparing a TMDL for ammonia is unwarranted at this time. *USEPA recommends that Echo Park Lake not be identified as impaired for ammonia in California's next 303(d) listing*."[1] ***Requested Action: Revise Decision ID 34696 for the ammonia listing for Echo Park Lake to Delist from 303(d) list and remove from Category 4 (Appendix C) based on USEPA's recommendation.***
14.	Lincoln Park Lake Lead	Decision ID 34817 proposes to change the lead listing for Lincoln Park Lake from List on 303(d) list (TMDL-required list) to list on the 303(d) list (being addressed by USEPA approved TMDL). However, the TMDL report made a finding of

[1] U.S. Environmental Protection Agency, Los Angeles Area Lakes TMDLs, Section 6.2.3.2 Summary of Ammonia Non-Impairment , March 2012, p.6-13

		nonimpairment for lead, as outlined in the following excerpt from Section 5.3 of the TMDL report (emphasis added): "Lincoln Park Lake was listed as impaired for lead in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB, 1996). Consistent with project plan recommendations provided in California's Impaired Waters Guidance (SWRCB, 2005), EPA and local agencies collected 40 additional samples (11 wet-weather) between October 2008 and December 2010 to evaluate current water quality conditions. There were zero dissolved lead exceedances in 40 samples (Appendix G, Monitoring Data). USEPA also collected one sediment sample in September 2010 to further evaluate lake conditions. There were zero sediment lead exceedances of the 128 ppm freshwater (Probable Effect Concentrations) sediment target (Appendix G, Monitoring Data). Therefore, Lincoln Park Lake meets lead water quality standards and USEPA concludes that preparing a TMDL for lead is unwarranted at this time. *USEPA recommends that Lincoln Park Lake not be identified as impaired by lead in California's next 303(d) list*."[2] ***Requested Action: Revise Decision ID 34817 for the lead listing for Lincoln Park Lake to Delist from 303(d) list and remove from Category 5 (Appendix B) based on USEPA's recommendation.***
15.	Lincoln Park Lake Ammonia	The data utilized to develop the original listing in 1998 are not available (these data were requested from USEPA and the Regional Board during development of the TMDL in 2010. Based on USEPA's TMDL report, data collected prior to 2009 were reported as ammonium, without corresponding ammonia, pH, or temperature measurements making it impossible to compare these data to ammonia criteria. Only ammonia data collected with corresponding pH and temperature data can be used to determine if criteria were exceeded. In 2008, the Regional Board collected eight ammonia samples all of which were below the reporting limit of 0.1 mg/L and chronic criterion. In 2009, the City of Los Angeles and USEPA/Regional Board conducted monitoring and collected 15 and three samples, respectively, all of which were below the chronic criterion. As stated in the TMDL report (pg. 5-10): *"There were no exceedances of the acute or chronic ammonia criteria during any recent sampling events with associated pH and temperature measurements."* In summary, there are no ammonia data with corresponding pH and temperature measurements available to support the original listing and all available recent data demonstrate there are no exceedances. ***Requested Action: Revise Decision ID 35004 for the ammonia listing for Lincoln Park Lake to Delist from 303(d) list and remove from Category 5 (Appendix B).***
16.	Los Angeles River Reach 2 (Carson to Figueroa Street) and Los Angeles River Reach	The source of oil seeping into the River was found to be naturally-occurring crude oil. This conclusion is supported by the results of investigations completed by various agencies, which are summarized as follows: An investigation was conducted following seeps of petroleum hydrocarbons into the LA River in June 2001. Based on lab results and borings, it was concluded that the source of the LA River channel oil seeps is naturally-occurring crude oil from Puente formation sands. Oil was visible in Puente formation seams, partings and fractures, as well as sand lenses, and appeared to have migrated upward into sandy alluvial soils. Gasses encountered included hydrogen sulfide, commonly sources from crude oil reservoirs. The hydrocarbon seeps appeared to be concentrated where the Puente formation

2 U.S. Environmental Protection Agency, Los Angeles Area Lakes TMDLs, Section 5.3 Lead Impairment, March 2012, p.5-18

	5 (within Sepulveda Basin) Oil	contacts with younger, less permeable units or layers. The USEPA On-Scene Coordinator (OSC) conducted subsurface investigations of the oil seeps in the LA River during August and September 2001. The OSC found that the oil did not discharge as a result of a spill, leak, or discharge from any facility and that the oil has been discharging to the river since at least 1943 and there is no practical means of preventing this oil seep from discharging to the River. On April 19, 2002, an email was sent to Steven Pedersen of City of Los Angeles /Watershed Protection Division (WPD) by Steven Poole of the US Coast Guard/National Pollution Funds Center (USGC/NPFC). Mr. Poole stated that City of Los Angeles cannot submit to USGC/NPFC a claim for reimbursement for cost incurred by the City associated with May 2001 oil clean-up efforts in the LA River because Title 1 of the Oil Pollution Act does not allow for reimbursement for **naturally-occurring oil** (natural seepage). In summary, the reports and correspondence discussed herein, indicate that multiple agencies believe that the oil found in the listed reaches of the LA River is associated with naturally-occurring seepage suggesting that a 303(d) listing is not warranted. **Studies Used in the Analysis** The following studies/correspondences were used in the analysis: • Pollution Report (2002), USEPA Region IX • Correspondence (2002) from Michael P. Brown, Manager, Geotechnical Engineering Division, Bureau of Engineering, City of Los Angeles • Correspondence (2002) from Steven Poole, Claims Manager, USGC/NPFC Despite repeated efforts by WPD to obtain the historical information utilized to develop the original listing, the Regional Board has not provided the information for inclusion in the analysis. Therefore, the analysis is based solely on recent information available to WPD. **Summary of Findings** The source of oil seeping into the River was found to be naturally-occurring crude oil. This conclusion is supported by the results of investigations completed by various agencies, which are summarized below. **Investigations of the Geotechnical Engineering Division, Bureau of Engineering, City of Los Angeles – June 2001** An investigation was conducted following seeps of petroleum hydrocarbons into the engineered channel of the LA River across from the Piper Technical Center in June 2001. This study concluded that the source of the LA River channel oil seeps is naturally-occurring crude oil from Puente formation sands, based on lab results and borings. The samples of the oil seeps and associated bacterial-growth scums revealed that the seeps were predominantly in the oil or heavy-hydrocarbon range. This supports the conclusion that the LA River oil seeps are natural crude oil as opposed to

		fuel leaks. Drilling of wells along Mission St. (east of the river channel) confirmed that oil-bearing Puente formation sands and fractures are the source of crude oil and gases that migrate into the shallow alluvial soils. The hydrocarbons, visible oil and PID readings generally increased with depth toward the Puente formation. Oil was visible in Puente formation seams, partings, and fractures, as well as sand lenses, and appeared to have migrated upward into sandy alluvial soils. Gasses encountered included hydrogen sulfide, commonly sources from crude oil reservoirs. The hydrocarbon seeps appeared to be concentrated where the Puente formation contacts younger, less permeable units or layers. **Pollution Report, EPA – January 2002** The USEPA OSC conducted extensive subsurface investigations of the oil seeps in the LA River during August and September 2001. The OSC found that the oil did not discharge to the River as a result of a spill, leak, or discharge from any facility based on the investigation. The oil has been discharging to the river since the least 1943 and there is no practical means of preventing this oil seep from discharging to the LA River. The OSC also evaluated the use of epoxy or urethane sealants on the seeps to reduce the flow of oil. However, it was concluded that the use of sealants on the seeps would cause the oil to get into the subdrain system and eventually enter the LA River. In summary, WPD attempted to evaluate the original listing information in light of the currently available information. Although the Regional Board did not provide the information, the reports and correspondence discussed herein, and attached to this letter, indicate that multiple agencies believe that the oil found in the listed reaches of the Los Angeles River is associated with naturally-occurring seepage. ***Requested Action: Revise Decision IDs 34118 and 34203 for the oil listings for Los Angeles River Reaches 2 and 5 to Delist from 303(d) list and remove from Category 5 (Appendix B) given that the oil found in the listed reaches of the Los Angeles River is associated with naturally-occurring seepage. Alternatively, move the listing to Category 4b as other regulatory programs are reasonably expected to result in attainment of the water quality standard.***
17.	Various waterbodies Various pollutants	Section 2 of the *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (Listing Policy) states (pg. 3): "At a minimum, the California section 303(d) list shall identify waters where standards are not met, **pollutants or toxicity** contributing to standards exceedance, and the TMDL completion schedule." In addition, Section 2.1 of the Listing Policy titled "Water Quality Limited Segments" states (pg. 3): "Waters shall be placed in this category of the section 303(d) list if it is determined, in accordance with the California Listing Factors that the water quality standard is not attained; **the standards nonattainment is due to toxicity, a pollutant, or pollutants**; and remediation of the standards attainment problem requires one or more TMDLs." As such, all listings that do not identify either toxicity or a pollutant as the impairment do not meet the requirements for being placed in the water quality-limited segments category. This is supported by current listing decisions made by the Los Angeles Regional Water Quality Control Board (Regional Board) in Burbank Western Channel for excess algal growth, scum foam-unnatural, and taste and odor and Calleguas Creek Reach

13 for excess algal growth that state the following (emphasis added): “Based on the readily available data and information, the weight of evidence indicates that there is sufficient justification in favor of **removing** these listing from the 303(d) Water Quality Limited Segment list **because the segment pollutant combinations is not a pollutant**.” The following table presents water body segments and listings that correspond to instances where there is not a pollutant.

Decision ID	Water Body Segment	Listing
44553	Arroyo Seco Reach 1 (LA River to West Holly Ave.)	Benthic Community Effects
65656	Ballona Creek	Benthic Community Effects
44746	Ballona Creek Wetlands	Exotic Vegetation
34697	Ballona Creek Wetlands	Habitat alterations
34699	Ballona Creek Wetlands	Hydromodification
44747	Ballona Creek Wetlands	Reduced Tidal Flushing
44498	Compton Creek	Benthic Community Effects
32967	Compton Creek	pH
66165	Dominguez Channel (lined portion above Vermont Ave)	Benthic Community Effects
38511	Dominguez Channel Estuary (unlined portion below Vermont Ave)	Benthic Community Effects
34030	Echo Park Lake	Algae
34698	Echo Park Lake	Eutrophic
34756	Echo Park Lake	Odor
44748	Echo Park Lake	pH
35180	Lincoln Park Lake	Eutrophic
44641	Lincoln Park Lake	Odor
35223	Lincoln Park Lake	Organic Enrichment/Low Dissolved Oxygen
35168	Los Angeles Harbor - Consolidated Slip	Benthic Community Effects
33456	Los Angeles River Reach 1 (Estuary to Carson Street)	Nutrients (Algae)
32959	Los Angeles River Reach 2 (Carson to Figueroa Street)	Nutrients (Algae)
66229	Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.)	Benthic Community Effects
34204	Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.)	Nutrients (Algae)
64386	Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.)	Temperature, water
66232	Los Angeles River Reach 4 (Sepulveda Dr. to Sepulveda Dam)	Benthic Community Effects
44326	Los Angeles River Reach 4 (Sepulveda Dr. to Sepulveda Dam)	Nutrients (Algae)

35160	Los Angeles River Reach 5 (within Sepulveda Basin)	Nutrients (Algae)
34207	Los Angeles/Long Beach Inner Harbor	Beach Closures
34208	Los Angeles/Long Beach Inner Harbor	Benthic Community Effects
34305	Machado Lake (Harbor Park Lake)	Algae
42417	Machado Lake (Harbor Park Lake)	Eutrophic
42262	Machado Lake (Harbor Park Lake)	Odor
61605	Marina del Rey Harbor - Back Basins	Oxygen, Dissolved

Requested Action: Revise the decision for the segments listed in the preceding table to Delist from 303(d) list or Do Not List on 303(d) list, whichever is applicable, and remove from Category 5 (Appendix B) or Category 4 (Appendix C).

18. Various waterbodies Various pollutants

There are numerous listings that include waterbody segments which are in nonattainment due to pollution that is not caused by a pollutant. The *2016 Clean Water Act Sections 305(b) and 303(d) Integrated Report for the Los Angeles Region Staff Report* states the following (pg. 9): "Impaired waters are placed in Category 4c if the impairment is not caused by a pollutant, but rather caused by pollution, such as flow alteration or habitat alteration." Impairments for benthic community effects, exotic vegetation, habitat alterations, hydromodification, reduced tidal flushing, and temperature are caused by either flow and/or habitat alteration (not by a pollutant or combination of pollutants) and; therefore, waterbody segments under these listings should instead be moved to Category 4c.

Decision ID	Water Body Segment	Listing
44553	Arroyo Seco Reach 1 (LA River to West Holly Ave.)	Benthic Community Effects
65656	Ballona Creek	Benthic Community Effects
44746	Ballona Creek Wetlands	Exotic Vegetation
34697	Ballona Creek Wetlands	Habitat alterations
34699	Ballona Creek Wetlands	Hydromodification
44747	Ballona Creek Wetlands	Reduced Tidal Flushing
44498	Compton Creek	Benthic Community Effects
66165	Dominguez Channel (lined portion above Vermont Ave)	Benthic Community Effects
38511	Dominguez Channel Estuary (unlined portion below Vermont Ave)	Benthic Community Effects
35168	Los Angeles Harbor - Consolidated Slip	Benthic Community Effects
66229	Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.)	Benthic Community Effects
64386	Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.)	Temperature, water
66232	Los Angeles River Reach 4 (Sepulveda Dr. to Sepulveda Dam)	Benthic Community Effects

<table>
<tr><td></td><td></td><td><table><tr><td>34207</td><td>Los Angeles/Long Beach Inner Harbor</td><td>Benthic Community Effects</td></tr></table>
Requested Action: Notwithstanding the previous comment that supports revising the decision for the segments listed in the preceding table to Delist from 303(d) list or Do Not List on 303(d) list, whichever is applicable, move all segments listed in the preceding table with impairments caused by pollution to Category 4c and revise Appendix B or C as appropriate.</td></tr>
<tr><td>19.</td><td>Lincoln Park Lake
PCBs</td><td>Decision ID 64083 proposes to list PCBs in fish tissue for Lincoln Lake Park. However, this Lake is annually stocked with fish and therefore the lake population does not spend its lifespan in Lincoln Park Lake and may have accumulated PCBs from another waterbody. A number of studies have indicated that farmed salmon accumulate PCBs from the fish meal they are fed. In order to determine the source of the exceedance, fish from the State's stocking system need to be tested prior to introduction and the duration of time they spend in the Lake needs to be determined by a tagging program. The current analysis makes the assumption that fish are introduced to the Lake free of PCBs and subsequently bioaccumulate PCBs from Lake sediments. In addition, the Lake is restocked every year in April which suggests that all fish stocked are immediately removed and consumed. Both of these assumptions need to be fully evaluated prior to determining the source of the exceedance and therefore Lincoln Park Lake does not meet the minimum requirements to justify a listing.

Requested Action: Remove Decision ID 64083 from Category 5 (Appendix B) or revise from Category 5 to Category 3 so that further evaluation of whether or not the lake itself is actually impaired.</td></tr>
<tr><td>20.</td><td>Santa Monica Bay Offshore/Nearshore
Arsenic</td><td>The Fact Sheet for Decision ID 67208 presents two lines of evidence related to arsenic in Santa Monica Bay (88949 and 88950). LOE 88949 presents information related to sediment and found that 0 of 32 samples exceeded the sediment goals utilized in the assessment. LOE 88950 presents information related to fish tissue and indicates that 19 of 19 samples collected as part of Hyperion Water Reclamation Plan NPDES Permit during August of 2006, and August, September, October, and November of 2007 exceeded the evaluation guideline with the presumption that results were reported on a wet-weight basis and 10% of the total arsenic result represented the amount of inorganic arsenic in the sample for comparison to the guideline.

In reviewing LOE 88950, no information/citation can be found supporting the assumption that 10% of the total arsenic result represented the amount of inorganic arsenic in the sample. It is appropriate to utilize inorganic arsenic in assessing potential risk; however, either measured inorganic arsenic or a conversion factor developed from actual measured ratios from Santa Monica Bay should be utilized. In USEPA's 2000 Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Volume 1 Fish Sampling and Analysis Third Edition (EPA 823-B-00-007), USEPA recommends that, in both screening and intensive studies, total inorganic arsenic tissue concentrations be determined for comparison with the recommended screening value for chronic oral exposure. Scientific literature demonstrates that a range of total to inorganic arsenic ratios exist. For example, a 2008 study specifically looking at arsenic speciation in 383 samples of marine fish and shellfish, showed that the inorganic fraction of arsenic is typically <0.5% with a few of the highest samples ranging from 1-5%[3]. The City's concern with the approach has been expressed in other regions of California as well. The Port of San</td></tr>
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[3] Peshut, P.J. et al., 2008. *Arsenic speciation in marine fish and shellfish from American Samoa*. Chemosphere 71 488-492. doi:10.1016/j.chemosphere.2007.10.014

		Diego in an August 11, 2016 comment letter to the San Diego Regional Water Quality Control Board regarding a 303(d) arsenic listing[4], noted the high level of variability of the proportion of inorganic arsenic across species (typically □10□) as measured in a number of other studies, as well as a methodology that could be used to ground truth the applied proportion through actual sample data. In response to the Port of San Diego's comment the San Diego Regional Board removed an arsenic listing from their draft 303(d) list and stated: *"… there is a high level of uncertainty in the levels of inorganic arsenic in shellfish tissue. The assumption regarding the percent of total arsenic in shellfish tissue is likely conservative, and the San Diego Water Board agrees that a listing based on those assumptions has a high probability of mischaracterizing the results as an impairment. The San Diego Water Board supports the Port's suggestion that future monitoring of shellfish incorporate a measurement of both total and inorganic arsenic.[5]"* The City also has concerns with the approach to utilizing the data in comparison to the guidelines. Section 6.1.5.3 of the Listing Policy states that "Samples used in the assessment must be temporally independent." However, each individual sample was considered on its own without consideration for temporal representation. Samples collected on the same day (i.e., October 2007, November 2007, and September 2008) should not be considered independently from one another as they are clearly not temporally independent. Furthermore, given tissue concentrations represent the accumulation of pollutants over a time period of years and the risk endpoint relates to a carcinogenic effect over a 30-year period, considering samples collected within months of each other (October and November 2007 and August and September 2008) also does not provide the required temporal independence. Data should be aggregated across appropriate temporal timeframes, which should be assessed on a case-by-case basis, but should be no less than annually. Lastly, in assessing tissue data, consideration should be given to the fact that multiple samples and species are collected and the range of concentrations within those samples and across species represents exposure and potential risk. Considering each individual sample separately from one another or across species results in an assumption that an individual sample is representative of the exposure condition. Data should not only be aggregated on an appropriate temporal scale, but also across species, potentially weighted based on likely consumption patterns. In summary, the lack of inorganic arsenic data and use of an unsupported conversion factor in combination with the approach to comparing tissue data that does not appropriately meet the requirements of temporal independence or reflect actual exposure conditions does support listing arsenic in Santa Monica Bay. The City welcomes the opportunity to discuss approaches to develop inorganic arsenic data for use in future evaluations, as well as an approach to consider tissue data to properly evaluate arsenic in Santa Monica Bay. ***Requested Action: Remove Decision ID 67208 from the 303(d) list. However, if the Regional Board feels it is***

[4] Port of San Diego comment letter to California Water Quality Control Board – San Diego Region. *"Comment – CWA Section 305(b)/303(d) Integrated Report."* Letter Dated August 11, 2016.

[5] Page 47 of San Diego Region Response to Comment on 2014 303(d) list. http://www.swrcb.ca.gov/sandiego/water_issues/programs/303d_list/docs/Response_To_Comments.pdf

		necessary to categorize the information within the Integrated Report, place the waterbody pollutant combination in Category 3 as there is insufficient data and information to make a beneficial use support determination, but information and/or data indicates beneficial uses may be potentially threatened.
21.	Santa Monica Bay Offshore Nearshore Mercury	The Fact Sheet for Decision ID 67209 presents three lines of evidence related to mercury in Santa Monica Bay (4165, 88894, and 88891). LOE 4165 and 88891 presents information related to sediment toxicity and sediment chemistry, respectively. LOE 88894 presents information related to fish tissue and indicates that 2 of 19 samples collected as part of Hyperion Water Reclamation Plan NPDES Permit during August of 2006, and August, September, October, and November of 2007 exceeded the evaluation guideline with the presumption that results were reported on a wet-weight basis. Section 6.1.5.3 of the Listing Policy states that "Samples used in the assessment must be temporally independent." However, each individual sample was considered on its own without consideration for temporal representation. Samples collected on the same day (i.e., October 2007, November 2007, and September 2008) should not be considered independently from one another as they are clearly not temporally independent. Furthermore, given tissue concentrations represent the accumulation of pollutants over a time period of years, considering samples collected within months of each other (October and November 2007 and August and September 2008) also does not provide the required temporal independence. Data should be aggregated across appropriate temporal timeframes that should be assessed on a case-by-case basis, but should be no less than annually. Lastly, in assessing tissue data, consideration should be given to the fact that multiple samples and species are collected and the range of concentrations within those samples and across species represents exposure and potential risk. Considering each individual sample separately from one another or across species results in an assumption that an individual sample is representative of the exposure condition. Data should not only be aggregated on an appropriate temporal scale, but also across species, potentially weighted based on likely consumption patterns. The City welcomes the opportunity to discuss an approach to appropriately consider tissue data to properly evaluate mercury in Santa Monica Bay. ***Requested Action: Remove Decision ID 67209 from the 303(d) list. However, if the Regional Board feels it is necessary to categorize the information within the Integrated Report, place the waterbody pollutant combination in Category 3 as there is insufficient data and information to make a beneficial use support determination, but information and/or data indicates beneficial uses may be potentially threatened.***
22.	Echo Park Lake and Machado Lake (Harbor Park Lake) Various pollutants	Echo Park Lake and Machado Lake (Harbor Park Lake) are two waterbodies located in Los Angeles County which have both been included on the 303(d) impaired waters list since 2006. Because of their water quality impairments, the City invested significant resources to rehabilitate the water quality of the lakes. The 45 million Echo Park Lake Rehabilitation Project was completed in 2015 and included extensive changes to the lake hydrology (e.g., storm drain upgrades, inlet and outlet upgrades, removal of contaminated lake sediments, and installation of lake aeration system) and immediately surrounding areas, including best management practices (BMPs) to reduce the loads of targeted pollutants including trash, metals, coliform, pesticides, and nutrients[6]. The Machado Lake Ecosystem Rehabilitation Project involved dredging and

[6] City of Los Angeles. Echo Park Lake Rehabilitation Proposition O Project. December 13, 2006. http://www.lapropo.org/sitefiles/docs/concept_reports/echoparklakerehab.pdf

capping the lake bottom, constructing an oxygenation system, adding new storm drain systems, as well as a number of other BMPs to improve water quality[7]. These award-winning projects have been very successful and produced significant water quality improvements; however, these improvements are not reflected in the Regional Board's proposed 303(d) list.

The proposed changes for Echo Park Lake includes two delistings for copper and lead, which the City supports; however, two new listings were added for chlordane (tissue) and dieldrin. The other legacy listings for Echo Park Lake and Machado Lakes remain on the proposed 303(d) list (see following table). The City maintains that these legacy listings are inappropriately categorized and should instead be listed as Category 3 based on the significant restoration efforts conducted since the last update to the 303(d) list. The USEPA 2010 Integrated Report Guidance[8] uses the following definition for Category 3 listings:

> *"The existing and readily available data and information is not representative of current conditions of the water body. This rationale might include a determination that: significant land use changes have occurred in the watershed changing the hydrology and nonpoint source loadings; point source discharges were removed; new discharges are now operating; or the locations of sampling stations did not reflect the character of the segment (e.g., limited to locations near discharge outfalls)."*

The extensive restoration projects have entirely changed not only the chemical and physical conditions of the lakes themselves, but have also completely transformed the nonpoint source loadings, and hydrology of the system. Any data collected prior to the restoration efforts (i.e., all of the data used for the current listings) are not representative of the current condition of the lakes; therefore, both of these waterbodies are excellent candidates for a Category 3 listing and should be categorized as such until enough data exists to establish their current condition. It is likely that as a result of both of these restoration efforts, the lakes could be entirely delisted. However, until that time, a Category 3 listing would represent the most conservative listing on the part of the Regional Board.

The City appreciates the time and effort that goes into maintaining the 303(d) list and notes that these award-winning restoration projects were facilitated in part by the Regional Board's historical listing actions. The City hopes that the extensive resources put into restoring the beneficial use of these waterbodies can be recognized by assigning the proper Category 3 listing to Echo Park and Machado Lake pollutants.

Decision ID	Water Body Segment	Listing
34030	Echo Park Lake	Algae
34696	Echo Park Lake	Ammonia
62679	Echo Park Lake	Chlordane
62680	Echo Park Lake	Dieldrin

7 http://www.machadoprojects.com/machado_lake_ecosystem.php
8 Page 5 of USEPA Information Concerning 2010 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions. https://www.epa.gov/sites/production/files/2015-10/documents/2009_05_06_tmdl_guidance_final52009.pdf

34698	Echo Park Lake	Eutrophic
34756	Echo Park Lake	Odor
33999	Echo Park Lake	PCBs (Polychlorinated biphenyls)
44748	Echo Park Lake	pH
32435	Echo Park Lake	Trash
34305	Machado Lake (Harbor Park Lake)	Algae
42416	Machado Lake (Harbor Park Lake)	Ammonia
34362	Machado Lake (Harbor Park Lake)	ChemA (tissue)
42417	Machado Lake (Harbor Park Lake)	Eutrophic
42262	Machado Lake (Harbor Park Lake)	Odor
35181	Machado Lake (Harbor Park Lake)	Trash

In reviewing the proposed listings for the 303(d) list for Echo Park and Machado Lakes a number of inconsistencies were noted. They have been identified below:

- Echo Park Lake PCB (tissue) (Decision ID 33999) is listed as a new 4A listing in Appendix C, but the change is not noted in Appendix A.
- Machado Lake Chlordane (tissue) (Decision ID 33013), Dieldrin (tissue) (Decision ID 33643), and PCBs (tissue) (Decision ID 33285) are not listed as changes in Appendix A, do not appear in Appendix B or C, but are listed in Appendix G.
- Machado Lake DDT (tissue) (Decision ID 33211) is not listed as a change in Appendix A and does not appear in Appendix B or C, but is listed in Appendix G, although incorrectly, as requiring a TMDL despite the fact that DDT is covered by an existing TMDL.
- Machado Lake algae, ammonia, ChemA (tissue), eutrophication, odor and trash are included in Appendix G Fact Sheets as already being addressed by a USEPA-approved TMDL, which is expected to result in attainment of the standard; however, they are all listed as Category 5B in Appendix B and as unchanged in Appendix A in the proposed 303(d) List.

The Regional Board should clarify if these omissions and inconsistencies equate to a delisting of the pollutants. As explained above, the City supports the delisting of the pollutants due to the extensive restoration projects that have been completed. If, for some reason, these listing were omitted in error and the RWQCB disagrees with the City's comment to include them as Category 3, then all of the listings should, at a minimum, be included as Category 4A. Category 4A is defined as "*A TMDL has been developed and approved by USEPA and the approved implementation plan is expected to*

		result in full attainment of the water quality standard within a specified time frame." Category 4A is supported by the approved TMDLs covering Echo Lake Chlordane and PCB listings[9], as well as the Machado Lake Chlordane, DDT, Dieldrin, PCB, algae, ammonia, ChemA(tissue), eutrophication, odor, and trash listings[10,11,12]. ***Requested Actions:*** ***(1) Move all segments listed in the preceding table to Category 3 based on the completion of extensive restoration projects, and include the following text to explain the category change: "Due to recent extensive restoration efforts, data from 2010 and prior is not representative of current conditions of the water body. Available data are insufficient to determine attainment status."*** ***(2) If Category 3 listing of suggested pollutants does not occur, ensure that all pollutants listed in the preceding table are correctly categorized as Category 4A based on the existence of USEPA approved TMDLs.*** **(3)** ***Correct and/or clarify inconsistent listings in Appendices for consistency throughout the entire proposed 303(d) document.***
23.	Various waterbodies Benthic Community Effects	Notwithstanding the City's comments related to removing all listings that do not identify either toxicity or a pollutant as the impairment, the City identified the following listings for Benthic Community Effects (summarized in the following table) that are inappropriate: • Ballona Creek: Decision ID 65656 • Dominguez Channel (lined portion above Vermont Ave): Decision ID 66165 • LA River Reach 3 (Figueroa St. to Riverside Dr.): Decision ID 66229 • LA River Reach 4 (Sepulveda Dr. to Sepulveda Dam): Decision ID 66232 • Arroyo Seco Reach 1 (LA River to West Holly Ave.): Decision ID 44553 • Arroyo Seco Reach 2 (West Holly Ave to Devils Gate Dam): Decision ID 65548 • Compton Creek: Decision ID 44498 The City believes the listings are inappropriate, based on the following issues that are described in more detail below: • <u>Impairment of the reaches was not demonstrated using an appropriate metric for benthic community condition.</u> The listing decisions were based on Southern California Coastal Index of Biotic Integrity (SCIBI). The State Water Board has rejected use of the SCIBI in favor of the California Stream Condition Index (CSCI). The Regional Board Staff Conclusions (Staff Conclusions) for the listing decisions do not acknowledge that the data used to support the decisions were SCIBI scores, not CSCI scores. Instead, the Staff Conclusions imply that the decisions are based on CSCI scores.

9 The Los Angeles Area Lakes Nitrogen, Phosphorus, Mercury, Trash, Organochlorine Pesticides and PCBs TMDL approved by USEPA March 26, 2012.
10 The Machado Lake Nitrogen TMDL approved by USEPA on March 11, 2009.
11 The Machado Lake Toxics TMDL was approved by USEPA on March 20, 2012.
12 The Machado Lakes Trash TMDL approved by USEPA on March 6, 2008.

- There is no established water quality criteria for benthic community condition. Use of a SCIBI score of 40 (or other "cutoffs" promulgated by the authors of the SCIBI) as a listing threshold is not consistent with the State Board's current approach for identifying impairment thresholds for benthic community data. The Regional Board use of a CSCI score of 0.79 in other listing decisions (and implied to be appropriate for Ballona Creek) is also not consistent with the State Board's current approach for identifying impairment thresholds for benthic community data.
- Listings for concrete-lined channels using current metrics are inappropriate. Reference reaches for concrete-lined channels in highly urbanized catchments are lacking. Physical habitat conditions were apparently not considered during data evaluation. The State Board is planning to develop expectations for benthic community condition for developed landscapes using the CSCI and a new Algal Stream Condition Index (ASCI). TMDL development for benthic community effects in concrete-lined channels based on unofficial IBI thresholds is premature.
- Insufficient data are available to meet the listing requirements. Notwithstanding the previous issues, several of the listings rely on a single site for data as a basis of the listing inconsistent with the Listing Policy.

Type of Decision	Segment / Station	Cited Benthic Community Data				
		Line of Evidence (LOE) ID	**Data Source**	**Metric used in Data Source**	**Time Frame**	**Scores[a]**
New Listing	Ballona Creek (Station 14)	82971	Bioassessment Monitoring Report in LA County, 2006-2008	SCIBI	2006, 07, 08	3/3 scores were below 40
New Listing	Dominguez Channel (Station 19)	83960		SCIBI	2006, 07, 08	3/3 scores were below 40
New Listing	LA River Reach 3 (Stations 11 and 12)	85994		SCIBI	2006, 07	4/4 scores were below 40
New Listing	LA River Reach 4 (Station 13)	86097		SCIBI	2006, 07	2/2 scores were below 40
Do Not Delist	Compton Creek (Station 8)	83829		SCIBI	2006, 07, 08	3/3 scores were below 40
		30224	LA County 1994-2005 Integrated Receiving Water Impacts Report. Section 5, LA River Watershed Management Area, pp 5.1 - 5.40	SCIBI	2003, 04	2/2 scores were "very poor"
Previous Listing	Arroyo Seco Reach 1 (Station LALT501)	30223		SCIBI	2003, 04	2/2 scores were below 13
		82895	Bioassessment Monitoring Report in LA County, 2006-2008	SCIBI	2008	1/1 score was below 40
New Listing	Arroyo Seco Reach (Station 7)	82896		SCIBI	2006, 07, 08	3/3 scores were below 40

[a] Per Staff Conclusions, SCIBI scores were binned as very good (80-56), good (41-55), fair (27-40), poor (14-26) and very poor (0-13) habitat conditions; sites with scores below 26 are considered to have impaired conditions.

Impairment of the reaches was not demonstrated using an appropriate metric for benthic community condition.

SCIBI-based datasets should not be considered for listing decisions. Section 3.9 of the Listing Policy states:

		“A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities ***as compared to reference site(s)*** *and is associated with water or sediment concentrations of pollutants including, but not limited to chemical concentrations, temperature, dissolved oxygen, and trash.” [Emphasis added.]* While it is commonly assumed that the SCIBI inherently accounted for reference conditions, the reference conditions used to develop the SCIBI were not representative of the low-elevation low-gradient streams commonly found in the alluvial plains of the Los Angeles Region.[13,14] It was developed using data from 275 sites, ranging from Monterey County to the Mexican border, but not a single reference location represented low-elevation and low-gradient streams. The reaches listed in the table above are extremely low gradient, low-elevation water bodies, and thus the SCIBI does not adequately define relevant reference conditions. Furthermore, the reference conditions used in the SCIBI represent a less restrictive definition of the reference condition than that which was deemed adequate as part of the State’s Reference Condition Management Program[15]. The lead scientist for development of the SCIBI, Dr. Peter Ode, has acknowledged the limitations on application of the SCIBI. In a recently published paper regarding a study examining the SCIBI relative to other benthic macroinvertebrate bioassessments, he concluded that the SCIBI did not adequately address reference conditions in low-elevation sites, stating that the SCIBI was “not completely effective at controlling for an elevation gradient.”[16] Dr. Ode was also the coauthor of a March 2009 report on recommendations for development and maintenance of a network of reference sites to support biological assessment of California’s wadeable streams.[17] This report describes recommendations made by a technical panel of experts on bioassessment, including experts from the California Department of Fish and Wildlife, Southern California Coastal Water Research Project (SCCWRP), US EPA Region 9, and various universities. The technical panel laid out a number of steps that would be necessary to develop a network of adequate reference sites for implementation of criteria for bioassessments. They note that adequate reference sites have not been identified in southern California, stating, “human-dominated landscapes can be so pervasive in locations such as urban southern California and the agriculturally dominated Central Valley that no undisturbed reference sites may currently exist in these regions. A statewide framework

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[13] Ode, P.R., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management Vol. 35, No 4, pp. 494, Figure 1.

[14] Carter, J.L. and V.H. Resh. (2005). Pacific Coast Rivers of the Coterminous United States. pp. 541-590 *in*: A.C. Benke and C.E. Cushing (eds.), Rivers of North America. Elsevier Academic Press. Boston, MA.

[15] Mazor, R.D. (2012). Reference Streams and the Development of Bio-Objectives. Presentation to Member Agencies, Southern California Coastal Water Research Project. Costa Mesa, CA. Accessed on 02/21/2017.

ftp://ftp.sccwrp.org/pub/download/PRESENTATIONS/Symposium2012/Bioassessment_1_Mazor.pdf.

[16] Ode, P.R., C.P. Hawkins, R.D. Mazor, Comparability of Biological Assessments Derived from Predictive Models and Multimetric Indices of Increasing Geographic Scope, J. N. Am. Benthol. Soc., 2008, 27(4):967-985.p. 982. Copy included in Appendix 4.

[17] Ode, P.R., K. Schiff. Recommendations for the Development and Maintenance of a Reference Condition Management Program to Support Biological Assessment of California’s Wadeable Streams: Report to the Surface Water Ambient Monitoring Program. Southern California Coastal Water Research Project, Technical Report 581. March 2009. Copy included in Appendix 5.

		for consistent selection of reference sites must account for this complexity." In 2010, as part of its project to develop a statewide Biointegrity Policy, the State Board abandoned use of the SCIBI and other regional IBIs, and funded development of the statewide CSCI (Mazor et al., 2016). The CSCI addressed at least some of the problems with the SCIBI through its use of a modeled reference condition as opposed to a regional reference pool. Starting in late 2016, the State Board began funding the development of a "companion" Algal Stream Condition Index (ASCI). The State Board is developing expectations for benthic community condition using both the CSCI and the ASCI which will be incorporated in a statewide Biointegrity Assessment Implementation Plan.[18] The Staff Conclusions associated with the new listings in the preceding table do not acknowledge that the data used to support the new listings were SCIBI scores. Further, the Staff Conclusions for all of the new listings imply that Regional Board staff based the listing decision on CSCI scores. The source of the BMI data for each of the new listings, and the new LOE for Compton Creek, ("Bioassessment Monitoring Report in Los Angeles County, 2006-2008") were appendices (Appendix H) of the Los Angeles County Stormwater Monitoring Reports for 2006, 2007, and 2008. *In these reports, BMI data were scored using the SCIBI (Ode et al. 2005), not the CSCI*. In two cases (Ballona Creek and Arroyo Seco Reach 2), the Staff Conclusions explicitly, but erroneously, state that the underlying BMI data were CSCI scores. In the other cases, the ambiguous acronym "IBI" is used where scores are cited, and then the narrative ends with a passage implying that the "IBI" scores were CSCI scores. The misleading information in the Staff Conclusion for each new listing recommendation is provided below. • Ballona Creek: "Based on the readily available data and information, the weight of evidence indicates that there is sufficient justification in favor of placing Benthic Community Effects on the CWA section 303(d) List. .... "**3 of 3 samples were below the California Stream Condition Index (CSCI) score of 0.79**, indicating poor water quality and that pollutant concentration and toxic effects are impacting aquatic life in this waterbody segment" ... "**The CSCI** is available statewide, accounts for a much wider range of natural variability, and provides equivalent scoring thresholds in all regions of the state. **The CSCI** will be used in the future for water quality assessment purposes statewide over the regional indices of biologic integrity." (Regional Board Staff Conclusion for Decision ID 65656, emphasis added) • Dominguez Channel (lined portion above Vermont Ave.): "Three of the three samples collected had IBI scores below 40 there are several other pollutants in this water body that are listed for impairment including ammonia, copper, diazinon, nitrogen, toxicity, and zinc." ... "**The CSCI** is applicable statewide, accounts for a much wider range of natural variability, and provides equivalent scoring thresholds in all regions of the state. **The CSCI** will be used in the future for water quality assessment purposes statewide over the regional indices of biologic integrity (IBIs)." (Regional Board Staff Conclusion for Decision ID 66165, emphasis added) • Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.): "Four of the four samples collected had IBI scores below 40." ... "**The CSCI** is applicable statewide, accounts for a much wider range of natural variability, and provides equivalent scoring thresholds in all regions of the state. **The CSCI** will be used in the future for water quality assessment purposes statewide over the regional indices of biologic integrity (IBIs)." (Regional Board Staff

18 Sutula, M., A. R. Mazor, S. Theroux, E. Stein, P. Ode, A. Rehn, M. Paul, and B. Jessup. (2017) Science Plan to Support the State Water Board's Biostimulatory-Biointegrity Project for California Wadeable Streams.

		Conclusion for Decision ID 66299, emphasis added) • Los Angeles River Reach 4 (Sepulveda Dr. to Sepulveda Dam): "Both of the two samples collected had IBI scores below 40.... Two of the two samples collected had IBI scores below 40. ... "**The CSCI** is applicable statewide, accounts for a much wider range of natural variability, and provides equivalent scoring thresholds in all regions of the state. **The CSCI** will be used in the future for water quality assessment purposes statewide over the regional indices of biologic integrity (IBIs)." (Regional Board Staff Conclusion for Decision ID 66232, emphasis added) • Arroyo Seco Reach 2 (West Holly Ave to Devils Gate Dam): "3 of 3 samples exceeded the GUIDELINE... **3 of 3 samples were below the California Stream Condition Index (CSCI) score of 0.79**. ... "**The CSCI** is applicable statewide, accounts for a much wider range of natural variability, and provides equivalent scoring thresholds in all regions of the state. **The CSCI** will be used in the future for water quality assessment purposes statewide over the regional indices of biologic integrity (IBIs)." (Regional Board Staff Conclusion for Decision ID 65548, emphasis added) **There is no established water quality criteria.** Regional Board staff utilized a SCIBI score of 40 as a listing threshold. However, this value is not an established water quality criteria, nor does it represent the type of threshold the State Board intends to use to identify community condition or levels of impairment in its Biointegrity Assessment Implementation Plan. A SCIBI score of 39 was originally promulgated by the authors of the SCIBI (Ode et al. 2005) as an "impairment threshold" because it was equal to an arbitrary statistical criterion (two standard deviations below the mean reference site score). Although it was not used for the listings in the table above, Regional Board staff have also used a CSCI score of 0.79 as a listing threshold for other reaches (see also the statement regarding this threshold in the Staff Conclusions excerpt for Ballona Creek above). However, a CSCI threshold of 0.79 is also based on an arbitrary statistical criterion (10th percentile of the reference calibration site scores; Mazor et al. 2016), and is not an adopted water quality criteria. The State Board is not pursuing use of arbitrary statistical cutoffs, such as reference population percentiles, to identify benthic community impairment going forward. As outlined in the November 2016 Work Plan[19], the State Board is using a Biological Condition Gradient Expert Synthesis approach to relate ranges of biological condition scores to community condition. Using this approach, a team of experts uses taxonomic metrics to assign degrees of biological condition to test sites while being blind to the degree of anthropogenic stressors present at the sites. In addition, the analysis is blind to the relationship between site scores and statistical distributions of overall datasets or reference datasets. **Listings for concrete-lined channels using currently available metrics are inappropriate.** Application of the SCIBI to concrete-lined channels is especially inappropriate given the lack of a reference population for low-gradient streams in coastal southern California, in general, much less for modified channels, in specific. Section 6.1.5.8 of the listing policy states: *"When evaluating biological data and information, RWQCBs shall evaluate all readily available data and information and shall evaluate bioassessment data from other sites, and compare to reference condition. Evaluate physical habitat*

[19] Sutula, M., E. Stein, R. Mazor, S. Theroux, M. Paul, B. Jessop, and J. Gerritsen. 2016. Draft Work Plan "Expert Interpretation of the Biological Condition Gradient in California Wadeable Streams" November 2016 Update.

data and other water quality data, when available, to support conclusions about the status of the water segment."

EPA's causal assessment manual cites physical habitat as a leading cause of impairment in streams on 303(d) lists and recommends that, in all cases where physical habitat is evaluated, stream size and channel dimensions, channel gradient, channel substrate size and type, habitat complexity and cover, vegetation cover and structure, and channel-riparian interactions should all be considered before making a decision.[20]

Physical habitat conditions are not referenced in the Lines of Evidence for the benthic community effects listings in the preceding table, although physical habitat data collection is a standard part of bioassessment monitoring and reporting. Ultimately, benthic community impairments in concrete-lined channels should be evaluated for potential listing in Category 4c of the 305(b) integrated report, instead of on the 303(d) list of segments requiring a TMDL. The USEPA Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act (IRG) states:

> *"Circumstances where an impaired segment may be placed in Category 4c include segments impaired solely due to lack of adequate flow or to stream channelization."*

As part of its statewide Biostimulatory-Biointegrity Project, in recognition that it may not be appropriate or productive to apply a single set of benthic community condition expectations to streams in pristine and developed landscapes, the State Board is currently employing SCCWRP and CDFW to developing expectations for benthic community condition for developed landscapes using the CSCI and the Algal Stream Condition Index (ASCI).[21] The probability that concrete-lined channels in highly urbanized settings will be candidates for alternative benthic community endpoints is illustrated by language from the Work Plan:

> *"**In some streams, direct channel modifications (e.g., bank armoring) may also limit opportunities to sustain high-quality ecological conditions for aquatic life**. In these highly developed settings, the large number of linked stressors may prevent a stream from supporting its beneficial uses or attaining high scores on indices of biological condition. **Often, these stressors are difficult to mitigate or remove under the traditional mechanisms available to the Water Boards**. In these circumstances, the range of CSCI and/or ASCI scores may be constrained, but targeted restoration could improve conditions. Key technical questions underpinning the range of options and prioritization of management actions for wadeable streams along the continuum from undeveloped to highly developed landscapes found within California are: For which streams is biological integrity constrained by development in the catchment? How can they be identified and mapped? What are the ranges of biological conditions these developed landscapes can support?" (Mazor et al. 2017; emphasis added)*

Triggering TMDL development for benthic community effects in concrete-lined channels using unofficial impairment thresholds derived from statistical distributions of IBIs from unarmored reference reaches is unwarranted.

Insufficient data are available to meet the listing requirements

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[20] U.S. EPA (Environmental Protection Agency). (2010). Causal Analysis/Diagnosis Decision Information System (CADDIS). Office of Research and Development, Washington, DC. Available online at https://www.epa.gov/caddis. Last updated September 23, 2010

[21] Mazor, R., M. Sutula, E. Stein, A. Rehn, and R. Ode (2017) Work Plan. Predicting Biological Integrity of Streams Across a Gradient of Development in California Landscapes.

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Notwithstanding the previous issues, several of the listings rely on a single site for bioassessment data, which is inconsistent with the Listing Policy. Per section 3.9 (Degradation of Biological Populations and Communities) of the Listing Policy, “The analysis should rely on measurements from at least two stations.” Only one site is referenced in the Fact Sheets for the following listing decisions:

Ballona Creek
Dominguez Channel (lined portion above Vermont Ave)
Los Angeles River Reach 4 (Sepulveda Dr. to Sepulveda Dam) [Also, note that the data associated with Los Angeles River Reach 4 was actually collected in Los Angeles River Reach 5.]
Arroyo Seco Reach 1 (LA River to West Holly Ave.)
Arroyo Seco Reach 2 (West Holly Ave to Devils Gate Dam)
Compton Creek

Because data were only collected at one site within these waterbodies, the requirements of the Listing Policy are not met.
Summary
As described in detail above, the approach utilized to establish benthic community effects impairments are not demonstrated using an appropriate metric for benthic community condition. The listings rely on an unestablished water quality criteria based on metrics that are not appropriate for concrete-lined channels. Lastly, in all but one listing, there are not sufficient data to meet the listing requirements per the Listing Policy as the data were only collected at a single site within a waterbody.
Requested Action: Remove the following Decision IDs from the 303(d) list:

Ballona Creek: Decision ID 65656
Dominguez Channel (lined portion above Vermont Ave): Decision ID 66165
LA River Reach 3 (Figueroa St. to Riverside Dr.): Decision ID 66229
LA River Reach 4 (Sepulveda Dr. to Sepulveda Dam): Decision ID 66232
Arroyo Seco Reach 1 (LA River to West Holly Ave.): Decision ID 44553
Arroyo Seco Reach 2 (West Holly Ave to Devils Gate Dam): Decision ID 65548
Compton Creek: Decision ID 44498

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<tr><td>24.</td><td>Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.)
Temperature, water</td><td>
The temperature listing for Los Angeles River Reach 3 uses an evaluation guideline of 13-21°C as the optimum growth range for rainbow trout. However, the beneficial use listed for Los Angeles River Reach 3 is WARM. Only the COLD beneficial use uses the rainbow trout growth range as a listing criteria. This guideline should be removed and the number of exceedances recalculated based on the Basin Plan criteria for WARM.
Notwithstanding that the evaluation guideline of 13-21°C is inappropriate for Los Angeles River Reach 3 given the water body’s beneficial uses, the manner in which the evaluation guideline is applied is also inappropriate. Line of Evidence (LOE) 85933 references Moyle 1976 as the source of the evaluation guideline. Moyle 1976 was revised and expanded by Moyle 2002[22]. Moyle 2002 states: “Rainbows are found where daytime temperatures range from nearly 0°C in winter to
</td></tr>
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22 Moyle, Peter B. 2002. Inland Fishes of California – Revised and Expanded. University of California Press Berkeley and Los Angeles, California.

		26-27°C in summer, although extremely low (□4°C) or extremely high (□23°C) temperatures can be lethal if the fish have not previously been gradually acclimated. Even when acclimation temperatures are high, temperatures of 24-27°C are invariably lethal to trout, except for very short exposures." As such, while temperatures above 21°C may not be optimal according to Moyle 1976, Moyle 2002 clearly states that lethal temperatures are those greater than 23°C which indicates that the evaluation guideline of 21°C is more appropriately applied as a chronic guideline (necessitating the establishment of an averaging period) and 23°C is the more appropriate "not-to-exceed" guideline as used in the proposed listing. When utilizing 23°C, only 40 of the 542 samples exceed the guideline, which does not meet the *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (Listing Policy) minimum number of measured exceedances needed to place a water segment on the Section 303(d) list for conventional or other pollutants (a minimum of 90 exceedances would be required). As such, even if the Los Angeles River Reach 3 was designated with a COLD beneficial use, applying the appropriate "not-to-exceed" guideline of 23°C results in a finding of nonimpairment for temperature in Los Angeles River Reach 3. Lastly, notwithstanding that the evaluation guideline of 13-21°C is inappropriate for Los Angeles River Reach 3 given the water body's beneficial uses and that 23°C is the more appropriate "not-to-exceed" guideline, when the average water temperature across Los Angeles River Reach 3 was above 21°C (69.8°F), with only one exception out of 33, the air temperature was also above 21°C (69.8°F). As such, ambient air temperature above 21°C is most likely cause of exceedances of the 21°C evaluation guideline. ***Requested Action: Revise Decision ID 64386 for the temperature water listing for Los Angeles River Reach 3 to Do Not List on 303(d) list and remove from Category 5 (Appendix B) because the beneficial use protected by the evaluation guideline is not an existing or potential beneficial use within Los Angeles River Reach 3; the number of measured exceedances does not meet the minimum number of measured exceedances needed to place a water segment on the Section 303(d) list for conventional or other pollutants if an appropriate evaluation guideline is applied; and ambient air temperature is the most likely cause of exceedances of the evaluation guideline.***
25.	Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.), Los Angeles River Reach 5 (within Sepulveda Basin), Bull Creek, Wildlife Lake, and Balboa Lake	The Fact Sheet for Decision ID 32974 corresponds to the ammonia listing for Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.) and states that two lines of evidence are available in the administrative record to assess the pollutant, although there are three lines of evidence present (85894, 86019, and 2507). LOE 2507 is a placeholder to support a 303(d) listing decision made prior to 2006. LOEs 85894 and 86019 each state that all of the exceedances in each dataset occurred prior to and in 2007. The City found that the last exceedance was July 2007, which is to be expected given that 2007 was the year that the nitrification□denitrification (NDN) treatment process as completed at both the Los Angeles-Glendale Water Reclamation Plant (LAGWRP) and Donald C. Tillman Water Reclamation Plant (DCTWRP). Both the LAGWRP and DCTWRP discharges travel through Los Angeles River Reach 3, and since the NDN processes to remove ammonia were completed in July 2007, no exceedances in this waterbody have been observed. The Fact Sheet for Decision ID 32567 corresponds to the ammonia listing for Los Angeles River Reach 5 (within Sepulveda Basin) and states that two lines of evidence are available in the administrative record to assess the pollutant, although there are three lines of evidence present (86205, 86204, and 2520). LOE 2520 is a placeholder to support a 303(d) listing decision made prior to 2006. LOEs 86205 and 86204 each state that all of the exceedances in each dataset occurred prior to March and August 2007, respectively. The DCTWRP discharge flows through part of Reach 5 and the NDN processes to remove ammonia were completed in 2007.

	Ammonia	The Fact Sheet for Decision ID 60597 corresponds to the ammonia listing for Bull Creek and states that two lines of evidence are available in the administrative record to assess the pollutant (83158 and 83154). LOE 83154 presents one data point collected in May 2008 that does not show an exceedance. LOE 83158 states that all of the exceedances occurred prior to August 2007. The DCTWRP discharge flows through Bull Creek and the NDN processes to remove ammonia were completed in 2007. The Fact Sheet for Decision ID 66374 corresponds to the ammonia listing for Wildlife Lake and states that one line of evidence is available in the administrative record to assess the pollutant (90174). LOE 90174 states that all of the exceedances occurred prior to August 2007. The DCTWRP discharge flows through Wildlife Lake and the NDN processes to remove ammonia were completed in 2007. The Fact Sheet for Decision ID 60378 corresponds to the ammonia listing for Balboa Lake and states that one line of evidence is available in the administrative record to assess the pollutant (82930). LOE 82930 states that all of the exceedances occurred prior to August 2007. The DCTWRP discharge flows through Balboa Lake and the NDN processes to remove ammonia were completed in 2007. Furthermore, the Fact Sheet for Decision ID 32913 corresponds to the ammonia listing for Los Angeles River Reach 4 (Sepulveda Dr. to Sepulveda Dam) and includes the decision to Delist from 303(d) list (being addressed by USEPA approved TMDL) based on the following Regional Board Staff Decision Recommendation: "RWQCB staff concludes that the water body-pollutant combination should be removed from the section 303(d) list because applicable water quality standards for the pollutant are not being exceeded." This decision is based on two LOEs (2513 and 86136). LOE 2513 states "A TMDL and implementation plan have been approved for this water segment-pollutant combination. The Los Angeles River Nitrogen TMDL was approved by RWQCB on August 19, 2003 and subsequently approved by USEPA on March 18, 2004." LOE 86136 finds that 0 of 152 samples exceeded the site-specific basin plan objective for total ammonia as nitrogen and only includes samples collected from 2008 to 2010 (which is after the date when the WRPs added the NDN treatment process and is inconsistent with the dates used in the assessments conducted for Los Angeles River Reaches 3 and 5, Bull Creek, and Wildlife Lake). Through the installation and implementation of NDN treatment facilities and process optimization by the City of Los Angeles (and City of Burbank), which has spent approximately □75 million to construct advanced treatment facilities to address ammonia, and approximately □6 million per year to operate those facilities, the quality of the water in the Los Angeles River watershed has been demonstrated to be fully attaining the applicable water quality objectives for ammonia. The message from the City and the Regional Board should be that the cooperative process worked, and that the applicable water quality standards are now being attained. Instead, the 303(d) list does not reflect the water quality improvement. Given that the addition of the NDN treatment process to the WRPs has eliminated exceedances, the timeframe used to evaluate impairments due to ammonia should be made consistent with the timeframe used in Los Angeles River Reach 4 which would result in the same listing decision for each water body (i.e., Delist from 303(d) list [being addressed by USEPA approved TMDL]). ***Requested Action: Revise the following Decision IDs to a finding of nonimpairment and remove listings for ammonia from Category 5 (Appendix B) because the data used to conclude that the applicable water quality standards for the pollutant were exceeded are no longer representative of ammonia concentrations observed within the water bodies due to the installation and operation of NDN:***

		- ***Los Angeles River Reach 3 Decision ID 32947*** - ***Los Angeles River Reach 5 Decision ID 32567*** - ***Bull Creek Decision ID 60597*** - ***Wildlife Lake Decision ID 66374*** - ***Balboa Lake Decision ID 60378***
26.	Los Angeles River Reach 1 (Estuary to Carson Street) and Los Angeles River Reach 2 (Carson to Figueroa Street) Ammonia	The Fact Sheet for Decision ID 32973 corresponds to the ammonia listing for Los Angeles River Reach 1 (Estuary to Carson Street) and is based on one LOE (2319), which does not contain any data. As such, the decision previously approved by the State Water Resources Control Board and the USEPA has not changed. The Fact Sheet for Decision ID 32911 corresponds to the ammonia listing for Los Angeles River Reach 2 (Carson to Figueroa Street) and is based on one LOE (2465) which does not contain any data. As such, the decision previously approved by the State Water Resources Control Board and the USEPA has not changed. In light of the information presented in the previous comment, it can be expected that conditions in Los Angeles River Reaches 1 and 2 since NDN was fully implemented (mid-2007) are consistent with what has been observed in Los Angeles River Reaches 3, 4, and 5 (i.e., no exceedances). A review of the ammonia data analyzed as part of the Upper Los Angeles River (ULAR) Enhanced Watershed Management Program (EWMP) do not show any exceedances. ***Requested Action: Revise the following Decision IDs to a finding of nonimpairment and remove listings for ammonia from Category 5 (Appendix B) because the data used to conclude that the applicable water quality standards for the pollutant were exceeded are no longer representative of ammonia concentrations observed within the water bodies due to the installation and operation of NDN:*** - ***Los Angeles River Reach 1 Decision ID 32973*** - ***Los Angeles River Reach 2 Decision ID 32911***
27.	Tujunga Wash (LA River to Hansen Dam) Ammonia	The Fact Sheet for Decision ID 32873 corresponds to the ammonia listing for Tujunga Wash (LA River to Hansen Dam) and is based on one LOE (2554) which does not contain any data. Rather, the Fact Sheet states that “One line of evidence is available in the administrative record to assess this pollutant. A TMDL has been developed and approved by USEPA and an approved implementation plan is expected to result in attainment of the standard. The Los Angeles River Nitrogen TMDL was approved by RWQCB on August 19, 2003 and subsequently approved by USEPA on March 18, 2004. This listing will substitute for the previous listings for foam, floc, scum, and taste and odor.” As there are no data to support the listing, the ammonia listing for Tujunga Wash should be removed. Also, substituting the listing for foam, scum, and taste and odor is not necessary because the Regional Board removed those listings from the section 303(d) list because they are not pollutants or toxicity. ***Requested Action: Revise Decision ID 32873 for the ammonia listing for Tujunga Wash to Delist from 303(d) list and remove from Category 5 (Appendix B).***
28.	Bull Creek, Los Angeles River Reach 3 (Figueroa St. to	The Fact Sheets for the following Decision IDs relate to toxicity in the water column: - Decision ID 39159 Bull Creek - Decision ID 64389 Los Angeles River Reach 3 (Figueroa St. to Riverside Dr.) - Decision ID 64465 Los Angeles River Reach 4 (Sepulveda Dr. to Sepulveda Dam)

	Riverside Dr.), Los Angeles River Reach 4 (Sepulveda Dr. to Sepulveda Dam), Los Angeles River Reach 5 (within Sepulveda Basin), Los Angeles River Reach 6 (Above Sepulveda Flood Control Basin), and Los Angeles–Long Beach Outer Harbor (inside breakwater) Toxicity	- Decision ID 64489 Los Angeles River Reach 5 (within Sepulveda Basin) - Decision ID 64536 Los Angeles River Reach 6 (Above Sepulveda Flood Control Basin) - Decision ID 33930 Los Angeles–Long Beach Outer Harbor (inside breakwater) The City has several concerns with the proposed listings: 1. Section 6.1.5.3 of the Listing Policy states that “Samples used in the assessment must be temporally independent.” However, data collected on the same day within the same waterbody are considered as independent samples without consideration of the fact they represent the same condition. These samples should be evaluated as representative of a single day. 2. In developing the number of samples analyzed and exceeded, the Regional Board appears to count a sample collected as one sample, but count acute and chronic results separately. In certain situations the result is two exceedances for the same sample. However, the Regional Board does not consider it conversely when there are no exceedances of acute or chronic end points there is only one sample that is identified as not exceeded. One sample should result in only one nonexceedance or one exceedance. 3. For Decision IDs associated with the Los Angeles River watershed, data are included that do not represent current conditions. As described previously, the LAGWRP and DCTWRP upgraded their treatment processes to remove ammonia. Since the NDN processes to remove ammonia were completed, no exceedances for ammonia have been observed since August 2007. All toxicity data prior to August 2007 should be removed from the analysis. 4. A number of the results are based on testing with *Ceriodaphnia dubia* (*C. dubia*). As discussed in the Stormwater Monitoring Coalition: Toxicity Testing Laboratory Guidance Document (SCCWRP Technical Report 956 December 2016), the report states (page 18) that during the intercalibration study, multiple laboratories observed *C. dubia* toxicity in laboratory dilution water (which should be non-toxic). Additionally, the report (page 16) found testing variability observed during the intercalibration study for *C. dubia* which had a response that ranged from 16 to 27% effect, and a standard deviation of 19 to 27% effect. The report further indicated that this large variability is not uncharacteristic of the variability observed by others. 5. Toxicity testing results were developed with a statistical approach that is no longer utilized in the NPDES monitoring programs. The LAGWRP, DCTWRP, HWRP and TIWRP NPDES permits require that toxicity endpoints be calculated using the Test of Significant Toxicity (TST) statistical approach. Future data will not be comparable to the listing data. As such, data used for listings should be assessed in a manner consistent with current regulations prior to making a determination of impairment. Given the issues associated with the data analysis and testing methods used as well as the implications of the listings, the City believes that additional efforts are needed to validate and assess whether or not an impairment exists. The City welcomes the opportunity to discuss an approach to properly evaluate toxicity in the affected waterbodies. ***Requested Action: Revise Decision IDs 39159, 64389, 64465, 64489, 64536, and 33930 for toxicity listings from Category 5 to Category 3.***

City of Manhattan Beach
Public Works Department
3621 Bell Avenue, Manhattan Beach, CA 90266
Phone: (310) 802-5313 Fax: (310) 802-5301

March 28, 2017

Samuel Unger, P.E., Executive Officer
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013
Via email: losangeles@waterboards.ca.gov

Attn: Jun Zhu, Environmental Scientist (jzhu@waterboards.ca.gov)

Subject: Comment Letter—Revisions to the Los Angeles Region 303(d) list

Dear Mr. Unger:

On February 8, 2017, the Los Angeles Regional Water Quality Control Board (Regional Board) issued a 30-day Notice of Public Hearing and Opportunity to Comment on the Proposed Revisions to the Clean Water Act Section 303(d) List for the Los Angeles Region and the 2016 Integrated Report. The City of Manhattan Beach (City) submitted a letter to the Regional Board on February 21, 2017 requesting an additional 60 days to review and comment on the proposed changes to the 303(d) List—we understand that at least ten (10) other stakeholders/groups submitted similar requests. On February 24, 2017, the Regional Board issued a Notice of Extension of Comment Deadline with a revised comment deadline of March 30, 2017 and that the public hearing is scheduled for May 4, 2017. While the additional 21 days for review and comment is appreciated, it does not allow sufficient time to conduct a comprehensive review of the Appendix H data and references that support the proposed revisions, accordingly our comments have been necessarily limited to review of the staff report and Appendices A through G.

The City of Manhattan Beach is gratified that its beaches meet the criteria for delisting for indicator bacteria. However, the staff report states that even though the delisting is being proposed, "it is important to note that the Santa Monica Bay Bacteria TMDL remains in effect for those beaches even if the delistings are fully approved." Appendix A indicated that the beach will be removed entirely from listing rather than changing the status to *Category 4a - TMDL has been developed and the approved implementation plan is expected to result in full attainment of the water quality standard within a specified time frame*. The City is concerned that delisting during all weather condtions may adversely affect our ability to compete for grant funding for multi-benefit regional and green street projects identified in the Beach Cities EWMP to address the Santa Monica Bay Beaches Bacteria TMDL (SMBBB TMDL) during wet weather within the high priority 28th Street Storm Drain System. Since the SMBBB TMDL targets are set differently for wet and dry weather, it would seem logical for the Regional Board to distinguish these conditions in the 303d listing and we ask that the Board revise the proposed delisting Manhattan Beach for indicator bacteria to be specific to dry weather since final compliance is now in effect and the TMDL objectives are being met for dry weather at all three sites, and that the beach at the SMB 5-2 28th Street monitoring location remain on the list in Category 4a for wet weather conditions. This will enable the City to be more competitive when applying for grant funding to complete its implementation of the wet weather SMBBB TMDL.

The Regional Board Notice of Extension of Comment Deadline notes that Regional Board staff are aware that "in several instances, Appendix A, the Proposed Updates to the 303(d) List has not fully captured all of the new listing and delisting decisions that are detailed in Appendix G, the Fact Sheets due to system and clerical errors". This has made review of the proposed listing changes quite challenging but we have done our best given the limited time available. The City of Manhattan Beach respectfully provides the attached comments on the proposed revisions to the 2016 Section 303(d) and 305(b) Integrated Report.

Sincerely,

Stephanie Katsouleas, P.E.
Director of Public Works

Attachment

Copies: Dr. L.B. Nye (LB.Nye@waterboards.ca.gov)

City of Manhattan Beach Comments on Proposed Revisions to 303(d) List

Water Body/Pollutant	Comment	Recommendation
Manhattan Beach/Indicator Bacteria	The the staff report states that even though Manhattan Beach is being proposed for delisting for indicator bacteria, the Santa Monica Bay Bacteria TMDL remains in effect. Likewise, Appendix A indicated that the beach will be removed entirely from listing rather than changing the status to Category 4a (A TMDL has been developed and the approved implementation plan is expected to result in full attainment of the water quality standard within a specified time frame.) The City is concerned that delisting may adversely impact our ability to compete for grant funding for multi-benefit regional and green street projects to address the Santa Monica Bay Beaches Bacteria TMDL during wet weather	Consider delisting of Manhattan Beach for indicator bacteria only during dry weather since final compliance is now in effect and the TMDL objectives are being met for dry weather at all three sites, and that the SMB 5-2 28th Street beach remain on the list in Category 4a for wet weather conditions. Delisting of Manhattan Beach for wet weather indicator bacteria should be considered once the final wet weather SMBBB TMDL compliance deadline has passed.
Santa Monica Bay Offshore-Nearshore/Arsenic and Mercury	Santa Monica Bay Offshore-Nearshore areas are being proposed for listing for Arsenic and Mercury based on sampling conducted for the City of Los Angeles Hyperion Wastewater Treatment Plant NPDES Permit. Samples were collected during August 2006, October and November 2007, and August through September of 2007. This data predates the last listing cycle and no data collected within the past decade is presented to support the listing. The SWRCB Listing Policy Section 1.1.2.1 states that "data and information previously submitted to the Regional Water Boards, such as Discharge Monitoring Reports, need not be solicited if the data and information remain available to the Regional Boards."	Before making such important new listings Regional Board staff should review all readily available data including data collected within the past decade from the Hyperion Wastewater Treatment Plant NPDES Permit.

Water Body/Pollutant	Comment	Recommendation
Santa Monica Bay Offshore-Nearshore/Sediment Toxicity	On March 26, 2012 USEPA issued a final TMDL for Santa Monica Bay DDT and PCBs which found that "Our evaluation of the data showed only 3 out of 116 samples exhibited toxicity. Following the California listing policy, Santa Monica Bay is meeting the toxicity objective and there is sufficient evidence to delist sediment toxicity. We therefore make a finding that there is no significant toxicity in Santa Monica Bay and recommend that Santa Monica Bay not be identified as impaired by toxicity in the California's next 303(d) list."[1] Contrary to this recommendation the Regional Board has not proposed delisting sediment in Santa Monica Bay for toxicity.	Appendix G Decision ID 34120 should be revised to delist Santa Monica Bay for sediment toxicity based on the review and recommendation by USEPA in developing the Santa Monica Bay DDT and PCBs TMDL. Appendix A should be revised to place a "Y" in the New Delistings column and the "Y" eliminated from the Pollutant Name Change column since there does not appear to be any name change being proposed.
Santa Monica Bay Offshore-Nearshore/DDT and PCBs	The listing for Santa Monica Bay Offshore-Nearshore/DDT and PCBs is included in Attachment B Category 5 (a water segment where standards are not met and a TMDL is required but not yet completed) however this listing is being addressed by the USEPA developed and approved TMDL. This change is explained in Attachment A summary under "other revisions".	The listings for DDT and PCBs should be moved to Category 4a in Attachment C
Santa Monica Bay Offshore-Nearshore/Chordane	The revised Appendix G Fact Sheet associated with Decision ID 37492 recommending delisting Santa Monica Bay Offshore-Nearshore waters for chlordane is not reflected in the Appendix A summary of recommended changes.	Revise Attachment A to place a "Y" in the New Delisting column for Santa Monica Bay Offshore/Nearshore line for Chlordane.
Santa Monica Bay Offshore-Nearshore/Polycyclic Aromatic Hydrocarbons (PAHs)	The revised Appendix G Fact Sheet associated with Decision ID 32656 recommending delisting Santa Monica Bay Offshore-Nearshore waters	Revise Attachment A to place a "Y" in the New Delisting column for Santa Monica Bay Offshore/Nearshore line for PAHs.

[1] US Environmental Protection Agency Region IX. Santa Monica Bay Total Maximum Daily Loads for DDTs and PCBs, March 26, 2012.

Water Body/Pollutant	Comment	Recommendation
	for PAHs is not reflected in the Appendix A summary of recommended changes.	
Dominguez Channel (lined portion above Vermont)/Benthic Community Effects	Appendix G Decision ID 66165 is proposing to list the Dominguez Channel concrete-lined section above Vermont Avenue due to degradation of biological populations and communities (Benthic Community Effects) as evidenced by IBI scores below 40, however use of IBI scoring methodologies does not provide a reference that takes into account that concrete lined channels do not typically provide benthic habitat that will support biological populations and communities. The listing policy states that to make this determination the water body must "exhibit significant degradation in biological populations and/or communities as compared to reference sites" . . . . "This condition requires diminished numbers of species or individuals of a single species or other metrics when compared to reference sites." Additionally the listing policy states that "The analysis should rely on measurements from at least two stations." Whereas the data presented to support Decision ID 66165 came from a single station.	Do not list Dominguez Channel lined portion above Vermont for Benthic Community Effects because the analysis is not supported by data consistent with the SWRCB listing policy.
Dominguez Channel (lined portion above Vermont)/Lead	The quality of the data set used to support the original listing does not meet the data quality standards of the SWRCB's listing policy. The listing policy states that "when the sample value is less than the quantitation limit and the quantitation limit is greater than the water quality standard, objective, criterion, or evaluation guideline, the result shall not be used in the analysis." This listing was based on a	Decision Recommendation ID 37347 should be revised to state that the water body should be delisted due to inadequate data and because the data reviewed did not demonstrate that applicable water quality standards are being exceeded. Alternatively, Regional Board staff could review the more recent readily available data collected at these same Mass Emission stations as part of the LA County MS4 NPDES

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Water Body/Pollutant	Comment	Recommendation
	data set more than a decade old with no actual detections of lead but where exceedances were presumed to have potentially occurred because the quantitation limit of 5 ug/L was not in all instances sufficiently low to determine compliance with the CTR dissolved lead criterion for continuous concentration in water (where the CTR value ranged from 0.23 to 7.27 ug/L, depending on the associated hardness of the water sample). The data set reviewed was for samples collected between January 2002 and April 2007 at the LACFCD Mass Emission Station S28 where Artesia Boulevard crosses Dominguez Channel and between 2000 and 2001 at S23 near LAX. Lead was not apparently detected in any of the samples above the quantitation limits, rather the identified exceedances of the lead standard were non-detections where the positive quantification limits 5 ug/L were too high to determine compliance with the standard when hardness caused depression of the standard below 5 ug/L. No measured exceedances of the standard were observed in the data set which is more than a decade old and for which more recent data sets exist.	Permit monitoring program CI 6948 NPDES No. CAS004001 and the listing decision revised based on data of quality consistent with the SWRCB's listing policy.
Dominguez Channel (lined portion above Vermont)/Copper and Zinc	Are listed in Appendix B as Category 5 needing a TMDL, when the Dominguez Channel Toxics TMDL is in affect and is addressing these pollutants.	Recategorize Copper and Zinc as Category 4a being addressed by a TMDL and move to Appendix C
Dominguez Channel (lined portion above Vermont)/Diazinon	We are supportive of the proposed delisting for Diazinon.	Consider eliminating the statement in Attachment A under Other Revisions which states "TMDL status changed from TMDL still required to Being Addressed by Completed

Water Body/Pollutant	Comment	Recommendation
		TMDL" since this pollutant is being proposed for delisting.
Dominguez Channel (lined portion above Vermont)/Nitrogen, ammonia (Total Ammonia)	The Appendix G Fact Sheet Decision ID 35134 continues to support a listing for ammonia. This listing does not appear to be based on all readily available data since Los Angeles County Mass Emissions Station Data on the Dominguez Channel is not included in the data set. Monitoring data from 55 samples collected between November 2006 and July 2013 at LACFCD mass emission station S28 located where the Dominguez Channel crosses Artesia Boulevard in the City of Torrance, show that all 55 samples met the freshwater Basin Plan objective for ammonia. An additional 24 samples collected at LACFCD mass emission station TS19 between November 2008 and April 2011 also met the freshwater Basin Plan objective in every instance. These data were readily available to Regional Board staff since they were reported as part of the LA County MS4 NPDES Permit monitoring program CI 6948 NPDES No. CAS004001.	Delist Dominguez Channel lined portion above Vermont for ammonia and include readily available data reported as part of the LA County MS4 NPDES Permit monitoring program CI 6948 NPDES No. CAS004001 into Decision ID 35134 to support this delisting.
Dominguez Channel (lined portion above Vermont)/Aldrin	Appendix G Fact Sheet Decision ID 34620 for Aldrin recommends delisting due to flaws in the original listing.	Attachment A should be updated for Dominguez Channel lined portion above Vermont Avenue to include a "Y" in New Delistings column for Aldrin.
Dominguez Channel (lined portion above Vermont)/ ChemA	Appendix G Fact Sheet Decision ID 34426 for Aldrin recommends delisting due to flaws in the	Attachment A should be updated for Dominguez Channel lined portion above

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Water Body/Pollutant	Comment	Recommendation
	original listing because the data used for the original listing was not from this water body.	Vermont Avenue to include a "Y" in New Delistings column for ChemA.
Dominguez Channel (lined portion above Vermont)/ Chlordane	Appendix G Fact Sheet Decision ID 34426 for Aldrin recommends delisting due to flaws in the original listing because the data used for the original listing was not from this water body.	Attachment A should be updated for Dominguez Channel lined portion above Vermont Avenue to include a "Y" in New Delistings column for Chlordane.
Dominguez Channel (lined portion above Vermont)/ Chromium	Appendix G Fact Sheet Decision ID 34430 for Chromium recommends delisting due to flaws in the original listing because the data used for the original listing was not from this water body.	Attachment A should be updated for Dominguez Channel lined portion above Vermont Avenue to include a "Y" in New Delistings column for Chromium and remove the "Y" from the Pollutant Name Change column.
Dominguez Channel (lined portion above Vermont)/ DDT	Appendix G Fact Sheet Decision ID 36720 for DDT recommends due to flaws in the original listing because the data used for the original listing was not from this water body.	Attachment A should be updated for Dominguez Channel lined portion above Vermont Avenue to include a "Y" in New Delistings column for DDT.
Dominguez Channel (lined portion above Vermont)/ Dieldrin	Appendix G Fact Sheet Decision ID 34330 for Dieldrin recommends delisting due to flaws in the original listing because the data used for the original listing was from fish tissue collected in the soft-bottom estuary below Vermont and was incorrectly applied to the lined portion of Dominguez Channel above Vermont.	Attachment A should be updated for Dominguez Channel lined portion above Vermont Avenue to include a "Y" in New Delistings column for Dieldrin and remove the "Y" from the Pollutant Name Change column.
Dominguez Channel (lined portion above Vermont)/ Polycyclic Aromatic Hydrocarbons (PAHs)	Appendix G Fact Sheet Decision ID 34431 for PAHs recommends due to flaws in the original listing because the data used for the original listing was not from this water body.	Attachment A should be updated for Dominguez Channel lined portion above Vermont Avenue to include a "Y" in New Delistings column for PAHs.
Dominguez Channel (lined portion above Vermont)/ Polycholorinated Biphenyls (PCBs)	Appendix G Fact Sheet Decision ID 34429 for PCBs recommends delisting due to flaws in the original listing because the data used for the original listing was not from this water body.	Attachment A should be updated for Dominguez Channel lined portion above Vermont Avenue to include a "Y" in New Delistings column for PCBs.

March 30, 2017

Samuel Unger, P.E., Executive Officer
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Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013
Via email: losangeles@waterboards.ca.gov

Attn: Jun Zhu, Environmental Scientist (jun.zhu@waterboards.ca.gov)

Subject: Comment Letter—Revisions to the Los Angeles Region 303(d) list

Dear Mr. Unger:

On February 8, 2017, the Los Angeles Regional Water Quality Control Board (Regional Board) issued a 30-day Notice of Public Hearing and Opportunity to Comment on the Proposed Revisions to the Clean Water Act Section 303(d) List for the Los Angeles Region and the 2016 Integrated Report. On February 24, 2017, the Regional Board issued a Notice of Extension of Comment Deadline with a revised comment deadline of March 30, 2017 and the public hearing scheduled for May 4, 2017.

The City is pleased that Malaga Cove Beach and Bluff Cove Beach are being proposed for delisting for indicator bacteria. The City agrees with the Regional Board Staff Decision Recommendation in Appendix G that Bluff Cove Beach and Malaga Cove Beach should be removed from the 303(d) list for indicator bacteria because applicable water quality standards for the pollutant are not being exceeded. This is supported by Regional Board Resolution No. 2006-008 reviewing the Implementation Plan submitted by Jurisdictional Group 7 for the Santa Monica Bay Beaches Bacteria Wet Weather TMDL which stated:

> "The Implementation Plan submitted by Jurisdictional Group 7 differs from other Implementation Plans because the beaches along the Palos Verdes Peninsula have had historically fewer exceedances than the reference beach used in the Santa Monica Bay Beaches TMDLs to establish the allowable exceedance frequency. Therefore, the antidegradation provision applies, which requires responsible jurisdictions and agencies to maintain existing water quality. . . . The Implementation Plan for Jurisdictional Group 7 adopts a non-integrated approach, since existing water quality is equivalent to compliance with the Santa Monica Bay Beaches Wet Weather TMDL."[1]

[1] California Regional Water Quality Control Board – Los Angeles Region, Resolution No. 2006-008

Please see the City of Palos Verdes Estates' specific comments on the proposed revisions to the 2016 Section 303(d) and 305(b) Integrated Report, included herewith as Attachment A.

Sincerely,

Director of Public Works/City Engineer

Attachment

Copies: Dr. L.B. Nye (LB.Nye@waterboards.ca.gov)
Anton Dahlerbruch, City Manager for the City of Palos Verdes Estates

Appendix A – City of Palos Verdes Estates Comments on Proposed Revisions to 303(d) List

Water Body/Pollutant	**Comment**	**Recommendation**
Santa Monica Bay Offshore/Nearshore(Arsenic)	Decision No. 67208 (located in Appendix G of the February 2017 integrated staff report for the Los Angeles region) proposes that the Santa Monica Bay Offshore/Nearshore areas be placed on the section 303(d) list because sampling conducted for the City of Los Angeles Hyperion Wastewater Treatment Plant NPDES Permit in areas of Santa Monica Bay north of Redondo Beach Pier influenced by the Hyperion WWTP outfall revealed the presence of arsenic. These samples were collected during August 2006, October and November 2007, and August through September of 2007 from nearfield and from Zones 4 & 5.	While the Santa Monica Bay Offshore/Nearshore areas include the waters of the Palos Verdes Peninsula, this listing should be defined in geographic scope to exclude the Offshore/Nearshore waters of the Palos Verdes Peninsula. The data supporting Decision No. 67208 is not spatially representative of the Palos Verdes Peninsula waters; therefore this listing should be revised to clearly exclude areas of Santa Monica Bay south of Redondo Beach Pier from the listing.
Santa Monica Bay Offshore/Nearshore(Mercury)	Decision No. 67209(located in Appendix G of the February 2017 integrated staff report for the Los Angeles region) proposes that the Santa Monica Bay Offshore/Nearshore areas be placed on the section 303(d) list because sampling conducted for the City of Los Angeles Hyperion Wastewater Treatment Plant NPDES Permit in areas of Santa Monica Bay north of Redondo Beach Pier influenced by the Hyperion WWTP outfall revealed the presence of mercury. These samples were collected during August 2006, October and November 2007, and August through September of 2007 from nearfield and from Zones 4 & 5.	While the Santa Monica Bay Offshore/Nearshore areas include the waters of the Palos Verdes Peninsula, this listing should be defined in geographic scope to exclude the Offshore/Nearshore waters of the Palos Verdes Peninsula. The data supporting Decision No. 67209 is not spatially representative of the Palos Verdes Peninsula waters; therefore this listing should be revised to clearly exclude areas of Santa Monica Bay south of Redondo Beach Pier from the listing.

Water Body/Pollutant	Comment	Recommendation
Malaga Cove Beach/Indicator Bacteria	Decision No. 32565(located in Appendix G of the February 2017 integrated staff report for the Los Angeles region) proposes delisting Malaga Cove Beach from the section 303(d) list for indicator bacteria due to the fact that applicable water quality standards for this pollutant are not being exceeded. The City agrees with the Regional Board Staff Decision Recommendation in Decision No. 32565. However, while Decision No. 32565 has been modified since the last listing cycle in order to make the recommendation to delist, it continues to appear in the list of "original fact sheets" in Appendix G of the February 2017 integrated staff report for the Los Angeles region. Additionally, it is unclear why there is a "Y" in the Pollutant Name Change column in Appendix A since the original fact sheet relating to Decision No. 32565 shows the pollutant name as "indicator bacteria".	Modify the Revision Status entry in Fact Sheet 32565 from "original" to "revised" and move the fact sheet into the revised fact sheet group.
Lunada Bay Beach(Indicator Bacteria and Beach Closures)	The fact sheet for Decision No. 34394 (located in Appendix G of the February 2017 integrated staff report for the Los Angeles region) recommends that the original "beach closures" listing for Lunada Bay Beach should be revised to an "indicator bacteria" listing. No data is available to support a listing at this location as this is not an accessible beach but is in fact a rocky cove with steep bluff faces that cannot be safely accessed for monitoring. The original listing was for beach closures and Decision ID 34394 changed the pollutant name to indicator bacteria without any providing indicator bacteria data for evidence.	Like the rest of the shoreline areas on the Palos Verdes Peninsula, Lunada Bay should be delisted for indicator bacteria and beach closures due to faulty listing by revising the recommendation in the Fact Sheet for Decision No. 34394 and place a "Y" in the New Delistings column of Appendix A to the February 2017 integrated staff report for the Los Angeles region. Also please eliminate the word "beach" from the waterbody because this is not an accessible beach, but rather a rocky cove with a steep bluff face that is not readily accessible to the public.

Water Body/Pollutant	Comment	Recommendation
Flat Rock Point Beach Area (Indicator Bacteria and Beach Closures)	Flat Rock Point forms the northern point of Bluff Cove and is part of the same "beach" as Bluff Cove. The fact sheet for Decision ID No. 34628 (located in Appendix G to the February integrated staff report for the Los Angeles Region) is proposing to revise the listing for Flat Rock Point from "beach closures" to "indicator bacteria" however no data to support the listing is provided. Since there is no separate monitoring data set for Flat Rock Point and Flat Rock Point is contiguous with Bluff Cove, Decision ID 32848 and supporting lines of evidence for Bluff Cove should also be applied to Flat Rock Point.	Flat Rock Point Beach Area should be included with Bluff Cove Beach in the fact sheet for Decision ID No. 32848 and delisted along with Bluff Cove Beach. Also please eliminate the word "beach" from the waterbody because this is not an accessible beach, but rather a rocky point that is not safely accessible for monitoring.
Malaga Cove Beach(DDT and PCBs)	Appendix C to the February 2017 integrated staff report for the Los Angeles region states that Malaga Cove Beach is included on the 303d list for DDT and PCBs with "Source Unknown". The source of the DDT and PCB listings are known to be associated with the Palos Verdes Shelf Superfund Site because this source is well documented in the USEPA TMDL for these pollutants in Santa Monica Bay.	Change "source unknown" to "source – Palos Verdes Shelf Superfund Site" for both DDT and PCBs.
Bluff Cove Beach(DDT and PCBs)	Appendix C to the February 2017 integrated staff report for the Los Angeles region states that Bluff Cove Beach is included on the 303d list for DDT and PCBs with "Source Unknown". The source of the DDT and PCB listings are known to be associated with the Palos Verdes Shelf Superfund Site because this source is well documented in the USEPA TMDL for these pollutants in Santa Monica Bay.	Change "source unknown" to "source – Palos Verdes Shelf Superfund Site Palos Verdes Shelf Superfund Site" for DDT and PCBs.

Water Body/Pollutant	Comment	Recommendation
Santa Monica Bay Offshore/Nearshore(DDT and PCBs)	Category 5 of Appendix B to the February 2017 integrated staff report for the Los Angeles region includes DDT and PCBs in the listing for Santa Monica Bay Offshore/Nearshore(a water segment where standards are not met and a TMDL is required but not yet completed); however this listing is being addressed by the USEPA developed and approved TMDL. This change is explained in the “other revisions” summary in Appendix A to the February 2017 integrated staff report for the Los Angeles region.	The listings for DDT and PCBs should be moved to Category 4a in Appendix C since there is a USEPA approved TMDL in effect addressing the listings.
Santa Monica Bay Offshore/Nearshore(Chordane)	Decision No. 37492(located in Appendix G of the February 2017 integrated staff report for the Los Angeles region) has been revised to recommend delisting Santa Monica Bay Offshore/Nearshore waters for chlordane; this revision is not reflected in the summary of recommended changes in Appendix A of the February 2017 integrated staff report for the Los Angeles region.	Revise Appendix A to place a “Y” in the New Delisting column for Santa Monica Bay Offshore/Nearshore row for Chlordane.
Santa Monica Bay Offshore/Nearshore(Polycyclic Aromatic Hydrocarbons (PAHs))	Decision No. 32656 (located in Appendix G of the February 2017 integrated staff report for the Los Angeles region) has been revised to recommend delisting Santa Monica Bay Offshore/Nearshore waters for PAHs; this revision is not reflected in the summary of recommended changes in Appendix A of the February 2017 integrated staff report for the Los Angeles region.	Revise Appendix A to place a “Y” in the New Delisting column for Santa Monica Bay Offshore/Nearshore row for PAHs.

Water Body/Pollutant	Comment	Recommendation
Wilmington Drain(Lead)	Decision No. 35085 (located in Appendix G of the February 2017 integrated staff report for the Los Angeles region) recommends delisting the Wilmington Drain for lead based on the weight of evidence. The City agrees with this recommendation due to the fact that LOE No. 90133 describes data collected in Compton Creek, which is unrelated to the Wilmington Drain.	Remove LOE No. 90133 from the Fact Sheet for Decision No. 35085, and revise the supporting evidence statement to the Regional Board Staff Conclusion to state that: "0 of 33 samples exceeded the CRITERIA."
Wilmington Drain/Copper	Decision ID 44676 (located in Appendix G of the February 2017 integrated staff report for the Los Angeles region) for copper in Wilmington Drain includes a data set that should not have been included: LOE ID 90473 describes data collected in Compton Creek which is unrelated to Wilmington Drain. Removal of this data set from Decision ID 44676 would still leave LOE ID 90131 which is described as 33 samples, only two (2) of which exceeded the criteria for copper. This revised data set now meets the SWRCB Delisting criteria because the number of exceedances is 2 or less in a data set size of 28-36 samples.	Remove LOE No. 90473 from the Fact Sheet for Decision ID 44676 and revise the supporting evidence statement "2 of 33 samples exceeded the CRITERIA." Also revise the recommendation to Delist from 303(d) List.
Machado Lake(Algae, Ammonia, ChemA, Eutrophic, Odor, Trash)	Category 5 of Appendix B to the February 2017 integrated staff report for the Los Angeles region includes listings for algae, ammonia, ChemA, eutrophic, odor and trash for Machado Lake (a water segment where standards are not met and a TMDL is required but not yet completed); however all of these pollutant listings are being addressed by USEPA-approved TMDLs.	These listings should be moved to Category 4a in Appendix C to the February 2017 integrated staff report for the Los Angeles region. Additionally, Appendix A should include language under the column for "Other Revisions" for each of these pollutants explaining that: "TMDL status changed from TMDL still required to Being Addressed by Completed TMDL."

THE CITY OF
POMONA
Public Works Department

March 30, 2017

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Dr. Jun Zhu
320 West 4th Street, Suite 200
Los Angeles, CA 90013

VIA EMAIL: losangeles@waterboards.ca.gov

RE: Comment Letter – Revisions to the Los Angeles Region 303(d) List

Dear Dr. Zhu:

The City of Pomona (City) is pleased to submit for you consideration the attached comments regarding the Regional Board's propose 2016 303(d) list revisions.

Staff notes there are significant changes compared with the 2010 303(d) list. According to our review of those changes, 84% of the metals (copper, lead, selenium, and zinc) fall under the "de-list" or "do not list" categories. These eliminated metals should be sufficient to void the San Gabriel River Metals TMDL by amending the Los Angeles Basin Plan. Further, the City also recommends that three (3) additional metals be removed from the 2016 303(d) list.

The City appreciates the opportunity to comment on this matter. Eliminating the San Gabriel River Metals TMDL will greatly reduce the City's storm water compliance costs. Should you have questions please do not hesitate to contact me at (909) 620-2266.

Sincerely,

Meg McWade

Meg McWade
Public Works Director

Attachment: Comment Letter

cc: Linda Lowry, City Manager
Darron Poulson, Water/Wastewater Operations Director
Julie Carver, Environmental Programs Supervisor

City of Pomona Comments on the Proposed Revisions to the 2016 303(d) List for the San Gabriel River, Los Angeles County Region

Summary

The 2016 303(d) revisions for the several reaches (water quality segments) of the San Gabriel River propose to ***de-list***, ***do not de-list***, and ***do not list*** metals-related pollutants including copper, lead, selenium and zinc. These pollutants are the subject of the *Total Maximum Daily Loads for Metals and Selenium for the San Gabriel River and Impaired Tributaries* (San Gabriel Metals TMDL) adopted by USEPA Region IX (USEPA) and the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) in 2007. This TMDL has been incorporated into the current Los Angeles County MS4 Permit MS4 Permit). The MS4 Permit enables compliance with its waste load allocations (WLAs) -- also referred to as numeric targets. The numeric targets are translated into water quality based effluent limitations (WQBELs) which are applied to MS4 outfall discharges and to receiving waters. To comply with both, the MS4 Permit coercively encourages compliance through Watershed Management Programs (E/WMPs).

The City is appreciative of the several metals pollutants that Regional Board is proposing to de-list and not to list. A total of 22 metals are reported for all San Gabriel River water quality segments. 19 (84.3%) of them fall under the "de-list" and "do not list" categories.[1] This result should be sufficient to void the San Gabriel River Metals TMDL. 3 additional metals (15.7%) should be de-listed[2], which would raise the total to 22 (100%), for reasons more particularly described below.

The data here strongly demonstrates that that the San Gabriel Metals TMDL should be removed from the Los Angeles Basin Plan.

I. San Gabriel River: Estuary

As the table below illustrates, copper for the estuary is listed on the 2010 303(d) list but was not carried over to the 2016 303(d) list. It must be assumed that the Regional Board did not intend to place **copper** on this list. If this is an oversight on the part of the Regional Board there is, nevertheless, ample justification for not listing copper for the estuary. As is the case with most metals and toxics referenced in TMDLs and in the MS4 Permit, the Regional Board did not comply with the federal California Toxic Rule (CTR) to the following extent:

1. The Regional Board did not calculate the numeric limitation for lead properly. CTR establishes water quality standards (including TMDLs), based only on ambient (dry) weather sampling and analysis. However, the Regional Board calculated a wet weather numeric limitation for lead based on stormwater sampled from receiving waters. Further, CTR requires a "real time" hardness parameter (using calcium carbonate) as an adjustment factor in establishing water quality standards for metals

[1] copper = 4 (21%); lead = 5 (26.3%); zinc = 6 (31.6%); and selenium = 4 (21%).
[2] copper = 2 (SGR Estuary and Coyote Creek); lead = 1 (SGR R2).

and toxics. The Regional Board apparently used a default hardness factor of 100 mg/l. CTR states clearly that the 100 mg/l for hardness is only intended be an example in calculating CTR water quality standards. It is important that the actual hardness value be applied (which must be sampled and analyzed as the same toxics and metals are sampled). Too low of a hardness value will set a lower numeric limit. The higher the limit is, the less difficult it is to meet it.

2. Regional Board also did not follow the *Water Quality Control Policy for California's Clean Water Act Section 303(d) List* (Listing Policy). The Listing Policy requires a binomial distribution based on a null hypothesis) to determine if the number of the samples that resulted in exceedances (of CTR) are statistically sufficient to warrant placement on lead on the 303(d) list. There is no evidence that this task was completed. It is possible that it was not completed because the Listing Policy was not adopted until 2004. The copper was added to the 303(d) list in 1998 and carried-over to the 2000 303(d) list. Based on the San Gabriel River Metals TMDL, it appears that the copper data was based on water quality samples conducted in 1998.

3. The Regional Board's Surface Water Ambient Monitoring Program (SWAMP) performed water quality samples for metals in the estuary in June of 2005. **Copper**, after properly adjusted for hardness, resulted in 3.23 micrograms per liter (ug/l). The limit is 9.4 ug/l. In other words, no exceedance was detected.

Table I. San Gabriel River: Estuary

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	X	-	-	-	-	x	Yes
Lead	-	-	-	x	-	-	Yes
Selenium	-	-	-	x	-	-	Yes
Zinc	-	-	-	x	-	-	Yes

Placing copper on the 2016 303(d) list "do not list" category should effectively eliminate the need for impacted MS4 Permittees to comply with the estuary's copper limitation of 3.7 ug/l (see Table I(a) below).

Table I(a) from Attachment P of the Los Angeles MS4 Permit

Water Body	WLA Daily Maximum	
	Copper	Selenium
San Gabriel Reach 1	18 µg/L	---
Coyote Creek	0.941 kg/day*	---
San Gabriel River Estuary	3.7 µg/L	---
San Jose Creek Reach 1 and 2	---	5 µg/L

Recommendation to Regional Board: (1) approve staff's recommendation not to list **lead, selenium**, and **zinc** for the estuary; (2) grant the City's request de-list **copper** for the estuary; and (3) use the de-list and do not list justification for this and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

II. San Gabriel River: Estuary to Firestone

Metals for San Gabriel River from the Estuary to Reach 1 were not placed on the 2010 303(d) List and not placed on the "do not list" category of the 2016 303(d) List. It is unclear, however, why the MS4 Permit requires compliance with the copper limitation of 18 ug/l (shown above in Table 1(a), despite the fact that copper was not listed on the 2010 303(d) list in the first place.

Table II. San Gabriel River: Estuary to Reach 1

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-	-	-	x	-	-	Yes
Lead	-	-	-	x	-	-	Yes
Selenium	-	-	-	x	-	-	Yes
Zinc	-	-	-	x		-	Yes

Recommendation to Regional Board: (1) approve staff's recommendation not to list **copper, lead, selenium**, and **zinc** for the estuary; and (2) use the do not list justification for this and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan

III. San Gabriel River: Reach 2 (Firestone to Whitter Narrows Dam)

As shown on Table III below, the 2016 303(d) list rolls-over **lead** from the 2010 303(d) list. **Lead**, however, should be de-listed for the following reasons:

1. Lead is a legacy pollutant (lead content in fuels have been significantly reduced).

2. The 303(d) lists for 1998 and 2000 placed lead on the "list" category, but failed to comply with the California Toxic Rule (CTR) as explained above.

3. The Regional Board did not follow the State's 303(d) Listing Policy. More specifically, according to the San Gabriel River Metals TMDL (Table 2-7), Reach 2 was sampled during dry weather (ambient) for dissolved lead by the Los Angeles County Department of Public Works (LACDPW), in accordance with CTR using the correct hardness adjustment. The 10 samples taken resulted in no exceedances. If this result were applied to the 303(d) Listing Policy, it would not be sufficient to place lead on the 303(d) List. For a sample size between 2 and 24, 2 exceedances are required for 303(d) list placement.

4. Regional Board's Surface Water Ambient Monitoring Program (SWAMP) performed water quality samples for metals in the estuary in June of 2005. **Lead,** after properly adjusted for hardness, resulted in 0.81 micrograms per liter (ug/l). The limit is 3.8 ug/l. In other words, no exceedance was detected.

Table III. San Gabriel River: Reach 2 (Firestone to Whittier Narrows Dam)

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-	-	x	-	-	-	Yes
Lead	x	-	-	-	x	x	Yes
Selenium	-	-	-	-	-	-	Yes
Zinc	-	-	x	-	-	-	Yes

Recommendation to Regional Board: (1) do not approve staff's recommendation not to de-list lead; and (2) use the do not list justification for this and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

IV. San Gabriel River: Reach 3 (Whittier Narrows Dam to Ramona)

As shown on Table IV below, San Gabriel River Reach 3 was not placed on the 2010 303(d) list and, therefore, it is easy to see why it is placed on the 2016 303(d) "do not list" category. What is difficult to understand is why the Los Angeles MS4 Permit requires compliance with copper, lead, and zinc. The answer lies on MS4 Permit *Attachment P: TMDLs in San Gabriel River Watershed Management Area.* It states: *Permittees shall comply with grouped wet WLAs ... expressed as total recoverable metals discharged to all upstream reaches and tributaries of the San Gabriel River Reach 2 and Coyote Creek* (see Table I(b) below). In other words, even though San Gabriel River Reach 3 is not on the 2010 303(d) list for metals, the MS4 Permit requires compliance with them nevertheless. It does this by applying TMDL numeric targets for copper, lead, and zinc because: (1) San Gabriel River Reach 2 lists a lead TMDL number target of 81/34 ug/l; and (2) Coyote Creek lists copper target of 24.71 ug/l and zinc at 144.57 ug/l. The rationale for applying downstream numeric targets for copper, lead, and zinc is at best murky. How can metals as pollutants associated with downstream reaches be applied to upstream Reach 3 of the San Gabriel River? Pollutants cannot travel upstream against gravity.

Table IV. San Gabriel River: Reach 3 (Whittier Narrows to Ramona)

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-	-	-	x	-	-	Yes
Lead	-	-	-	x	-	-	Yes
Selenium	-	-	-	x	-	-	Yes
Zinc	-	-	-	x	-	-	Yes

Table I(b) from Attachment P of the Los Angeles MS4 Permit

Water Body	WLA Daily Maximum (kg/day)		
	Copper	Lead	Zinc
San Gabriel Reach 2	---	81.34 µg/L x daily storm volume (L)	---
Coyote Creek	24.71 µg/L x daily storm volume (L)	96.99 µg/L x daily storm volume (L)	144.57 µg/L x daily storm volume (L)

Recommendation to Regional Board: (1) approve staff's recommendation not to list copper, lead, and zinc; and (2) use the de-list for these metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

V. San Gabriel River: Coyote Creek

The 2016 303(d) List correctly de-lists lead and zinc but does not de-list copper. Copper should be de-listed for the following reasons:

1. The San Gabriel River Metals TMDL contains ambient sample data for Coyote Creek correctly applying CTR. Under Table 2-7, 8 samples are listed with 0 exceedances. If this result were applied to the 303(d) listing policy, it would not qualify for 303(d) placement. A sample size between 2 and 24 would require exceedances equal to and greater than 2.

2. Wet weather water quality data was used to justify placing copper on the 303(d) list. Listing support information cites that CTR relative to copper was applied to wet weather. As mentioned above, wet weather and CTR requirements are mutually exclusive. Wet weather limitations for San Gabriel River and other receiving water bodies in Los Angeles County are intended to be applied – incorrectly -- to MS4s and other NPDES permittees.

Table V. Coyote Creek

(San Gabriel River Tributary)2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-lis	Should De-List	Yes/No
Copper	x	-	-	-	x	x	Yes
Lead	x	-	x	-	-	-	Yes
Selenium	-	-	-	-	-	-	Yes
Zinc	x	-	x	-	-	-	Yes

Recommendation to Regional Board: (1) approve staff's recommendation not to list lead and zinc; (2) approve the City's request to de-list copper; and (3) use the de-list and do not list justification for this and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

VI. San Jose Creek Reach 1 (SG Confluence to Temple St.)

Regional Board staff recommends that: (1) selenium be de-listed; and (2) copper, lead, and zinc not be listed (see Table VI below).

Table VI: San Jose Creek Reach 1

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-			x			Yes
Lead	-			x			Yes
Selenium	-		x				Yes
Zinc	-			x			Yes

Recommendation to Regional Board: (1) approve staff's recommendation to de-list selenium and not list copper, lead, and zinc; and (2) use the de-list and do not list justification for these and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

VI. South San Jose Creek (Los Angeles County)[3]

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	-			x			Yes
Lead	-			x			Yes
Selenium	-			x			Yes
Zinc	-			x			Yes

Recommendation to Regional Board: (1) approve staff's recommendation not list to selenium copper, lead, and zinc; and (2) use the de-list and do not list justification for these and other metals to remove the San Gabriel River Metals TMDL from the Los Angeles Basin Plan.

[3]This is Reach is a new listing under the 2016 303(d) List.

TECS Environmental Compliance Services
106 South Mentor Avenue – 125 • Pasadena, CA 91106 • Tel: 626.396.9424
Fax: 626.396.1916 email: rtahir@tecsenv.com

March 30, 2017

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Email: losangeles@waterboards.ca.gov

Subject: Comment Letter – Revisions to the Los Angeles Region (303(d) List

Dear Mr. Zhu:

Attached are comments submitted on behalf of the City of San Fernando regarding the Regional Board's proposed 2016 303(d) list revisions.

Should you have any questions please feel free to contact me at 626.396.9424 or City of San Fernando Assistant City Manager Chris Macarello at 818.898.1222.

Sincerely,

Ray Tahir

I. Summary

The 2016 303(d) revisions for the several reaches (water quality segments) of the Los Angeles River and tributaries[1] propose to *de-list*, *do not de-list*, and *do not list* metals-related pollutants including copper, lead, selenium and zinc. These pollutants are the subject of the *Total Maximum Daily Loads for Metals for the Los Angeles River (LAR-MTMDL)* adopted by Regional Board in 2007. This TMDL has been incorporated into the current Los Angeles County MS4 Permit MS4 Permit (MS4 Permit). The MS4 Permit enables compliance with TMDL waste load allocations (WLAs) -- also referred to as numeric targets. The numeric targets are translated into water quality based effluent limitations (WQBELs) which are applied to MS4 outfall discharges and to receiving waters as limitations. To comply with both, the MS4 Permit coercively encourages compliance through Watershed Management Programs (E WMPs).

Although many metals have either been placed on the "de-list" or "do not list" categories for Los Angeles River water quality segments, many also have been placed on the "list" and do not de-list categories. These listings should be voided because:

1. although the LAR-MTMDL claims to have developed water quality standards (includes TMDLs) in accordance with the federal California Toxic Rule (CTR) adopted in 2000, it actually has not; and

2. the LAR-MTMDL is based on water quality samples that were conducted before the *Water Quality Control Policy for California's Clean Water Act Section 303(d) List* (Listing Policy), which was adopted in 2004.

- California Toxic Rule

CTR was adopted to provide a mathematical method for establishing ambient (dry weather) water quality standards for toxics necessary to protect beneficial uses of receiving waters. The LAR-MTMDL, however, along with other TMDLs, does not comply with CTR in two significant respects.

First, the TMDL calculates numeric water quality standards/TMDLs for both wet weather and ambient receiving water conditions instead of only on ambient. The LAR-TMDL misinterprets CTR by claiming EPA did not differentiate between wet and dry weather conditions when establishing metals and toxics limitations. There is nothing in CTR that supports that view. CTR makes it clear that its purpose is to establish ambient water quality standards: *This final rule establishes ambient water quality for priority toxic pollutants.* USEPA defines ambient as:

> *Natural concentration of water quality constituents prior to mixing of either point or nonpoint source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact to human health.*

In other words, ambient is the normal reference condition of a receiving water. This is also the clear understanding of the Regional Board's Surface Water Ambient Monitoring Program (SWAMP). MS4 and other point source stormwater (wet weather) outfall discharges, using sampling and analysis results, are measured against the ambient target for a pollutant established by CTR. For example, suppose a copper limitation is set at 37 micrograms per liter for a given water body. This limit is required to protect fish. Persistent exceedances of the limit based on outfall monitoring would necessitate a revision to the MS4 Permittee's stormwater management program.

Second, CTR requires a hardness parameter (calcium carbonate) to make chemical water quality analysis of toxics more accurate. Generally, the higher the hardness value the higher the toxic pollutant expressed as a numeric limit. The LAR-MTMDL calculates CTR for metals/toxics using a hardness value of 100 milligrams per liter (mg/l). It contends that this is the hardness value required by CTR. This is false. CTR requires actual hardness to be determined by water quality sampling and analysis at the same time a toxic pollutant is sampled. The Regional Board's SWAMP abides by this requirement. Therefore, the LAR-MTMDL establishes limitations for metals and toxics that are more stringent than necessary. This provides another reason for voiding the LAR-MTMDL and revising it with a recalculated limitation for each metal by using an actual hardness value based on future ambient water quality sampling and analysis.

- **California 303(d) Listing Policy (Listing Policy)**

The Listing Policy was adopted to provide a statistical method to determine how many water quality samples that exceed a water quality standard are required to place a pollutant on the 303(d) list. That method is a binomial distribution based on the rejection of a null hypothesis measured against sample sizes (see attachment #1). A review of the 2016 303(d) list fact sheets reveals that the metals placed on previous 303(d) lists did not conform to the Listing Policy. In fact, the LAR-MTMDL is based on water quality data that was developed prior to the adoption of the Listing Policy in 2004. According to the LAR-MTMDL, the metals numeric targets were based on data that was limited to 2002. Based on this fact alone the LAR-MTMDL should be voided.

II. Los Angeles River Reach/Tributary Specific Comments

Presented below are specific justifications for removing metals that fall under either the "list" or "do not list" categories because they do not conform to CTR or the Listing Policy. Almost all of them fall into these categories.

1. **Los Angeles River Reach 4**

Copper and lead are placed on the "do not de-list" category. Selenium and zinc are placed on the "do not list." As noted on the table below there are no listing issues here.

Table II. LAR Reach 4

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	**List**	**List**	**De-List**	**Don't List**	**Don't De-list**	**Should De-List**	**Yes/No**
Copper	**x**	**-**	**x**	**-**	**-**	**-**	**Yes**
Lead	**x**	**-**	**x**	**-**	**-**	**-**	**Yes**
Selenium	**-**	**-**	**-**	**x**	**-**	**-**	**Yes**
Zinc	**-**	**-**	**-**	**x**	**-**	**-**	**Yes**

2. **Los Angeles River Reach 5**

Selenium and zinc are recommended for placement on the "do not list" category. Copper and lead, on the other hand, are recommended for placement on the "list" category. However, they should not. The justification reported on the fact sheet for both copper and lead is that *0 of the 12 samples and exceeded the criteria.* This must be in error. How can zero or "none" of the 12 samples have exceeded the criteria?

Based on this information, copper and lead should be on the do not list category.

Table II. LAR Reach 5

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don't List	Don't De-list	Should De-List	Yes/No
Copper	x	x	-	-	x	x	Yes
Lead	x	x	-	-	x	x	Yes
Selenium	-	x	-	x	-	-	Yes
Zinc	-		-	x	-	-	Yes

3. Tujunga Wash (Los Angeles River to Hansen Dam)

The Tujunga Wash is only listed (in the “do not list” category) for copper, carried-over from the previous 303(d) list (2010). According to the 303(d) list fact sheet, no samples were taken to justify placement (viz., 0 of the 12 samples exceeded the criteria).

Based on this information copper should be de-listed.

Table III. Tujunga Wash

2010 303 (d) List		2016 303 (d) List					MS4 Permit Requirement
Pollutant	List	List	De-List	Don’t List	Don’t De-list	Should De-List	Yes No
Copper	x	x	-	-	x	x	Yes
Lead	-	-	-	-	-	-	Yes
Selenium	-	-	-	-	-	-	Yes
Zinc	-	-	-	-	-	-	Yes

Attachment 1

TABLE 3.1: MINIMUM NUMBER OF MEASURED EXCEEDANCES NEEDED TO PLACE A WATER SEGMENT ON THE SECTION 303(D) LIST FOR TOXICANTS. *Null Hypothesis: Actual exceedance proportion < 3 percent. Alternate Hypothesis: Actual exceedance proportion > 18 percent. The minimum effect size is 15 percent.*	
Sample Size	List if the number of exceedances equal or is greater than
2 – 24	2
25– 36	3
37– 47	4
48– 59	5
60– 71	6
72– 82	7
83– 94	8
95– 106	9
107– 117	10
118– 129	11

Application of the binomial test requires a minimum sample size of 16. The number of exceedances required using the binomial test at a sample size of 16 is extended to smaller sample sizes.

For sample sizes greater than 129, the minimum number of measured exceedances is established where α and f3 < 0.2 and where |α - f3| is minimized.

α = Excel® Function BINOMDIST(n-k, n, 1 – 0.03, TRUE)
f3 = Excel® Function BINOMDIST(k-1, n, 0.18, TRUE)
where n = the number of samples,
k = minimum number of measured exceedances to place a water on the section 303(d) list,
0.03 = acceptable exceedance proportion, and
0.18 = unacceptable exceedance proportion.

March 30, 2017

Electronic Submission: losangeles@waterboards.ca.gov

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 W 4th Street, Suite 200
Los Angeles, CA 90013

Subject: Comment Letter – Proposed Revisions to the Clean Water Act Section 303(d) List for the Los Angeles Region and the 2016 Integrated Report

Dear Dr. Zhu,

The City of San Buenaventura (City) appreciates the opportunity to provide comments on the proposed revisions to the Clean Water Act Section 303(d) list of impaired waterbodies in the Los Angeles Region [hereinafter referred to as "303(d) list"] which was distributed for public review on February 8, 2017. A separate comment letter is being submitted by Ventura Water, a department of the City, which specifically focuses on the Santa Clara River Estuary proposed listings and the Ventura Water Reclamation Facility.

The City understands that the Los Angeles Regional Water Quality Control Board (Regional Board) is proposing over 200 new waterbody segment-pollutant combination 303(d) listings. The development and implementation of total maximum daily loads (TMDLs) is a significant investment of resources and it is critical that the 303(d) list be based on sound science and methodologies. The City participates in the implementation of several TMDLs in the Santa Clara and Ventura River Watersheds covering a diverse set of pollutants.

The City notes that Ventura County, the Stakeholders Implementing Total Maximum Daily Loads in the Calleguas Creek Watershed, and the Ventura County Agricultural Irrigated Lands Group (VCAILG) will be submitting separate comments regarding the listing changes in Ventura County, Calleguas Creek Watershed, and VCAILG-affected waterbody segments, respectively. The City recognizes the importance of following the State Water Resources Control Board's "Water Quality Control Policy For Developing California's Clean Water Act Section 303(d) List" ("Listing Policy")[1] when developing the 303(d) list and agrees with those comments from other stakeholders that speak to the process for assessing the quality and quantity of data used to develop proposed listings.

[1] California State Water Resources Control Board, "Water Quality Control Policy For Developing California's Clean Water Act Section 303(d) List," Adopted September 30, 2004, Amended February 3, 2015.

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The City has several concerns regarding the Regional Board's proposed 303(d) list and feels that it requires significant review and modifications before adoption. The City requests that the issues identified in this letter be addressed and the revised, proposed 303(d) list be released for another 60-day comment period prior to adoption. Several of the issues identified herein have resulted in the inability of the proposed 303(d) list to be fully vetted and reviewed by the affected parties.

The requested modifications fall into two general categories:

1. New Category 5 listings that should not be listed due to incorrect thresholds being applied for the beneficial use and/or incorrect interpretation of the data (e.g., lack of temporal representation).
2. Errors in the listing information that make it difficult to fully evaluate the listings. Examples include challenges in identifying the data sets and analysis methods used, inconsistencies between the Category 5 list (Appendix B) and the Proposed updates to the 303(d) list (Appendix A), incorrect HUC/Calwater designations, incorrect beneficial uses listed for the applicable water quality objectives, and inconsistent use of thresholds for interpreting narrative objectives.

The remaining sections of this letter provide the detailed list of requested changes to the proposed 303(d) list and the rationale for the requests. In summary, the City requests that all waterbody pollutant combinations in **Table 1** below not be listed on the 303(d) list and the errors and inconsistencies identified in the other letters cited above be addressed.

I. REQUESTED MODIFICATIONS TO THE LISTING STATUS

Based on a review of the proposed Category 5 waterbody pollutant combinations, the City has identified several waterbodies that should either be delisted based on available data or proposed listings that should not be listed based on errors in the evaluation. The requested modifications are shown in **Table 1**, below, with a summary of the justifications for the requested change. A detailed discussion of each of the justifications follows the table.

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody Segment	**Pollutant**	**Justification**
Santa Clara River Estuary[2]	pH	• No demonstration high pH is a result of waste discharge. A listing is not warranted in light of reference conditions for pH within estuaries.
	Ammonia	• Appropriate data not considered and current data does not meet Listing Policy criteria.
	Nitrogen, Nitrate	• Appropriate data not considered and current data does not meet Listing Policy criteria.

[2] See generally Ventura Water comment letter specifically addressing the Santa Clara River Estuary proposed listings.

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody Segment	**Pollutant**	**Justification**
Santa Clara River Reach 1 (Estuary to Hwy 101 Bridge)	pH	• No demonstration high pH is a result of waste discharge.
Ventura Harbor: Ventura Keys	Arsenic	• Data does not include proper temporal representation.
	Cadmium	• Data does not include proper temporal representation.
	Chlordane	• Data does not include proper temporal representation.
	DDT	• Data does not include proper temporal representation.
	Dieldrin	• Data does not include proper temporal representation.
	PCBs (Polychlorinated biphenyls)	• Data does not include proper temporal representation.
Ventura River Reach 1 and 2 (Estuary to Weldon Canyon)	Benthic Community Effects	• Benthic Community Effects listing is based on flawed analyses. • Data does not include proper spatial representation.
	Temperature, water	• Analysis does not demonstrate temperature is above natural temperature.
Ventura Harbor: Ventura Keys	Indicator Bacteria	• Data from mouth of Arundell Barranca used in listing assessment.

1. There is no demonstration that high pH is a result of waste discharge.

The waterbodies listed for high pH do not appropriately demonstrate that the high pH was a result of waste discharge as required in the Los Angeles Region Basin Plan (Basin Plan).[3] The Santa Clara River Estuary and Santa Clara River Reach 1 are both listed for high pH. As stated in the Fact Sheets and according to the Basin Plan, "*The pH of inland surface waters shall not be depressed below 6.5 or raised above 8.5* ***as a result of waste discharges***."[4] However, it was not demonstrated for either of these waterbodies that the elevated pH levels were a result of waste discharge as opposed to natural causes. Therefore, the Regional Board should either provide evidence that the elevated pH was a result of waste discharge and detail that in the Fact Sheets or, if no such evidence exists, the Regional Board should remove this proposed listing.[5]

Requested Action:
Remove the pH listings for Santa Clara River Estuary and Santa Clara River Reach 1 as these high pH values are not the result of waste discharge.

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[3] Water Quality Control Plan Los Angeles Region R4 Basin Plan.
[4] Basin Plan at 3-35 [emphasis added].
[5] Please see additional comments in the Ventura Water comment letter.

2. Listing data lacks proper temporal representation.
There are many instances where the data to support the listed pollutant lacks proper temporal representation. Section 6.1.5.3 of the Listing Policy states that:

> *"Samples should be representative of the critical timing that the pollutant is expected to impact the water body. Samples used in the assessment must be temporally independent. If the majority of samples were collected on a single day or during a single short-term natural event (e.g., a storm, flood, or wildfire), the data shall not be used as the primary data set supporting the listing decision."*

Many of the pollutants listed in **Table 1** included data collected from a single sampling date, which violates the Listing Policy. For instance, all of the newly proposed pollutants for the Ventura Harbor: Ventura Keys (i.e., arsenic, cadmium, chlordane, DDT, dieldrin, and PCBs) were collected on a single day – February 28, 2007. These pollutants should not be listed because there is no temporal resolution provided.

Requested Action:
Remove all listings shown in Table 1 that were based on a single sample collection date.

3. Benthic Community Effects listing is based on flawed analyses and should be removed.
The benthic community effects listing is based on a metric which has since been deemed arbitrary and inappropriate. The Index of Biotic Integrity (IBI) stream assessment was a commonly used metric to determine benthic community effects where the threshold used to distinguish an impaired reach was identified as a value of 39 and below. However, this threshold value was arbitrarily assigned as a statistical cut-off value in the originating study. The State has since endorsed the use of the California Stream Condition Index (CSCI), as stated in the Appendix G Fact Sheets for numerous other benthic community effects listings (e.g., Decision ID 66264)v, "*The CSCI is applicable statewide, accounts for a much wider range of natural variability, and provides equivalent scoring thresholds in all regions of the state. The CSCI will be used in the future for water quality assessment purposes statewide over the regional indices of biologic integrity (IBIs).*" Despite this, the newly listed benthic community effects for Ventura River Reach 1 and 2 (Estuary to Weldon Canyon) utilizes the IBI to assess the waterbody. Therefore, the City requests that this flawed listing be removed until the waterbody can be assessed with a more representative metric such as the CSCI.

In addition to use of an arbitrary metric, the proposed listing for benthic community effects for the Ventura River Reach 1 and 2 lacks proper spatial representation since only two samples were collected from the same sample site ("Station 0 Main Street Bridge, Mainstem Ventura River" according to the Fact Sheets). In addition, temperature is used as a line of evidence to support the benthic community effects listing, however, the temperature listing for this same waterbody segment is also flawed and should be removed as discussed in the comment below.

Requested Action:
Remove the benthic community effects listing for Ventura River Reach 1 and 2 (Estuary to Weldon Canyon) due to use of an outdated metric, lack of spatial resolution, and lack of supporting evidence from the temperature listing.

4. Correct the proposed temperature listings which are based on incorrect criteria.
The temperature listing for Ventura River Reach 1 and 2 (Estuary to Weldon Canyon) uses an evaluation guideline of 13-21°C as the optimum growth range for rainbow trout. However, the applicable Basin Plan objective for waterbodies designated as COLD is, "*For waters designated COLD, water temperature shall not be altered by more than 5°F above the natural temperature.*"[6] The fact sheets provide no discussion of natural temperatures or a demonstration that the temperature was raised above natural temperatures in order to exceed the objectives.

Notwithstanding that a deviation from natural temperatures has not been demonstrated, the way the evaluation guideline is applied is also inappropriate. Moyle 1976 is referenced as the source of the evaluation guideline. Moyle 1976 was revised and expanded by Moyle 2002.[7] Moyle 2002 states: "Rainbows are found where daytime temperatures range from nearly 0°C in winter to 26-27°C in summer, although extremely low (<4°C) or extremely high (>23°C) temperatures can be lethal if the fish have not previously been gradually acclimated. Even when acclimation temperatures are high, temperatures of 24-27°C are invariably lethal to trout, except for very short exposures."[8] As such, while temperatures above 21°C may not be optimal according to Moyle 1976, Moyle 2002 clearly states that lethal temperatures are those greater than 23°C, which indicates that the evaluation guideline of 21°C is more appropriately applied as a chronic guideline (necessitating the establishment of an averaging period) and 23°C is the more appropriate "not-to-exceed" guideline if used for listing.

Using the threshold of 23°C, only 2 samples would exceed the threshold in Ventura River Reach 1 and 2, which would not be enough to meet the listing threshold.

Requested Action:
Remove the temperature listing for Ventura River Reach 1 and 2 based on lack of exceedances.

5. Data from Arundell Barranca mouth is inappropriate to assess Ventura Harbor.
Based on a review of the data provided in the spreadsheet entitled: Peninsula Beach, Ventura Harbor-Keys, and Arundell Barranca Data, site K5 appears to have been included in the analysis of the Ventura Harbor: Ventura Keys assessment. Site K5 is located in the mouth of the Arundell Barranca and is not within Ventura Harbor. A review of the data shows that the indicator bacteria concentrations at this site are much more similar to Arundell Barranca and not representative of the data for the rest of Ventura Harbor.

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[6] Basin Plan at 3-38.
[7] Moyle, Peter B. *Inland fishes of California: revised and expanded.* University of California Press, 2002.
[8] Moyle 2002 at 276 [internal citations omitted].

In 2009, as part of the review of the proposed Harbor Cove TMDL, the City conducted an analysis of indicator bacteria data from Ventura Harbor using what appears to be the same dataset as used in the Regional Board's assessment. While the dataset appears to be the same, the number of samples and exceedances did not match completely (e.g., 103 exceedances of the enterococcus geomean with 510 samples in the City's analysis as compared to 104 exceedances and 537 samples in the Regional Board's analysis). The City could not easily determine what the differences in the calculations were and requests that the Regional Board review the exceedance calculations to ensure that all geomeans were calculated using a minimum of 5 samples and that duplicate samples in the dataset were correctly handled in accordance with the Listing Policy.

Regardless of the potential differences in the calculations, the clear majority of the exceedances are from site K5 (64 of the 103 exceedances in the City's analysis). If site K5 is removed from the Ventura Harbor analysis (and added to the Arundell Barranca analysis so it is in the correct waterbody), based on the City's calculations, insufficient samples exist to list Ventura Harbor: Ventura Keys for fecal coliform or enterococcus. A summary of the City's analysis is shown in **Table 2**.

Table 2. Summary of City's Analysis of Ventura Harbor Indicator Bacteria

Constituent	Number Samples	Number Exceedances	Number exceedances required to List
Total Coliform-Single Sample	636	74	106
Total Coliform-Geomean	440	186	73
Fecal Coliform-Single Sample	636	24	106
Fecal Coliform-Geomean	440	2	73
Enterococcus-Single Sample	595	48	99
Enterococcus-Geomean	408	39	68

Requested Action:
Revise the calculations for Ventura Harbor: Ventura Keys by removing site K-5 which is not located in the Harbor. Revise any Lines of Evidence that no longer support a listing for indicator bacteria and remove the listing if appropriate.

II. CORRECT OTHER ERRORS AND INCONSISTENCIES IN APPENDICES AND FACT SHEETS

Appendix A, Appendix B, Appendix C, and Appendix G have many inconsistencies which make the analysis of new additions very difficult since it is unclear which segment-pollutant combinations are new listings. Additionally, in many cases, data and Quality Assurance Project Plan (QAPP) references in the fact sheets are inconsistent with the data provided for review and it is not always clear what data were used in the analysis presented in the fact sheets. Examples of these inconsistencies and errors are detailed in the Calleguas Creek Watershed Stakeholders, VCAILG, and County of Ventura comment letter. The City requests that the Regional Board do a thorough review of all appendices to ensure that the proposed 303(d) list is internally consistent, the correct data were used for the assessment, and the errors identified in the other comment letters are addressed.

Requested Action:
Correct the numerous errors and inconsistencies in the report and ensure that all the proposed 303(d) list appendices are internally consistent.

The City appreciates the opportunity to comment on the proposed 303(d) list and looks forward to continuing to work with the Regional Board to address these concerns. Thank you for your time and consideration of these comments. If you have questions, please contact Joe Yahner, Environmental Services Manager, at 805-652-4558 or jyahner@cityofventura.net.

Sincerely,

Tulson Clifford
Public Works Director
City of San Buenaventura

COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

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MARK PESTRELLA, Director

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ALHAMBRA, CALIFORNIA 91802-1460

March 30, 2017

IN REPLY PLEASE
REFER TO FILE: WM-9

Mr. Samuel Unger, P.E.
Executive Officer
California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Attention Jun Zhu

Dear Mr. Unger:

COMMENT LETTER – REVISIONS TO THE LOS ANGELES REGION 303(D) LIST

The County of Los Angeles and the Los Angeles County Flood Control District appreciate the opportunity to provide comments on the proposed revisions to the Clean Water Act Section 303(d) List of Impaired Waters in the Los Angeles Region. Enclosed are our comments for your review and consideration.

If you have any questions, please contact me at (626) 458-4300 or ageorge@dpw.lacounty.gov or your staff may contact Mr. Paul Alva at (626) 458-4325 or palva@dpw.lacounty.gov.

Very truly yours,

MARK PESTRELLA
Director of Public Works

ANGELA R. GEORGE
Assistant Deputy Director
Watershed Management Division

GA:ba
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Enc.

cc: County Counsel (Grace Chang, Lillian Salinger, Michael Simon)

THE COUNTY OF LOS ANGELES AND THE LOS ANGELES COUNTY FLOOD CONTROL DISTRICT COMMENTS ON THE PROPOSED REVISIONS TO THE 303(d) LIST FOR THE LOS ANGELES REGION

I. Waterbodies With Water Quality Attainment Should Be Delisted As Requested By The Los Angeles County Flood Control District During The 2010 Data Solicitation Period And Pursuant to the 303d Listing Policy

In August 2010 in response to the State Water Resources Control Board's (State Water Board's) data solicitation for the 2012 Integrated Report for Clean Water Act Sections 303(d) and 305(b), the Los Angeles County Flood Control District (LACFCD) submitted all the data and information that it collected since the State's previous data solicitation in 2007. As part of the 2010 data submission, the LACFCD conducted a detailed analysis of the new data and found 15 listed waterbody-pollutant combinations that had attained their water quality standards and met the delisting criteria set forth in Section 4 of the *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (303(d) Listing Policy). To this end, LACFCD provided a detailed analysis of this data and identified those waterbodies that should be delisted pursuant to the *State's 303(d) Listing Policy*. Those waterbody-pollutant combinations are listed below.

WATERBODY	POLLUTANT	Addressed in Current Proposed Revisions?
Coyote Creek	Diazinon	No
Dominguez Channel (lined portion)	Diazinon	Yes
Legg Lake	Ammonia Copper Lead	No
Los Angeles River Reach 1	Diazinon	No
Peck Road Park Lake	Lead Dissolved Oxygen	No
Santa Clara River Reach 6	Chlorphyrifos Diazinon Copper Iron	No
Santa Fe Dam Park Lake	Copper Lead pH	No

As set forth in the above table, none of the identified waterbody-pollutant combinations are currently proposed for delisting as part of the 2016 303(d) list, except for the Dominguez Channel Diazinon, despite meeting the delisting criteria under the *State's Listing Policy*. Based on a review of the fact sheets for these waterbodies in Appendix G, it appears that the post-2007 data and analysis submitted by the LACFCD was not taken into consideration by the Los Angeles Regional Water Quality Control Board (Regional Board).

The County and the LACFCD request that the Regional Board consider the data set forth in the LACFCD's 2010 submission. Attached is a copy of the LACFCD comment letter and technical report from the 2010 data solicitation for your review and consideration. The County and the LACFCD further request that the Regional Board delist these waterbodies as requested.

II. The Regional Board Should Wait For The Completion Of The State's Biointegrity Policy Development Before Listing Waterbodies For Benthic Community Effects

Currently, there is no officially established California water quality objective or guideline for listing waterbodies for benthic community effects. As such, the State Water Board is currently developing statewide biological objectives to assist in addressing this gap. The 2010 State Water Board's initial notice letter[1] for development of these biological objectives states the following:

> *"State and Regional Water Board plans and policies do not contain numeric objectives or guidance for using biological data in regulatory decision-making. Therefore, biological objectives are needed to provide the narrative or numeric benchmarks that describe conditions necessary to protect aquatic life beneficial uses. The initial effort will focus on wadeable perennial streams and rivers."*

Similarly, the CEQA public scoping document[2] released in 2012 for this project states the following:

> *"Benchmarks for identifying biological impairments and interpreting narrative water quality objectives are not formally adopted in Water*

[1] http://www.swrcb.ca.gov/plans_policies/docs/biological_objective/kickoff_ltr.pdf
[2] Pages 6 and 8 of http://www.swrcb.ca.gov/plans_policies/docs/biological_objective/bioobj_ceqa.pdf

Board plans or policies and, therefore, not readily used as enforceable requirements …" [Page 6 of the scoping document]
"The State Water Board will develop [biological objectives and] program of implementation that describes how biological objectives will be incorporated into permits and other regulatory actions, such as assessing attainment of aquatic life beneficial uses for 303(d) listing." [Page 8 of the scoping document]

Thus, there is no established objective in California for assessing biological data, such as benthic macroinvertabrate data, for regulatory decision-making. This includes 303(d) listings.

The State Water Board is currently making progress on compiling available information and conducting necessary scientific studies to develop applicable objectives and implementation policy (also known as Biointegrity Policy). The State Water Board has hired the Southern California Coastal Water Research Project (SCCWRP) and the California Department of Fish and Wildlife to develop technical information to aid development of the policy. To ensure that a range of public interests are represented during the development process, the State Water Board has reached out to interested stakeholders. The County and LACFCD is actively participating in these meetings.

Although the State Water Board is currently developing biological objectives for benthic communities, the Regional Board has listed multiple waterbodies for benthic community impairment prior to the development of those objectives and its implementation guideline. The following table summarizes the waterbodies being proposed for benthic community listings by the Regional Board in the County.

WATERSHED	WATERBODY SEGMENT	CONCRETE CHANNEL?
Ballona Creek	Ballona Creek	Yes
Dominguez Channel	Dominguez Channel	Yes
Los Angeles River	Alhambra Wash	Yes
	Arroyo Seco Reach 3	No
	Los Angeles River Reach 3	Yes
	Los Angeles River Reach 4	Yes
Malibu Creek	Medea Creek Reach 1	No

	Triunfo Creek Reach 1	No
San Gabriel River	San Gabriel River – East Fork	No
Santa Clara River	Santa Clara River Reach 5	No

Adopting these benthic community impairment listings without first awaiting the State Water Board's development of water quality objectives and implementation guidance is premature. First, in assessing biological data and justifying the proposed listings, the Regional Board used the Index of Biological Integrity (IBI) and the California Stream Condition Index (CSCI). The benchmarks/thresholds used are 40 for IBI and 0.79 for CSCI. While IBI and CSCI are available tools for evaluating the relative biological condition of perennial wadeable streams, the associated benchmarks/thresholds used by Regional Board staff for justifying the listings have not been officially adopted by the State Water Board or the Regional Board for purposes of determining 303(d) listings. Thus, to ensure statewide consistency, the appropriate benchmarks should be set by the Biointegrity Policy being developed by the State Water Board.

Second, the CSCI was developed to replace the IBI and is expected to be used in the Biointegrity Policy. Thus, the IBI and its associated benchmark should not be used for assessing stream conditions for purposes of regulatory decisions, such as 303(d) listing.

Third, many of the listings set forth in the table above are for concrete/modified channels, which are being treated the same as natural channels. This is inconsistent with the approach that the State Water Board has been taking in developing the Biointegrity Policy, which provides that in highly altered conditions, the standard should be based on "best attainable conditions". In this regard, the State Water Board's 2012 CEQA Scoping document[3] for biological objectives states the following:

> *"One of the difficulties of defining reference conditions in California is that many waterbodies in the State have been severely altered from their natural condition. Some of these alterations are not a result of the controllable environmental factors…. In highly altered systems where biological conditions are limited by uncontrollable factors, the focus is on expectations for the 'best attainable' conditions."*

[3] Page 3 of http://www.swrcb.ca.gov/plans_policies/docs/biological_objective/bioobj_ceqa.pdf

Concrete/engineered flood control channels in urban environments are among the systems that the State Water Board considers highly altered. For those systems, the State's goal is to establish standards that are reasonably expected to be attainable, which is different than standards for natural channels. The State Water Board is using a gradient approach where the biological expectations for altered stream channels are based on the level of alteration. Since altered stream channels have limited habitat, it is improbable to expect a thriving benthic community in these channels the same way as in natural stream channels. This conclusion is well demonstrated in the stream survey report published in 2016 by the Southern California Stormwater Monitoring Coalition (SMC) – the *2015 Report on the SMC Regional Stream Survey*[4]*, with Special Study on Engineered Channels.*

For the reasons described above, the Regional Board should not list waterbodies, and particularly those with concrete or engineered channels, for benthic impairments until the State Biointegrity Policy is developed and adopted. However, if the Regional Board lists any waterbody for benthic impairment, then the listings should be listed under Category 4c, and not under Category 5, since it is uncertain that these impairments are caused by pollutants.

III. Toxicity Listings Are Based On Unreliable Data and Should Be Removed

Ten County waterbodies are newly listed for toxicity, nine of which are streams or rivers, and one is an estuary. The majority of toxicity data used in the listings are from water toxicity tests conducted using the *Ceriodaphnia dubia* or other species.

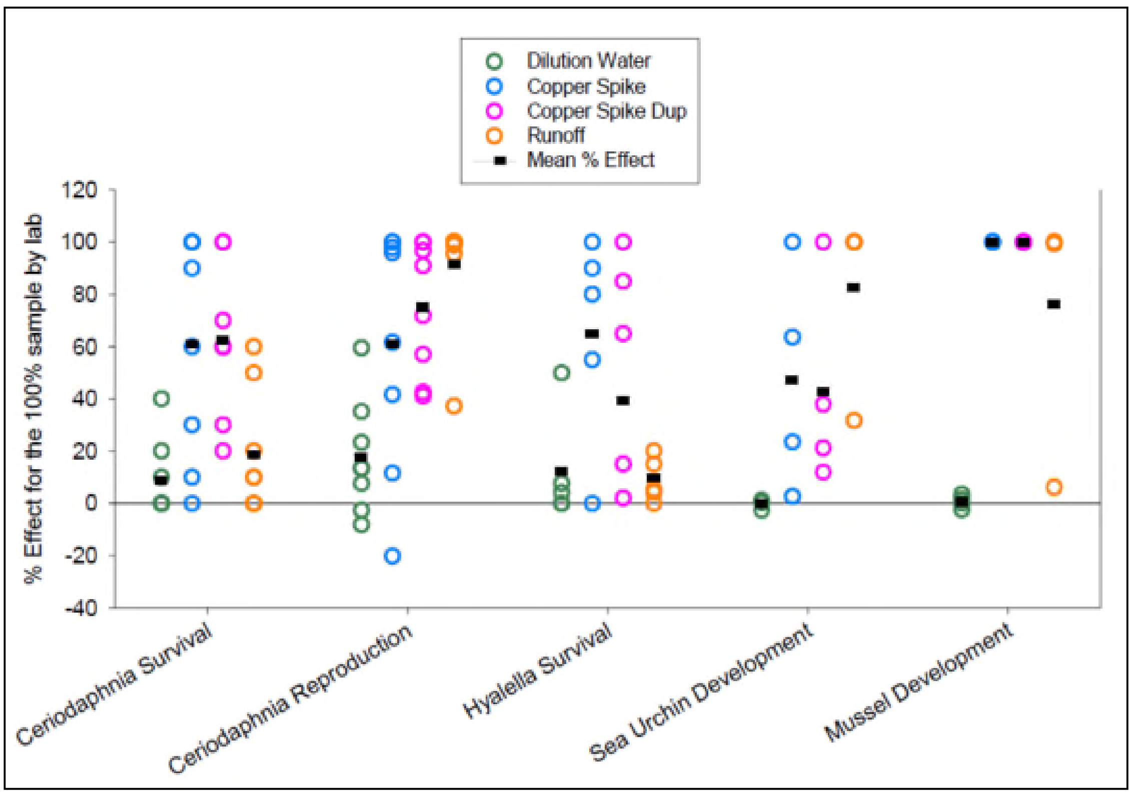
WATERSHED	WATERBODY SEGMENT	TEST SPECIES
Los Angeles River	Bull Creek	C. dubia, Fathead
	LA River Reach 4	
	LA River Reach 5	
	LA River Reach 6	C. dubia, Fathead, Hyalella
San Gabriel River	SG River Estuary	Topsmelt, Fathead
	SG River Reach 3	C. dubia, Fathead
	San Jose Creek Reach 2	

[4] http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/963_2015_SMC_Report_EnginChannels.pdf

	South San Jose Creek	
Santa Clara River	Piru Creek	C. dubia
	SC River Reach 5	C. dubia

These toxicity tests, however, have recently been found to be unreliable by a laboratory intercalibration study conducted by SMC[5]. The study utilized 10 laboratories in Southern California that are certified by the State of California for toxicity testing. (Almost all toxicity tests in Southern California are conducted by these laboratories.) Although standard methods and protocols were followed by all the laboratories, the test results for the same sample varied significantly between laboratories.

The below chart summarizes the results of the study. Each symbol in the chart represents the result from a single laboratory.



[5] SMC Toxicity Testing Laboratory Guidance Document
ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/956_StrmWtrMonitCoalitToxTestingLabGuid.pdf

As can be seen from the chart, there is high variability in the toxicity results between different laboratories for all the test species despite the fact that analytical procedures were performed on identical samples. For example, the results for *Ceriodaphnia survival* vary between 0 percent and 100 percent for the same sample depending on the laboratory used. Also, a sample of lab dilution water, which is expected to be non-toxic was found to be toxic by many labs. Such high magnitudes of inconsistency and incomparability between the labs makes the existing toxicity data invalid or not useful. It is thus very probable that the proposed 303(d) listings for toxicity are the result of false positive toxicity tests, resulting in unimpaired waterbodies being wrongly listed for toxicity.

It is incumbent upon the State to ensure that the laboratories it certifies produce consistent and accurate toxicity test results. The uncertainties and variability reflected in testing results between laboratories, as shown in the SMC study, can have a profound effect on the regulatory actions placed on a waterbody.

For these reasons the proposed water toxicity listings are not supported by reliable data. The County and the LACFCD therefore request that all toxicity listing based off of water toxicity testing be removed from the list. We also request that the State continue to re-evaluate its laboratory certification protocols and address the problems identified by SMC.

IV. The Proposed Temperature Listings Are Based On An Inapplicable Standard And Therefore Should Be Removed

The following four waterbodies in the County are proposed listings for temperature-related impairment: Los Angeles River Reach 3, San Gabriel River Reaches 1 and 2, and Santa Clara River Reach 6. These listings should not be adopted for the following reasons:

First, natural temperatures for waterbodies in the Los Angeles Region are not known. Chapter 3 of the Los Angeles Region Basin Plan states the following for temperature:

> *"For waters designated WARM, water temperature shall not be altered by more than 5°F above the natural temperature. At no time shall these WARM-designated waters be raised above 80°F as a result of waste discharges."*
>
> *"For waters designated as COLD, water temperature shall not be altered by more than 5°F above the natural temperature."*

The current Basin Plan does not have an established "natural temperature" baseline for waterbodies, nor does it have guidance for estimating natural temperatures. This precludes the use of alteration of natural temperature as a basis for assessing waterbodies in the region.

The Regional Board therefore appears to have used the 80ºF objective as the basis for the proposed temperature listings. This standard, however, is not appropriate for two reasons: (1) Under the Basin Plan, the 80ºF threshold is to be used only when there is evidence that the temperature rise was "as a result of waste discharges." The Regional Board did not provide evidence that any of the temperatures above 80°F were caused by waste discharges. (2) The 80ºF threshold was applied to all waterbodies without considering the physical attributes or the historical ambient air temperatures of the waterbodies, which are uncontrollable. In the Los Angeles Region, ambient air temperatures can vary drastically, which would easily alter or raise the temperature above 80°F, especially in concrete channels during warmer months. Concrete channels are very susceptible to fluctuations in temperature due the material's ability to absorb heat. Even if the water is at a reasonable temperature when it enters a concrete channel, the water temperature may naturally rise as it travels through the channel, and not as the result of waste discharges.

Second, Basin Plans of other Southern California Regions, which have similar habitats as in the Los Angeles Region, do not use 80ºF as a water quality objective for WARM-designated waters. For example, the Santa Ana Region Basin Plan[6] uses 90˚F during warmer months of the year (June through October) and 78˚F during the rest of the year. The San Diego Region does not have any temperature water quality objectives for WARM-designated waters.

Therefore, the use of 80˚F for purposes of assessing temperature-related impairments and listing waterbodies is unreasonable and unsupported, especially in concrete channels during dry seasons. The Regional Board should not list waterbodies for temperature until applicable standards are established for the Region.

[6] www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/docs/2016/Chapter_4_Feb_2016.pdf

V. Alondra Park Lake Is Not A Water of the United States And Therefore Should Be Removed From The Proposed 303(d) List

Alondra Park Lake is a man-made lake that was created in the late 1940s as part of County's plan to establish Alondra Park. The lake does not receive any runoff discharge from areas outside of the park and is not connected to the Dominguez Channel or any other surface waterbody. The lake's source of water is entirely groundwater that is pumped from the West Coast Groundwater Basin. This water is used to irrigate the park and the nearby golf course.

In addition, Alondra Lake is not identified in the Basin Plan and, thus, does not have any beneficial use designation assigned to it. This confirms that the lake is not a receiving waterbody.

The Section 303(d) list applies only to waters of the United States[7]. Alondra Park Lake is a man-made enclosed lake not connected to any other waterbody. Any listings associated with Alondra Park Lake should therefore be removed from the proposed 2016 303(d) list.

VI. Data Being Used For Legacy Pollutant Listings Do Not Satisfy The Temporal Representativeness Requirements of The State's Listing Policy

The data being used to support proposed listings of waterbody-pollutant combinations for legacy pollutants does not satisfy the temporal requirements of the State's 303(d) Listing Policy as described below. Thus, these proposed listings should be removed.

Section 6.1.5.3 of the State's 303(d) Listing Policy states:

> *"Samples used in the assessment must be temporally independent. If the majority of samples were collected on a single day or during a single short-term natural event (e.g., a storm, flood, or wildfire), the data shall not be used as the primary data set supporting the listing decision. Samples should be available from two or more seasons or from two or more events . . ."*

[7] 33 U.S.C §1313(d)

Section 6.1.5.6 of the Listing Policy states:

> *"To be considered temporally independent, samples collected during the averaging period shall be combined and considered one sampling event. For data that is not temporally independent (e.g., when multiple samples are collected at a single location on the same day), the measurements shall be combined and represented by a single resultant value."*

Section 3.1 of the Listing Policy requires a minimum of two exceedances to place a waterbody on the 303(d) list for toxic pollutants.

The data used to support some of the new listings was collected only on a single day. Therefore, pursuant to Sections 6.1.5.3 and 6.1.5.6 of the Listing Policy, these samples are not temporally independent and should be combined and considered as a single data point. Moreover, under Section 3.1 of the Listing Policy, a minimum of two exceedances are needed to place a waterbody on a 303(d) list. Thus, the following listings do not meet these Listing Policy guidelines:

WATERSHED	WATERBODY SEGMENT	POLLUTANT(S)
Dominguez Channel	Alondra Park Lake	PCBs
Malibu Creek	Malibou Lake	Dieldrin
Los Angeles River	Echo Park Lake	Chlordane, Dieldrin
	Lincoln Park Lake	PCBs
San Gabriel River	Legg Lakes	DDT, PCBs
	Santa Fe Dam Park Lake	PCBs
Santa Clara River	Castaic Lagoon	PCBs
	Castaic Lake	PCBs
	Elderberry Forebay	Dieldrin, PCBs
	Pyramid Lake	Chlordane, DDT, Dieldrin, PCBs

The County and the LACFCD request that these listings be removed until more samples are collected to satisfy the temporal representativeness of data of the State's Listing Policy.

VII. Legacy Pollutants (PCBs, DDT, Dieldrin, Chlordane) Should be Listed As a Category 4b, Not as Category 5

Many of the pollutants that are being considered for incorporation into the 303(d) list are legacy pollutants that have been banned by the U.S. Environmental Protection Agency (EPA) decades ago and are no longer manufactured or used in the United States. These pollutants include PCBs, DDT, Dieldrin, and Chlordane. PCBs were banned in 1979, DDT in 1980, Dieldrin in 1987, and Chlordane in 1988.

The newly proposed listing includes several waterbodies in the County that are listed for impairments associated with these pollutants:

WATERSHED	WATERBODY SEGMENT	POLLUTANT(S)
Dominguez Channel	Alondra Park Lake	PCBs
Malibu Creek	Malibou Lake	Dieldrin
Los Angeles River	Echo Park Lake	Chlordane, Dieldrin
	Lincoln Park Lake	PCBs
San Gabriel River	Legg Lakes	DDT, PCBs
	Santa Fe Dam Park Lake	PCBs
Santa Clara River	Castaic Lagoon	PCBs
	Castaic Lake	PCBs
	Elderberry Forebay	Dieldrin, PCBs
	Pyramid Lake	Chlordane, DDT, Dieldrin, PCBs

The complete ban on these pollutants three decades ago, which is the strongest regulatory action an agency can take, has effectively addressed the true sources of these pollutants in the environment. Since these chemicals are no longer manufactured or used, the regulatory program already in place by the U.S. EPA is reasonably expected to result in the attainment of the water quality standard for these pollutants over time.

As indicated in comment VI, waterbodies that contain legacy pollutants should not be listed because the data used for their listing does not satisfy the Listing Policy. However, if the Regional Board does list these waterbodies, we request that they be listed as Category 4b, not Category 5, because a regulatory program is already in place to address them.

VIII. The State Should Rely On The Most Updated Guideline to List Waterbodies Based On Fish Tissue Contamination

In assessing waterbodies for fish tissue contamination, the Regional Board used the following two guidelines:

a. The 2008 Office of Environmental Health Hazard Assessment (OEHHA) fish contaminant goal[8], and
b. The 1972 National Academy of Sciences (NAS) guidelines.[9]

The OEHHA guideline, developed in 2008 is not only up-to-date but also specific to California and, thus, reasonable to use for this particular assessment. On the other hand, the NAS guideline is half a century old and out of date. In the absence of an up-to-date NAS guideline, the assessment should be based exclusively on the OEHHA standard's line of evidence.

Based on the OEHHA guideline, the following waterbodies meet water quality standards and, therefore, should be removed from the proposed listing:

- Castaic Lagoon for PCBs
- Elderberry Forebay for Dieldrin
- Pyramid Lake for Chlordane, DDT, Dieldrin, PCBs
- Alondra Park Lake for PCBs
- Echo Park Lake for Chlordane and Dieldrin
- Legg Lakes for DDT and PCBs.

IX. ADDITIONAL COMMENTS

A. Wilmington Drain-Copper should be delisted

Per Appendix G fact sheets, two lines of evidences (LOE) were used to support the listing for copper in Wilmington Drain. However, the information used for the second LOE is data collected in Compton Creek, which is a different waterbody. This data should not be used to evaluate Wilmington Drain. Removal of this LOE would lead to only 2 exceedances out of 33 data points. This would satisfy the delisting criteria of the State's Listing Policy. Therefore, copper should be delisted for Wilmington Drain.

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[8] http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/state_board/2008/ref2456.pdf
[9] http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/state_board/2006/ref19.pdf

B. The listings in Appendix A should be corrected to reflect the listing and delisting decisions in Appendix G

As already acknowledged in the February 24 Regional Board notice letter, Appendix A does not accurately capture all the listing and delisting decisions detailed in the fact sheets in Appendix G. For example, for Ballona Creek, Chlordane, DDT, Dieldrin, and PCBs were delisted during the previous listing cycle. However, these listings continue to be identified in Appendix A as part of the 2016 303(d) list. This is true for many of the waterbodies summarized in Appendix A. This error should be corrected to avoid any confusion and misinterpretation of the information by the general public.

C. Waterbodies that are on the 303(d) list and being addressed by a USEPA approved TMDL should be moved to Category 4a from Category 5

Many of 303(d)-listed waterbodies from the previous listing cycle now have TMDLs. This requires a change in their status from Category 5 (TMDL required list) to Category 4a (being addressed by US EPA approved TMDL). Some of these status changes are not reflected in the revised list and need correction.

Similarly, some of the newly proposed listings are already being addressed by an existing TMDL for that watershed. In those cases, it is appropriate to put them also under Category 4a as opposed to Category 5. Examples, include:

- LA River Reach 3 and Rio Hondo Reach 2 for Indicator Bacteria, which are being addressed by the Los Angeles River Watershed Bacteria TMDL
- LA River Reach 6 for Copper and Compton Creek for Zinc, which are being addressed by the Los Angeles River Metals TMDL.

COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

"To Enrich Lives Through Effective and Caring Service"

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GAIL FARBER, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

August 26, 2010

IN REPLY PLEASE
REFER TO FILE: WM-9

Mr. Jeffrey Shu, Environmental Scientist
State Water Resources Control Board
Division of Water Quality
P.O. Box 100
Sacramento, CA 95812-0100

Dear Mr. Shu:

RESPONSE TO WATER QUALITY DATA AND INFORMATION SOLICITATION FOR 2012 CALIFORNIA INTEGRATED REPORT CLEAN WATER ACT SECTIONS 303(D) AND 305(B)

Thank you for the opportunity to submit data and information for the 2012 Integrated Report – Clean Water Act Sections 303(d) and 305(b). The Los Angeles County Flood Control District conducts a minimum of six sampling events (four wet weather and two dry weather) per year at seven mass emission monitoring stations and six tributary monitoring stations in accordance with the Los Angeles County Municipal Stormwater Permit (NPDES Permit No. CAS004001). All data collected under the permit are submitted to the Los Angeles Regional Water Quality Control Board in August of each year. In addition, the Los Angeles County Flood Control District assisted the U.S. Environmental Protection Agency in collecting data for a development of the draft Los Angeles Area Lakes Total Maximum Daily Loads. Enclosed is a compact disk (CD) containing all data collected since the last data solicitation in 2007. Also included in the CD is a copy of this cover letter and the enclosures.

Our analysis of the newly available data and information, collected after the State's last data solicitation cycle in 2007, found that some listed water bodies have attained their water-quality standards and meet the delisting criteria in Section 4 of the State's Water Quality Control Policy for Developing Clean Water Act Section 303(d) List. We, therefore, request that the following water body-pollutant combinations be considered for removal from the 2012 Clean Water Act Section 303(d) List:

- Coyote Creek - Diazinon
- Dominguez Channel lined portion above Vermont Avenue - Diazinon

- Legg Lakes - Ammonia, Copper, and Lead
- Los Angeles River Reach 1 - Diazinon
- Peck Road Park Lake - Lead and Organic Enrichment/Low-Dissolved Oxygen
- Santa Clara River Reach 6 - Chlorpyrifos, Diazinon, Copper, and Iron
- Santa Fe Dam Park Lake - Copper, Lead, and pH

Each water body-pollutant combination is discussed in detail in the enclosed Technical Report.

We look forward to your consideration of these comments. If you have any questions, please contact me at (626) 458-4300 or ghildeb@dpw.lacounty.gov or your staff may contact Ms. Rossana D'Antonio at (626) 458-4325 or rdanton@dpw.lacounty.gov.

Very truly yours,

GAIL FARBER
Director of Public Works

GARY HILDEBRAND
Assistant Deputy Director
Watershed Management Division

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Enc.

Technical Report:
Data Analysis and Justifications for Delisting Waterbody-Pollutant Combinations

Submitted to:

California State Water Resources Control Board

1001 I Street, Sacramento, CA 95814

August 30, 2010

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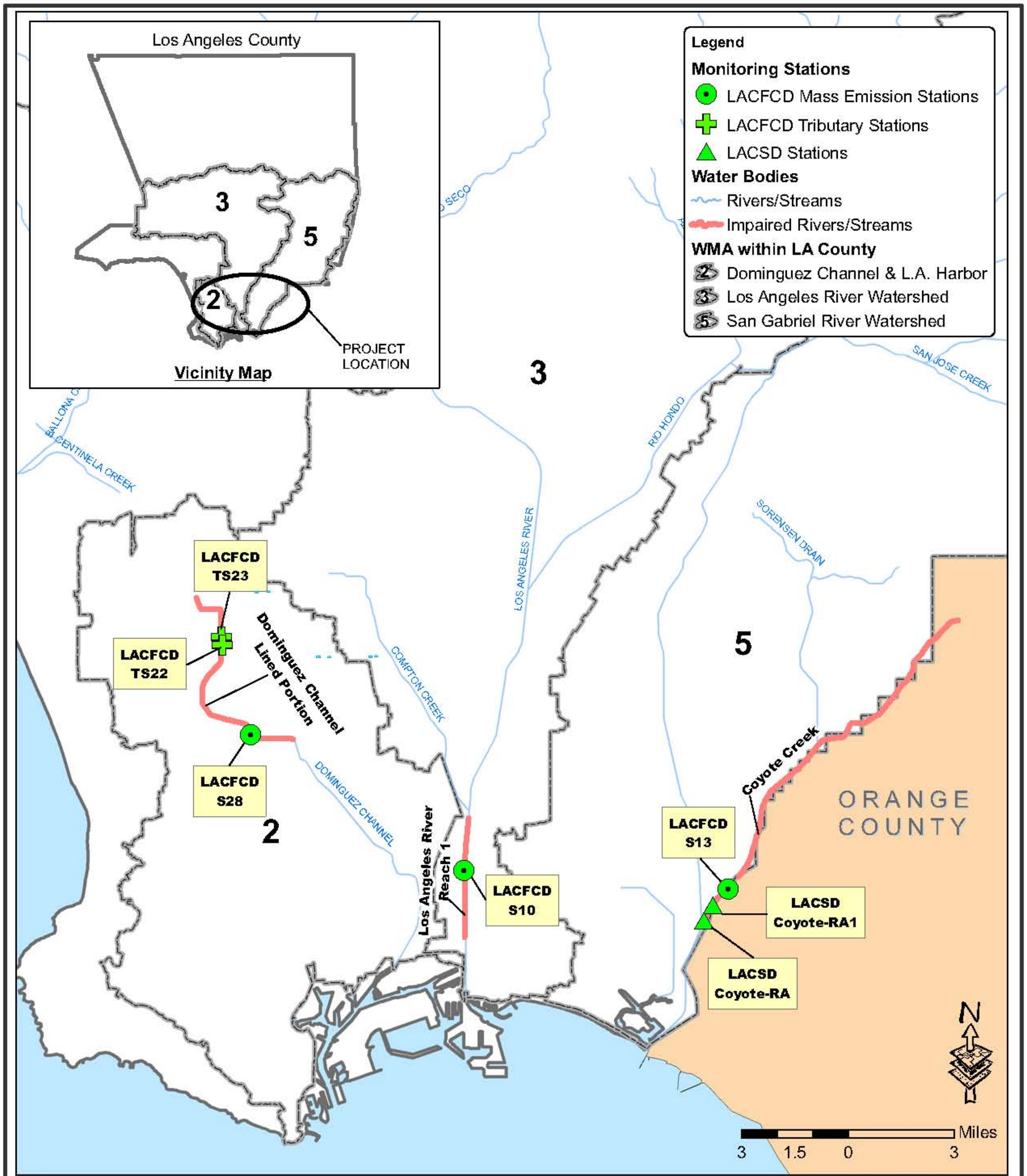
1. Coyote Creek - Diazinon

Watershed	San Gabriel River Watershed, Los Angeles County
Waterbody Reach	Coyote Creek (see Figure 1). This waterbody reach is concrete-lined channel.
Pollutant	Diazinon
Year First Listed and Evidences Used for the Listing	This waterbodypollutant was initially placed on the 303(d) list in 2006. The evidence used for the original listing indicates that two out of 20 samples of available data exceeded the California Department of Fish and Game (DFG) freshwater criteria for diazinon. No additional information was used at the time of first listing. The analysis for the most recent 2008 listing shows that seven out of 79 shows exceedance of the Chronic Criteria and six out of 79 shows exceedance of the acute criteria.
Applicable Water Quality Objectives	The DFG lists an acute and chronic hazard assessment criterion of 0.16 ug/L and 0.10 ug/L, respectively, for diazinon.
Changes in the Watershed since the First Listing	The U.S. Environmental Protection Agency (EPA) has banned the sales of diazinon in 2005. The data collected for Coyote Creek since 2005 shows the effectiveness of the EPA policy in removing diazinon from receiving water.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	LACFCD station (S13): Los Angeles County Flood Control District's (LACFCD) Mass Emission Monitoring Station (S13) is located on Coyote Creek below Spring Street in the lower San Gabriel River Watershed (see Figure 1). Since the last data solicitation, additional 24 samples were collected between September 2007 and March 2010 at S13 in accordance with the Los Angeles County MS4 permit monitoring program. There were zero exceedances during this period. LACSD Stations (RA1, RA): the Sanitation Districts of Los Angeles County (LACSD) conducted sampling in two receiving water monitoring stations: station RA1 located upstream of discharge from Long Beach Water Reclamation Plant and station RA located downstream of discharge from Long Beach Water Reclamation Plant (see Figure 1).
Data Analysis and Justification for de-listing	Of the total 68 samples collected by the LACFCD at S13 from October 2000 through March 2010, there were five exceedances out of 29 samples before the 2005 sales ban (Pre-EPA Ban), and only one out of 39 samples exceeded the diazinon criteria after the sales ban (Post-EPA Ban). The last diazinon exceedance at station S13 was observed on April 7, 2007. Of the total 52 samples collected by the LACSD at RA1 and RA stations, there were three exceedances out of five samples during the pre-EPA ban, while only one exceedance out of 43 samples during the post-EPA ban (see Table 1). The last exceedance of diazinon at these stations was observed on July 18, 2005. In summary, there were 8 exceedances out of 34 samples pre-EPA ban, while there were only 2 exceedances out of 82 samples post-EPA ban. This shows that the EPA policy is very effective in eliminating diazinon from Coyote Creek, and the waterbody has attained its water quality objectives. All supporting data is summarized in Table 1.
Conclusions and Recommendation	After the EPA sales ban of diazinon, Coyote Creek is meeting section 4.1 of the State Listing Policy and should be removed from the 303(d) list.



Map Showing Dominguez Channel Lined Portion, Los Angeles River Reach 1, Coyote Creek and Associated Monitoring Stations

Figure 1

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July 27, 2010

Table 1. Summary of Diazinon Data in Coyote Creek

	LACFCD	LACSD	Total
Pre-EPA Ban			
Number of Exceedance	5	3	8
Number of Sample	29	5	34
Average of Result (ug/L)	0.06	0.17	0.08
Minimum of Result (ug/L)	0.005	0.05	0.005
Maximum of Result (ug/L)	0.49	0.39	0.49
Water Quality Objectives (ug/L)	0.1	0.1	0.1
Start Date	10/12/2000	07/12/2004	10/12/2000
End Date	12/05/2004	10/04/2004	12/05/2004
Post-EPA Ban			
Number of Exceedance	1	1	2
Number of Sample	39	43	82
Average of Result (ug/L)	0.01	0.05	0.03
Minimum of Result (ug/L)	0.003	0.05	0.003
Maximum of Result (ug/L)	0.147	0.19	0.19
Water Quality Objectives (ug/L)	0.1	0.1	0.1
Start Date	01/07/2005	01/17/2005	01/07/2005
End Date	03/23/2010	02/16/2010	03/23/2010
Total Summary			
Total Number of Exceedance	6	4	10
Total Number of Sample	68	48	116
Total Average of Result (ug/L)	0.03	0.07	0.04
Total Minimum of Result (ug/L)	0.003	0.05	0.003
Total Maximum of Result (ug/L)	0.49	0.39	0.49
Water Quality Objectives (ug/L)	0.1	0.1	0.1
Total Start Date	10/12/2000	07/12/2004	10/12/2000
Total End Date	03/23/2010	02/16/2010	03/23/2010

EPA=Environmental Protection Agency

LACFCD=Los Angeles County Flood Control District

LACSD=Los Angeles County Sanitation Districts

2. Dominguez Channel (Lined Portion Above Vermont Ave.) - Diazinon

Watershed	Dominguez Channel Watershed, Los Angeles County
Waterbody Reach	Dominguez Channel Lined Porting Above Vermont Ave. (see Figure 1 for the location of this particular reach). This waterbody reach is concrete-lined channel.
Pollutant	Diazinon
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was initially placed on the 303(d) list in 2008. The evidence used for the listing indicates that five out of 31 samples collected between January 2002 and April 2007 exceeded the California Department of Fish and Game (DFG) freshwater criteria for diazinon.
Applicable Water Quality Objectives	The DFG lists an acute and chronic hazard assessment criterion of 0.16 ug/L and 0.10 ug/L, respectively, for diazinon.
Changes in the Watershed since the First Listing	The U.S. Environmental Protection Agency (EPA) has banned the sales of diazinon in 2005. Water quality improvement BMPs has been implemented as part NPDES permits. Additional data has been collected. The data collected for Coyote Creek since 2005 shows the effectiveness of the EPA policy in removing diazinon from receiving water.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	<u>LACFCD station (S28):</u> Los Angeles County Flood Control District's (LACFCD) Mass Emission Monitoring Station (S28) is located on Dominguez Channel and Artesia Boulevard in the City of Torrance (see Figure 1). Since the last data solicitation, additional 24 samples were collected between September 2007 and March 2010 at S28 in accordance with the Los Angeles County MS4 permit monitoring program. There were zero exceedances during this period. <u>LACFCD Tributary Stations (TS22, TS23):</u> LACFCD's tributary monitoring stations, TS22 and TS23, are located near a confluent to Dominguez Channel and located approximately 2.5 miles upstream of S28 (see Figure 1). 36 samples were collected at these two stations between November 2008 and March 2010.
Data Analysis and Justification for de-listing	Of the total 55 samples collected by the LACFCD at S28 from October 2000 through March 2010, there were three exceedances out of 16 samples before the 2005 sales ban (Pre-EPA Ban), and only two out of 39 samples exceeded the diazinon criteria after the sales ban (Post-EPA Ban). The last diazinon exceedance at station S28 was observed on October 17, 2005. Of the total 36 samples collected by the LACFCD at TS22 and TS23 stations, there were zero exceedances at these stations since the LAFCD started monitoring in November 2008. In summary, there were three exceedances out of 16 samples during the pre-EPA ban, while there were only 2 exceedances out of 75 samples during the post-EPA ban. This shows that the EPA policy is very effective in eliminating diazinon from Dominguez Channel, and the waterbody has attained its water quality objectives. All supporting data is summarized in Table 2.
Conclusions and Recommendation	After the EPA sales ban of diazinon, Dominguez Channel Lined Portion is meeting section 4.1 of the State Listing Policy for diazinon and should be removed from the 303(d) list.

Table 2. Summary of Data in Dominguez Channel lined portion above Vermont Ave.

	S28	TS22*	TS23*	Total
Pre-EPA Ban				
Number of Exceedance	3			3
Number of Samples	16			16
Max of Result (ug/L)	0.415			0.415
Min of Result (ug/L)	0.003			0.003
Reporting Limit (ug/L)	0.01			0.01
Water Quality Objectives (ug/L)	0.1			0.1
Start Date	01/28/2002			01/28/2002
End Date	12/05/2004			12/05/2004
Post-EPA Ban				
Number of Exceedance	2	0	0	2
Number of Samples	39	18	18	75
Max of Result (ug/L)	0.96	0.003	0.003	0.96
Min of Result (ug/L)	0.003	0.003	0.003	0.003
Reporting Limit (ug/L)	0.01	0.01	0.01	0.01
Water Quality Objectives (ug/L)	0.1	0.1	0.1	0.1
Start Date	01/07/2005	11/04/2008	11/04/2008	01/07/2005
End Date	03/23/2010	03/23/2010	03/23/2010	03/23/2010
Total Summary				
Total Number of Exceedance	5	0	0	5
Total Number of Samples	55	18	18	91
Total Max of Result (ug/L)	0.96	0.003	0.003	0.96
Total Min of Result (ug/L)	0.003	0.003	0.003	0.003
Total Reporting Limit (ug/L)	0.01	0.01	0.01	0.01
Water Quality Objectives (ug/L)	0.1	0.1	0.1	0.1
Total Start Date	01/28/2002	11/04/2008	11/04/2008	01/28/2002
Total End Date	03/23/2010	03/23/2010	03/23/2010	03/23/2010

EPA=Environmental Protection Agency

* Monitoring at tributary stations were activated on October 2008.

3. Los Angeles River Reach 1 - Diazinon

Watershed	Los Angeles River Watershed, Los Angeles County
Waterbody Reach	Los Angeles River Reach 1 (see Figure 1). This waterbody reach is a concrete-lined channel.
Pollutant	Diazinon
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 2006. The evidence used for the listing indicates that two out of 22 samples collected from October 2000 through April 2003 exceeded the California Department of Fish and Game (DFG) freshwater criteria for diazinon. The data submitted by Los Angeles County Flood Control District (LACFCD) for the 2008 data solicitation was not evaluated.
Applicable Water Quality Objectives	The DFG lists an acute and chronic hazard assessment criterion of 0.16 ug/L and 0.10 ug/L, respectively, for diazinon.
Changes in the Watershed since the First Listing	The U.S. Environmental Protection Agency (EPA) has banned the sales of diazinon in 2005. Water quality improvement BMPs has been implemented as part NPDES permits. Additional data has been collected. The data collected for Los Angeles River Reach 1 since 2005 shows the effectiveness of the EPA policy in removing diazinon from receiving water.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	<u>LACFCD station (S10):</u> LACFCD's Mass Emission Monitoring Station (S10) is located on Los Angeles River between Willow Street and Wardlow Road in the City of Long Beach (see Figure 1). 46 samples were collected between October 2003 and March 2010 at S10 in accordance with the Los Angeles County MS4 permit monitoring program. There were zero exceedances during this period.
Data Analysis and Justification for de-listing	Of the total 67 samples collected by the LACFCD at S10 from October 2000 through March 2010, there were two exceedances out of 31 samples before the 2005 sales ban (Pre-EPA Ban), and zero out of 36 samples exceeded the diazinon criteria after the sales ban (Post-EPA Ban). The last diazinon exceedance at S10 was observed on February 11, 2003. This shows that the EPA policy is very effective in eliminating diazinon from Los Angeles River Reach 1, and the waterbody has attained its water quality objectives. All supporting data is summarized in Table 3.
Conclusions and Recommendation	Los Angeles River Reach 1 is meeting section 4.1 of the State Listing Policy for diazinon and should be removed from the 303(d) list.

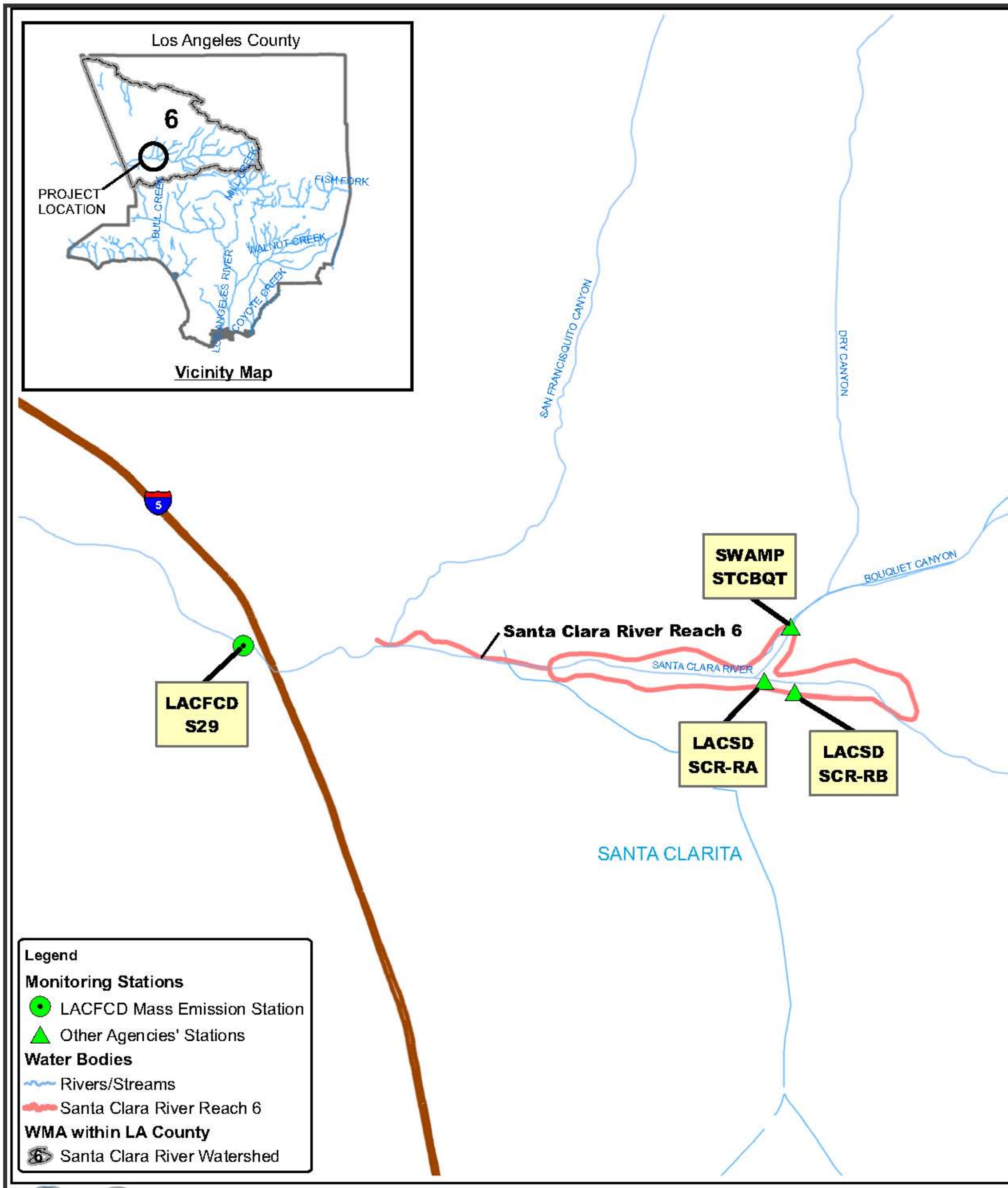
Table 3. Summary of Diazinon Data in Los Angeles River Reach 1

	S10
Pre-EPA Ban	
Number of Exceedance	2
Number of Sample	31
Average of Result (ug/L)	0.024
Max of Result (ug/L)	0.179
Min of Result (ug/L)	0.003
Water Quality Objectives (ug/L)	0.1
Start Date	10/12/2000
End Date	12/05/2004
Post-EPA Ban	
Number of Exceedance	0
Number of Sample	36
Average of Result (ug/L)	0.003
Max of Result (ug/L)	0.003
Min of Result (ug/L)	0.003
Water Quality Objectives (ug/L)	0.1
Start Date	01/07/2005
End Date	03/23/2010
Total Summary	
Total Number of Exceedance	2
Total Number of Sample	67
Total Average of Result (ug/L)	0.013
Total Max of Result (ug/L)	0.179
Total Min of Result (ug/L)	0.003
Water Quality Objectives	0.1
Total Start Date	10/12/2000
Total End Date	03/23/2010

EPA=Environmental Protection Agency

4. Santa Clara River Reach 6 - Diazinon

Watershed	Santa Clara River Watershed, Los Angeles County
Waterbody Reach	Santa Clara River Reach 6 (see Figure 2). This waterbody reach is a soft bottom channel.
Pollutant	Diazinon
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 2006. The evidence used for the listing indicates that 28 out of 29 samples collected between October 2001 and May 2003 exceeded the California Department of Fish and Game (CDFG) freshwater criteria for diazinon. In actuality, however, there were 24 samples with 23 exceedances. The data were collected by the Surface Water Ambient Monitoring Program (SWAMP). These data do not satisfy the section 6.1.4 of the Listing Policy because only two data points out of 24 were reported to be in "Compliant with associated QAPP" for the data set.
Applicable Water Quality Objectives	The CDFG lists an acute and chronic hazard assessment criterion of 0.16 ug/L and 0.10 ug/L, respectively, for diazinon.
Changes in the Watershed since the First Listing	The U.S. Environmental Protection Agency (EPA) has banned the sales of diazinon in 2005. Also, water quality improvement BMPs has been implemented as part NPDES permits and additional data has been collected. The data collected for Santa Clara River Reach 6 since 2005 shows the effectiveness of the EPA policy in removing diazinon from receiving water.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	LACFCD station (S29): Los Angeles County Flood Control District's (LACFCD) Mass Emission Monitoring Station (S29) is located on Santa Clara River (see Figure 2). 48 samples were collected between October 2002 and March 2010 at S29 in accordance with the Los Angeles County MS4 permit. LACSD Stations (RA, RB): the Sanitation Districts of Los Angeles County (LACSD) conducted sampling at two receiving water monitoring stations: station RA located 300 feet upstream of discharge from Saugus Water Reclamation Plant and station RB located 100 feet downstream of discharge from Saugus Water Reclamation Plant (see Figure 2).
Data Analysis and Justification for de-listing	Of the total 48 samples collected by the LACFCD at S29 from October 2002 through March 2010, there were three exceedances out of 13 samples before the 2005 sales ban (Pre-EPA Ban), and only one out of 35 samples exceeded the diazinon criteria after the sales ban (Post-EPA Ban). The last diazinon exceedance at S29 was observed on January 14, 2006. Of the total 27 samples collected by the LACSD at RA and RB stations, there were only one exceedance out of 25 samples during the post-EPA ban. The last exceedance of diazinon at these stations was observed on Februray 7, 2005. In summary, there were three exceedances out of 15 samples during the pre-EPA ban, while there were only two exceedances out of 60 samples during the post-EPA ban. All supporting data is summarized in Table 4. This shows that the EPA policy is very effective in eliminating diazinon from Santa Clara River Reach 6, and the waterbody has attained its water quality objectives.
Conclusions and Recommedation	After the EPA sales ban of diazinon, Santa Clara River Reach 6 is meeting section 4.1 of the State Listing Policy for diazinon and should be removed from the 303(d) list.



PUBLIC WORKS

Map Showing Santa Clara River Reach 6 and Associated Monitoring Stations

Figure 2

N

0.5 0.25 0 0.5 Miles

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July 27, 2010

Table 4. Summary of Diazinon Data in Santa Clara River Reach 6

	Diazinon			
Pre-EPA Ban	SWAMP*	LACFCD	LACSD	Total
Number of Exceedance	23	3	0	26
Number of Sample	24	13	2	39
Average of Result (ug/L)	1.94	0.10	0.05	1.23
Minimum of Result (ug/L)	0.054	0.003	0.05	0.003
Maximum of Result (ug/L)	6.7	0.43	0.05	6.7
Water Quality Objectives (ug/L)	0.1	0.1	0.1	0.1
Start Date	10/31/2001	10/10/2002	11/01/2004	10/31/2001
End Date	05/17/2003	10/26/2004	12/22/2004	12/22/2004
Post-EPA Ban				
Number of Exceedance		1	1	2
Number of Sample		35	25	60
Average of Result (ug/L)		0.01	0.07	0.03
Minimum of Result (ug/L)		0.003	0.05	0.003
Maximum of Result (ug/L)		0.11	0.51	0.51
Water Quality Objectives (ug/L)		0.1	0.1	0.1
Start Date		01/07/2005	01/17/2005	01/07/2005
End Date		03/23/2010	01/08/2010	03/23/2010
Total Summary				
Total Number of Exceedance	23	4	1	28
Total Number of Sample	24	48	27	99
Total Average of Result (ug/L)	1.94	0.03	0.07	0.51
Total Minimum of Result (ug/L)	0.054	0.003	0.05	0.003
Total Maximum of Result (ug/L)	6.7	0.43	0.51	6.7
Water Quality Objectives (ug/L)	0.1	0.1	0.1	0.1
Total Start Date	10/31/2001	10/10/2002	11/01/2004	10/31/2001
Total End Date	05/17/2003	03/23/2010	01/08/2010	03/23/2010

EPA=Environmental Protection Agency

LACFCD=Los Angeles County Flood Control District

LACSD=Los Angeles County Sanitation Districts

SWAMP=Surface Water Ambient Monitoring Program

*Data is not found from SWAMP database after May 2003 at this location

5. Santa Clara River Reach 6 - Chlorpyrifos

Watershed	Santa Clara River Watershed, Los Angeles County
Waterbody Reach	Santa Clara River Reach 6 (see Figure 2 for the location of this particular reach). This waterbody reach is a soft bottom channel.
Pollutant	Chlorpyrifos
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 2006. The evidence used for the listing indicates that 10 out of 39 samples collected by SWAMP (10), LACFCD (5) and Newhall Land and Farming Co. (24, unable to locate) between August 2002 and April 2003 exceeded the California Department of Fish and Game (CDFG) freshwater criteria for chlorpyrifos. All exceedances were from SWAMP STCBQT Bouquet Canyon Station (see Figure 2 for locations). The SWAMP data used in here do not satisfy the section 6.1.4 of the Listing Policy because only two data points out of 10 were reported to be in "Compliant with associated QAPP" for the data set.
Applicable Water Quality Objectives	CDFG Aquatic life toxicity one hour average: 0.08 ug/l and 4 day average: 0.05 ug/L.
Changes in the Watershed since the First Listing	The U.S. Environmental Protection Agency (EPA) has banned the sales of chlorpyrifos in 2001. Also, water quality improvement BMPs has been implemented as part NPDES permits and additional data has been collected. The data collected for Santa Clara River Reach 6 by LACFCD and LACSD since 2001 shows the effectiveness of the EPA policy in removing chlorpyrifos from receiving water.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	LACFCD station (S29): Los Angeles Flood Control District's (LACFCD) Mass Emission Monitoring Station (S29) is located on Santa Clara River and the Old Road in Santa Clara (see Figure 2). 48 samples were collected between October 2002 and March 2010 at S29 in accordance with the Los Angeles County MS4 permit monitoring program. LACSD Stations (RB): the Sanitation Districts of Los Angeles County (LACSD) conducted sampling in Santa Clara River in a receiving water monitoring station (RB) located 100 feet downstream of discharge from Saugus Water Reclamation Plant (see Figure 2). Three samples were collected by LACSD between July 2009 and January 2010.
Data Analysis and Justification for de-listing	Of the total 48 samples collected by the LACFCD at S29 from October 2002 through March 2010, there were three samples exceeded the chlorpyrifos criteria after the sales ban (Post-EPA Ban). The last chlorpyrifos exceedance at S29 was observed on January 14, 2006. Of the three samples were collected by the LACSD at station RB, there were zero exceedances. In summary, there were three exceedances out of 51 samples during the post-EPA ban. This shows that the EPA policy is very effective in eliminating chlorpyrifos from Santa Clara River Reach 6, and the waterbody has attained its water quality objectives. All supporting data is summarized in Table 5.
Conclusions and Recommendation	Santa Clara River Reach 6 is meeting section 4.1 of the State Listing Policy for chlorpyrifos and should be removed from the 303(d) list.

Table 5. Summary of Chlorpyrifos Data in Santa Clara River Reach 6

	Chlorpyrifos			
Pre-EPA Ban*	SWAMP	LACFCD	LACSD	Total
Number of Exceedance				
Number of Sample				
Average of Result (ug/L)				
Minimum of Result (ug/L)				
Maximum of Result (ug/L)				
Water Quality Objectives (ug/L)				
Start Date				
End Date				
Post-EPA Ban				
Number of Exceedance	10	3	0	13
Number of Sample	10	48	3	61
Average of Result (ug/L)	0.06	0.15	0.04	0.13
Minimum of Result (ug/L)	0.051	0.02	0.015	0.015
Maximum of Result (ug/L)	0.083	3.02	0.05	3.02
Water Quality Objectives (ug/L)	0.05	0.05	0.05	0.05
Start Date	10/31/2001	10/10/2002	07/06/2009	10/31/2001
End Date	03/03/2003	03/23/2010	01/08/2010	03/23/2010
Total Summary				
Total Number of Exceedance	10	3	0	13
Total Number of Sample	10	48	3	61
Total Average of Result (ug/L)	0.06	0.15	0.04	0.13
Total Minimum of Result (ug/L)	0.051	0.02	0.015	0.015
Total Maximum of Result (ug/L)	0.083	3.02	0.05	3.02
Water Quality Objectives (ug/L)	0.05	0.05	0.05	0.05
Total Start Date	10/31/2001	10/10/2002	07/06/2009	10/31/2001
Total End Date	03/03/2003	03/23/2010	01/08/2010	03/23/2010

EPA=Environmental Protection Agency

LACFCD=Los Angeles County Flood Control District

LACSD=Los Angeles County Sanitation Districts

SWAMP=Surface Water Ambient Monitoring Program

*Data was not collected before the EPA ban in 2001

6. Santa Clara River Reach 6 - Copper

Watershed	Santa Clara River Watershed, Los Angeles County
Waterbody Reach	Santa Clara River Reach 6 (see Figure 2 for the location of this particular reach). This waterbody reach is a soft bottom channel.
Pollutant	Copper
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 2008. The evidence used for the listing indicates that 2 out of 20 samples collected by Ventura County Flood Control District between October 2003 and October 2007 exceeded the California Toxics Rule's (CTR) acute and chronic criteria for copper to protect aquatic life in freshwater for dissolved copper. In actuality, however, these samples were collected by Los Angeles Flood Control District (LACFCD), and there were zero exceedances, which would not qualify section 3.1 of the Listing Policy. Another data used for the listing was 15 samples of total copper concentrations, which was compared to the CTR for dissolved copper, causing one exceedance out of 15 samples while compared to the total copper CTR, there are zero exceedances.
Applicable Water Quality Objectives	The CTR criterion for copper in freshwater is hardness dependent for each sample and varies based on the ambient hardness during sampling.
Changes in the Watershed since the First Listing	The pollutant was wrongly listed based on the insufficient evidence. Further, water quality improvement BMPs has been implemented as part of NPDES permits and additional data has been collected.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	LACFCD station (S29): LACFCD's Mass Emission Monitoring Station (S29) is located on Santa Clara River at the Old Road (see Figure 2). 6 samples collected between October 2002 to April 2003 at S29 were not used or mistakenly neglected in the analysis during the first listing. Additionally, 20 samples were collected between September 2007 and March 2010 at S29 in accordance with the Los Angeles County MS4 permit monitoring program. LACSD Stations (RA, RB): the Sanitation Districts of Los Angeles County (LACSD) conducted sampling at two receiving water monitoring stations: station RA located 300 feet upstream of discharge from Saugus Water Reclamation Plant and station RB located 100 feet downstream of discharge from Saugus Water Reclamation Plant (see Figure 2). 12 samples were collected between April 2007 and January 2010.
Data Analysis and Justification for de-listing	Of the total 48 samples collected by the LACFCD at S29 from October 2002 through March 2010, there were three exceedances out of 48 samples for dissolved copper. Of the total 27 samples collected by the LACSD at RA and RB stations between July 2004 and January 2010, there were zero exceedances for total copper. In summary, there were three exceedances out of 75 samples collected by LACFCD and LACSD from October 2002 through March 2010. Data is summarized in Table 6. Based on these multiple line of evidence, there is sufficient justification that this waterbody is meeting its water quality objectives.
Conclusions and Recommendation	Santa Clara River Reach 6 is meeting section 4.1 of the State Listing Policy for copper and should be removed from the 303(d) list.

Table 6. Summary of Copper Data in Santa Clara River Reach 6

		Copper	
		Dissolved (ug/L)	Total (ug/L)
LACFCD*			
New Data	Number of Exceedance	1	
	Number of Sample	6	
	Average of Result	5.39	
	Minimum of Result	2.55	
	Maximum of Result	8.39	
	Start Date	10/10/2002	
	End Date	10/28/2003	
Ref 2720	Number of Exceedance	2	
	Number of Sample	22	
	Average of Result	6.26	
	Minimum of Result	2.19	
	Maximum of Result	22.6	
	Start Date	10/31/2003	
	End Date	04/02/2007	
New Data	Number of Exceedance	0	
	Number of Sample	20	
	Average of Result	4.09	
	Minimum of Result	0.5	
	Maximum of Result	11.5	
	Start Date	09/21/2007	
	End Date	03/23/2010	
LACSD**			
Ref 2657	Number of Exceedance		0
	Number of Sample		15
	Average of Result		6.76
	Minimum of Result		0.8
	Maximum of Result		29
	Start Date		07/14/2004
	End Date		02/14/2007
New Data	Number of Exceedance		0
	Number of Sample		12
	Average of Result		7.43
	Minimum of Result		4.55
	Maximum of Result		14
	Start Date		04/11/2007
	End Date		01/05/2010
Total Summary			
Total Number of Exceedance		3	0
Total Number of Sample		48	27
Total Average of Result		5.25	7.06
Total Minimum of Result		0.5	0.8
Total Maximum of Result		22.6	29
Total Start Date		10/10/2002	07/14/2004
Total End Date		03/23/2010	01/05/2010

LACFCD=Los Angeles County Flood Control District; LACSD=Los Angeles County Sanitation Districts

*Dissolved fraction data is shown for its appropriateness although total fraction data is also available

**Only total fraction data is available at LACSD stations

7. Santa Clara River Reach 6 - Iron

Watershed	Santa Clara River Watershed, Los Angeles County
Waterbody Reach	Santa Clara River Reach 6 (see Figure 2). This waterbody reach is a soft bottom channel.
Pollutant	Iron
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 2008. The evidence used for the listing indicates that 2 out of 20 samples collected by Ventura County Flood Control District between October 2003 and February 2007 exceeded the U.S. Environmental Protection Agency (EPA) National Recommended Water Quality Criteria for Freshwater Aquatic Life Protection for dissolved iron. In actuality, however, these sampled were collected by Los Angeles Flood Control District (LACFCD), and there were 22 samples. Another data used for the listing was collected in total iron concentrations by the Sanitation Districts of Los Angeles County (LACSD), and there were two exceedances out of 15 samples (instead of referenced 10 samples in the listing).
Applicable Water Quality Objectives	EPA National Recommended Water Quality Criteria for Freshwater Aquatic Life Protection for dissolved iron is 1 mg/L, or 1000 ug/L
Changes in the Watershed since the First Listing	The pollutant was wrongly listed based on the insufficient evidence. Further, water quality improvement BMPs has been implemented as part of NPDES permits and additional data has been collected.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	LACFCD station (S29): LACFCD's Mass Emission Monitoring Station (S29) is located on Santa Clara River at the Old Road (see Figure 2). 5 samples collected between October 2002 to April 2003 at S29 were not used or mistakenly neglected in the analysis during the first listing. Additionally, 21 samples were collected between March 2007 and March 2010 at S29 in accordance with the Los Angeles County MS4 permit monitoring program. LACSD Stations (RA, RB): LACSD conducted sampling at two receiving water monitoring stations: station RA located 300 feet upstream of discharge from Saugus Water Reclamation Plant and station RB located 100 feet downstream of discharge from Saugus Water Reclamation Plant (see Figure 2). 18 samples were collected between April 2007 and March 2010.
Data Analysis and Justification for de-listing	Of the total 48 samples collected by the LACFCD at S29 from October 2002 to March 2010, there were two exceedances for dissolved iron. Of the total 33 samples collected by the LACSD at RA and RB stations, there were two exceedances for total iron. In summary, there were four exceedances out of 81 samples collected by LACFCD and LACSD from October 2002 through March 2010. All Data is summarized in Table 7. Based on these multiple line of evidence, there is sufficient justification that this waterbody is meeting its water quality objectives.
Conclusions and Recommendation	Santa Clara River Reach 6 is meeting section 4.1 of the State Listing Policy for iron and should be removed from the 303(d) list.

Table 7. Summary of Iron Data in Santa Clara River Reach 6

		Iron	
		Dissolved (ug/L)	Total (ug/L)
LACFCD*			
New Data	Number of Exceedance	0	
	Number of Sample	5	
	Average of Result	190.6	
	Minimum of Result	100	
	Maximum of Result	460	
	Start Date	10/10/2002	
	End Date	04/30/2003	
Ref 2720	Number of Exceedance	2	
	Number of Sample	22	
	Average of Result	454.82	
	Minimum of Result	50	
	Maximum of Result	3635	
	Start Date	10/28/2003	
	End Date	02/22/2007	
New Data	Number of Exceedance	0	
	Number of Sample	21	
	Average of Result	144.43	
	Minimum of Result	50	
	Maximum of Result	434	
	Start Date	04/02/2007	
	End Date	03/23/2010	
LACSD**			
Ref 2657	Number of Exceedance		2
	Number of Sample		15
	Average of Result		4483.80
	Minimum of Result		30
	Maximum of Result		42700
	Start Date		07/14/2004
	End Date		02/14/2007
New Data	Number of Exceedance		0
	Number of Sample		18
	Average of Result		120.94
	Minimum of Result		9
	Maximum of Result		1000
	Start Date		04/11/2007
	End Date		03/16/2010
Total Summary			
Total Number of Exceedance		2	2
Total Number of Sample		48	33
Total Average of Result		291.50	2104.06
Total Minimum of Result		50	9
Total Maximum of Result		3635	42700
Total Start Date		10/10/2002	07/14/2004
Total End Date		03/23/2010	03/16/2010

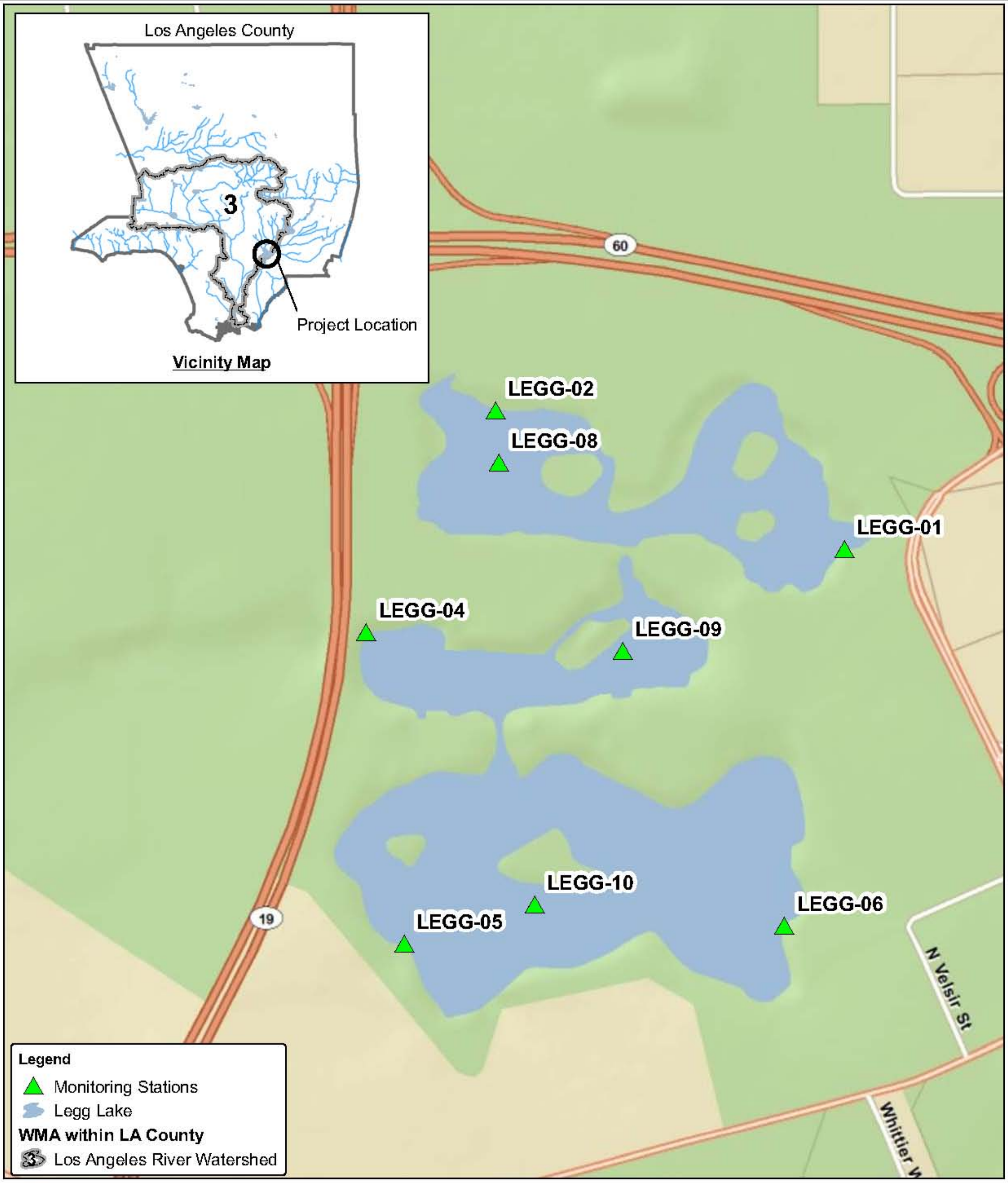
LACFCD=Los Angeles County Flood Control District; LACSD=Los Angeles County Sanitation Districts

*Dissolved fraction data is shown for its appropriateness although total fraction data is also available

**Only total fraction data is available at LACSD stations

8. Legg Lake - Ammonia

Watershed	San Gabriel River Watershed, Los Angeles County
Waterbody Reach	Legg Lake (see Figure 3). Legg Lakes consist of three interconnected lakes. Its watershed is approximately 1.8 square miles.
Pollutant	Ammonia
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB 1996).
Applicable Water Quality Objectives	As defined in the Basin Plan, ammonia criteria is a function of pH and temperature, and are expressed as 1-hr, 4-day, and 30-day averages.
Changes in the Watershed since the First Listing	There was not sufficient data that indicated ammonia impairment at the time of listing. Non-structural BMPs has been implemented and more data has been collected since then as part of the NPDES permits.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	The U.S. Environmental Protection Agency (EPA), the Regional Board and Los Angeles County Flood Control District (LACFCD) collected 41 ammonia samples between May 2007 and July 2009. There were eight sampling locations (LEGG-1, LEGG-2, LEGG-4, LEGG-5, LEGG-6, LEGG-8, LEGG-9, and LEGG-10) distributed throughout the lakes (see Figure 3).
Data Analysis and Justification for de-listing	Of the 41 samples collected between May 2007 and July 2009, there was only one exceedance for ammonia. Accordingly, during the development of the Los Angeles Lakes Total Maximum Daily Loads (TMDL), EPA concluded that Legg Lake meets ammonia water quality standards and recommended that it be removed from the 303(d) list. Supporting data is summarized in Table 8.
Conclusions and Recommendation	Legg Lake is meeting section 4.1 of the State Listing Policy for ammonia and should be removed from the 303(d) list. This concurs with EPA's findings and recommendations for Legg Lake.



Map Showing Legg Lake and Associated Monitoring Stations

Figure 3

0.1 0.05 0 0.1 Miles

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July 27, 2010

Table 8. Summary of Ammonia Data in Legg Lakes

	Ammonia (mg-N/L)
LACFCD	
Number of Exceedances	1
Number of Samples	28
Average Result	0.32
Minimum Result	0.01
Maximum Result	5.76
Start Date	05/18/2007
End Date	07/05/2007
Regional Board	
Number of Exceedances	0
Number of Samples	13
Average Result	0.04
Minimum Result	0.03
Maximum Result	0.07
Start Date	02/03/2009
End Date	07/18/2009
Total Summary	
Total Number of Exceedances	1
Total Number of Samples	41
Total Average Result	0.23
Total Minimum Result	0.01
Total Maximum Result	5.76
Total Start Date	05/18/2007
Total End Date	07/18/2009

LACFCD=Los Angeles County Flood Control District

9. Legg Lake - Copper

Watershed	San Gabriel River Watershed, Los Angeles County
Waterbody Reach	Legg Lake (see Figure 3). Legg Lakes consist of three interconnected lakes. Its watershed is approximately 1.8 square miles.
Pollutant	Copper
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB 1996).
Applicable Water Quality Objectives	The California Toxics Rule (CTR) criterion for copper in freshwater is hardness dependent for each sample and varies based on the ambient hardness during sampling.
Changes in the Watershed since the First Listing	There was not sufficient data that indicated copper impairment at the time of listing. Non-structural BMPs has been implemented and more data has been collected since then as part of the NPDES permits.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	The U.S. Environmental Protection Agency (EPA), the Regional Board and Los Angeles County Flood Control District (LACFCD) collected 33 copper samples between February 2009 and February 2010. There were eight sampling locations (LEGG-1, LEGG-2, LEGG-4, LEGG-5, LEGG-6, LEGG-8, LEGG-9, and LEGG-10) distributed throughout the lakes (see Figure 3).
Data Analysis and Justification for de-listing	Of the 33 samples collected between February 2009 and February 2010, there were no exceedances of copper. Accordingly, during the development of the Los Angeles Lakes Total Maximum Daily Loads (TMDL), EPA concluded that Legg Lake meets copper water quality standards (i.e., unimpaired) and recommended that it be removed from the 303(d) list. Supporting data is summarized in Table 9.
Conclusions and Recommendation	Legg Lake is meeting section 4.1 of the State Listing Policy for copper and should be removed from the 303(d) list. This concurs with EPA's findings and recommendations for Legg Lake.

Table 9. Summary of Copper Data in Legg Lakes

	Copper (µg/L)
EPA	
Number of Exceedances	0
Number of Samples	6
Average Result	1.34
Minimum Result	0.60
Maximum Result	2.30
Start Date	12/16/2009
End Date	12/16/2009
LACFCD	
Number of Exceedances	0
Number of Samples	18
Average Result	1.03
Minimum Result	0.40
Maximum Result	3.45
Start Date	12/08/2009
End Date	02/17/2010
Regional Board	
Number of Exceedances	0
Number of Samples	3
Average Result	1.18
Minimum Result	0.90
Maximum Result	1.55
Start Date	02/03/2009
End Date	02/03/2009
Regional Board/EPA	
Number of Exceedances	0
Number of Samples	6
Average Result	0.54
Minimum Result	0.50
Maximum Result	0.60
Start Date	07/14/2009
End Date	07/14/2009
Total Summary	
Total Number of Exceedances	0
Total Number of Samples	33
Total Average Result	1.01
Total Minimum Result	0.40
Total Maximum Result	3.45
Total Start Date	02/03/2009
Total End Date	02/17/2010

EPA=Environmental Protection Agency
LACFCD=Los Angeles County Flood Control District

10. Legg Lake - Lead

Watershed	San Gabriel River Watershed, Los Angeles County
Waterbody Reach	Legg Lake (see Figure 3). Legg Lakes consist of three interconnected lakes. Its watershed is approximately 1.8 square miles.
Pollutant	Lead
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB 1996).
Applicable Water Quality Objectives	The California Toxics Rule (CTR) criterion for lead in freshwater is hardness dependent for each sample and varies based on the ambient hardness during sampling.
Changes in the Watershed since the First Listing	There was not sufficient data that indicated lead impairment at the time of listing. Non-structural BMPs has been implemented and more data has been collected since then as part of the NPDES permits.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	The U.S. Environmental Protection Agency (EPA), the Regional Board and Los Angeles County Flood Control District (LACFCD) collected 33 lead samples between February 2009 and February 2010. There were eight sampling locations (LEGG-1, LEGG-2, LEGG-4, LEGG-5, LEGG-6, LEGG-8, LEGG-9, and LEGG-10) distributed throughout the lakes (see Figure 3).
Data Analysis and Justification for de-listing	Of the 33 samples collected between February 2009 and February 2010, there were no exceedances of lead. Accordingly, during the development of the Los Angeles Lakes Total Maximum Daily Loads (TMDL), EPA concluded that Legg Lake meets lead water quality standards (i.e., unimpaired) and recommended that it be removed from the 303(d) list. Supporting data is summarized in Table 10.
Conclusions and Recommendation	Legg Lake is meeting section 4.1 of the State Listing Policy for lead and should be removed from the 303(d) list. This concurs with EPA's findings and recommendations for Legg Lake.

Table 10. Summary of Lead Data in Legg Lakes

	Lead (µg/L)
EPA	
Number of Exceedances	0
Number of Samples	6
Average Result	0.15
Minimum Result	0.12
Maximum Result	0.18
Start Date	12/16/2009
End Date	12/16/2009
LACFCD	
Number of Exceedances	0
Number of Samples	18
Average Result	0.08
Minimum Result	0.05
Maximum Result	0.165
Start Date	12/08/2009
End Date	02/17/2010
Regional Board	
Number of Exceedances	0
Number of Samples	3
Average Result	0.15
Minimum Result	0.05
Maximum Result	0.21
Start Date	02/03/2009
End Date	02/03/2009
Regional Board/EPA	
Number of Exceedances	0
Number of Samples	6
Average Result	0.06
Minimum Result	0.05
Maximum Result	0.09
Start Date	07/14/2009
End Date	07/14/2009
Total Summary	
Total Number of Exceedances	0
Total Number of Samples	33
Total Average Result	0.10
Total Minimum Result	0.05
Total Maximum Result	0.21
Total Start Date	02/03/2009
Total End Date	02/17/2010

EPA=Environmental Protection Agency
LACFCD=Los Angeles County Flood Control District

11. Peck Road Park Lake - Lead

Watershed	Los Angeles River Watershed, Los Angeles County
Waterbody Reach	Peck Road Park Lake (see Figure 4). The Peck Road Park Lake is in the City of Arcadia.
Pollutant	Lead
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB 1996).
Applicable Water Quality Objectives	The California Toxics Rule (CTR) criterion for lead in freshwater is hardness dependent for each sample and varies based on the ambient hardness during sampling.
Changes in the Watershed since the First Listing	There was not sufficient data that indicated lead impairment at the time of listing. Non-structural BMPs has been implemented and more data has been collected since then as part of the NPDES permits.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	The U.S. Environmental Protection Agency (EPA), the Regional Board and Los Angeles County Flood Control District (LACFCD) collected 26 lead samples between December 2009 and February 2010. There were five sampling locations (PRPL-8, PRPL-9, PRPL-10, PRPL-11, and PRPL-11B) distributed throughout the lake (see Figure 4).
Data Analysis and Justification for de-listing	Of the 26 samples collected between December 2008 and February 2010, there were zero exceedances. Accordingly, during the development of the Los Angeles Lakes Total Maximum Daily Loads (TMDL), EPA concluded that Legg Lake meets lead water quality standards and recommended that it be removed from the 303(d) list. Supporting data is summarized in Table 11.
Conclusions and Recommendation	Peck Road Park Lake is meeting section 4.1 of the State Listing Policy for lead and should be removed from the 303(d) list. This finding and recommendation concurs with EPA's.

Map Showing Peck Road Park Lake and Associated Monitoring Stations

Figure 4

Miles
0.1 0.05 0 0.1

N

July 27, 2010

Table 11. Summary of Lead Data in Peck Road Park Lake

	Lead (µg/L)
Regional Board/EPA	
Number of Exceedances	0
Number of Samples	6
Average Result	0.16
Minimum Result	0.05
Maximum Result	0.33
Start Date	12/11/2008
End Date	08/05/2009
EPA/LACFCD	
Number of Exceedances	0
Number of Samples	4
Average Result	0.26
Minimum Result	0.05
Maximum Result	0.61
Start Date	11/16/2009
End Date	11/16/2009
LACFCD	
Number of Exceedances	0
Number of Samples	12
Average Result	0.29
Minimum Result	0.05
Maximum Result	1.05
Start Date	12/08/2009
End Date	02/17/2010
EPA	
Number of Exceedances	0
Number of Samples	4
Average Result	0.22
Minimum Result	0.05
Maximum Result	0.46
Start Date	12/14/2009
End Date	12/14/2009
Total Summary	
Total Number of Exceedances	0
Total Number of Samples	26
Total Average Result	0.24
Total Minimum Result	0.05
Total Maximum Result	1.05
Total Start Date	12/11/2008
Total End Date	02/17/2010

EPA=Environmental Protection Agency
LACFCD=Los Angeles County Flood Control District

12. Peck Road Park Lake - Organic Enrichment/Low Dissolved Oxygen

Watershed	Los Angeles River Watershed, Los Angeles County
Waterbody Reach	Peck Road Park Lake (see Figure 4). The Peck Road Park Lake is located in the City of Arcadia.
Pollutant	Organic Enrichment/Low Dissolved Oxygen (DO)
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB 1996).
Applicable Water Quality Objectives	Per the Basin Plan, the mean annual DO concentration target should be > 7 mg/L, and the single sample concentration should be $\geq$ 5 mg/L
Changes in the Watershed since the First Listing	DO results from the above assessment may have not been analyzed with the consideration of lake stratification. Subsequently, the DO impairment was listed based on improper data analysis. Recently more data was collected.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	The U.S. Environmental Protection Agency (EPA) and the Los Angeles Regional Board have collected DO samples in 2008 and 2009 at five stations (PRPL-8, PRPL-9, PRPL-10, PRPL-11, PRPL-11B) distributed throughout the lake (see Figure 4). The data was collected as part of the Los Angeles Area Lakes Total Maximum Daily Load (TMDL) development.
Data Analysis and Justification for de-listing	Per the 1994 UC Riverside's Urban Lakes Study (referred in the EPA's draft LA Area Lakes TMDLs), the DO concentrations at depths less than 5 meters were around 7 mg/L during the summer months. This study proves that the lake's DO levels are not in violation of the Basin Plan criteria in the epilimnion (surface water above the thermocline). Sampling by Regional Board in June 2008 shows that the DO in the lake is greater than 9 mg/L in the epilimnion (thermocline at 2 meters). Further, a sampling conducted by EPA and Regional Board in August 2009 shows that the DO in the epilimnion is greater than 8 mg/L. Based on evaluation of historical and recent data during the development of LA Area Lakes TMDL, EPA concluded that "DO levels in the epilimnion are typically greater than 7 mg/L and impairment due to low DO is not evident in either the historic or recent sampling events". Further, EPA concluded that though historical data may show lower DO levels in the deeper waters (which might be the reason for the initial listing), no exceedances have been observed relative to the target depths. Data is summarized in Table 12. In summary, DO results collected for the 1996 assessment did not incorporate the depth/stratification effects into the data analysis which led to wrongly listing the DO impairment for the lake. The recent investigation conducted by EPA concluded that the lake is attaining water quality objectives for DO.
Conclusions and Recommendation	Peck Road Park Lake is meeting section 4.1 of the State Listing Policy for DO and should be removed from the 303(d) list. This finding and recommendation concurs with EPA's.

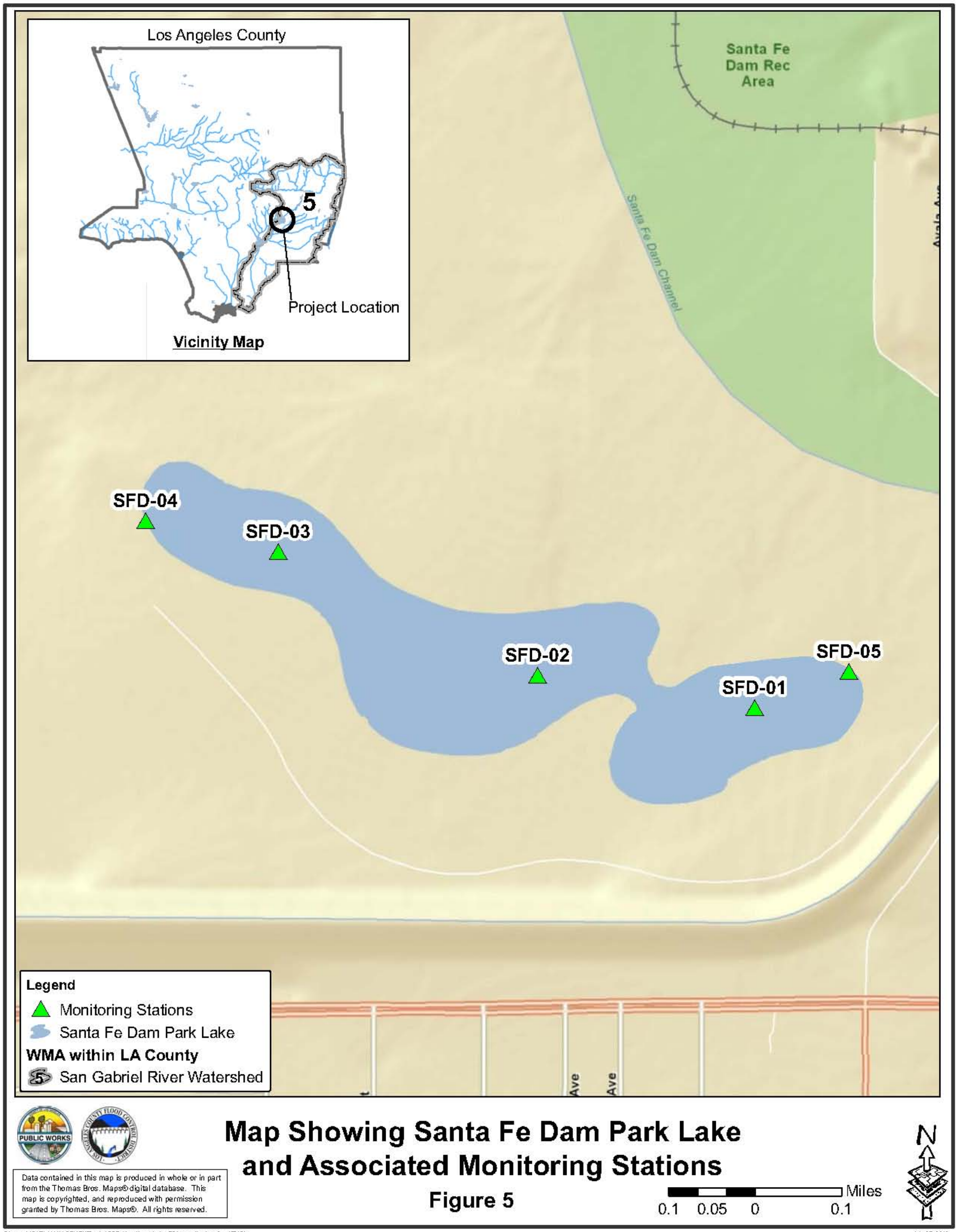
Table 12. Summary of Dissolved Oxygen Data in the Epilimnion in Peck Road Park Lake

	DO (mg/L)
Regional Board/EPA	
Number of Exceedances	0
Number of Samples	13
Average Result	17.54
Minimum Result	9.00
Maximum Result	20.10
Start Date	06/17/2008
End Date	06/17/2008
EPA	
Number of Exceedances	0
Number of Samples	26
Average Result	10.45
Minimum Result	8.84
Maximum Result	12.02
Start Date	08/05/2009
End Date	08/05/2009
Total Summary	
Total Number of Exceedances	0
Total Number of Samples	39
Total Average Result	12.82
Total Minimum Result	8.84
Total Maximum Result	20.10
Total Start Date	06/17/2008
Total End Date	08/05/2009

DO=Dissolved Oxygen
EPA=Environmental Protection Agency

13. Santa Fe Dam Park Lake - Copper

Watershed	San Gabriel River Watershed, Los Angeles County
Waterbody Reach	Santa Fe Dam Park Lake (see Figure 5). This waterbody is a man-made, fully enclosed lake, hydrologically disconnected from the surrounding stream system and has neither stormwater inputs nor outlets.
Pollutant	Copper
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB 1996).
Applicable Water Quality Objectives	The California Toxics Rule (CTR) criterion for copper in freshwater is hardness dependent for each sample and varies based on the ambient hardness during sampling.
Changes in the Watershed since the First Listing	There was not sufficient data that indicated copper impairment at the time of listing. More water quality data has been collected since the first leasting.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	The U.S. Environmental Protection Agency (EPA), Los Angeles Regional Board, and Los Angeles County Flood Control District (LACFCD) collected 28 samples between March 2009 and February 2010 as part of the Los Angeles Area Lakes Total Maximum Daily Load (TMDL) development. The samples were collected at five stations (SFD-1, SFD-2, SFD 3, SFD-4, and SFD-5) distributed throughout the lake (see Figure 5).
Data Analysis and Justification for de-listing	Of the total 28 samples collected between December 2009 and February 2010, there were zero exceedances. Accordingly, EPA concluded that Santa Fe Dam Park Lake meets the water quality objectives for copper and recommended its removal from the 303(d) List. Supporting data is summarized in Table 13.
Conclusions and Recommendation	Santa Fe Dam Park Lake is meeting section 4.1 of the State Listing Policy for Copper and should be removed from the 303(d) list. This concurs with EPA's findings and recommendation.



Map Showing Santa Fe Dam Park Lake and Associated Monitoring Stations

Figure 5

Table 13. Summary of Copper Data in Santa Fe Dam Park Lake

	Copper (μg/L)
EPA	
Number of Exceedances	0
Number of Samples	8
Average Result	0.81
Minimum Result	0.65
Maximum Result	1.00
Start Date	11/17/2009
End Date	12/14/2009
LACFCD	
Number of Exceedances	0
Number of Samples	12
Average Result	1.05
Minimum Result	0.60
Maximum Result	1.50
Start Date	12/08/2009
End Date	02/17/2010
Regional Board	
Number of Exceedances	0
Number of Samples	8
Average Result	1.58
Minimum Result	1.03
Maximum Result	1.90
Start Date	03/03/2009
End Date	08/03/2009
Total Summary	
Total Number of Exceedances	0
Total Number of Samples	28
Total Average Result	1.13
Total Minimum Result	0.60
Total Maximum Result	1.90
Total Start Date	03/03/2009
Total End Date	02/17/2010

EPA=Environmental Protection Agency
LACFCD=Los Angeles County Flood Control District

14. Santa Fe Dam Park Lake - Lead

Watershed	San Gabriel River Watershed, Los Angeles County
Waterbody Reach	Santa Fe Dam Park Lake (see Figure 5). This waterbody is a man-made, fully enclosed lake, hydrologically disconnected from the surrounding stream system and has neither stormwater inputs nor outlets.
Pollutant	Lead
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB 1996).
Applicable Water Quality Objectives	The California Toxics Rule (CTR) criterion for lead in freshwater is hardness dependent for each sample and varies based on the ambient hardness during sampling.
Changes in the Watershed since the First Listing	There was not sufficient data that indicated lead impairment at the time of listing. More water quality data has been conducted since the first listing.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	The U.S. Environmental Protection Agency (EPA), Los Angeles Regional Board, and Los Angeles County Flood Control District (LACFCD) collected 28 samples between March 2009 and February 2010 as part of the Los Angeles Area Lakes Total Maximum Daily Load (TMDL) development. The samples were collected at five stations (SFD-1, SFD-2, SFD 3, SFD-4, and SFD-5) distributed throughout the lake (see Figure 5).
Data Analysis and Justification for de-listing	Of the total 28 samples collected between December 2009 and February 2010, there were zero exceedances. Accordingly, EPA concluded that Santa Fe Dam Park Lake meets the water quality objectives for lead and recommended its removal from the 303(d) List. Supporting data is summarized in Table 14.
Conclusions and Recommendation	Santa Fe Dam Park Lake is meeting section 4.1 of the State Listing Policy for lead and should be removed from the 303(d) list. This concurs with EPA's findings and recommendation.

Table 14. Summary of Lead Data in Santa Fe Dam Park Lake

	Lead (µg/L)
EPA	
Number of Exceedances	0
Number of Samples	8
Average Result	0.05
Minimum Result	0.05
Maximum Result	0.05
Start Date	11/17/2009
End Date	12/14/2009
LACFCD	
Number of Exceedances	0
Number of Samples	12
Average Result	0.05
Minimum Result	0.05
Maximum Result	0.07
Start Date	12/08/2009
End Date	02/17/2010
Regional Board	
Number of Exceedances	0
Number of Samples	8
Average Result	0.06
Minimum Result	0.05
Maximum Result	0.10
Start Date	03/03/2009
End Date	08/03/2009
Total Summary	
Total Number of Exceedances	0
Total Number of Samples	28
Total Average Result	0.05
Total Minimum Result	0.05
Total Maximum Result	0.10
Total Start Date	03/03/2009
Total End Date	02/17/2010

EPA=Environmental Protection Agency
LACFCD=Los Angeles County Flood Control District

15. Santa Fe Dam Park Lake - pH

Watershed	San Gabriel River Watershed, Los Angeles County
Waterbody Reach	Santa Fe Dam Park Lake (see Figure 5). This waterbody is a man-made, fully nclosed lake, hydrologically disconnected from the surrounding stream system and has neither stormwater inputs nor outlets.
Pollutant	pH
Year First Listed and Evidences Used for the Listing	This waterbody-pollutant was placed on the 303(d) list in 1996 based on an assessment in the Regional Board's Water Quality Assessment and Documentation Report (LARWQCB 1996).
Applicable Water Quality Objectives	Basin Plan: the pH of inland surface waters shall not be depressed below 6.5 or raised above 8.5 (i.e., 6.5 < pH < 8.5)
Changes in the Watershed since the First Listing	More data has been collected, and recent evaluations of the data indicate that the elevated pH level in Santa Fe Dam Park Lake is most likely caused by the presence of naturally occurring anions in the lake.
Monitoring Stations and Additional Data Collected since the Last Data Solicitation	The U.S. Environmental Protection Agency (EPA), the Los Angeles Regional Board and the Los Angeles County Parks and Recreation conducted water quality monitoring between March 2009 and December 2009 as part of the Los Angeles Area Lakes Total Maximum Daily Load (TMDL) development. The samples were collected at five stations (SFD-1, SFD-2, SFD 3, SFD-4, and SFD-5) distributed throughout the lake (see Figure 5). In total, 75 pH samples were collected during this period.
Data Analysis and Justification for de-listing	During the 1996 water quality assessment, 95 pH samples were collected. pH ranged from 7.5 to 9.6 with an average value of 8.7. For the 75 samples collected in 2009, the pH ranged from 7.4 to 9.0 with an average of 8.3. Some of the samples have exceeded the target. This data is summarized in Table 15. The Santa Fe Dam Park Lake is an enclosed lake and the only discharges to the lake are groundwater and poteble water. The pH of both the groundwater and potable water feeding the lake was measured to be in the range of 7.5 - 7.7 and, thus, are not sources of high pH in the lake. After evaluating various water quality parameters associated with the lake during the development of the LA Area Lakes TMDLs, EPA concluded that "the elevated pH levels in the Santa Fe Dam Park Lake are likely due to natual conditions, ... the lake meets the pH water quality standard, ... and be removed from the 303(d) list." In summary, elevated pH in Santa Fe Dam Park Lake is not due to anthropogenic sources, and the lake is attaining the pH standard.
Conclusions and Recommendation	The Santa Fe Dam Park Lake meets pH water quality standards and should be removed from the 303(d) list. This concurs with the EPA findings and recommendations.

Table 15. Summary of pH and Other Data in Santa Fe Dam Park Lake

	pH
UC Riverside	
Number of Sample	37
Average of Result	8.75
Min of Result	8.0
Max of Result	9.6
Start Date	08/10/1992
End Date	06/21/1993
EPA	
Number of Sample	8
Average of Result	8.7
Min of Result	8.6
Max of Result	8.8
Start Date	03/03/2009
End Date	08/03/2009
LACDPR	
Number of Sample	21
Average of Result	7.6
Min of Result	7.39
Max of Result	7.96
Start Date	05/04/2009
End Date	05/04/2009
Regional Board	
Number of Sample	46
Average of Result	8.62
Min of Result	7.45
Max of Result	9.02
Start Date	08/03/2009
End Date	12/14/2009
Total Summary	
Total Number of Sample	112
Total Average of Result	8.48
Total Min of Result	7.39
Total Max of Result	9.6
Total Start Date	08/10/1992
Total End Date	12/14/2009

UC = University of California
EPA = Environmental Protection Agency
LACDPR=Los Angeles County Department of Park and Recreation

county of ventura

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March 30, 2017

Electronic Submission: losangeles@waterboards.ca.gov

California Regional Water Quality Control Board
Los Angeles Region
Attn: Jun Zhu
320 W 4th Street, Suite 200
Los Angeles, CA 90013

Subject: Comment Letter – Revisions to the Los Angeles Region 303(d) List

Dear Dr. Zhu:

The County of Ventura (County) appreciates the opportunity to provide comments on the proposed revisions to the Clean Water Act Section 303(d) list of impaired waterbodies in the Los Angeles Region [hereinafter referred to as 303(d) list] which was distributed for public review on February 8, 2017.

The County understands that the California Regional Water Quality Control Board - Los Angeles Region (Los Angeles Water Board) is proposing over 200 new waterbody segment-pollutant combination 303(d) listings. The development and implementation of Total Maximum Daily Loads (TMDLs) is a significant investment of resources and it is critical that the 303(d) list be based on sound science and methodologies. The County participates in the implementation of many TMDLs in the Calleguas Creek, Santa Clara River, and Ventura River Watersheds addressing a diverse set of pollutants.

The County and the other stakeholders implementing TMDLs in the Calleguas Creek Watershed (CCW TMDL Stakeholders), as well as the Ventura County Agricultural Irrigated Lands Group (VCAILG) will be submitting separate comment letters regarding the proposed listing changes in the Calleguas Creek Watershed and VCAILG-affected waterbody segments. The County supports comments from both CCW TMDL Stakeholders and VCAILG and requests that the Los Angeles Water Board address all identified errors and issues therein.

The County has a number of concerns regarding the draft 2016 Los Angeles Water Board's proposed revisions to the 303(d) list of impaired waterbodies and believes that it requires significant review and modification before adoption. The County requests that the issues identified in this letter be addressed and the proposed 303(d) list be released for another 60-day comment period prior to adoption. Several of the issues identified herein have resulted in the inability of the proposed 303(d) list to be fully vetted and reviewed.

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Requested modifications fall into three broad categories:

1. New Category 5 listings should not be listed due to incorrect thresholds applied to the beneficial use, incorrect sample locations, and incorrect interpretation of the data (e.g., mismatched units or lack of temporal representation).
2. Delistings requested previously by the County that have not been incorporated.
3. Errors in the listing information that make it difficult to fully evaluate the listings. Examples include inconsistencies between the Category 5 list (Appendix B) and the proposed updates to the 303(d) list (Appendix A), incorrect HUC/Calwater designations, incorrect beneficial uses listed for the applicable water quality objectives (WQOs), and inconsistent use of thresholds for interpreting narrative objectives.

The remaining sections of this letter provide a detailed summary of requested changes to the 303(d) list and the rationale for the requested actions. In summary, the County requests that all waterbody pollutant combinations in **Table 1** not be listed on the 303(d) list, nitrogen compounds in Santa Clara River Reach 3 be delisted, and the errors and inconsistencies identified in the CCW TMDL Stakeholders Letter be addressed.

I. REQUESTED MODIFICATIONS TO THE LISTING STATUS

Based on a review of the proposed Category 5 waterbody segment-pollutant combinations, the County has identified a number of waterbodies that should be either delisted based on available data or for which proposed new listings should not be listed based on errors in the data evaluation. The requested modifications are shown in **Table 1**, below, with a summary of the justifications for the requested changes. A detailed discussion of each of the justifications follows the table.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody Segment	Pollutant	Justification for Not Listing
Boulder Creek (Ventura County)	Chlordane	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. • J-flagged data incorrectly used in assessment (WARM).
	Nitrogen, Nitrate	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody Segment	Pollutant	Justification for Not Listing
Boulder Creek (Ventura County) - continued	Specific Conductivity	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
	Toxicity	• Data does not include proper temporal representation.
Ellsworth Barranca	DDE	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. • J-flagged data incorrectly used in assessment.
Javon Canyon	Benthic Community Effects	• Data does not include proper temporal representation. • Benthic Community Effects listing is based on flawed analyses.
	Selenium	• Data does not include proper temporal representation.
Los Sauces Creek	Selenium	• Data does not include proper temporal representation.
Madranio Canyon	Benthic Community Effects	• Data does not include proper temporal representation. • Benthic Community Effects listing is based on flawed analyses
	Copper	• Data does not include proper temporal representation.
	Selenium	• Data does not include proper temporal representation.
Medea Creek Reach 1 (Lake to Confl. with Lindero)	Benthic Community Effects	• Benthic Community Effects listing is based on flawed analyses. • Data does not include proper temporal representation.
Padre Juan Canyon	Benthic Community Effects	• Benthic Community Effects listing is based on flawed analyses. • Benthic Community Effects data do not support listing. • Data does not include proper temporal representation.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody Segment	Pollutant	Justification for Not Listing
Padre Juan Canyon	Selenium	• Data does not include proper temporal representation.
Port Hueneme Harbor (Back Basins)	Arsenic	• Data does not include proper temporal representation.
	Cadmium	• Data does not include proper temporal representation.
	Dieldrin	• Data does not include proper temporal representation.
	PAHs (Polycyclic Aromatic Hydrocarbons)	• Data does not include proper temporal representation.
Santa Clara River Estuary	pH	• No demonstration high pH is a result of waste discharge.
Santa Clara River Reach 1 (Estuary to Hwy 101 Bridge)	pH	• No demonstration high pH is a result of waste discharge.
Santa Clara River Reach 3 (Freeman Diversion to A Street)	Chlordane	• Data from agricultural drain rather than waterbody used as basis for listing decision.
	Chlorpyrifos	• Data from agricultural drain rather than waterbody used as basis for listing decision.
	Cyfluthrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
	Cypermethrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
	DDD	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody Segment	Pollutant	Justification for Not Listing
Santa Clara River Reach 3 (Freeman Diversion to A Street) - continued	DDE	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
	DDT	• Data from agricultural drain rather than waterbody used as basis for listing decision.
	Mercury	• Data and objectives have different units (ng/L vs. µg/L); data do not exceed objectives.
Tapo Canyon	DDD	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. • Includes LOE for toxicity to support the listing. This LOE should be removed since there is a separate LOE specifically for toxicity.
	DDE	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. • Includes LOE for toxicity to support the listing. This LOE should be removed since there is a separate LOE specifically for toxicity.
	Nitrogen, Nitrate	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
	Specific Conductivity	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Triunfo Canyon Creek Reach 1	Benthic Community Effects	• Benthic Community Effects listing is based on flawed analyses.
Ventura Harbor: Ventura Keys	Arsenic	• Data does not include proper temporal representation.
	Cadmium	• Data does not include proper temporal representation.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody Segment	Pollutant	Justification for Not Listing
Ventura Harbor: Ventura Keys - continued	Chlordane	• Data does not include proper temporal representation.
	DDT	• Data does not include proper temporal representation.
	Dieldrin	• Data does not include proper temporal representation.
	PCBs (Polychlorinated biphenyls)	• Data does not include proper temporal representation.
Ventura River Reach 1 and 2 (Estuary to Weldon Canyon)	Benthic Community Effects	• Benthic Community Effects listing is based on flawed analyses.
	Temperature, water	• Analysis does not demonstrate temperature is above natural temperature.
Ventura River Reach 3 (Weldon Canyon to Confl. w/ Coyote Cr)	Benthic Community Effects	• Benthic Community Effects listing is based on flawed analyses.
	Mercury	• Data and objectives have different units (ng/L vs. µg/L); data do not exceed objectives.
	Toxicity	• Toxicity data from prior to pesticide use restrictions used for listings. More recent data does not show toxicity.
Ventura River Reach 4 (Coyote Creek to Camino Cielo Rd)	Benthic Community Effects	• Benthic Community Effects listing is based on flawed analyses. • Data does not include proper temporal representation.
	Temperature, water	• Analysis does not demonstrate temperature is above natural temperature.
Wheeler Canyon/Todd Barranca	Specific Conductivity	• Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.

Listing data lacks proper temporal representation.
There are many instances where the data to support the listed pollutant lacks proper temporal representation. Section 6.1.5.3 of the State Water Resources Control Board (SWRCB) Listing Policy[1] states that:

> "*Samples should be representative of the critical timing that the pollutant is expected to impact the water body. Samples used in the assessment must be temporally independent. If the majority of samples were collected on a single day or during a single short-term natural event (e.g., a storm, flood, or wildfire), the data shall not be used as the primary data set supporting the listing decision.*"

Many of the pollutants listed in **Table 1** included data collected from a single sampling date. This violates the Listing Policy. For instance, all the newly proposed pollutants for the Ventura Harbor: Ventura Keys (i.e., arsenic, cadmium, chlordane, DDT, dieldrin, and PCBs) were collected on a single day – February 28, 2007. Because there is no temporal resolution provided for these pollutants they should not be listed.

> **Requested Action:**
> **Remove all listings shown in Table 1 that were based on a single sample collection date.**

1. Benthic Community Effects Listing are based on flawed analyses and should be removed.
The benthic community effects listings are based on a metric which has since been deemed arbitrary and inappropriate. The Index of Biotic Integrity (IBI) stream assessment was a commonly used metric to determine benthic community effects. The threshold used to distinguish an impaired reach was a value of 39 and below. However, this threshold value was arbitrarily assigned as a statistical cut-off value. The state has since endorsed the use of the California Stream Condition Index (CSCI), as stated in the Appendix G Fact Sheets, "*The CSCI is applicable statewide, accounts for a much wider range of natural variability, and provides equivalent scoring thresholds in all regions of the state. The CSCI will be used in the future for water quality assessment purposes statewide over the regional indices of biologic integrity (IBIs).* " Despite this, all of the newly listed benthic community effects in Table 1 utilize the IBI to assess the waterbodies. Therefore, the County is requesting that these flawed listings be removed until the waterbodies can be assessed with a more representative metric such as the CSCI.

In addition, a number of water segments are listed as an exceedance for benthic community effects citing a low CSCI score, however, the original data shows only IBI scores. The Water Board should clearly note whether a CSCI or IBI assessment was

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[1] State of California State Water Resources Control Board (SWRCB) Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. Amended February 3, 2015. [Referred to hereinafter as Listing Policy]

performed. For instance, the Fact Sheets show that Padre Juan Canyon has 2/2 samples which exceed for benthic community effects using a CSCI score of 0.35 and 0.52 which is below the 0.79 CSCI threshold. However, the raw data shows that an IBI was performed resulting in scores of 40 and 39, which would only represent one exceedance which would not support listing the water body. The Water Board should clearly state where the CSCI scores are that they are referring to. This issue applies to all new benthic community effects listings. More detailed information can be provided upon request.

In addition, many of the benthic community effects listings rely on a single day of sampling which does not provide proper temporal representation as discussed in the previous comment.

Requested Action:

- **Update the Appendix G Fact Sheets to clearly state that an IBI metric was used not the CSCI for all pollutants noted in Table 1.**
- **Remove all listings shown in Table 1 for benthic community effect that use the IBI listing.**

2. There is no demonstration that high pH is a result of waste discharge.

The waterbodies listed for high pH do not appropriately demonstrate that the high pH was a result of waste discharge as required in the Basin Plan. The Santa Clara River Estuary and Santa Clara River Reach 1 are both listed for high pH. As stated in the Fact Sheet and according to the Los Angeles Region Basin Plan[2] "*The pH of inland surface waters shall not be depressed below 6. 5 or raised above 8. 5* ***as a result of waste discharges***" [emphasis added]. However, it was not demonstrated for either of these waterbodies that the elevated pH levels were a result of waste discharge as opposed to natural causes. Therefore, the Los Angeles Water Board should either provide evidence that the elevated pH was a result of waste discharge and detail that in the Fact Sheets, or, if no such evidence exists, the Los Angeles Water Board should remove these proposed listings.

Requested Action:

Remove the pH listings for Santa Clara River Estuary and Santa Clara River Reach 1 as there is no data provided in the Fact Sheet that demonstrate that these high pH values are the result of waste discharge.

3. Remove any pollutant listing based on municipal drinking water objectives where the MUN beneficial use does not apply.

Numerous listings were made using WQOs for the protection of the municipal drinking for waterbodies that do not have applicable municipal drinking water beneficial uses. Many of the waterbodies listed are waterbodies for which no beneficial uses are designated or waterbodies designated for the municipal beneficial use with an asterisk (i.e., P*) in the Basin Plan. The asterisked MUN beneficial use should not be used to propose new 303(d)

[2] Water Quality Control Plan Los Angeles Region R4 Basin Plan.

listings. Fact Sheets for previous 303(d) listing cycles have clearly noted that the asterisked MUN beneficial uses should not be used for 303(d) listing purposes.

State Board Resolution No. 88-63 (Sources of Drinking Water) and Regional Board Resolution 89-03 (Incorporation of Sources of Drinking Water Policy into the Water Quality Control Plans (Basin Plans)), state that "All surface and ground waters of the State are considered to be suitable, or potentially suitable, for municipal or domestic waters supply and should be so designated by Regional Boards [with certain exceptions which must be adopted by the Regional Board]." The Regional Board adopted a Water Quality Control Plan for the Los Angeles Region (Basin Plan) on June 4, 1994, that included provisions to implement State Water Board Resolution 88-63. On May 26, 2000, the USEPA approved the revised Basin Plan except for the implementation plan for potential MUN-designated water bodies. On August 22, 2000, the City of Los Angeles, City of Burbank, City of Simi Valley, and the County Sanitation Districts of Los Angeles County challenged USEPA's water quality standards action in the U. S. District Court. On December 18, 2001, the court issued an order remanding the matter to USEPA to take further action on the 1994 Basin Plan consistent with the court's decision. On February 15, 2002, USEPA revised its decision and approved the 1994 Basin Plan in whole. In its February 15, 2002 letter, USEPA stated:

> *"EPA bases its approval on the court's finding that the Regional Board's identification of waters with an asterisk ("*") in conjunction with the implementation language at page 2-4 of the 1994 Basin Plan, was intended "to only conditionally designate and not finally designate as MUN those water bodies identified by an ('*') for the MUN use in Table 2-1 of the Basin Plan, without further action." Court Order at p. 4. Thus, the waters identified with an ("*") in Table 2-1 do not have MUN as a designated use until such time as the State undertakes additional study and modifies its Basin Plan. Because this conditional use designation has no legal effect, it does not constitute a new water quality standard subject to EPA review under section 303(c)(3) of the Clean Water Act ("CWA"). 33 U. S. C. § 1313(c)(3). "*[3]

In addition to the above decision, the Basin Plan states that until the additional study is undertaken and the Basin Plan is modified "no new effluent limitations will be placed in Waste Discharge Requirements as a result of these designations". The Regional Board has also determined that WQOs applicable to the MUN beneficial use will not be used to assess impairments under the 303(d) listing programs. For constituents that only have objectives that are applicable to the MUN beneficial use, the decision Fact Sheets for the 303(d) listing process state that there are no applicable WQOs in waterbodies designated with an asterisk ("*"). In the 2010 listing cycle, a number of 303(d) listings were actually removed based on this determination. Below is an example of the language from a listing

[3] Language adapted from the 2014 National Pollutant Discharge Elimination System permit findings for wastewater treatment plants in the Calleguas Creek Watershed.

decision for Los Angeles River Reach 1:

> *"The listing for aluminum in this water body was originally based on data assessed using the MCL for aluminum. Since MUN is a "potential" beneficial use, it is not appropriate to use the MCL to evaluate aluminum data from this reach. Thus, there is no aluminum objective for this reach and the original listing is faulty. "*

Based on this evidence, it is clear that for waterbodies with a MUN designation that includes an asterisk ("*"), WQOs specific to the MUN beneficial use are not applicable. As such, water quality data collected in these receiving waters should not be compared to WQOs applicable to the MUN beneficial use.

> **Requested Action:**
> **Revise all the new listings in the Fact Sheets to ensure none are based on municipal drinking water objectives when the MUN beneficial use does not apply.**

4. Agricultural Drain and MS4 outfall monitoring data incorrectly used as basis for listing decisions.

There are some instances where listing decisions are based on data from the Agricultural VCAILG Monitoring Program which include monitoring data from agricultural drains. Santa Clara River Reach 3 (Freeman Diversion to A Street) listings (i.e., chlordane, chlorpyrifos, cyfluthrin, cypermethrin, DDD, DDE, and DDT) were based on multiple lines of evidence, but were primarily listed based on exceedances at VCAILG sample site "S03D_Bards" which is an agricultural drain that drains to Santa Clara River Reach 3. This site was selected to be representative of agricultural discharges to Reach 3 and it is not representative of receiving water conditions. Therefore, any data collected from "S03D_Bard" and other agricultural drain sites cannot be used to list the downstream reach. All listings should be evaluated to ensure that the monitoring locations were in receiving waters rather than agricultural drains.

In some cases, other lines of evidence cite location "Santa Clara River at Freeman Diversion at 11th Street Drain (tributary to Santa Clara River) at sample location Santa Paula-1" ("Santa Paula-1"). This location is an MS4 outfall location that is designed to characterize urban discharges from City of Santa Paula and is not located in the Santa Clara River's receiving waters. As a result, the data from "Santa Paula-1" location should not be used for listing receiving waters. However, it should be noted that the data linked to the Fact Sheet did not include any data from "Santa Paula-1" so it is unclear what data were evaluated for these listings. Unless receiving water data contain exceedances, none of the constituents for Santa Clara River Reach 3 should be listed.

> **Requested Action:**
> **Remove all listings shown in Table 1 that were based on Agricultural and MS4 discharge monitoring data not representative of the listed waterbody and**

evaluate remaining listings to ensure no other listings are based on agricultural drain or MS4 outfall monitoring rather than receiving water monitoring.

5. Remove toxicity Lines of Evidence (LOE) from pollutant Fact Sheets when a LOE specifically for toxicity already exists.

Numerous pollutants listed for Tapo Canyon (chlordane, DDD, and DDE) include a toxicity LOE to support the pollutant listing, when a toxicity LOE already exists for the waterbody. These pollutant-specific toxicity LOEs include no scientific evidence that the specific pollutant was the cause of observed toxicity and so should be removed from the Fact Sheet.

Requested Action:
Remove the Lines of Evidence for toxicity for Tapo Canyon in Table because no evidence was provided that these constituents were the cause of toxicity.

6. Reassess mercury listings using correct objective and correct units.

The data used to assess mercury for Santa Clara River Reach 3 and Ventura River Reach 3 are in ng/L (nanograms per liter) and the objective is μg/L (micrograms per liter). The data need to be converted into the same units as the objective before an exceedance can be determined. The County expects that after this calculation has been performed the waterbodies will no longer meet the listing guidelines. Additionally, although a California Toxics Rule objective exists for mercury, an USEPA nationally recommended criteria was used for the assessment. An explanation for the use of a recommended criteria when an established WQO exists should be provided.

Requested Action:
Repeat the mercury analysis after correcting the unit error and clarify the objective used.

7. Correct the proposed temperature listings which are based on incorrect criteria.

The temperature listing for Ventura River Reaches 1 and 2 (Estuary to Weldon Canyon) and Ventura River Reach 4 (Coyote Creek to Camino Cielo Rd) uses an evaluation guideline of 13-21 degrees Celsius (°C) as the optimum growth range for rainbow trout. However, the applicable Basin Plan objective for waterbodies designated as COLD is "*For waters designated as COLD, water temperature shall not be altered by more than 5 degrees F above the natural temperature.*" The Fact Sheets provide no discussion of natural temperatures or a demonstration that the temperature was raised above natural temperatures in order to exceed the objectives.

Notwithstanding that a deviation from natural temperatures has not been demonstrated, the manner in which the evaluation guideline is applied is also inappropriate. Moyle 1976 is referenced as the source of the evaluation guideline. Moyle 1976 was revised and expanded by Moyle 2002[4]. Moyle 2002 states: "Rainbows are found where daytime temperatures range from nearly 0°C in winter to 26-27°C in summer", although extremely low (<4°C) or extremely high (>23°C) temperatures can be lethal if the fish have not previously been gradually acclimated. Even when acclimation temperatures are high, temperatures of 24-27°C are invariably lethal to trout, except for very short exposures (25, 26). " As such, while temperatures above 21°C may not be optimal according to Moyle 1976, Moyle 2002 clearly states that lethal temperatures are those greater than 23°C which indicates that the evaluation guideline of 21°C is more appropriately applied as a chronic guideline (necessitating the establishment of an averaging period) and 23°C is the more appropriate "not-to-exceed" guideline if used for listing.

Using the threshold of 23°C, no samples would exceed the threshold in Ventura River Reach 4 and only 2 samples would exceed the threshold in Ventura River Reaches 1 and 2. Neither of these number of exceedances would meet the listing thresholds.

Requested Action:
Remove the temperature listing for Ventura River Reach 1 and 2 as well as Ventura River Reach 4.

8. The toxicity listing for Ventura River Reach 3 (Weldon Canyon to Confl. w/ Coyote Cr) relies on outdated data

Based on a review of the available data, all the observed toxic samples occurred prior to 2009. Of the 8 exceedances, 3 occurred in 2000/2001 and the rest were in 2006, 2007 and 2008. In the 2006-2008 time period, toxicity was commonly observed due to chlorpyrifos and diazinon which were subsequently restricted. Toxicity in many watersheds has been significantly reduced as a result of these use modifications. The available data shows that no samples exceeded after 2008, indicating that those pesticides or another cause that is no longer present, were the cause of the toxicity. Because of the transient nature of toxicity and the potential that the causes of the toxicity are no longer present, exceedances from prior to the pesticide use bans should not be used as the basis for a listing. The more recent samples since the pesticide use restrictions should be used as a basis for evaluation.

Requested Action:
Do not list Ventura River Reach 3 for toxicity based on exceedances from outdated data.

9. Ensure no J-flagged data were used in the assessment.

The listing policy specifically prohibits the use of J-flagged ("estimated") data that fall below the quantitation limit but above the water quality standard. Section 6.1.5.5 of the Listing Policy specifically states:

[4] Moyle, Peter B. *Inland fishes of California: revised and expanded.* University of California Press, 2002.

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> "*When the sample value is less than the quantitation limit and the quantitation limit is greater than the water quality standard, objective, criterion, or evaluation guideline, the result shall not be used in the analysis. The quantitation limit includes the minimum level, practical quantitation level, or reporting limit.* "

All listings based on the use of J-flagged data should, therefore, be removed from the draft 303(d) list. Specific instances are included in **Table 1**, but this list is by no means inclusive; this significant error will have to be addressed by a thorough review of all listing data to confirm that no J-flagged data were used to justify listings.

For example, the line of evidence for the Boulder Creek chlordane listing erroneously states that three out of five samples exceed the objectives. . A review of the data shows that only 1 out of 5 samples exceed indicated criteria. The remaining 4 results were (1) not detected and (2) "estimated" (J-flagged) by the laboratory because results were below the reporting limit. Because only 1 sample showed an exceedance, this listing should be removed as it does not meet the binomial test limits set forth in the Listing Policy. A similar situation also occurred in the Ellsworth Barranca DDE listing.

Both the Boulder Creek and Ellsworth Barranca listings should be removed based on the incorrect assignment of the beneficial use MUN (as discussed earlier) in addition to the use of J-flagged data.

Requested Action:

- **Review all Fact Sheets and Lines of Evidence for the use of J-flagged data and remove any instances where J-flagged data were used.**
- **Delist chlordane for Boulder Creek and DDE for Ellsworth Barranca as well as any other pollutants that lack the minimum number of exceedances required to justify a listing.**

II. REQUESTED DELISTINGS

In June 2015, the County and the Cities of Fillmore and Santa Paula submitted a letter with data and analysis that supported delisting of the Santa Clara River for ammonia. In the November 10, 2016 letter, Los Angeles Water Board staff responded with plans to recommend delisting of ammonia from Santa Clara River Reach 3 in the 2016 California Integrated Report. The letter is provided as an attachment to this letter. The County requests that the delistings provided in the attached letter be included in the 303(d) list scheduled for adoption on May 4, 2017.

Requested Action:
Delist Ammonia in Santa Clara River Reach 3.

III. CORRECT OTHER ERRORS AND INCONSISTENCIES IN APPENDICES AND FACT SHEETS

Appendix A, Appendix B, Appendix C, and Appendix G have many inconsistencies which make the analysis of new additions very difficult since it is unclear which segment-pollutant combinations actually are new listings. As a result, there is concern that not all changes to the 303(d) list that may be considered for adoption were identified in the review. The lack of clarity comes from the following inconsistencies:

- Not all new listings are summarized in Appendix A.
- Appendix B was found to be missing some new and old listings based on a comparison to Appendix G. ß
- Appendix G has fact sheets for some listings noted as new in Appendix A or B identified as old fact sheets from the last listing cycle (e. g. benthic community listings in Javon Canyon). This indicates they were old listings, but a comparison to the 2010 303(d) list identified that they were in fact new listings and the fact sheets were incorrect or located in the wrong location.

Additionally, in many cases, data and Quality Assurance Project Plan references in the Fact Sheets are inconsistent with the data provided for review. Examples of these inconsistencies and errors were detailed in the CCW TMDL Stakeholders' comment letter. The County asks that the Los Angeles Water Board do a thorough review of all appendices to ensure that the Proposed 303(d) List is internally consistent, the correct data were used for the assessment, and the other errors identified in the CCW TMDL Stakeholders' comment letter are addressed.

Requested Action:
Correct the numerous errors and inconsistencies in the report and ensure that all the proposed 303(d) list appendices are internally consistent.

The County appreciates the opportunity to comment on the 303(d) list and looks forward to continuing to work with the Los Angeles Water Board to address these concerns.

Thank you for your time and consideration of these comments. If you have questions or need additional information, please contact Ewelina Mutkowska at (805) 645-1382 or Ewelina.Mutkowska@ventura.org.

Sincerely,

Glenn Shephard, PE
Director
Ventura County Watershed Protection District

Enclosure: *Request for Delisting of Ammonia in Santa Clara River Reach 3*, Los Angeles Regional Water Quality Control Board Letter dated November 10, 2016

Cc: Ashli Desai, Larry Walker Associates
Jeff Pratt, Ventura County Public Works Agency
Arne Anselm, Ventura County Watershed Protection District
Ewelina Mutkowska, Ventura County Watershed Protection District

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WATERSHED PROTECTION

Los Angeles Regional Water Quality Control Board

November 10, 2016

Mr. Peter Sheydai, Interim Director
Ventura County Watershed Protection District
800 South Victoria Avenue
Ventura, CA 93009

Ms. Roxanne Hughes, City Engineer
City of Fillmore
Central Park Plaza, 250 Central Ave.
Fillmore, CA 93015

Mr. Brian Yanez, Public Works Director
City of Santa Paula Public Works Department
866 E Main St.
Santa Paula, CA 93060

Subject: REQUEST FOR DELISTING OF AMMONIA IN SANTA CLARA RIVER REACH 3

Dear Mr. Clifford, Ms. Hughes and Mr. Yanez:

The Los Angeles Regional Water Quality Control Board (Los Angeles Water Board) is in receipt of the letter from the Ventura County Watershed Protection District and the cities of Fillmore and Santa Paula dated June 4, 2015, with the subject "Reassessment and Delisting of Ammonia and Absence of Impairment for Other Nitrogen Compounds in the Santa Clara River Reach 3" (June 2015 letter), which requested delisting of Santa Clara River Reach 3 for ammonia. In the June 2015 letter, water quality data spanning the period from April 2014 to December 2014 were provided in support of the request for delisting. The Los Angeles Water Board responded to the June 2015 letter by email on October 5, 2015.

The Los Angeles Water Board is in receipt of the subsequent letter from the Ventura County Watershed Protection District and the cities of Fillmore and Santa Paula dated February 16, 2016, with the subject "Request for Official Regional Board Response" (February 2016 letter). The February 2016 letter reiterated the request for delisting and expressed concerns about the scope and timing of the upcoming 2016 listing decisions and, more generally, the implications of delisting decisions relative to regulatory requirements.

The Los Angeles Water Board provides this response to the request for delisting in both the June 2015 and the February 2016 letters and to address the concerns expressed in the February 2016 letter.

Response to Request for Delisting of Santa Clara River Reach 3 for Ammonia

The Los Angeles Water Board assessed the existing Lines of Evidence (LOEs) in the California Water Quality Assessment Database (CalWQA) as well as the water quality data provided in the June 2015 letter for the Santa Clara River Reach 3 Ammonia listing. Our data analysis shows that:

1) There were a total of 40 water quality data points for Santa Clara River Reach 3 during the time period of April 14, 2004 to August 30, 2010, the deadline for submittal of data for the 2012 California Integrated Report. The water quality data came from three data sources:
    a. Thirty-seven water samples were collected at the mass emission station ME-SCR by the Ventura Countywide NPDES Stormwater Monitoring Program.
    b. Two water samples were collected at the monitoring site S03D_Bards along Bardsdale Avenue on January 24, 2008 and February 6, 2009 by the Ventura County Agricultural Irrigated Lands Group pursuant to Order No. R4-2005-0080.
    c. One water sample was collected approximately 4 miles upstream of South Mountain Road in Santa Paula by the Southern California Stormwater Monitoring Coalition on June 1, 2010.
2) Water sample collection by these three programs, a through c, above, occurred after March 18, 2004 when the Santa Clara River Nitrogen Compounds TMDL became effective, following which the Fillmore and Santa Paula POTWs ceased discharging to Santa Clara River Reach 3.
3) Per the *Water Quality Control Plan, Los Angeles Region* (1994) as amended (Basin Plan), Santa Clara River Reach 3 is subject to the Early Life Stage (ELS) Provision for determination of the ammonia as nitrogen objective. Therefore, a 30-day average concentration of ammonia was calculated as a function of pH and temperature (°C) as follows:

$$\text{30-day Average Concentration} = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}}\right) * MIN\left(2.85, 1.45 * 10^{0.028*(25-T)}\right)$$

4) Based on Board staff's calculation, one of the 40 ammonia data points (13.5 mg/L, sampled on December 18, 2007) was found to have exceeded the numeric target for the 30-day average concentration of total ammonia as nitrogen (1.7 mg/L) set by the Santa Clara River Nitrogen Compounds TMDL.
5) Pursuant to the State's Listing Policy Section 4.1, the maximum number of measured exceedances allowed to remove a water segment from the section 303(d) list for toxicants (including priority pollutants, metals, chlorine and ammonia) is three when the sample size is between 37 and 47.

Based on the findings described above, the requirement for delisting has been met. Therefore, Los Angeles Water Board staff plans to recommend delisting of ammonia from Santa Clara River Reach 3 in the 2016 California Integrated Report.

We anticipate that the listing and delisting decisions for the 2016 California Integrated Report will be issued for public comment in early 2017. All interested persons will be able to provide comments at that time. The 2016 California Integrated Report would then be presented for approval at a Los Angeles Water Board meeting and/or State Water Board meeting in spring 2017.

However, we note that even once Santa Clara Reach 3 is delisted for ammonia through the 303(d) listing process, the Santa Clara River Nitrogen Compounds TMDL, including the established numeric targets and allocations, are part of the Basin Plan and remain in effect. Please see our additional discussion, below, under "Response to Concerns Regarding Implications of 303(d) Listings."

Response to Concerns Regarding Scope and Schedule for 2016 Integrated Report and Review of Previous Listing Decisions

The State Water Resources Control Board (State Water Board) solicited water quality data for the current California Integrated Report, including the Clean Water Act Section 305(b) report and the 303(d) list, with an original deadline of June 30, 2010, which was extended to August 30, 2010. On November 12, 2013, the State Water Board announced in a memorandum distributed to interested persons via the Board's Lyris subscription list a new strategy for the development of the state's Integrated Report including establishing three groups of Regional Water Boards and submitting an Integrated Report for one group per listing cycle (i.e. every two years). On February 3, 2015, the State Water Board amended the Listing Policy to reflect this and other changes.

As determined by the State Water Board after consultation with the USEPA, the 2012 Integrated Report addressed data in Regions 1, 6 and 7. The 2014 Integrated Report is addressing Regions 3, 5 and 9, and the 2016 Integrated Report will address Regions 2, 4 (Los Angeles) and 8. Despite the new strategy, the State Water Board decided that it would not solicit additional data for the 2014 and 2016 Integrated Reports; instead data submitted for the 2012 Integrated Report (i.e., data prior to August 30, 2010) would be used to develop the 2014 and 2016 Integrated Reports.

In addition, while the Listing Policy changes allow for a Regional Water Board to make decisions "off-cycle" (i.e., not in their assigned Integrated Report year), the State Water Board's November 2013 memorandum states that the Integrated Report process will allow for the "off cycle" decisions "beginning with the next data solicitation."

We recognize that the 2013 procedural changes (as incorporated into the 2015 amendment to the State's Listing Policy) represent a change from previous procedures and from the procedure that was anticipated during the 2010 data solicitation. We also understand stakeholder concerns that the data now being assessed by the Los Angeles Water Board for the 2016 303(d) list will only include data through August 2010.

However, we anticipate that the changes to the procedures included in the 2015 amendment to the Listing Policy, including the grouping of the Regional Water Boards and the requirement that all data be submitted via the California Environmental Data Exchange Network (CEDEN), will significantly improve the efficiency of the listing and delisting process so that even with regional updates only once every six years, California will have a more comprehensive assessment and 303(d) list than in the past.

The Los Angeles Water Board is currently reviewing LOEs and preparing to make decision recommendations for the 2016 303(d) list. The usefulness and appropriateness of making off-cycle listing decisions for the 2018 303(d) list can be considered on a case-by-case basis after we have completed the 2016 303(d) list.

In addition, we note that while listings established prior to the 2004 Listing Policy were not re-assessed in their entirety for the 2006 or 2010 303(d) lists, many re-assessments were made in both lists, as shown in the table below.

Numbers of "do not delist" and "delist" decisions in 2006 and 2010 in the Los Angeles Region

Decisions that included re-assessment of previous listings	Listing Year	
	2006	2010
Do not delist	85	33
Delist	110	22

Response to Concerns Regarding the Implications of 303(d) Listings and TMDLs

The Los Angeles Water Board agrees that 303(d) listings have important implications in terms of requirements that they are addressed through TMDLs or other programs of water quality improvement and in discharge permits and other Board orders.

The Clean Water Act and implementing regulations require that impairments included on the 303(d) list are addressed in a timely manner through TMDLs or other programs of water quality improvement. TMDLs are a technical regulatory tool to identify the loading capacity of a waterbody for a particular pollutant and allocate that allowable load among the sources of the pollutant in order to restore a waterbody to a condition that fully supports beneficial uses. TMDLs may also be relied upon to ensure ongoing protection of beneficial uses. As such, a waterbody does not need to remain impaired to be addressed by a TMDL in the Basin Plan.

That notwithstanding, the Los Angeles Water Board can, if it deems appropriate based on the weight of the evidence regarding receiving water conditions throughout the waterbody and the water quality of point and nonpoint source discharges, remove targets and allocations from an existing TMDL during a reconsideration of the TMDL. The Los Angeles Water Board can reconsider a TMDL that it has established at any time. In the case of the Santa Clara River Nitrogen Compounds TMDL, the Los Angeles Water Board could, in the future, withdraw or reconsider and modify the TMDL if it deemed appropriate. However, these potential actions would require a more comprehensive analysis than a 303(d) listing decision. A reconsideration of the Santa Clara River Nitrogen Compounds TMDL would require a reassessment of all the available ammonia and nitrate+nitrite data in the Santa Clara River, its tributaries and estuary, and also an evaluation of the eutrophic status and other related effects of nitrogen compounds on the River. Finally, it would require an evaluation of the discharge quality of the various sources of nitrogen compounds to the River relative to their wasteload and load allocations in the TMDL.

In addition, the Los Angeles Water Board would consider the utility of keeping the TMDL, or a revised TMDL, in place in order to ensure the continued progress toward, or maintenance of, attainment of water quality standards in the River. The USEPA's draft March 22, 2012

"Considerations for Revising and Withdrawing TMDLs" recommends keeping effective TMDLs in place:

> EPA recommends that existing TMDLs not be withdrawn simply because the load and wasteload allocations have been implemented successfully and the water is now attaining water quality standards. EPA recommends that such "successful" TMDLs remain in place to ensure that WQS [water quality standards] continue to be maintained in the future, and that their water quality analyses and allocation targets continue to inform permit writers' and stakeholders' efforts to maintain those water quality standards.

Response to Concerns Regarding Implications of 303(d) Listings in Permitting

NPDES permits and other Board orders may include specific requirements for actions that will be taken when the permitted discharge is to a 303(d) listed waterbody. These specific requirements are identified during the development of the permit and are subject to stakeholder comment and Board consideration.

As you anticipate and we have been discussing with you through our MS4 program, the Los Angeles County MS4 Permit will be a model for the upcoming Ventura County MS4 Permit renewal, so municipalities in Ventura County will have the opportunity to develop watershed management programs (WMP) or enhanced watershed management programs (EWMP). WMPs and EWMPs under a renewed Ventura County MS4 Permit will also likely have to consider waterbody-pollutant combinations on the 303(d) list within their watershed when prioritizing water quality issues and identifying watershed control measures. It is appropriate to conduct a reasonable assurance analysis (RAA) for 303(d) listed constituents (directly or through a limiting pollutant analysis) or otherwise provide a justification for how these pollutants are adequately addressed in the WMP/EWMP.

Although the 303(d) list does not reflect more recent data at this time, it remains an informative list based on a comprehensive evaluation of data per the Listing Policy criteria, which was subject to public review and comment and final approval by USEPA. Further, as indicated above, based on the findings of our analysis of data from 2004-2010, Los Angeles Water Board staff plans to recommend delisting of ammonia from Santa Clara River Reach 3 in the 2016 California Integrated Report.

Whether a renewed Ventura County MS4 Permit includes provisions to adjust requirements due to improvements in waterbodies that remain on the 303(d) list during the term of the permit can be addressed during development of the permit. The Ventura County MS4 Permit may well allow for the same compliance demonstration pathways as those in the Los Angeles County MS4 Permit, including demonstrating that receiving water limitations are being met in the adjacent and downstream waterbody. Monitoring requirements can also be addressed during permit development.

In closing, we acknowledge and appreciate the hard work and the resources committed by the Ventura County Watershed Protection District and the cities of Fillmore and Santa Paula to improve the water quality in the Santa Clara River and look forward to even more water quality improvement in the future. If you have any questions, please contact Dr. L.B. Nye at (213) 576-6785 or Dr. Jun Zhu at (213) 576-6681.

Sincerely,

Samuel Unger

Samuel Unger, P.E.
Executive Officer

cc: Nick Martorano, State Water Resources Control Board
Ewelina Mutkowska, Ventura County Watershed Protection District
Caesar Hernandez, City of Santa Paula
David Burkhart, City of Fillmore
Ashli Desai, Larry Walker Associates

March 30, 2017

Electronic Submission: losangeles@waterboards.ca.gov

Los Angeles Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 W 4th Street, Suite 200
Los Angeles, CA 90013

Subject: Comment Letter – Revisions to the Los Angeles Region 303(d) List

Dear Dr. Zhu:

The County of Ventura (County) and the Cities of Fillmore and Santa Paula (Cities) appreciate the opportunity to provide comments on the proposed updates to the Clean Water Act Section 303(d) list of impaired waterbodies in the Los Angeles Region [hereinafter referred to as 303(d) list], which was distributed for public review on February 8, 2017. The proposed updates to the 303(d) list did not include delisting of the Santa Clara River Reach 3 for ammonia as recommended by the Los Angeles Regional Water Quality Control Board (Los Angeles Water Board) in the letter dated November 10, 2016 provided as an attachment to this letter.

In June 2015, the County and the Cities submitted a letter with data and analysis that supported delisting of the Santa Clara River Reach 3 for ammonia. In the November 10, 2016 letter, Los Angeles Water Board staff responded:

> "Based on the findings described above, the requirements for delisting has been met. Therefore, Los Angeles Water Board staff plans to recommend delisting of ammonia from Santa Clara River Reach 3 in the 2016 California Integrated Report." (page 2 of the attached November 10, 2016 letter).

The County and the Cities request that the ammonia delistings be included in the 303(d) list scheduled for adoption on May 4, 2017.

Requested Action: Delist Ammonia in Santa Clara River Reach 3.

The County and the Cities are committed to being stewards to their local waterbodies, and have expended substantial time and resources to comply with these requirements. We are proud of the water quality improvements that are clearly reflected in the data that was submitted to the Los Angeles Water Board staff. The County and the Cities have a long history of working with the Los Angeles Water Board staff to improve water quality in the Ventura County region and believe that it has contributed to the success that has been achieved in improving water quality. We are hoping to continue this collaboration to celebrate the successes in water quality that have occurred in Ventura County through waterbody delistings.

We appreciate your further consideration of this matter. If you have any questions or need additional information, please contact Ewelina Mutkowska with Ventura County Public Works Agency, at (805) 645-1382 or Ewelina.Mutkowska@ventura.org.

Sincerely,

Jeff Pratt,
Director
Ventura County
Public Works Agency

Roxanne Hughes,
City Engineer
City of Fillmore

John Ilasin,
Interim Public Works
Director
City of Santa Paula

EAM/cs/K:\Programs\CountyStormwaterProgram\040508_TMDLs\Santa Clara\Nutrient\2015 Delisting\2017-03_2016 Integrated Rpt

Enclosure: "Request for Delisting of Ammonia in Santa Clara River Reach 3", Los Angeles Regional Water Quality Control Board Letter dated November 10, 2016

Cc: Samuel Unger, Los Angeles Regional Water Quality Control Board
Nick Martorano, State Water Resources Control Board
Glenn Shephard, Ventura County Watershed Protection District
Arne Anselm, Ventura County Watershed Protection District
Ewelina Mutkowska, Ventura County Public Works Agency
Caesar Hernandez, City of Santa Paula
David Burkhart, City of Fillmore
Ashli Desai, Larry Walker Associates

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Matthew Rodriquez
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Los Angeles Regional Water Quality Control Board

November 10, 2016

Mr. Peter Sheydai, Interim Director
Ventura County Watershed Protection District
800 South Victoria Avenue
Ventura, CA 93009

Ms. Roxanne Hughes, City Engineer
City of Fillmore
Central Park Plaza, 250 Central Ave.
Fillmore, CA 93015

Mr. Brian Yanez, Public Works Director
City of Santa Paula Public Works Department
866 E Main St.
Santa Paula, CA 93060

Subject: REQUEST FOR DELISTING OF AMMONIA IN SANTA CLARA RIVER REACH 3

Dear Mr. Clifford, Ms. Hughes and Mr. Yanez:

The Los Angeles Regional Water Quality Control Board (Los Angeles Water Board) is in receipt of the letter from the Ventura County Watershed Protection District and the cities of Fillmore and Santa Paula dated June 4, 2015, with the subject "Reassessment and Delisting of Ammonia and Absence of Impairment for Other Nitrogen Compounds in the Santa Clara River Reach 3" (June 2015 letter), which requested delisting of Santa Clara River Reach 3 for ammonia. In the June 2015 letter, water quality data spanning the period from April 2014 to December 2014 were provided in support of the request for delisting. The Los Angeles Water Board responded to the June 2015 letter by email on October 5, 2015.

The Los Angeles Water Board is in receipt of the subsequent letter from the Ventura County Watershed Protection District and the cities of Fillmore and Santa Paula dated February 16, 2016, with the subject "Request for Official Regional Board Response" (February 2016 letter). The February 2016 letter reiterated the request for delisting and expressed concerns about the scope and timing of the upcoming 2016 listing decisions and, more generally, the implications of delisting decisions relative to regulatory requirements.

The Los Angeles Water Board provides this response to the request for delisting in both the June 2015 and the February 2016 letters and to address the concerns expressed in the February 2016 letter.

Response to Request for Delisting of Santa Clara River Reach 3 for Ammonia

The Los Angeles Water Board assessed the existing Lines of Evidence (LOEs) in the California Water Quality Assessment Database (CalWQA) as well as the water quality data provided in the June 2015 letter for the Santa Clara River Reach 3 Ammonia listing. Our data analysis shows that:

1) There were a total of 40 water quality data points for Santa Clara River Reach 3 during the time period of April 14, 2004 to August 30, 2010, the deadline for submittal of data for the 2012 California Integrated Report. The water quality data came from three data sources:
   a. Thirty-seven water samples were collected at the mass emission station ME-SCR by the Ventura Countywide NPDES Stormwater Monitoring Program.
   b. Two water samples were collected at the monitoring site S03D_Bards along Bardsdale Avenue on January 24, 2008 and February 6, 2009 by the Ventura County Agricultural Irrigated Lands Group pursuant to Order No. R4-2005-0080.
   c. One water sample was collected approximately 4 miles upstream of South Mountain Road in Santa Paula by the Southern California Stormwater Monitoring Coalition on June 1, 2010.
2) Water sample collection by these three programs, a through c, above, occurred after March 18, 2004 when the Santa Clara River Nitrogen Compounds TMDL became effective, following which the Fillmore and Santa Paula POTWs ceased discharging to Santa Clara River Reach 3.
3) Per the *Water Quality Control Plan, Los Angeles Region* (1994) as amended (Basin Plan), Santa Clara River Reach 3 is subject to the Early Life Stage (ELS) Provision for determination of the ammonia as nitrogen objective. Therefore, a 30-day average concentration of ammonia was calculated as a function of pH and temperature (°C) as follows:

$$\text{30-day Average Concentration} = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}}\right) * MIN\left(2.85, 1.45 * 10^{0.028*(25-T)}\right)$$

4) Based on Board staff's calculation, one of the 40 ammonia data points (13.5 mg/L, sampled on December 18, 2007) was found to have exceeded the numeric target for the 30-day average concentration of total ammonia as nitrogen (1.7 mg/L) set by the Santa Clara River Nitrogen Compounds TMDL.
5) Pursuant to the State's Listing Policy Section 4.1, the maximum number of measured exceedances allowed to remove a water segment from the section 303(d) list for toxicants (including priority pollutants, metals, chlorine and ammonia) is three when the sample size is between 37 and 47.

Based on the findings described above, the requirement for delisting has been met. Therefore, Los Angeles Water Board staff plans to recommend delisting of ammonia from Santa Clara River Reach 3 in the 2016 California Integrated Report.

We anticipate that the listing and delisting decisions for the 2016 California Integrated Report will be issued for public comment in early 2017. All interested persons will be able to provide comments at that time. The 2016 California Integrated Report would then be presented for approval at a Los Angeles Water Board meeting and/or State Water Board meeting in spring 2017.

However, we note that even once Santa Clara Reach 3 is delisted for ammonia through the 303(d) listing process, the Santa Clara River Nitrogen Compounds TMDL, including the established numeric targets and allocations, are part of the Basin Plan and remain in effect. Please see our additional discussion, below, under "Response to Concerns Regarding Implications of 303(d) Listings."

Response to Concerns Regarding Scope and Schedule for 2016 Integrated Report and Review of Previous Listing Decisions

The State Water Resources Control Board (State Water Board) solicited water quality data for the current California Integrated Report, including the Clean Water Act Section 305(b) report and the 303(d) list, with an original deadline of June 30, 2010, which was extended to August 30, 2010. On November 12, 2013, the State Water Board announced in a memorandum distributed to interested persons via the Board's Lyris subscription list a new strategy for the development of the state's Integrated Report including establishing three groups of Regional Water Boards and submitting an Integrated Report for one group per listing cycle (i.e. every two years). On February 3, 2015, the State Water Board amended the Listing Policy to reflect this and other changes.

As determined by the State Water Board after consultation with the USEPA, the 2012 Integrated Report addressed data in Regions 1, 6 and 7. The 2014 Integrated Report is addressing Regions 3, 5 and 9, and the 2016 Integrated Report will address Regions 2, 4 (Los Angeles) and 8. Despite the new strategy, the State Water Board decided that it would not solicit additional data for the 2014 and 2016 Integrated Reports; instead data submitted for the 2012 Integrated Report (i.e., data prior to August 30, 2010) would be used to develop the 2014 and 2016 Integrated Reports.

In addition, while the Listing Policy changes allow for a Regional Water Board to make decisions "off-cycle" (i.e., not in their assigned Integrated Report year), the State Water Board's November 2013 memorandum states that the Integrated Report process will allow for the "off cycle" decisions "beginning with the next data solicitation."

We recognize that the 2013 procedural changes (as incorporated into the 2015 amendment to the State's Listing Policy) represent a change from previous procedures and from the procedure that was anticipated during the 2010 data solicitation. We also understand stakeholder concerns that the data now being assessed by the Los Angeles Water Board for the 2016 303(d) list will only include data through August 2010.

However, we anticipate that the changes to the procedures included in the 2015 amendment to the Listing Policy, including the grouping of the Regional Water Boards and the requirement that all data be submitted via the California Environmental Data Exchange Network (CEDEN), will significantly improve the efficiency of the listing and delisting process so that even with regional updates only once every six years, California will have a more comprehensive assessment and 303(d) list than in the past.

The Los Angeles Water Board is currently reviewing LOEs and preparing to make decision recommendations for the 2016 303(d) list. The usefulness and appropriateness of making off-cycle listing decisions for the 2018 303(d) list can be considered on a case-by-case basis after we have completed the 2016 303(d) list.

In addition, we note that while listings established prior to the 2004 Listing Policy were not re-assessed in their entirety for the 2006 or 2010 303(d) lists, many re-assessments were made in both lists, as shown in the table below.

Numbers of "do not delist" and "delist" decisions in 2006 and 2010 in the Los Angeles Region

Decisions that included re-assessment of previous listings	Listing Year	
	2006	2010
Do not delist	85	33
Delist	110	22

Response to Concerns Regarding the Implications of 303(d) Listings and TMDLs

The Los Angeles Water Board agrees that 303(d) listings have important implications in terms of requirements that they are addressed through TMDLs or other programs of water quality improvement and in discharge permits and other Board orders.

The Clean Water Act and implementing regulations require that impairments included on the 303(d) list are addressed in a timely manner through TMDLs or other programs of water quality improvement. TMDLs are a technical regulatory tool to identify the loading capacity of a waterbody for a particular pollutant and allocate that allowable load among the sources of the pollutant in order to restore a waterbody to a condition that fully supports beneficial uses. TMDLs may also be relied upon to ensure ongoing protection of beneficial uses. As such, a waterbody does not need to remain impaired to be addressed by a TMDL in the Basin Plan.

That notwithstanding, the Los Angeles Water Board can, if it deems appropriate based on the weight of the evidence regarding receiving water conditions throughout the waterbody and the water quality of point and nonpoint source discharges, remove targets and allocations from an existing TMDL during a reconsideration of the TMDL. The Los Angeles Water Board can reconsider a TMDL that it has established at any time. In the case of the Santa Clara River Nitrogen Compounds TMDL, the Los Angeles Water Board could, in the future, withdraw or reconsider and modify the TMDL if it deemed appropriate. However, these potential actions would require a more comprehensive analysis than a 303(d) listing decision. A reconsideration of the Santa Clara River Nitrogen Compounds TMDL would require a reassessment of all the available ammonia and nitrate+nitrite data in the Santa Clara River, its tributaries and estuary, and also an evaluation of the eutrophic status and other related effects of nitrogen compounds on the River. Finally, it would require an evaluation of the discharge quality of the various sources of nitrogen compounds to the River relative to their wasteload and load allocations in the TMDL.

In addition, the Los Angeles Water Board would consider the utility of keeping the TMDL, or a revised TMDL, in place in order to ensure the continued progress toward, or maintenance of, attainment of water quality standards in the River. The USEPA's draft March 22, 2012

"Considerations for Revising and Withdrawing TMDLs" recommends keeping effective TMDLs in place:

> EPA recommends that existing TMDLs not be withdrawn simply because the load and wasteload allocations have been implemented successfully and the water is now attaining water quality standards. EPA recommends that such "successful" TMDLs remain in place to ensure that WQS [water quality standards] continue to be maintained in the future, and that their water quality analyses and allocation targets continue to inform permit writers' and stakeholders' efforts to maintain those water quality standards.

Response to Concerns Regarding Implications of 303(d) Listings in Permitting

NPDES permits and other Board orders may include specific requirements for actions that will be taken when the permitted discharge is to a 303(d) listed waterbody. These specific requirements are identified during the development of the permit and are subject to stakeholder comment and Board consideration.

As you anticipate and we have been discussing with you through our MS4 program, the Los Angeles County MS4 Permit will be a model for the upcoming Ventura County MS4 Permit renewal, so municipalities in Ventura County will have the opportunity to develop watershed management programs (WMP) or enhanced watershed management programs (EWMP). WMPs and EWMPs under a renewed Ventura County MS4 Permit will also likely have to consider waterbody-pollutant combinations on the 303(d) list within their watershed when prioritizing water quality issues and identifying watershed control measures. It is appropriate to conduct a reasonable assurance analysis (RAA) for 303(d) listed constituents (directly or through a limiting pollutant analysis) or otherwise provide a justification for how these pollutants are adequately addressed in the WMP/EWMP.

Although the 303(d) list does not reflect more recent data at this time, it remains an informative list based on a comprehensive evaluation of data per the Listing Policy criteria, which was subject to public review and comment and final approval by USEPA. Further, as indicated above, based on the findings of our analysis of data from 2004-2010, Los Angeles Water Board staff plans to recommend delisting of ammonia from Santa Clara River Reach 3 in the 2016 California Integrated Report.

Whether a renewed Ventura County MS4 Permit includes provisions to adjust requirements due to improvements in waterbodies that remain on the 303(d) list during the term of the permit can be addressed during development of the permit. The Ventura County MS4 Permit may well allow for the same compliance demonstration pathways as those in the Los Angeles County MS4 Permit, including demonstrating that receiving water limitations are being met in the adjacent and downstream waterbody. Monitoring requirements can also be addressed during permit development.

In closing, we acknowledge and appreciate the hard work and the resources committed by the Ventura County Watershed Protection District and the cities of Fillmore and Santa Paula to improve the water quality in the Santa Clara River and look forward to even more water quality improvement in the future. If you have any questions, please contact Dr. L.B. Nye at (213) 576-6785 or Dr. Jun Zhu at (213) 576-6681.

Sincerely,

Samuel Unger, P.E.
Executive Officer

cc: Nick Martorano, State Water Resources Control Board
Ewelina Mutkowska, Ventura County Watershed Protection District
Caesar Hernandez, City of Santa Paula
David Burkhart, City of Fillmore
Ashli Desai, Larry Walker Associates

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

March 30, 2017

Mr. Samuel Unger
Executive Officer
Los Angeles Regional Water Quality Control Board
320 West 4th Street, Suite 200
Los Angeles, CA 90013

RE: Comments on the 2016 Los Angeles Region Clean Water Act Section 303(d) List of Impaired Waters

Dear Mr. Unger:

The CA Department of Water Resources (DWR) appreciates the opportunity to comment on the proposed updates to the 303(d) list. The updates to the 303(d) list propose to add the following pollutants to the following State Water Project (SWP) affiliated locations:

- Dieldrin, chlordane, DDT, and polychlorinated biphenyls (PCB) to Pyramid Lake
- PCBs to Castaic Lake and Castaic Lagoon, and
- Dieldrin and PCBs to Elderberry Forebay.

DWR has the following comments:

1) The proposed pollutant listings lack a clear rationale that supports the recommended listings. A clear rationale, such as recommended food (i.e. fish) exposure levels (Food and Drug Administration for example), Fish Contaminant Goal (FCG), or Advisory Tissue Levels (ATL) for each pollutant should be provided so a clear comparison can be made. Some of the levels for these contaminants are above the FCG, they have not reached the ATL, and in fact, the report labels these contaminants as very low, as compared to the other higher priority contaminants. Absent such comparison, it is difficult to assess the appropriateness for such listings.
2) The PCB data in Table 11 (Summary Report) for Elderberry Forebay does not seem to match that of the proposed listing status. Elderberry Forebay is absent from this Table.
3) Insufficient details are provided for dieldrin, chlordane and DDT. A more comprehensive effort that specifically focuses on these contaminants should be conducted before they are proposed for Pyramid Lake additions to the 303(d) list.
4) Further analysis, including statistical analysis, should be conducted to support this proposed listing. Given the proposed listing recommendations are based on sample analytical data, a statistical analysis to show that sufficient sample size has been obtained for each lake should be provided. Additional considerations for analysis should also include:

- Increasing sampling locations. Were the samples obtained truly representative of the entirety of the lakes, especially those that are the subject of this letter?
- Do the composite samples truly represent averages of the fish caught, or are they additive? Can composites identify anomalies? Can a lake-wide composite be skewed, as a result of one very high data point?
- One-time study involving one year seems insufficient. Studies with longer duration are more appropriate to accurately determine the pollutant levels.

If you have any questions, please contact Leah McNearney, Chief, Water Quality Section at (916) 653-5688.

Sincerely,

Anthony Chu, Chief
Environmental Assessment Branch
Division of Operations and Maintenance
California Department of Water Resources

cc:

Dr. L.B. Nye
Los Angeles Regional Water Quality Control Board
LB.Nye@waterboards.ca.gov

Dr. Jun Zhu
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March 30, 2017

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

VIA ELECTRONIC MAIL: losangeles@waterboards.ca.gov

Re: Comment Letter - Revisions to the Los Angeles Region 303(d) List

Dear Chair Ruh and Board Members:

On behalf of Earth Law Center (ELC), which works for waterways' rights to flow, we welcome the opportunity to submit these comments in support of inclusion of hydrologically-impaired (*i.e*., flow-impaired) waterways in the region's Integrated Report. Such waterways or waterway segments include but are not limited to: the Ventura River (Reaches 3 and 4) and the Santa Clara River.

The San Diego Regional Water Quality Control Board (SD RWQCB) recently approved identification of 30 hydrologically impaired waterway segments in Category 4C of their Integrated Report.[1] We urge the Los Angeles RWQCB to follow the lead of the SD RWQCB, as well as U.S. EPA and numerous other states (including California itself), in similarly identifying hydrologically impaired waters in its Integrated Report. We offer below our support for this request.

1. Full Compliance with Clean Water Act Sections 305(b) and 303(d) Requires Identification of All Hydrologically Impaired Waterways

a. *CWA Section 303(d)*

Clean Water Act (CWA) Section 303(d)(1)(A) requires California to "identify those waters within its boundaries for which the effluent limitations … are not stringent enough to implement any water quality standard applicable to such waters." This must be a robust listing, with sufficient details about the waterways (including flow) to allow the state to "establish a priority ranking" for the waterways, also required by Section 303(d)(1)(A). In other words, California's 303(d) list must provide a comprehensive list of all impairments. The state's Listing Policy provides some mixed

[1] *See* attached ELC's August 2016 comments on the SD RWQCB hydrologic impairment listings.
[2] SWRCB, "Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List," p. 3; at: http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2015/020315_8_amendment_clean_version.pdf (Listing Policy).
[3] *Id*. at p. 18 (emphasis added).

direction, stating on the one hand that 303(d) list only covers impairments by "pollutants" (rather than also by "pollution," such as flow),[2] but on the other hand stating that Regional Water Board Fact Sheets supporting Section 303(d) listings "shall contain . . . Pollutant *or type of pollution* that appears to be responsible for standards exceedance."[3] The latter path is the appropriate course.

No objection, further, can be made to including flow-impaired waterways on the Section 303(d) list on the basis that the state is not required to prepare TMDLs to address "pollution." First, Section 303(d)(1)(A) makes no mention of limiting the 303(d) list to those waterways requiring Total Maximum Daily Loads (TMDLs). In fact, no mention of TMDLs is made until Section 303(d)(1)(C), which sets requirements on how to manage impaired waterways. Moreover, the state itself does not take this position for waterways impaired by pollutants. Instead, the state lists in Category 5 (what it deems its Section 303(d) list) pollutant-impaired waterways that do, and do not, require TMDLs by state evaluation.[4] Accordingly, the state must include hydrologically impaired waterways, including those impaired by altered flow, on its 303(d) list. This is the path the Los Angeles RWQCB correctly took in listing the Ventura River (Reaches 3 & 4) for "pumping" and "water diversion" impairments.

However, rather than continuing to follow the clear intent of CWA Section 303(d), the Los Angeles RWQCB instead proposes to *delist* the Ventura River (Reach 3) for "pumping,"[5] despite this listing having been properly included on the 303(d) list since 1998. The primary reason given is that "[t]he listing is for a non-pollutant and therefore should be delisted."[6] However, as established above, the CWA requires the listing of both pollutants *and* pollution on the 303(d) list, regardless of whether a TMDL is required. Therefore, we ask that the Ventura River (Reach 3) remain on the 303(d) list.

b. CWA Section 305(b)

The state must also include hydrologically impaired waters in its broader, CWA Section 305(b) report. Section 305(b) requires states to submit biennial[7] reports that "shall" describe the "water quality of all navigable waters," including an analysis of the extent to which the waters protect fish

[2] SWRCB, "Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List," p. 3; at: http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2015/020315_8_amendment_clean_version.pdf (Listing Policy).
[3] *Id*. at p. 18 (emphasis added).
[4] Even the state does not take that position, choosing instead to include in the Section 303(d) list Category 5 waters that do, and do not, require TMDLs. Listing Policy, *supra*, at Section 2.2, p. 3; *see also* Santa Ana Regional Water Quality Control Board 2016 Clean Water Act Sections 305(b) and 303(d) Integrated Report for the Los Angeles Region: Technical Staff Report ("staff report"), p. 9 (stating that "…waterbodies remain in Category 5 until all 303(d)- listed pollutants are addressed by USEPA-approved TMDLs *or by another regulatory program that is expected to result in the reasonable attainment of the water quality standards*….") (emphasis added).
[5] *See* Clean Water Act Sections 303(d) and 305(b) Integrated Report for the Los Angeles Region, "Summary of Regional Board Recommended Changes to the 2012 303(d) List" (Feb. 8, 2017), at: www.swrcb.ca.gov/losangeles/water_issues/programs/303d/2016/Appendix_A.pdf.
[6] *See* Clean Water Act Sections 303(d) and 305(b) Integrated Report for the Los Angeles Region, Public Review Draft, Appendix G ("Fact Sheets"), Decision ID 34271.
[7] We note for the record that the state's Section 303(d) and 305(b) reports are extremely overdue. The 2014 regions (Central Coast, Central Valley, and San Diego Regions) are now almost three years overdue, while the 2016 regions (Los Angeles, Santa Ana, and San Francisco Bay Regions) are now almost one year overdue, contrary to the clear language of the CWA (*see* 33 U.S.C. § 1313(d), 1315(b); 40 C.F.R. § 130.7(d)(1)). *We object strongly to this continued, illegal, statewide delay in complying with CWA Sections 303(d) and 305(b).*

and wildlife, for compilation and submission to Congress.[8] Federal regulations describe this requirement and its purpose, stating that **the Section 305(b) report "serves as the primary assessment of State water quality" and the basis of states' water quality management plan elements, which "help direct all subsequent control activities."**[9] States must use the Section 305(b) report to develop their annual work program under Sections 106 and 205(j).[10] California's Integrated Report accordingly must include an adequate Section 305(b) report if the state is to develop meaningful water quality plans that appropriately direct staff and resources to the most important control activities.

The Section 305(b) report must particularly include information regarding waterway flows to ensure that the fundamental purpose of Section 305(b) in guiding workplanning is met. The provision of information regarding waterway flow is also called for by CWA Section 101, which sets the **national objective of restoring and maintaining the** "**chemical, *physical*, and biological integrity of the Nation's waters**." (Emphasis added.) The U.S. Supreme Court itself explicitly affirmed the importance of addressing physical elements of waterway health such as flow, stating that **the distinction between water quality and quantity under the CWA is "artificial."**[11]

The Staff Report runs afoul of the CWA by ignoring Category 4C entirely for inclusion in either its 303(d) list or its 305(b) report, reporting that *zero* water bodies in the Los Angeles Region are impaired due to altered hydrology under Category 4C.[12] As with other regional water boards, the Los Angeles RWQCB appears to rely on the Listing Policy for this decision, which states that the 303(d) list only includes those water segments that require the development of a TMDL.[13] Here, again, the Staff Report assumes an illegally narrow definition of its requirements under the CWA. The Integrated Report is supposed to include *both* a robust and legally adequate 303(d) list *as well as* a robust and legally adequate 305(b) report. These requirements are combined; they are not the same (*see also* sec. 8). If the State Water Board and Regional Water Boards take the position that pollution-impaired waterways (including flow-impaired waters) cannot be included in the Section 303(d) list, then the Listing Policy – which by definition applies *only* to the Section 303(d) list – is irrelevant. It cannot be used as an excuse to ignore flow impairments entirely. The state in that case must then turn to its requirements under Section 305(b), which broadly require it to report on water quality, including as impacted by altered flow.

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[8] 33 U.S. Code § 1315(b)(1); *see also* 40 CFR § 130.8. Section 305(b)(1) states that the biennial report "shall include": "(A) a description of the water quality of all navigable waters in such State during the preceding year, with appropriate supplemental descriptions as shall be required to take into account seasonal, tidal, and other variations, correlated with the quality of water required….;
(B) an analysis of the extent to which all navigable waters of such State provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water; …
(E) a description of the nature and extent of nonpoint sources of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources, including an estimate of the costs of implementing such programs." As to this last point, the SWRCB itself has recognized flow alterations as a form of nonpoint source pollution, reinforcing the need to properly account for it in the Section 305(b) report. *See, e.g.*, "Hydromodification, Wetlands and Riparian Areas Technical Advisory Committee: Recommendations to the SWRCB" (Dec. 6, 1994), at: http://www.waterboards.ca.gov/water_issues/programs/nps/tacrpts.shtml.
[9] 40 CFR § 130.8(a) (emphasis added).
[10] *Id.*
[11] *PUD No. 1 of Jefferson County v. Washington Department of Ecology*, 511 U.S. 700 (1994).
[12] Staff Report, *supra*, at p. 9.
[13] *See* Listing Policy, p. 3.

Indeed, the Staff Report recognizes that it must consider flow-impaired waterways in its assessment, describing Category 4C as being applicable if "[t]he non-attainment of any applicable water quality standard for the waterbody is the result of pollution and is not caused by a pollutant."[14] No legitimate reason is given for failing to comply with this requirement, however. A legally adequate Section 305(b) report must include waterways impaired by pollution, including hydrologically impaired waterways, whether or not the waterways are also impaired by a pollutant. This information is also critical for the state to set waterway protection priorities properly.

Proper identification of hydrologically impaired waterways is also important if the state is to fully comply not only with Section 305(b), but with CWA Section 303(d) as well. This section not only calls for identification of impaired and threatened waterways, but also requires the state to prepare a "*priority ranking*" of such waters, "taking into account the severity of the pollution" and waterway uses.[15] Flow and other hydrologic alteration data and information are critical to proper prioritization of impaired waters for further staff and resource attention.

Specifically in regards to the Ventura River (Reach 3), in addition to misguidedly delisting this water segment from the 303(d) list for its impairment due to "pumping," the Los Angeles RWQCB staff also fails to reclassify this water segment under Category 4C, finding that "[t]here is no established method for determining impairment due to pollution like pumping so a Category 4C finding is also inappropriate."[16] Once again, this response is misguided, as the state must at minimum include hydrologically impaired waters in its broader, CWA Section 305(b) report, as described above, whether or not there are flow standards or a formal methodology to do so. *See* Sec. 6, below.

Finally, we reiterate that because Section 303(d)(1)(A) broadly requires identification of impairments *regardless* of whether TMDLs are needed, the state's Section 303(d) list should include a robust Category 4C set of listings. State law cannot weaken the requirements of the CWA by artificially limiting the scope of this list.

2. <u>U.S. EPA Guidance and Reports, and the State Water Board Itself, Have Called for Identification of Hydrologically Impaired Waterways in Category 4C of the Integrated Report</u>

U.S. EPA issued formal Integrated Report Guidance (*i.e.,* for the combined Sections 303(d) and 305(b) reports) to states and territories in August 2015; in it, EPA specifically addresses the topic of hydrological impairment.[17] The U.S. EPA Guidance clearly states that

> If States have data and/or information that a water is impaired due to pollution not caused by a pollutant (e.g., aquatic life[18] use is not supported due to hydrologic alteration or habitat

[14] *Id*. at p. 3.
[15] 33 U.S. Code § 1313(d)(1)(A) (emphasis added).
[16] *See* Clean Water Act Sections 303(d) and 305(b) Integrated Report for the Los Angeles Region, Public Review Draft, Appendix G ("Fact Sheets"), Decision ID 34271.
[17] 2015 EPA Listing Guidance, *supra*, pp. 13-16.
[18] Note here that U.S. EPA specifically calls out protection of aquatic life as a reason to identify flow-impaired waters. The Staff Report similarly calls out aquatic life for specific protection (p. ii), but then ignores the next step of identifying flow impairments that injure aquatic life.

alteration), those causes should be identified and that water should be assigned to Category 4C.[19]

The Guidance specifically references hydrologic alteration as an example of a Category 4C listing.[20] It further references EPA Guidance going back at least to 2006, which similarly said that flow-impaired waters should be identified in the Integrated Report under Category 4C (the 2010 CCKA *et al.* Letter references this 2006 Guidance in support of flow listings; *see* attachment 3).

U.S. EPA and USGS reinforced this mandate in a joint report in February 2016 on flow, stating in part that "EPA recommends reporting impairments due to hydrologic alteration in Category 4c, which are those impairments due to pollution not requiring a TMDL."[21]

Even more specifically, U.S. EPA Region 9 has *directly* told the State Water Board that the Board is "well aware of [EPA's] interest toward listing selected streams for 'flow impairments' (at least under 305(b)) where lines of evidence are strong."[22]

Further, the State Water Board Executive Director himself decided that the state should identify flow-impaired waters in its Integrated Reports, stating that California "would now list for flow alterations" and that "[l]istings would be made under category 4C for impaired [sic] by pollution not a pollutant, and be based on staff's professional judgment as well as the evidence submitted by the data."[23] Again, no reason is given in the Staff Report for ignoring the clear flow impairments throughout the region in light of the CWA, guidance, and state direction.

3. <u>The San Diego RWQCB Has Adopted Numerous Listings for Hydrologic Impairment for Its Current Integrated Report</u>

The SD RWQCB recently adopted an Integrated Report and Staff Report[24] that **identified 30 waterway segments for listing in Category 4C, either with a Category 5 pollutant listing or alone**.[25] Consistent with U.S. EPA Guidance, the SD RWQCB recognized that identifying *all* pollutant and pollution impairments provides a far more accurate picture of the challenges before the state than ignoring key impairments. For example, the Staff Report found that "over 96 percent of streams that exhibited biological degradation had both an associated pollutant(s) and supporting information showing pollution from in-stream habitat/hydrologic alteration and/or watershed hydrologic alteration (hydromodification, Table 3)." If the Regional Board had ignored such pollution impairments, then virtually all of the impaired streams in the San Diego Region would

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[19] *Id.* at p. 15.
[20] *Id.*
[21] U.S. EPA and USGS, "Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration," Chapter 5 (Feb. 2016); at: https://www.epa.gov/sites/production/files/2016-03/documents/aquatic-life-hydrologic-alteration-report.pdf (U.S. EPA/USGS Report).
[22] Email from Tim Vendlinski, U.S. EPA Region 9 to Diane Riddle, SWRCB (Jan. 7, 2015); available upon request.
[23] Email from Nicholas Martorano, SWRCB to SWRCB/RWQCB staff (July 22, 2013) (referencing decision by Thomas Howard, SWRCB); available upon request. Note that such Category 4C listings can and should be made for waterways that are also listed for other categories, including Category 5 (*see* Sec. 8).
[24] *See* Draft adopted Oct. 12, 2016 at: http://www.waterboards.ca.gov/sandiego/water_issues/programs/303d_list/.
[25] http://www.waterboards.ca.gov/sandiego/water_issues/programs/303d_list/docs/IR_RB_StaffReport_R9_07-11-16_Clean.pdf, Table 3.

have been under-assessed, likely resulting in misallocation of limited resources and attention. ELC commented to the San Diego Board in support of these listings; these comments are attached.[26]

4. California Has Identified Hydrologically Impaired Waterways in the Past

In California, "pumping" and "water diversion" are currently listed as causes of impairment for Ventura River Reaches 3 and 4, in the Los Angeles Region. Additionally, Ballona Creek Wetlands is currently listed as impaired by "Hydromodification," among other impairments. All three water body segments are currently listed for these specific flow-related impairments in Category 5.[27] California's history of identifying flow-related impairments under Section 303(d) should be considered precedential. And as explained herein and by Santa Barbara Channelkeeper in its comment letter, there is no basis for delisting Reach 3 of the Ventura River.

5. Numerous Other States Have Identified Hydrologically Impaired Waterways in Categories 4C and 5

Many states around the country have followed U.S. EPA Guidance and the CWA by properly identifying flow-impaired waterways in their Integrated Reports. These include, but are not limited to, Western states such as Idaho, Montana, Wyoming, Washington and New Mexico.[28] One listing methodology that may be of particular interest to the Los Angeles is that used by Ohio, which identifies waters impaired by flow alteration by linking biological community degradation with upstream dams. Notably, a number of these states regularly include flow-impaired waterways on their 303(d) list as well as their 305(b) Report. ELC has collected a significant amount of information on other states' hydrologic impairment listings and processes (and provided this to the State Water Board); this can be made readily available to the Los Angeles Board if desired.

6. Flow Standards Are Not Required to Identify Hydrologically Impaired Waterways in Category 4C

Most, if not all, of the states that identify hydrologic (including flow) impairments make those listing decisions based on best professional judgment and the information before them. Flow standards are not required to be developed first. Even the State Water Board has stated that flow listings could be done "based on staff's professional judgment as well as the evidence submitted by the data," and that they "would likely be mostly narrative . . . unless there are specific numeric targets for flow in place."[29] In other words, the state itself has recognized that flow criteria are not necessary for flow impairment listings. ELC has compiled significant information collected on various states' hydrologic impairment listing strategies and would be pleased to provide this additional information if desired.

U.S. EPA addresses the process of identifying hydrologically impaired waters in its 2015 EPA Listing Guidance, stating that:

[26] Also found at: http://bit.ly/SDRWQCB (note attachments to this letter as well for further supporting information).
[27] http://www.swrcb.ca.gov/losangeles/water_issues/programs/303d/2008/Final%20303(d)/Appendix_E_08Aug09.pdf.
[28] *See* detailed memorandum on this topic prepared by ELC for the SWRCB at: http://bit.ly/303d305b.
[29] Email from Nicholas Martorano, SWRCB to SWRCB/RWQCB staff (July 22, 2013); available upon request.

> if States have data and/or information that a water is impaired due to pollution not caused by a pollutant (e.g., aquatic life use is not supported due to hydrologic alteration or habitat alteration), those causes should be identified and that water should be assigned to Category 4C. Examples of hydrologic alteration include: a perennial water is dry; no longer has flow; has low flow; has stand-alone pools; has extreme high flows; or has other significant alteration of the frequency, magnitude, duration or rate-of-change of natural flows in a water; or a water is characterized by entrenchment, bank destabilization, or channelization. Where circumstances such as unnatural low flow, no flow or stand-alone pools prevent sampling, it may be appropriate to place that water in Category 4C for impairment due to pollution not caused by a pollutant. In order to simplify and clarify the identification of waters impaired by pollution not caused by a pollutant, States may create further sub-categories to distinguish such waters.[30]

Note that this description of the process for identifying flow impairments does *not* require adoption of flow standards as a prerequisite for listing.

The SD RWQCB Staff Report also addressed this topic in their just-approved Staff Report and Integrated Report, similarly stating that:

> where a water segment exhibited significant degradation in biological populations and/or communities as compared to reference site(s) the San Diego Water Board assessed the segment for inclusion in Category 4c using data and information as prescribed in USEPA's 2015 Guidance . . .. Where in-stream data was lacking, stream segments were evaluated using desktop aerial reconnaissance for potential in-stream habitat and hydrologic alteration associated with channel modifications, stream diversion or augmentation, and to evaluate the level of associated development and use of best management practices to mitigate hydromodification.[31]

7. Sound Public Policy Dictates that Flow-Impaired Waterways Must Be Identified

States, including California, have identified and are identifying flow-impaired waterways in their Integrated Reports not only because the Clean Water Act calls for it and U.S. EPA Guidance reinforces it. They also do so because it makes smart policy sense. Why would a state limit the amount of information it releases, information that could help it make better decisions about how to prioritize its resources? If the main problem with a waterway is not temperature or dissolved oxygen but flow, for example, then that information should be available so the best permitting and resource allocation decisions can be made to protect affected waterways.

Identification of flow-impaired waterways is also important because those listings help the public exercise their own responsibility to help improve waterway health. U.S. EPA agreed in its Guidance, stating that "a variety of watershed restoration tools and approaches to address the

[30] 2015 EPA Listing Guidance, *supra*, p. 15.

[31] SD RWQCB, "Clean Water Act Sections 305(b) And 303(d) Integrated Report for The San Diego Region (July 2016); at: http://www.waterboards.ca.gov/sandiego/water_issues/programs/303d_list/docs/IR_RB_StaffReport_R9_07-11-16_Clean.pdf, pp. 13-14.

source(s) of the impairment" exist even in the absence of TMDLs, increasing the importance of full and complete identification for impaired waterways.[32]

Hydrologic impairment listings also can and should be used in CEQA analyses of proposed projects that could further impact the flow of identified waterways, thus preventing additional damage to already-impacted waterways and fish. ELC has prepared and submitted extensive comments to the state on the numerous policy benefits of properly identifying flow-impaired waterways.[33]

8. Water Bodies Can and Should Be Placed in *All* Relevant Categories of Identification

The Staff Report states that "[t]o meet CWA section 305(b) requirements of reporting on water quality conditions, the Integrated Report places each assessed waterbody segment into one of five *non-overlapping* categories based on the overall beneficial use support of the water segment…."[34] This statement appears to limit the RWQCB to placing water bodies in only one category, an interpretation presumably reflected in the recommendation to include zero listings in Category 4C.

This approach is simply incorrect. U.S. EPA has been quite clear that water bodies can be placed into multiple categories, and in fact should be in order to provide the best available information to U.S. EPA and Congress. As explained by the SD RWQCB in its Staff Report:

> It is important to note that USEPA recommended in its 2015 guidance that "States assign all of their surface water segments to **one *or more* of five reporting categories**"....[35]

U.S. EPA reiterated this point in its joint report with USGS, stating that "EPA's guidance has noted that **assessment categories *are not mutually exclusive*, and waters may be placed in more than one category (for example, categories 4C and 5)**."[36] Accordingly, flow impairments should be reflected in Category 4C *whether or not* there is a pollutant present, the approach taken recently by the SD RWQCB. Otherwise, the state is conflating the Section 303(d) and 305(b) reports rather than combining them, ignoring its Section 305(b) responsibilities in the process.[37] Because the state must comply with *both* Sections 305(b) and 303(d), it must provide information relevant to all categories applicable to a single water body.[38] The Integrated Report does not meet these mandates.

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[32] For an analysis of water governance tools that could effectively restore flows to California waterways, *see* Linda Sheehan *et al*., "California Water Governance for the 21st Century" (2017), available at: http://bit.ly/CAwatergovernance.
[33] Letter from ELC, CCKA to SWRCB, "Inclusion of Impairments Due to Low Flow in the California 2012 Section 303(d) List" (May 15, 2013); at: http://bit.ly/SWB303d.
[34] Staff Report, *supra*, p. 8 (emphasis added).
[35] SD RWQCB, *supra*, p. 14 (emphasis added).
[36] U.S. EPA/USGS Report, *supra*, Ch. 5 (emphasis added).
[37] 33 U.S.C. §§ 1315(b), 1313(d); 40 C.F.R. §§ 130.7, 130.8.
[38] This is consistent with the statutory intent of the CWA, which distinguishes the related Section 305(b) reports and Section 303(d) lists. In 2002, the EPA for the first time released guidance calling for a single "Integrated Report" merging Section 305(b) water quality reports and Section 303(d) lists. *See* U.S. EPA, 2002 Integrated Water Quality Monitoring and Assessment Report Guidance.

9. Readily Available Data Exist and Have Been Provided in Support of the Listing of Waterways as Hydrologically Impaired

As evident based on substantial, readily available information, the lines of evidence for hydrologic impairment are strong for numerous Los Angeles Region waterway segments, including but not limited to Reach 3 of the Ventura River (specifically for "pumping," as currently listed) as well as the Santa Clara River (particularly Reaches 1 and 2).[39] Federal regulations state that states must evaluate "all existing and readily available information" in developing their 303(d) lists and prioritizations.[40] The SWRCB's Executive Director reinforced the breadth of this requirement in a memorandum on the scope of listing regulations at 40 CFR § 130.7(b)(5).[41] This information must include flow, a position recently reinforced by U.S. EPA, who stated that the integrated reporting format is key to "acknowledge the important role of flow in contributing to water-body impairments."[42]

Data Supporting Listing of the Ventura River (Reaches 3 and 4)

Excessive pumping contributes to the severe dewatering of the Ventura River (Reach 3), imperiling endangered steelhead trout and other aquatic species. Therefore, the Los Angeles RWQCB must not delist this waterway for "pumping" as is currently proposed.

As support, ELC incorporates by reference those comments prepared by Santa Barbara Channelkeeper on the Los Angeles Region's 2012 Integrated Report[43] and 2016 Integrated Report,[44] both of which summarize the extensive body of evidence establishing the link between pumping on Reach 3 (as well as Reach 4) of the Ventura River and resulting negative biological impacts, including to steelhead trout. ELC also incorporates by reference numerous additional documents that highlight the negative effects of excessive pumping on Reach 3 (as well as Reach 4) of the Ventura River, including from U.S. EPA Region 9 (finding in its Draft TMDL for Reaches 3 and 4 of the Ventura River that "low flows due to pumping and diversion activities likely exacerbate the flow and water quality conditions in Reaches 3 and 4"),[45] the National Marine Fisheries Service (NMFS) (finding in a 2007 Draft Biological Opinion that "[w]ater withdrawals from surface diversions and subsurface pumping have affected the timing and magnitude of the Ventura River flows ... and has decreased the quantity and quality of critical habitat for steelhead")[46], and the Los

[39] See Attachment 1 for detailed information drawn from such sources.
[40] 40 CFR § 130.7(b)(5).
[41] At: http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/impaired_waters_list/clarification_30jan07.pdf (placing "no limits" on the data that can be provided to the RWQCBs for development of the Integrated Report's 303(d) and 305(b) lists).
[42] U.S. EPA/USGS Report, *supra*, Ch. 5.
[43] *See* Santa Barbara Channelkeeper, "Comment Letter—303(d) List portion of the 2012 California Integrated Report" (Feb. 5, 2015), available at: http://bit.ly/2o8pL5P.
[44] *See* letter from Santa Barbara Channelkeeper to the LA RWQCB on 2016 Revisions to the Los Angeles Region 303(d) List (Mar. 2017; available upon request).
[45] U.S. EPA Region 9, Ventura River Reaches 3 and 4 - Total Maximum Daily Loads For Pumping & Water Diversion-Related Water Quality Impairments (Draft Dec. 2012), at: https://www3.epa.gov/region9/water/tmdl/pdf/ventura-river-reaches3-4_tmdl.pdf.
[46] National Marine Fisheries Service, 2007 Draft Biological Opinion for the Army Corps of Engineers' permitting of the City of Ventura's proposed Foster Park Well Facility ("FPWF") repairs.

Padres National Forest Ojai Ranger District (describing the historic impacts low flows have upon steelhead trout populations in the Ventura River watershed in a report on steelhead restoration).[47]

Together, this data demonstrates that pumping impairs beneficial uses in Reach 3 of the Ventura River, particularly those beneficial uses related to aquatic life and habitat. In accordance with Section 3.11 of the Listing Policy, when information indicates non-attainment of standards by a water body, the appropriate methodology for evaluation is weight of evidence to determine listing under Section 303(d).

This recommendation is consistent as well with Section 3.9 of the Listing Policy, which supports listing if the water body exhibits degradation in biological populations and pollutants sufficient to impair, or threaten impairment of, beneficial uses. Reach 3 of the Ventura River has exhibited degradation in populations of fish (including steelhead trout) that rely upon adequate flows for survival.

Based on the readily available data and information, the evidence is sufficient to support the continued listing of Reach 3 of the Ventura River on the 303(d) list due to "pumping." Thus, the proposed delisting of the "pumping" impairment on Reach 3 must not proceed. The Los Angeles RWQCB staff has not provided sufficient information to justify this delisting, nor have they addressed the above evidence that clearly validates the "pumping" listing as it originally occurred. Similarly, this evidence supports the continued listing (as currently proposed) of Reach 3 as impaired due to "water diversion," and of Reach 4 as impaired due to both "water diversion" and "pumping."

Data Supporting Listing of the Santa Clara River

Since at least 2013, ELC and partners have submitted detailed information establishing a clear impairment due to altered flows on the Santa Clara River (in particular Reaches 1 and 2, located downstream of the Vern Freeman Diversion Dam). In May 2013, we submitted a "shortlist" of ten California waterways being drained dry for inclusion on the 303(d) list, along with supporting evidence (*see* Attachment 2). The Santa Clara River was one of those waterways. As described in the submitted evidence:

> The Santa Clara River is Southern California's last major free flowing waterway and is home to 17 species listed as threatened or endangered under the state and federal Endangered Species Acts. At River mile 10.5, United Water Conservation District (United) diverts almost all of the River's flows outside of large storm events. United, USGS, and local agency data show that water diverted at the Vern Freeman Diversion Dam for agricultural usage, groundwater recharge, and other uses, deprive migrating steelhead of sufficient flows and juvenile steelhead of healthy estuary rearing grounds.[48] In addition to impacting beneficial uses associated with the provision of adequate steelhead habitat, surface water withdrawals also destroy downstream native riparian and endangered bird

[47] Ventura Watershed Analysis - Focused for Steelhead Restoration, Los Padres National Forest Ojai Ranger District, Prepared by Sara Chubb (Forest Fishery Biologist) (1997), available at: http://friendsofventurariver.org/wp-content/themes/client-sites/venturariver/docs/ventura-river-watershed-steelhead-restoration-los-padres.pdf.
[48] Letter from Jason Weiner (Ventura Coastkeeper) to Jeffrey Shu (SWRCB), Public Solicitation of Water Quality Data and Information for 2012 Integrated Report (Aug. 30, 2010).

habitat, degrade the ecological integrity of the River's estuary, and impair a plethora of cultural and recreational beneficial uses downstream.[49]

Additional readily available information further supports the imperative to list the Santa Clara River as impaired due to altered flows. This includes documents published by NMFS (describing in a Final Biological Opinion the negative biological impacts of the Vern Freeman Diversion Dam, which can deplete the Santa Clara River of all its flows and jeopardizes the existence of endangered Southern California steelhead trout),[50] the Santa Clara River Trustee Council and The Nature Conservancy (describing Santa Clara River flow reductions caused by water diversions and groundwater pumping and the resulting impact on steelhead trout),[51] the Los Angeles RWQCB (describing the historic decline of steelhead trout in the Santa Clara River, as well as flow impacts from water diversions and hydromodification in its "State of the Watershed" report),[52] and others.

Severely reduced flows below the Vern Freeman Diversion Dam
Photo courtesy of Wishtoyo Chumash Foundation

Together, this data demonstrates that reduced flows impair beneficial uses in the Santa Clara River, particularly those beneficial uses related to aquatic life and habitat. This is most clearly true in Reaches 1 and 2 of the Santa Clara River, where over-diversion and other flow impacts (due in large part to the Vern Freeman Diversion Dam) can cause the waterway to go completely dry. In accordance with Section 3.11 of the Listing Policy, when information indicates non-attainment of standards by a water body, the appropriate methodology for evaluation is weight of evidence to determine listing under Section 303(d).

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49 "Ten California Waterways Being Drained Dry - Using the Clean Water Act to Resuscitate Disappearing Waterways" (May 2013).

50 National Marine Fisheries Service, Final Biological Opinion to Reclamation Re: Approve United Water Conservation District's Proposal to Operate the Vern Freeman Diversion and Fish Passage Facility (Jul. 23, 2008), at: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/south_central_southern_california/nmfs_bo_vern_freeman___fish_passage_facility_7-23-08.pdf.

51 Matt Stoecker and Elise Kelley, "Santa Clara River Steelhead Trout: Assessment and Recovery Opportunities" prepared for the Santa Clara River Trustee Council and The Nature Conservancy (Dec. 2005), at: http://www.stoeckerecological.com/reports/SantaClaraReport.pdf.

52 Los Angeles Regional Water Quality Control Board, State of the Watershed - Report on Surface Water Quality: The Santa Clara River Watershed, p. 13 (Nov. 2006) at: www.waterboards.ca.gov/rwqcb4/water_issues/programs/stormwater/municipal/AdminRecordOrderNoR4_2012_0175/Section%2010_References-Part%20I_COMPLETED.pdf.

This recommendation is consistent as well with Section 3.9 of the Listing Policy, which supports listing if the water body exhibits degradation in biological populations and pollutants sufficient to impair, or threaten impairment of, beneficial uses. The Santa Clara River has exhibited degradation in populations of fish (including steelhead trout) that rely upon adequate flows for survival. Based on the readily available data and information, the evidence is sufficient to support the listing of the Santa Clara River (particularly Reaches 1 and 2) on the 303(d) list for impairment caused by altered flow. This evidence also supports including Santa Clara River on the 305(b) report.

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In sum, we once again urge the Los Angles RWQCB to follow the lead of the SD RWQCB, as well as U.S. EPA and numerous other states, in identifying flow- and otherwise hydrologically-impaired waters in the region's Integrated Report. To do so, the staff report must be revised to support the continued listing of Reach 3 of the Ventura River as impaired due to pumping (as done in previous years), as well as by listing the Santa Clara River (particularly Reaches 1 and 2) as impaired due to altered flows.

Thank you for the opportunity to submit these comments. If you have any questions or would like additional information, please do not hesitate to contact us.

Sincerely,

Grant Wilson
Interim Director, ELC
gwilson@earthlaw.org
510-566-1063

Attachment 1: Comment Letter from ELC to San Diego RWQCB, "Comment – CWA Section 305(b)/303(d) Integrated Report" (Aug. 8, 2016)
Attachment 2: "Ten California Waterways Being Drained Dry" (May 2013)
Attachment 3: Letter from CCKA *et al* to State Water Resources Control Board, "Re: Notice of Public Solicitation of Water Quality Data and Information for 2012 California Integrated Report [Clean Water Act Sections 305(b) and 303(d)]" (Aug. 30, 2010)

Attachment 1

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August 8, 2016

Henry Abarbanel, Chair and Board Members
San Diego Regional Water Quality Control Board
2375 Northside Drive, Suite 100
San Diego, California 92108

VIA ELECTRONIC SUBMITTAL: sandiego@waterboards.ca.gov

Re: Comment – CWA Section 305(b)/303(d) Integrated Report, Attn: Xueyuan Yu

Dear Chair Abarbanel and Board Members:

On behalf of Earth Law Center (ELC), I welcome the opportunity to submit these comments on the above-referenced CWA Section 305(b)/303(d) Integrated Report (Report). ELC has been working at the state and national levels for a number of years to ensure that waterbodies impaired by "pollution," particularly altered flow and hydrology, are represented in either Category 5 or Category 4C of the 305(b)/303(d) Integrated Report. Our recent comment letter to U.S. EPA and USGS in support of such listings is attached.

We write today in support of your proposal to list waterways as impaired due to hydromodification and habitat alteration in Category 4C, as discussed in the July 2016 Draft Staff Report[1] at pages 12-17. As noted in the Staff Report, on August 13, 2015 U.S. EPA released guidance on Integrated Reporting and Listing Decisions that reaffirmed the duty to list in Category 4C those waters impaired by "pollution."[2] In this guidance, U.S. EPA notes that "[w]hile TMDLs are not required for waterbody impairments assigned to Category 4C, States can employ a variety of watershed restoration tools and approaches to address the source(s) of the impairment," raising the importance of full and complete listing identification for these impaired waterways. The Staff Report echoes EPA's finding, stating that Category 4C listed waters "may be a priority for restoration by a Regional Water Board."

We further support your staff's work, consistent with U.S. EPA guidance and regulations, to identify flow-impaired stream segments where in-stream data was lacking, using such tools as

[1] At: http://www.waterboards.ca.gov/sandiego/water_issues/programs/303d_list/docs/IR_RB_StaffReport_R9_07-11-16_Clean.pdf.

[2] Memorandum from U.S. EPA, Office of Wetlands, Oceans, and Watersheds Information to Water Division Directors, Regions 1 – 10, Concerning 2016 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions (August 13, 2015), at: https://www.epa.gov/sites/production/files/2015-10/documents/2016-ir-memo-and-cover-memo-8_13_2015.pdf. *See also* U.S. EPA, "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act," p. 56 (July 29, 2005), at: http://bit.ly/2aIVP8h.

"desktop aerial reconnaissance for potential in-stream habitat and hydrologic alteration associated with channel modifications, stream diversion or augmentation."

Finally, we support staff's assertion that it is "important to note that USEPA recommended in its 2015 guidance that 'States assign all of their surface water segments to *one or more* of five reporting categories'." (Emphasis added.) In other words, a stream segment can be listed for *both* impaired hydrology and pollutant contamination, rather than one or the other.

Specific listing of all waters impaired by "pollution" gives a far more accurate picture of the challenges facing state agencies and Californians than ignoring pollution impairments. For example, the Staff Report states that "over 96 percent of streams that exhibited biological degradation had both an associated pollutant(s) and supporting information showing pollution from in-stream habitat/hydrologic alteration and/or watershed hydrologic alteration (hydromodification, Table 3)." If pollution impairments were ignored, then virtually all of the impaired streams in the San Diego Region would be under-assessed, likely resulting in misallocation of limited resources and attention.

The Clean Water Act calls on the nation to protect the chemical, biological *and physical* integrity of our waters. The full and proper identification of all impaired waterways, including for altered flow and hydrology, is an important step in meeting this mandate. We urge the San Diego Regional Water Quality Control Board to adopt the proposed listings for habitat alteration/hydromodification, as described in Table 3 of the Draft Staff Report and elsewhere. Thank you for the opportunity to submit these comments.

Sincerely,

Linda Sheehan
Executive Director
lsheehan@earthlaw.org

attachments

Attachment 2

Ten California Waterways Being Drained Dry

Using the Clean Water Act to Resuscitate Disappearing Waterways *(May 2013)*

In August 2010, environmental, tribal, and fishing groups submitted more than one thousand pages of detailed studies, data, and analysis to inform the Board's development of the 2012 Clean Water Act Section 303(d) List. As detailed in that letter, and at the August 2012 Water Board informational item on this matter, California is legally required to include on its Section 303(d) list *all* of the waterways for which "readily available" data indicate impairment, including impairments due to alterations in natural flow.

Other states have begun this essential task of identifying water bodies impaired by altered flows, with support by U.S. EPA. Within California, U.S. EPA's Bay Delta Action Plan[i] anticipates flow listings, noting that "identifying those impairments and identifying the cause (whether it is a "pollutant" for purposes of Section 303(d) or some other cause) is a critical part of the Clean Water Act response to the Estuary's problems."

Given California's current struggles with water, and the challenges to come with climate change, every tool must be used to prevent further damage and to restore degraded waterways to full health. California must begin a process of identifying and listing flow-impaired waterways in its 2012 303(d) list, as detailed in our 2010 scoping letter and the 2012 flows listing informational hearing.

To help begin this Board effort, we have developed a shortlist of waterways that are clearly and incontrovertibly impaired, and for which low flows are so clearly a cause that there are no reasonable arguments against their 303(d) listing for flow, in either Category 4C or 5. Preference was given in this initial shortlist to mainstem waterways as opposed to tributaries, as mainstem flow issues are more likely to impact entire watersheds and regions. At a minimum, these critically impaired waterways should be included on the draft 2012 303(d) List and released for public review at Regional and State Water Board hearings.

We worked closely with local groups to create this list based on the following criteria, among others:[ii]

a. Significant data was submitted by August 2010 as part of the CWA 2012 303(d) scoping process, or is otherwise readily available (e.g., such as in government databases), and demonstrates altered flows such that impairment could not be dismissed as either naturally occurring or episodic.
b. Local stakeholders are invested in the health of the waterway, and could inform and participate in restoration of the health of the listed waterway.
c. Prior formal recognition of flow issues with the waterway by State Water Board, Department of Fish and Wildlife, or other state or local agencies.
d. Ongoing or potential injury to threatened or endangered species.
e. Waterways within the National or California Wild and Scenic River System, or Class I streams (habitat for fishery resources) or Class II streams (habitat for aquatic non-fish vertebrates and/or aquatic benthic macroinvertebrates).
f. Waterways where listing would help prevent waste, unreasonable use or unreasonable method of use of water, or unreasonable diversion or method of diversion of water.

Listed from north to south, our proposed "top ten" candidates for which altered flow is a basis for listing on California's 2012 Section 303(d) List are as follows:

1. **Scott River** (Region 1) Sections of the Scott River are completely dewatered during summer months, while other sections are severely flow-impaired. Adjudicated water rights alone are sufficient to allow complete dewatering of the Scott River during the summer and early fall. In

addition, a shift from surface diversions, which are naturally self-limiting, to groundwater wells has made worse the apparent over-appropriation of water in the watershed.[iii, iv]

2. **Shasta River** (Region 1) The hydrology of the Shasta River is strongly affected by surface water diversions, groundwater pumping, and Dwinnell Dam. Seven major diversion dams and numerous smaller structures located on the Shasta River substantially and rapidly reduce flows in the main stem when they are in operation. In addition, Dwinnell Dam, located at about river mile 40, has dramatically altered the flow regime in all seasons of the main stem river. During various times of the year, no water is released from Dwinnell Dam for fish in the Shasta River. These flow alterations have adversely affected salmonid populations in the river.[v]

3. **Eel River** (Region 1) Historic land use, including pervasive logging and road construction that reduced shade, vastly increased sedimentation and altered hydrology and soils, is exacerbated in many areas by unregulated dry-season diversions related to marijuana cultivation. As a result, Eel River and its tributaries suffer from low flows that often produce temperatures lethal to listed fish species.[vi]

4. **Mattole River** (Region 1) A detailed study of the Mattole River Basin found that lack of adequate late summer and early fall stream flow is recognized as one of the most important limitations on salmonid habitat in the Mattole River basin. In recent years, juvenile salmonids have become stranded in pools due to excessively low flows, causing mortality and necessitating fish rescue operations.[vii]

5. **Mark West Creek** (Region 1) Ten years ago all 28 miles of Mark West Creek had water in the summer. Today, because of increased diversions, only approximately 3½ miles have water. Mark West Creek provides important habitat to steelhead trout and endangered coho salmon, whose populations are being adversely affected by elevated water temperatures.

6. **Napa River** (Region 2) Numerous studies referenced in the development of AB 2121 Instream Flow Guidelines for Northern Coastal Streams, among other places, illustrate the significantly degraded habitat of the Napa River, which can only be restored with a focus on reversing severely reduced natural flows.[viii]

7. **San Joaquin River, inflow to the Delta** (Region 5)[ixx] The San Joaquin River was selected as a shortlist priority in light of the data contained in the proceedings being held on potential revisions to the Bay-Delta Water Quality Control Plan to increase flows from the San Joaquin River into the Delta. Current flows are wholly inadequate, as the state and federal wildlife agency, EPA, and NGO analyses show (as well as the SWRCB's own analyses and peer reviews).

8. **San Francisco Bay-Delta, outflow to Suisun Bay and San Francisco Bay** (Region 5) In addition to the above information, one of the key findings of the SWRCB's 2010 Public Trust flows report is that Delta outflow is significantly impaired, and that substantially greater outflow is needed to protect Public Trust fishery populations. This is especially true in the spring and fall months. Consideration should also be given to listing other portions of the Delta as flow-impaired, again in light of the data/information and agency processes described above.

9. **Salinas River** (Region 3) "Channel alteration and changes in flow regime have caused a virtual loss of the anadromous life history of three steelhead in the Salinas River." More generally, "flows in lower reaches for adult and juvenile steelhead passage are often lacking," with "[g]roundwater pumping related to agricultural activities . . . caus[ing] the loss of surface flow in winter and spring."[xi] This detailed analysis concluded that "unless the Salinas River channel and flow move back towards their more normal range of variability, steelhead cannot be restored."

10. **Santa Clara River** (Region 3) The Santa Clara River is Southern California's last major free flowing waterway and is home to 17 species listed as threatened or endangered under the state and federal Endangered Species Acts. At River mile 10.5, United Water Conservation District (United) diverts almost all of the River's flows outside of large storm events. United, USGS, and local agency data show that water diverted at the Vern Freeman Diversion Dam for agricultural usage, groundwater recharge, and other uses, deprive migrating steelhead of sufficient flows and juvenile steelhead of healthy estuary rearing grounds. [xii] In addition to impacting beneficial uses associated with the provision of adequate steelhead habitat, surface water withdrawals also destroy downstream native riparian and endangered bird habitat, degrade the ecological integrity of the River's estuary, and impair a plethora of cultural and recreational beneficial uses downstream.

Contacts for Additional Data & Information

(1) and (2): for Scott and Shasta River and other flow listings in the Klamath Basin, contact Konrad Fisher (konrad@klamathriver.org) at Klamath Riverkeeper or Craig Tucker (ctucker@karuk.us) with the Karuk Tribe.

(3): for Eel River listing, contact Zeke Grader (zgrader@ifrfish.org) with PCFFA, Darren Mierau (dmierau@caltrout.org) with CalTrout, or Scott Greacen (scott@eelriver.org) with Friends of the Eel River.

(4): for Mattole River listing, contact Brian Johnson (bjohnson@tu.org) with Trout Unlimited or Hezekiah Allen (Hezekiah@mattole.org) with Mattole Restoration Council.

(5) and (6): for Sonoma waterways, contact Don McEnhill (don@russianriverkeeper.org) with Russian Riverkeeper.

(7) and (8): for San Joaquin River and Delta, contact (among others) Bill Jennings (deltakeep@aol.com) with California Sportfishing Protection Alliance or Zeke Grader (zgrader@ifrfish.org) with PCFFA.

(9): for Salinas River, contact Steve Shimek (exec@montereycoastkeeper.org) with Monterey Coastkeeper.

(10): for Santa Clara River, contact Jason Weiner (jweiner.venturacoastkeeper@gmail.com) with Ventura Coastkeeper, Ron Bottorff (bottorffm@verizon.net) with Friends of the Santa Clara River or Cameron Yee (cyee@causenow.org) with CAUSE.

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[i] U.S. EPA. August 2012. Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: EPA's Action Plan, p. 9, *available at* http://www2.epa.gov/sites/production/files/documents/actionplan.pdf.
[ii] Criteria 4-6 are taken from the State Water Board's AB 2121 Enforcement Priorities, Appendix G, available at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/docs/ab2121_0210/adopted050410instreamflowpolicy.pdf.
[iii] National Research Council (NRC). 2004. Endangered and Threatened Fishes in the Klamath River Basin – Causes of Decline and Strategies for Recovery. The National Academies Press, Washington, DC.
[iv] S.S. Papadopulos & Associates Inc. 2012. Groundwater Conditions in Scott Valley, California. Report prepared for the Karuk Tribe, Happy Camp, CA.
[v] Lestelle, L. 2012. Effects of Dwinnell Dam on Shasta River salmon and considerations for prioritizing recovery actions. Report prepared for the Karuk Tribe, Happy Camp, CA.
[vi] Higgins, Patrick, Consulting Fisheries Biologist. Feb. 2010. Evaluation of the Effectiveness of Potter Valley Project National Marine Fisheries Service Reasonable and Prudent Alternative (RPA): Implications for the Survival and Recovery of Eel River, Coho Salmon, Chinook Salmon, and Steelhead Trout.

[vii] Klein, Randy D., Hydrologist. March 2007. Hydrologic Assessment of Low Flows in the Mattole River Basin 2004-2006, p. 1.

[viii] Letter from Patrick Higgins, Consulting Fisheries Biologist to SWRCB. April 2, 2008. *Comments on Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams,* pp. 13-15 (in Appendix A).

[ix] For both of the Region 5 sets of waterways, there are agency processes ongoing to address flow issues. However, the lengthy time frame and uncertain future of these processes, and the sensitive and declining health of these waterways, demands that we use all available tools to (at a minimum) prevent waterway health from deteriorating further as these processes play out. Formal listing as "flow impaired" on the 303(d) list would provide invaluable assistance in this regard.

[x] Based on the agency, NGO and academic testimony presented at the State Board's 2010 "Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem" hearing and State Board's Phase I SED hearing, as well as Fish and Wildlife's 2010 "Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta," we believe the Merced, Tuolumne, Stanislaus and San Joaquin Rivers would all qualify to be listed as flow impaired.

[xi] *Id*.

[xii] Letter from Jason Weiner, Ventura Coastkeeper to Jeffrey Shu, SWRCB. Aug. 30, 2010. Public Solicitation of Water Quality Data and Information for 2012 Integrated Report.

Attachment 3

CALIFORNIA COASTKEEPER. ALLIANCE

Heal the Bay

Surfrider Foundation.

SIERRA CLUB CALIFORNIA

PACIFIC COAST FEDERATION OF FISHERMEN'S ASSOCIATIONS
PCFFA
STEWARDS OF THE FISHERIES

CENTER for BIOLOGICAL DIVERSITY
Because life is good.

SOUTHERN CALIFORNIA WATERSHED ALLIANCE

CLEAN WATER ACTION
CALIFORNIA

PACIFIC ENVIRONMENT

PLANNING AND CONSERVATION LEAGUE

FRIENDS OF TRINITY RIVER
DEDICATED TO RESTORING A GREAT RIVER

ENDANGERED SPECIES COALITION

COASTAL ENVIRONMENTAL RIGHTS FOUNDATION

ENVIRONMENTAL HEALTH COALITION
Justice HEALTH Justicia Comunidad
Coalición de Salud Ambiental

Institute for Fisheries Resources
Unite. Protect. Restore.

BEC
Serving Butte County since 1975

the watershed project

california water impact network

California Sportfishing Protection Alliance
"An Advocate for Fisheries, Habitat and Water Quality"

AQUALLIANCE
DEFENDING NORTHERN CALIFORNIA WATERS

RRWPC
Russian River Watershed Protection Committee

August 30, 2010

Jeffrey Shu, State Water Resources Control Board
Division of Water Quality
P.O. Box 100
Sacramento, CA 95812-0100

VIA ELECTRONIC AND U.S. MAIL: jshu@waterboards.ca.gov

RE: **Notice of Public Solicitation of Water Quality Data and Information for 2012 California Integrated Report [Clean Water Act Sections 305(b) and 303(d)]**

Dear Mr. Shu:

The undersigned organizations have been active for many years on programs and issues affecting the quality and flow of the waters of the State. Our organizations have performed water monitoring and watershed surveys, and conducted outreach among a diverse group of citizens around California, to determine the most pressing issues for state waterway health. We welcome the opportunity to submit these comments in light of these significant and ongoing efforts.

We present in this letter two general themes of proposed listings. First, we highlight some examples of traditional "pollutant"-based "Category 5"[1] listings that are being proposed to you separately. This Category of listings has been the focus of the State Water Resources Control Board's (State Board) 303(d) list to date. We urge the State Board's careful attention to these and the other Category 5 listings proposed by the identified commenters as well as the undersigned organizations and others. The adoption of such proposed listings will help ensure clean, healthy waterways throughout the State.

Second, we highlight additional groups of listings that also identify impaired and threatened waters that should be listed under Category 4 (particularly 4C) or Category 5. Our analysis reveals three such groups that regularly impair designated beneficial uses but that have received inadequate attention in the state's 303(d) process to date. These are: altered natural flows in surface waters, groundwater contamination and excessive groundwater withdrawals that impact surface water health, and anthropogenic climate change-caused impacts to surface waters. Impaired and threatened waterways from these groups of listings must be included in the 2012 303(d) list to ensure compliance with the Clean Water Act, and to achieve full restoration of the health of the waters of the state.

[1] Category references from U.S. EPA, "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act" (July 29, 2005), available at: http://www.epa.gov/owow/tmdl/2006IRG/report/2006irg-report.pdf (2006 Guidance), and SWRCB, "Staff Report: 2010 Integrated Report Clean Water Act Sections 303(d) and 305(b)" (April 19, 2010) (2010 Integrated Report Staff Report), available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/2010ir0419.pdf.

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I. FEDERAL AND STATE MANDATES REQUIRE 303(D) LIST IDENTIFICATION OF ALL IMPAIRED AND THREATENED CALIFORNIA WATER BODIES.

A. Impaired or Threatened Water Bodies Must Be Identified on the 303(d) List Regardless of Whether Impacted by "Pollutants" or "Pollution."

Section 303(d) of the Federal Clean Water Act represents the Act's "safety net."[2] It is the bedrock component of the Clean Water Act, the backstop to ensure that the goals of the Act can be achieved when initial efforts fail. At the advent of implementation of Section 303(d) in the late 1990s, U.S. EPA Assistant Administrator for Water Robert Perciasepe called the TMDL program "crucial to success because it brings rigor, accountability, and statutory authority to the process."[3]

Section 303(d) requires states to address comprehensively all human activities that affect the chemical, physical, and biological integrity of the nation's waters.[4] Section 303(d) is widely recognized as an essential means to achieving the Clean Water Act's goal of restoring waters so that they are safe for swimming, fishing, drinking, and other "beneficial uses" that citizens enjoy, or used to be able to enjoy.[5]

Section 303(d) first requires the State Water Board to identify waters that do not meet, or are not expected to meet by the next listing cycle, water quality standards after the application of certain technology-based controls. Specifically, Section 303(d)(1)(A) states as follows:

> Each State shall identify those waters within its boundaries for which the effluent limitations required by section 1311(b)(1)(A) and section 1311(b)(1)(B) of this title are not stringent enough to implement any water quality standard applicable to such waters. The State shall establish a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters.

In other words**,** if a water body's standards are not being met in the water body, then it *must* be listed under the state's Section 303(d) list. This is a separate and distinct task from the effort of determining whether or not total maximum daily loads (TMDLs) are required, as discussed in CWA Section 303(d)(1)(C):

> Each State shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those

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[2] Houck, Oliver A., *The Clean Water Act TMDL Program* 49 (Envtl. Law Inst. 1999).
[3] Memorandum from Robert Perciasepe, Assistant Administrator for Water, U.S. EPA, to Regional Administrators and Regional Water Division Administrators, U.S. EPA, "New Policies for Establishing and Implementing Total Maximum Daily Loads (TMDLs)" (August 8, 1997).
[4] *See* 33 U.S.C. §§ 1251 *et seq*. and 33 U.S.C. § 1313(d).
[5] 33 U.S.C. § 1313(d)(1) and (2); *see also* 40 C.F.R. § 130.7(b)(1). California law defines an existing use as one that has occurred since 1975 and recognizes 23 designated or beneficial uses for water bodies, including uses such as freshwater replenishment, and migration of aquatic organisms. (2002 California 305(b) Report on Water Quality, Appendix A, State Water Resources Control Board, August, 2003. Available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/305b.shtml.

> pollutants which the Administrator identifies under section 1314(a)(2) of this title as suitable for such calculation. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

This means that a water body is listed on the 303(d) list if beneficial uses are being impaired, and a TMDL is developed if they are being impaired by a "pollutant" (including a combination of pollutants and pollution).

"Pollutant" is defined in CWA Section 502(6).[6] Courts have interpreted the definition of "pollutant" expansively, stating that it "encompass[es] substances not specifically enumerated but subsumed under the broad generic terms" listed in Section 502(6).[7] Similarly, courts have stated that the definition of pollutant is "meant to leave out very little."[8]

"Pollution" is also defined in CWA Section 502, as "the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water." U.S. EPA has found that "pollution" must result in a 303(d) listing if it results in impairment, and will result in a TMDL if pollutants are also present:

> In some cases, the pollution is caused by the presence of a pollutant and a TMDL is required. In other cases, pollution does not result from a pollutant and a TMDL is not required. States should schedule these segments for monitoring to confirm that there continues to be no pollutant associated with the failure to meet the water quality standard and to support water quality management actions necessary to address the cause(s) of the impairment.[9]

The mandate to list impaired waterways under Section 303(d)(1)(A) regardless of the cause of impairment is consistent with the reasoning of *Pronsolino v. Nastri*.[10] The Ninth Circuit Court of Appeals found that the source of the impairment at issue is irrelevant to listing, and that decisionmakers may consider only the issue of whether the water body is impaired in determining whether to list it. This position is also supported by the National Research Council (NRC), which found that the TMDL program "should encompass all stressors, <u>both pollutants</u>

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[6] The definition of "pollutant" in Section 502(6) includes: "dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water." Several other items are specifically excluded; flow alteration is not one of those items.

[7] *U.S. PIRG v. Atlantic Salmon of Maine* (U.S. Dist. Ct. Maine, Aug. 2001), available at http://www.med.uscourts.gov/Site/opinions/kravchuk/2001/MJK_08282001_1-00cv150_USPIRG_v_Heritage.pdf, citing *United States v. Hamel*, 551 F.2d 107 (6th Cir. 1977).

[8] *Id*., citing *Sierra Club, Lone Star Chapter v. Cedar Point Oil Co*., 73 F.3d 546, 566-568 (5th Cir. 1996), *cert. denied*, 519 U.S. 811 (1996).

[9] 2006 Guidance at 56.

[10] *Pronsolino v. Nastri*, 291 F.3d 1123, 1137-38 (9th Cir. 2002), cert. denied, 123 S. Ct. 2573 (2003) ("Water quality standards reflect a state's designated *uses* for a water body and do not depend in any way upon the source of pollution").

and pollution, that determine the condition of the waterbody."[11] The NRC found this step to be important in part because "activities that can overcome the effects of 'pollution' and bring about water body restoration – such as habitat restoration and channel modification – should not be excluded from consideration during TMDL plan implementation."[12]

In its 2006 Guidance informing states on how to prepare their biennial report on water quality (the states' "305(b)/303(d) Integrated Report"), U.S. EPA recommended a division of impaired water body segments into Categories as follows:[13]

- Category 4: Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed;
- Category 5: Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

California adopted the following, similar state categories for impaired waterways:[14]

- Category 4a: A water segment for which ALL its 303(d) listings are being addressed; and 2) at least one of those listings is being addressed by a USEPA approved TMDL.
- Category 4b: A water segment for which ALL its 303(d) listings are being addressed by action(s) other than TMDL(s).
- Category 4c: A water segment that is impaired or affected by non-pollutant related [*i.e.*, "pollution"] cause(s).
- Category 5: A water segment where standards are not being met and a TMDL is required but not yet completed for at least one of the pollutants being listed for this segment.

Categories "4" and "5" together represent the state's "303(d) List," as *both* categories encompass the total of the state's impaired or threatened waterways under Section 303(d)(1)(A). Category 5 waters require a TMDL. This Category includes waters impaired only by pollutants and those impaired both by pollutants and "pollution" (in which case consideration of the "pollution" would be given in the TMDL development for the waterway). Category 4 also includes impaired waters, but categorizes them as not requiring development of a TMDL,[15] though other actions may be taken to improve their health, as noted below.

California's 2008/2010 303(d) list of impaired waters, adopted by the State Water Board on August 4, 2010, contains Category 4A, 4B, and Category 5 waters. However, **the state's 2008/2010 303(d) list fails to include *any* Category 4C waters**, a glaring omission given the numerous pollution-related impairments facing many of the state's threatened and impaired waterways. The State Board must rectify this oversight in the state's 2012 303(d) list.

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[11] National Research Council, "Assessing the TMDL Approach to Water Quality Management," p. 4 (Nat'l Academy Press, Wash. D.C., 2001) (emphasis added).
[12] *Id*.
[13] 2006 Guidance at pp. 46 *et seq*. (emphasis added).
[14] *See* 2010 Integrated Report Staff Report at 20 (emphasis added).
[15] As noted below, we would argue that flow alterations can and should require development of a TMDL even if present without pollutants; there is precedent for this position in California.

In sum, the 2012 303(d) list must identify *all* impaired and threatened waters, whether impaired by pollutants and/or pollution – not only so that they may be addressed as required by the TMDL process,[16] but also so they may be restored to health as well through other programs and policies. For example, California's Porter-Cologne Water Quality Control Act requires that Basin Plans include a program of implementation that describes how water quality standards will be attained.[17] Where standards are not being attained – such as where flow alterations have been identified as impairing waterway beneficial uses – these implementation plans must incorporate strategies for achieving waterway health. Implementation of this state mandate, along with the TMDL program mandates where applicable, will ensure that water bodies whose health is threatened and impaired – in Categories 4(a)-(c) *and* Category 5 – are restored to health.

B. The State Must Use and Consider All Readily Available Information

The body of regulations and guidance that bear on 303(d) listing are unambiguous about the information that should be considered in making listing decisions: *all of it*. Federal regulations state clearly that "[e]ach State shall assemble and evaluate all existing and readily available water quality-related data and information to develop the [303(d)] list."[18] The regulations further mandate that local, state and federal agencies, members of the public, and academic institutions "should be *actively* solicited for research they may be conducting or reporting."[19] Furthermore, EPA's 2006 Guidance explicitly states that U.S. EPA's review of California's list will include an "assess[ment of] whether the state conducted an adequate review of all existing and readily available water quality-related information."[20] To that end, the 2006 Guidance also requires states to provide "[r]ationales for any decision to not use any existing and readily available data and information."[21]

Accordingly, and the State Board's data solicitation notice notwithstanding,[22] any and all existing and readily available data and information must be considered to determine the health of the state's increasingly-degraded water bodies.

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[16] *See supra* n. 15 regarding TMDLs for flow-related impairments in California, and *see infra* regarding requirements to develop TMDLs that consider flows when waterways are also listed due to pollutant impairments. *See also* SWRCB, "A Process for Addressing Impaired Waters in California" (July 2005), available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/iw_guidance.pdf.

[17] Water Code Section 13241 reads: "Each regional board shall establish such water quality objectives in water quality control plans as in its judgment will ensure the reasonable protection of beneficial uses and the prevention of nuisance…." Section 13242 follows that: "The program of implementation for achieving water quality objectives shall include, but not be limited to:

(a) A description of the nature of actions which are necessary to achieve the objectives, including recommendations for appropriate action by any entity, public or private.

(b) A time schedule for the actions to be taken.

(c) A description of surveillance to be undertaken to determine compliance with objectives."

It is both the law and good public policy for the state to take action to ensure that waterways identified as impaired, including those impaired by pollution, are restored to health.

[18] 40 C.F.R. § 130.7(b)(5).

[19] 40 C.F.R. § 130.7(b)(5)(iii) (emphasis added).

[20] 2006 Guidance at 29.

[21] *Id*. at 18.

[22] SWRCB, "Notice of Public Solicitation of Water Quality Data and Information for 2012 California Integrated Report – Surface Water Quality Assessment and List of Impaired Waters" (Jan. 10, 2010; updated May 24, 2010), http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/data_solicitation_ir2012v2.pdf.

II. THE UNDERSIGNED ORGANIZATIONS URGE THE STATE WATER BOARD TO LIST ALL WATERWAYS IMPAIRED BY "POLLUTANTS."

The 2008/2010 303(d) list adopted by the State Board on August 4, 2010 shows a 64% increase from the number of listings in 2006. This number likely reflects both a growing number of severely polluted waterways in California and an improvement in the Board's ability to assess a larger number of waterways and pollutants. We applaud the State Water Board for its efforts to assess a larger number of waterways and sources and causes of impairments and expect to see the 2012 303(d) list capture an even larger number of impairments.

The 2012 list can improve upon the 2008/2010 list by including additional new listings as needed, and in particular those waterways impaired by trash and bacteria. In order to rectify this, the State Water Board must ensure that the 2012 List reflects water quality data and information submitted by Waterkeeper and other groups monitoring local water quality. We bring to the Board's attention just some of the numerous water quality issues in watersheds from the Oregon border to San Diego that have yet to be addressed by the State Board's 303(d) List, and incorporate by reference the related data submissions by local Waterkeepers and the undersigned organizations. This information is by no means comprehensive, but provides the Water Board with examples of additional listings that should be carefully reviewed for inclusion in the 2012 303(d) list.

North Coast

Humboldt Baykeeper's Citizen Monitoring Program has collected water quality data from sites throughout the Humboldt Bay, Mad River, and Little River watersheds since 2005. Numerous waterbodies in the Humboldt Bay, Mad River, and Little River watersheds have quite high levels of fecal coliform (*E. coli*), particularly after major rain events. High fecal coliform levels have resulted in posted closures of several local beaches by the Ocean Monitoring Program of the Humboldt County Division of Environmental Health.[23] These beaches include Moonstone Beach County Park (at the outlet of Little River), and Mad River Mouth North (at the outlet of Widow White Creek and Mad River). The County has sampled ocean waters since 2003, and has documented exceedences of fecal coliform and/or Enterococcus at both Moonstone Beach County Park and Mad River Mouth North.[24] Moonstone Beach County Park is on the 303(d) list for indicator bacteria, but Humboldt Baykeeper's Citizen Monitoring Program is the only source of water quality data upstream from these beaches were water pollution due to indicator bacteria is of concern. This water quality data warrants several additional listings, as described in Humboldt Baykeeper's 303(d) comment letter.

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23 http://co.humboldt.ca.us/hhs/phb/environmentalhealth/oceanmonitoringprogram/.

24 http://co.humboldt.ca.us/hhs/phb/environmentalhealth/oceanmonitoringprogram/waterqualitytestresults-archive.asp.

Central Coast

From July 2008 to March 2010 San Francisco Baykeeper conducted *Enterococcus* monitoring near storm drains in San Francisco Bay's Oakland Inner Harbor.[25] The data collected reflected exceedences of Basin Plan water quality standards for *Enterococcus*,[26] and showed that contact recreation in the vicinity of these storm drains poses serious risks.[27] Accordingly, Oakland Inner Harbor should be designated as impaired for Indicator Bacteria. In addition, polybrominated diphenyl ethers (PBDEs) are present in Bay sediments, are accumulating in Bay organisms, and are known to negatively impact aquatic life. For these and other reasons, Baykeeper found that the Regional Board should consider a PBDE listing for San Francisco Bay in this 2012 listing cycle. Please refer to San Francisco Baykeeper's independent letter in response to the State Board's data solicitation for further information regarding Indicator Bacteria concentrations and PBDE toxicity in San Francisco Bay.

Despite Santa Barbara Channelkeeper's (SB Channelkeeper) submission of data and photographic evidence reflecting a serious trash problem in San Pedro Creek, the Creek was not listed for trash on the 2010 303(d) List. SB Channelkeeper's data for 2012, which was collected in compliance with the State Water Board's SWAMP guidance on rapid trash assessments, confirms that trash impairs over half the streams monitored in the Santa Barbara and Goleta Area.[28] The State Water Board should review this carefully, and consider other data submitted on trash listings so that another listing cycle does not go by without action to address this important water quality issue.

Ventura Coastkeeper (VCK) conducted water quality monitoring throughout the Santa Clara River, Ormond Beach, Calleguas Creek, and Nicholas Canyon Creek watersheds from June 2009 to August 2010. VCK found based on this information that trash listings for Nicholas Canyon Creek, San Jon Barranca, the Ormond Beach Lagoon, the Santa Clara River Estuary, and Santa Clara River Reaches 1, 3, 4a, and 5 are warranted. Additionally, VCK found the following exceedences that warrant listing on the 2012 303(d) list: Santa Clara River Estuary for flow, dissolved oxygen, pH, phosphate, and nitrate; Santa Clara River Reach 3 for *E. coli*; Ormond Beach wetlands for pH, nitrate, and *E. coli*; San Jon Barranca for *E. coli*; and Santa Clara River Reaches 1 and 2 for flow.

[25] Under this standard, only two stations satisfied the geometric mean objective during the summer and none satisfied the objective during the winter. In addition, none of the stations achieved compliance with the "no sample greater than 104 MPN/100ml" objective within a given 30-day sampling period during either the summer or winter monitoring seasons.
[26] Pursuant to the San Francisco Bay Basin Plan, the *Enterococcus* objectives include a geometric mean of less than 35 MPN/100 ml and states that no sample should exceed 104 MPN/100 ml.
[27] San Francisco Bay is only subject to bacteriological monitoring at designated beaches, although contact recreation occurs routinely throughout the Bay, including Oakland Inner Harbor.
[28] Atascadero, Bell, Cieneguitas, Maria Ygnacio, Phelps Ditch (El Encanto Creek), San Jose, and San Pedro Creeks. *See* Santa Barbara Channelkeeper's 2012 303(d) Comment Letter responding to the State Water Board's request for data.

South Coast

From July of 2007 through February of 2010 Orange County Coastkeeper (OCCK) conducted water monitoring at a total of seven sites on San Juan, San Mateo and Cristianitios Creeks in Orange and San Diego County. All of these Creeks are under the authority of the San Diego Regional Water board. After analyzing the data from this monitoring in accordance with the current state guidelines for developing 303d listings, OCCK found that there are sufficient exceedences of basin plan objectives for ammonia, nitrate, phosphate, and cadmium to warrant additional impairment listings on the 2012 impaired waters list.

The Inland Empire Waterkeeper sampled 10 sites on a weekly basis from July 2008 through November 2009 under contract with the Santa Ana Regional Water Quality Control Board. The project included four locations on San Timoteo Creek (one site perpetually dry), four locations on Warm (Twin) Creek and two locations on City Creek; all of which drain to Reach 4 of the Santa Ana River.[29] The primary focus was *E. coli* bacteria indicators, but samples were also taken for pH, conductivity, dissolved oxygen, flow rate, temperature, metals, minerals, nutrients, PCBs, organochlorine pesticides, TDS, hardness, and COD. Five sites contained *E. coli* bacteria levels during the warm season or cool season (or both) that exceed the proposed geo-mean basin plan objective. All nine sites had a minimum of two exceedences; ranging from the most natural mountain stream, up to as many as twelve in a highly urban concrete channel.

San Diego Coastkeeper is submitting information about trash collected at beach cleanups to seek the listing of all 21 San Diego County beaches. Volunteer data shows the annual removal of more than 200 pounds of trash from 9 out of 21 beaches from Oceanside to Imperial Beach. Data indicates pervasive and widespread debris impairment along the San Diego shoreline as well as nearby watersheds which drain into coastal waters.[30] San Diego Coastkeeper is also submitting ambient water quality data for nine of the eleven watersheds in San Diego County. San Diego has collected data on conventional constituents (pH, DO, temperature) as well as other key water quality indicators (including, but not limited to, nitrogen, phosphorus, toxicity, *E. coli*, *Enterococcus*) for over three dozen sites across San Diego County each month. Data indicate that exceedences of objectives are widespread and require management action.

III. THE STATE MUST IDENTIFY AND LIST ALL WATER BODIES THREATENED OR IMPAIRED BY ALTERATIONS IN NATURAL FLOW.

U.S. EPA requires waterways with flow-related impairments to be listed on the state's 303(d) list, typically (though not exclusively) in Category 4C ("water segment that is impaired or affected by non-pollutant related cause(s)"). If pollutants are also present, the waterway must be listed in Category 5. As discussed further below, we contend that despite U.S. EPA inclination to assess flow alterations as "pollution" to be listed in Category 4C (which should *at a minimum* be populated with flow listings for California in the 2012 list), there is also support for listing such impairments in Category 5 and preparing TMDLs to address them.

[29] *See* final report at: http://www.iewaterkeeper.org/iewaterkeeper/work/projects/UpperSARWaterQuality/.
[30] Please refer to San Diego Coastkeeper's 2012 303(d) Letter to the SWRCB on trash impairments.

A. The State Water Board Must Address Impacts to Beneficial Uses of Water Bodies Caused By Alterations in Natural Flows.

The health of rivers, streams, creeks and other waterways is inextricably linked to the volume, frequency, magnitude, timing, and duration of flows.[31] "[W]ater quantity is closely related to water quality; a sufficient lowering of the water quantity in a body of water could destroy all of its designated uses, be it for drinking water, recreation, navigation, or . . . a fishery."[32] As the U.S. Supreme Court has held,

> there is recognition in the Clean Water Act itself that reduced stream flow, *i.e.,* diminishment of water quantity, can constitute water pollution. First, the Act's definition of pollution . . . encompasses the effects of reduced water quantity. *33 U.S.C. 1362(19).* This broad conception of pollution – one which expressly evinces Congress' concern with the physical and biological integrity of water – refutes petitioners' assertion that the Act draws a sharp distinction between the regulation of water 'quantity' and water 'quality.'[33]

The state's ability to ensure healthy waterways hinges in part on its ability to identify waterways impaired or threatened by altered natural flow, and to take targeted action to restore and maintain necessary flow regimes.

Water quality standards encompass both the designated uses of a water body and the water quality criteria established to protect those uses, as well as antidegradation requirements. Altered natural flows (usually reduced flows) may impact a water body's beneficial uses in a number of ways, causing a violation of standards that prompts 303(d) listing. For example, if a river is designated for use as a coldwater fishery, but reduced flows have resulted in increased temperatures and lowered water depths such that the river can no longer support fish, low flows clearly have impacted the water body's designated use.[34] Where low flows in rivers, creeks, and stream have impaired a beneficial use, the water quality standards have been violated, and the water body segment must be listed under Section 303(d).[35]

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[31] MacDonnell, Lawrence J., "Return to the River: Environmental Flow Policy in the United States and Canada. Journal of the American Water Resources Association" 45(5):1087-1099 (2009), DOI: 10.1111/j.1752-1688.2009.00361 *citing* Poff, N.L., *et al.,*"The Natural Flow Regime: A Paradigm for River Conservation and Restoration," *BioScience* 47:769-784 (1997); Poff, N.L., "Managing for Variation to Sustain Freshwater Ecosystems," *Journal of Water Resources Planning and Management* 135:1-4 (2009).

[32] *PUD No.1 v. Washington Department of Ecology*, 511 U.S. 700, 719 (May 31, 1994).

[33] *Id. See also* U.S. EPA, **"**Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act" (July 21, 2003) ("2004 Guidance"), available at: http://www.epa.gov/owow/tmdl/tmdl0103/2004rpt_guidance.pdf *(2004 (*"Low flow can be a man-induced condition of a water (i.e., a reduced volume of water) which fits the definition of pollution. Lack of flow sometimes leads to the increase of the concentration of a pollutant (e.g., sediment) in a water.")

[34] For example, adult coho salmon migrate at water temperatures of 45 to 59ºF, a minimum water depth of approximately seven inches, and streamflow velocities less than eight ft/sec. National Marine Fisheries Service, "Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan," p. 4 (July 2007), available at: http://www.swr.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf. Research has demonstrated that upstream migration of Klamath River Chinook salmon is suppressed at mean daily water temperatures above 23.5°C if temperatures are falling.

[35] Attachment 2 provides photos and other information of waterways in California so impacted, such as the Scott River.

For example, in the Russian River Watershed, excessive water diversions have turned fish-bearing creeks such as Mark West Creek and Macaama Creek into dry stream beds.[36] In the Klamath River Watershed, high diversion rates from agricultural developments limit flow levels in river mainstems and tributaries, which raise water temperatures and lower water quality, making segments of the Scott and Shasta Rivers unsuitable for rearing juvenile coho salmon.[37]

In addition, excessive withdrawals, water diversions and dams can concentrate pollutant loadings, resulting in higher in-stream concentrations and impacts. For example, rivers in the Klamath watershed are impaired by toxic algae, temperature, and nutrient pollution caused by dams, cattle grazing and irrigated agriculture.[38] All of these problems are made significantly worse by reduced natural flows. In 2006, U.S. EPA formally recognized that dam impacts to flow caused the impairment of the Klamath River by toxic blue green algae *Microcystis aeruginosa*, a liver toxin and known tumor promoter.[39]

1. Altered Flows Must Be Identified as *Causes* of Impairment, Not Solely *Sources* of Impairment

The State Water Board has identified altered natural flows in its just-adopted 303(d) list as a potential *source* of impairment of dozens of water body-segment pollutant combinations. However, California generally has avoided its responsibility to recognize reduced natural flows, streamflow alterations, water diversions, or similar flow issues as *independent causes* of impairment that require listing of the waterway for "flow alterations" under Category 4C *at a minimum*, or Category 5 where appropriate.[40] This failure to address flow alterations directly is a serious omission by the State Water Board and must be addressed in the 2012 303(d) List.

The *source* of impairment provides available information tied to the impaired segment that generally describes the type of *activity* that has resulted in the impairment. Typical examples in California's 303(d) list include, but are not limited, to the following: range grazing, silviculture, agriculture, construction/land development, urban runoff/storm sewers, mine tailings, onsite wastewater systems (septic tanks), and marinas and boating. This information is generally used to help sort out which parties will be allocated responsibility for addressing the contamination at issue.

By contrast, altered natural flows can be the *cause* of impairment of a water body – just as altered concentrations of various contaminants (dissolved oxygen, mercury, temperature, etc.)

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[36] *See* Appendix A and A-1 for more information.
[37] NMFS, "Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan Prepared by The National Marine Fisheries Service Southwest Region," p. 32 (July 10, 2007), available at: http://www.swr.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf.
[38] *See* SWRCB, "2010 California 303(d) List of Water Quality Limited Segments: Category 5," North Coast RWQCB, available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml.
[39] http://www.klamathriver.org/media/pressreleases/Press-Release-032008.html.
[40] Exceptions include Regional Water Quality Control Board 4's listing of Ballona Creek Wetlands as impaired by "Hydromodification" and "Reduced Tidal Flushing," and applicable segments of the Ventura River as impaired by "Pumping" and "Water Diversion." *See infra* n. 48.

similarly *cause* impairment. The *sources* of the listings for "altered natural flows" would then be activities such as agriculture, mining, construction, grazing, etc. The parties undertaking these activities would then be contacted to take action to reduce the impacts of their various operations on waterway flow.

This distinction is important if the actual impairment of a water body is to be properly addressed. For example, if natural flows in a creek that has been designated as "cold freshwater habitat" have been diverted to the point that the shallow water becomes too warm to be adequate fish habitat, the water body should be listed as impaired in Category 5 because of *both* low natural flow *and* elevated temperature, rather than improperly listed only for elevated temperature, with flow alteration as a mere "source" of impairment. If the creek is solely listed as impaired because of elevated temperature, the mitigating action could be (for example) solely planting trees along the banks to create shade. If a creek is listed because of both flow and temperature impairments, responsive actions are much more likely to include increased flows as well as increased shade, which would provide for a healthier outcome for the stream and its inhabitants overall.[41]

EPA's 2006 Guidance specifically describes "lack of adequate flow" as a *cause* for listing an impaired or threatened segment on the 303(d) list,[42] distinguishing it from listings of *sources* contained in separate summary tables.[43] A number of states accordingly include flow alterations as a cause of impairment in their 303(d) lists. Specifically, **U.S. EPA has compiled nationwide data submitted by states showing that 56,981 miles of rivers and streams, 517,857 acres of lakes, reservoirs and ponds, 299 square miles of bays and estuaries, and 33,054 acres of wetlands nationwide have been listed on states' 303(d) lists as impaired by "Flow Alterations."**[44] This corresponds to listings for over 100 water bodies nationwide in the District of Columbia, Idaho,[45] Michigan, Wyoming, Ohio and California.[46]

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[41] Of course, the listing should also ideally include the "sources" of both the temperature and low flows impairments, such as agriculture or other activities.

[42] "Examples of circumstances where an impaired segment may be placed in Category 4c include segments impaired solely due to lack of adequate flow or to stream channelization." 2006 Guidance at 56.

[43] *See* U.S. EPA, "National Causes of Impairment" versus "National Probable Sources Contributing to Impairment," available at: http://iaspub.epa.gov/waters10/attains_nation_cy.control#causes.

[44] *See* U.S. EPA, "Specific State Causes of Impairment That Make Up the National Flow Alteration(s) Cause of Impairment Group," available at: http://iaspub.epa.gov/tmdl_waters10/attains_nation_cy.cause_detail?p_cause_group_name=FLOW%20ALTERATION%28S%29. *See also* details of flow impairment listings at U.S. EPA, "Impaired Waters , Cause of Impairment Group: Flow Alteration(s)," available at: http://iaspub.epa.gov/tmdl_waters10/attains_impaired_waters.control?p_cause_group_id=545. For information on the status of data collection by state for these tables, *see* U,S, EPA, "Status of Available Data Used in This Report," available at: http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T#status_of_data.

[45] Idaho's 2008 Integrated Report shows more than 100 waterbody-pollutant segment listings for low flow alterations and other flow regime alterations under its "Section 4C Waters Impaired by Non-Pollutants." Idaho 2008 Integrated Report: "Section 4c Waters Impaired by Non-Pollutants," http://www.deq.state.*Id*.us/water/data_reports/surface_water/monitoring/integrated_report_2008_final_sec4c.pdf.

[46] *See* U.S. EPA, "Watershed Assessment, Tracking and Environmental Results: Specific State Causes of Impairment That Make Up the National Flow Alteration(s) Cause of Impairment Group," (last updated August 12, 2010), available at: http://iaspub.epa.gov/tmdl_waters10/attains_nation_cy.cause_detail_303d?p_cause_group_id=545. Conversation with Douglas Norton, U.S. EPA Headquarters (August 9, 2010).

2. Waterways Impaired by Altered Flows Must at a Minimum Be Listed in Category 4C of the 303(d) List, and Also May Be Listed in Category 5

As discussed above, U.S. EPA's and California's Category 4C *must* be populated with all waterways that are impaired or threatened solely due to the presence of non-pollutants. At a minimum, then, *all* flow-related impairments in California *must* be included in the Category 4C portion of the 2012 303(d) list. We would argue as well, however, that many if not all of these impairments could be included in Category 5.[47]

In California, "Pumping" and "Water Diversion" are listed as the sole causes of impairment for the water body segment Ventura River Reach 4.[48] This water body segment is listed specifically in Category 5 and requires a TMDL by 2019, even though Pumping and Water Diversion are the *only* causes of impairment. Water Diversion is specifically identified as a "Pollutant" in the Fact Sheet[49] describing this listing, as is the case with Pumping.[50]

California's choice to list, and most recently uphold the listing of, flow-caused impairments as a "pollutant" under Category 5 is not prohibited by the definition of "pollutant" or by U.S. EPA guidance. First, courts have interpreted the definition of "pollutant" broadly, as noted above, stating that it is "meant to leave out very little."[51] Second, U.S. EPA Guidance, while favoring a position that flow-related impairments are "pollution," does so in a less than

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[47] Idaho, which deferred to EPA's preference that flows be included in Category 4C, tried to provide a rationale for EPA's preference on flows as follows: "A pollutant is a substance, such as bacteria or sediment, that is identifiable and in some way quantifiable. Some unnatural conditions that impair water quality, such as flow alteration, human-caused lack of flow, and habitat alteration, are considered pollution, but are not caused by quantifiable pollutants. Temperature, while not a substance, is considered a pollutant, as changes in water temperature are quantifiable." Idaho DEQ, "Surface Water: Water Quality Improvement Plans (TMDLs), available at: http://www.deq.state.Id.us/water/data_reports/surface_water/tmdls/overview.cfm#Pollution. This loyal though somewhat strained reasoning ignores the fact that flow itself, as well as its impacts, is most certainly quantifiable – as are Pumping and Water Diversion, for which California waters have been listed in Category 5 as discussed below.

[48] SWRCB, "2010 California 303(d) List of Water Quality Limited Segments: Category 5," "Ventura River Reach 4 (Coyote Creek to Camino Cielo Road)," available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml?wbid=CAR4022002119990203090836. Ventura River Reach 3 had an identical listing in 2006, also with a 2019 TMDL, though Indicator Bacteria was added as a cause of impairment in the 2010 list update. SWRCB, "2006 CWA Section 303(D) List of Water Quality Limited Segments Requiring TMDLS," Region 4: "Ventura River Reach 3 (Weldon Canyon to Confl. w/ Coyote Cr)," available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/303dlists2006/epa/r4_06_303d_reqtmdls.pdf.

[49] Supporting Information, 2010 Integrated Report, Ventura River Reach 4: Water Diversion, http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/01015.shtml#7310.

[50] Supporting Information, 2010 Integrated Report, Ventura River Reach 4: Pumping, http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/01015.shtml#7308.

[51] *See supra* n. 8. The definition of "pollutant" in Section 502(6) includes: "dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water." Several other items are specifically excluded; flow alteration is not one of those items. Arguably, the actions taken by industrial, municipal and agricultural operations (*i.e.* essentially all activities that could impact flow) could be viewed as the discharge of "waste," which is undefined in Section 502 but which could readily be interpreted as the by-product of "operations"*; i.e.* changes in the health of the waterway to its detriment.

definitive manner and without analysis, leaving room for California to make its own determination. For example, the 2004 Guidance states simply that "EPA does not *believe* that flow, or lack of flow, is a pollutant as defined by CWA Section 502(6)."[52] The 2006 Guidance similarly simply asserts without further support or discussion that "[e]xamples of circumstances where an impaired segment may be placed in Category 4c include segments impaired solely due to lack of adequate flow or to stream channelization."[53]

In sum, California can and should protect its waterways as fully as possible, including through the complete identification and listing of waterways impaired by the *cause* of natural flow alterations. Other states have shown leadership in this regard, and California's waters are no less precious or threatened.

Moreover, to ensure full protection and restoration of the waterways' beneficial uses, the identified waters should be placed on the 303(d) list under Category 5 (most certainly if there are additional pollutant impairments), and at a minimum in Category 4C. Section 510 of the Clean Water Act sets a floor but no ceiling for state action to protect and enhance the health of waters of the United States. California should make full use of this provision, and should leverage its prior flow-related listings in Category 5 into a comprehensive effort to address *all* flow-related impairments under the federal Section 303(d) listing and TMDL program, as well as under state law and other programs.

B. The State Must Use and Consider All Readily Available Information Related to Identifying Natural Flow-Related Impairments.

Under federal law[54] and the California Listing Policy, the State and Regional Water Boards must "actively solicit, assemble, and consider <u>all</u> readily available data and information,"[55] including from local, state and federal agencies, for purposes of developing the 303(d) list. This includes but is not limited to: reports of fish kills; dilution calculations; and "<u>predictive models for assessing the physical, chemical, or biological condition</u> of streams, rivers, lakes, reservoirs, estuaries, coastal lagoons, or the ocean."[56]

Accordingly, the State Water Board must examine and consider all readily available information that could inform 303(d) decisions related to alterations in natural flow. This includes but is not limited to the following:

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[52] U.S. EPA, "Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act," p. 8 (July 21, 2003) (emphasis added), available at: http://www.epa.gov/owow/tmdl/tmdl0103/2004rpt_guidance.pdf. It also states, as quoted above, that reduced water volume "fits the definition of pollution" – which could be the case for essentially any water impairment, including more traditional "pollutants."

[53] 2006 Guidance, *supra* n. 1, at 56.

[54] 40 CFR 130.7.(b)(5), see http://law.justia.com/us/cfr/title40/40-21.0.1.1.17.0.16.8.html.

[55] SWRCB, *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (Listing Policy) (Sept. 2004), Section 6.1.1" Definition of Readily Available Data and Information (emphasis in original), available at http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/ffed_303d_listingpolicy093004.pdf.

[56] *Id*. (emphasis added).

- Data collected through the Department of Fish and Game's Instream Flow Program[57]
- Information compiled pursuant to programs and funding by the Ocean Protection Council[58]
- The findings of the recently-adopted State Water Board report on Delta flow criteria requirements (attached)[59]
- All comments, information and associated data sets submitted to the State Water Board during the development of its AB 2121 "Policy for Maintaining Instream Flows in Northern California Coastal Streams"[60]
- Flow data released by the California Department of Water Resources,[61] including data from the Water Data Library[62] generally and the Interagency Ecological Program[63] in particular, as well as and outside compilations of DWR data organized by waterbody segments[64]
- Data in the Klamath Resource Information System (KRIS);[65]
- Information and datasets presented at "My Water Quality" meetings,[66] including data from the Department of Natural Resources presented at the August 11, 2010 meeting
- Data contained in CalFish, the California Cooperative Anadromous Fish and Habitat Data Program,[67] especially the Passage Assessment Database.[68]

Note that Federal agencies, such as the U.S. Fish and Wildlife Service,[69] Federal Energy Regulatory Commission,[70] NOAA (particularly the National Marine Fisheries Service[71] and

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[57] *See* DFG Instream Flow Program, http://www.dfg.ca.gov/water/instream_flow_docs.html. *See also* DFG Water Rights Program, http://www.dfg.ca.gov/water/water_rights_docs.html.

[58] This includes but is not limited to Instream Flow Analysis – Santa Maria River, http://www.opc.ca.gov/2009/05/instream-flow-analysis-santa-maria-river/, Instream Flow Analysis – Big Sur River, http://www.opc.ca.gov/2009/05/instream-flow-analysis-big-sur-river/, and Instream Flow Analysis – Shasta River, http://www.opc.ca.gov/2009/05/instream-flow-analysis-shasta-river/.

[59] SWRCB, "Final Report on Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem" (Aug. 3, 2010) (Delta Flow Report), available at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/final_rpt.shtml.

[60] As required by California Water Code § 1259.4 (AB 2121), available at http://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/.

[61] DWR, California Data Exchange Center, http://cdec.water.ca.gov/.

[62] DWR, Water Data Library, http://www.water.ca.gov/waterdatalibrary/.

[63] Interagency Ecological Program, http://www.water.ca.gov/iep/.

[64] "CA DWR CDEC Interface," a compilation of data from DWR's California Data Exchange Center, available at: http://acme.com/jef/flow/cdec.html.

[65] http://www.krisweb.com/index.htm.

[66] http://www.waterboards.ca.gov/mywaterquality/monitoring_council/meetings/index.shtml.

[67] www.calfish.org;

[68] http://www.calfish.org/portals/0/Programs/CalFishPrograms/FishPassageAssessment/tabid/83/Default.aspx. This letter incorporates by reference the comments of Heal the Bay with respect to required 303(d) listings needed for beneficial uses impaired by fish passage barriers. The same legal and policy requirements that call for 303(d) listing of water bodies impaired by altered natural flows also apply to listings for water bodies impaired by fish barriers. The Water Board should review the Passage Assessment Database, which has extensive information on barriers, to ensure that all impaired waterways are properly included on the Section 30(d) list. *See also* CCKA's compilation of fish barriers impacting the RARE beneficial use at: http://www.cacoastkeeper.org/programs/mapping-initiative/fish-barriers.

[69] *See, e.g.*, U.S. FWS, Water and Fishery Resources Program, http://www.fws.gov/cno/fisheries/.

[70] *See* http://elibrary.ferc.gov/idmws/search/fercgensearch.asp to search for details of California hydropower projects, which would provide further information on flows.

[71] California is in the Fisheries Service's Southwest Region; *see* http://swfsc.noaa.gov/ for data and publications.

analyses such as the Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan[72]), USGS[73] and U.S. EPA, must also be "*actively*" solicited for data and information.[74]

This and other flow information can provide invaluable insight into the "physical, chemical, or biological condition" of the state's waterways as required by federal law and state Policy. It should be considered carefully in developing a comprehensive Category 4C list as well as Category 5 listings that appropriately include impairments caused by altered natural flows, and combinations of altered natural flows and pollutants.

C. Specific Listing Proposals for Impairments Caused by Reduced Natural Flows

Numerous beneficial uses are impaired by the altered flows, including but not limited to GWR (groundwater recharge discussed separately below), COLD (cold freshwater habitat), MIGR (fish migration), SPWN (fish spawning) and RARE (preservation of rare and endangered species). In addition to the data described elsewhere in this letter and other readily available data sources, data and information for a number of many flow-impaired waterways can be found through KRIS.[75] This letter also includes and incorporates by reference the flow-related listing proposals provided in the detailed comments submitted by Heal the Bay,[76] the Natural Resources Defense Council (NRDC),[77] and Ventura County Coastkeeper.[78]

Please note that the waterways described below, in addition to the flow-related listing proposals incorporated by reference, are just *some* of the numerous flow-impaired waterways throughout the state. <u>This list is by no means a comprehensive assessment</u>. The final 2012 303(d) list should include *all* of the waterways that "readily available" data indicate are threatened or impaired due to alterations in natural flow.

1. <u>Rivers, Creeks and Streams</u>

Carmel River and San Clemente Creek

As documented in a white paper prepared for the Carmel River Steelhead Association, significantly reduced flows in the Carmel River and its tributaries, particularly San Clemente

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[72] National Marine Fisheries Service, "Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan" (July 2007), available at: http://www.swr.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf.
[73] *See* USGS, "What kinds of water data does the U.S. Geological Survey gather?" available at: http://www.usgs.gov/faq/index.php?action=artikel&cat=102&id=1148&artlang=en.
[74] Listing Policy, Section 6.1.1: Definition of Readily Available Data and Information (emphasis added).
[75] Klamath Resource Information System, http://www.krisweb.com/index.htm.
[76] Letter from W. Susie Santilena, Heal the Bay to Jeffrey Shu, SWRCB, Public Solicitation of Water Quality Data and Information for 2012 Integrated Report (Aug. 20, 2010).
[77] Letter from Doug Obegi, NRDC, to Jeffrey Shu, SWRCB, Public Solicitation of Water Quality Data and Information for 2012 Integrated Report (Aug. 27, 2010).
[78] Letter from Jason Weiner, Ventura County Coastkeeper, to Jeffrey Shu, SWRCB, Public Solicitation of Water Quality Data and Information for 2012 Integrated Report (Aug. 30, 2010) (incorporated herein by reference).

Creek, are placing serious stress on native steelhead populations.[79] This white paper, which includes a comprehensive bibliography of information, should be considered along with DFG data in assessing the Carmel River and San Clemente Creek for listing as impaired by water diversions/flow alterations.

Eel River

A comprehensive assessment of Eel River conditions shows significant impairment as a result of low flows.[80] The report found that:

> low flows . . . often produce temperatures lethal to listed fish species in the Eel River and beneficial to predatory pikeminnow, resulting in a compounding adverse effect on salmonids. Based on available science, increasing flows in the Eel River to 68-265 cfs in the summer will produce corresponding temperature benefits for salmonids that will likely support survival of the species. Bradbury et al (1995) point out that Pacific salmon cannot be recovered without having access to habitat similar to that with which they co-evolved; therefore, to ensure longer term salmonid recovery, access to refugia above the PVP must be provided.[81]

The report recommended that "[i]If summer flow levels were maintained at the 76 to 166 cfs . . . surface water temperatures would drop due to effects described above, increased volume and decreased transit time and steelhead could successfully rear . . . in the mainstem."[82] The flow conditions in the Eel have clearly impaired the health of the river and its associated beneficial uses, and accordingly the waterway must be listed.

Gualala River

The "National Marine Fisheries Service (NMFS, 2001), the California Department of Fish and Game (CDFG, 2002) and Brown et al. (1994) have found that coho salmon are at risk of extinction throughout Mendocino and Sonoma County."[83] With native species facing extinction, healthy water flows should be of paramount importance. However, "CDFG 2001 habitat typing surveys [citation] found that extensive reaches of the Gualala River and its tributaries lacked surface flows."[84] As in the Russian River, water diversions continue despite the serious and

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[79] *See* Appendix A.
[80] Patrick Higgins, Consulting Fisheries Biologist, "Evaluation of the Effectiveness of Potter Valley Project National Marine Fisheries Service Reasonable and Prudent Alternative (RPA): Implications for the Survival and Recovery of Eel River Coho Salmon, Chinook Salmon, and Steelhead Trout" (Feb. 2010) (included in Appendix A under "Eel River").
[81] *Id*. at p. 39 (emphasis added).
[82] *Id*.
[83] Letter from Patrick Higgins, Consulting Fisheries Biologist to Allen Robertson, California Department of Forestry and Fire Protection, "Negative Declaration for Sugarloaf Farming Corporation dba Peter Michael Winery" (Dec. 12, 2003)
[84] *Id*. at p. 10.

significant impairments in the Gualala, prompting a recent public trust lawsuit.[85] Significant data and information on the Gualala River is provided in Appendix A.

Mark West Creek

Ten years ago all 28 miles of Mark West Creek had water in the summer. Today, because of increased diversions, only 3½ miles have water. DFG flow records of Mark West Creek dating back to the 1960s show that the lowest summer stream flow has historically been 2 cfs, and Summer 2010 is measuring on average at approximately that level. The Russian Riverkeeper[86] has photo-documented this decline. Data and information on the serious and escalating impairments to this creek are provided in Appendix A-1[87] and on the Friends of the Mark West Watershed website.[88]

Mattole River

A detailed study of the Mattole River Basin found that:

> Lack of adequate late summer and early fall streamflow is recognized as one of the most important limitations on salmonid habitat in the Mattole River basin (NCWAP, 2000). In recent years, juvenile salmonids have become stranded in pools due to excessively low flows, causing mortality and necessitating fish rescue operations.[89]

Additional support for a flow-related listing of the Mattole River is found in Appendix A.

Napa River

Studies referenced in AB 2121 comments illustrate the significantly degraded habitat of the Napa River, which can only be restored with a focus on reversing severely reduced natural flows.[90] Research shows that "even in good years. . . 80% of tributary habitat surveyed was marginally functional or non-functional."[91] The Napa River "was formerly a very important nursery area for older age juvenile steelhead (Anderson 1969) . . . and that habitat is now completely non-functional for rearing. Therefore, all indications are that lack of older age steelhead rearing habitat is limiting the population."[92] Moreover, low water years (which are to

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[85] Center for Biological Diversity, "Lawsuit Imminent over Water Diversions Killing Salmon and Steelhead in Russian and Gualala Rivers," (Nov. 17, 2009), available at: http://www.biologicaldiversity.org/news/press_releases/2009/russian-river-11-17-2009.html.
[86] www.russianriverkeeper.org.
[87] Appended separately from Appendix A due solely to formatting requirements.
[88] http://www.markwestwatershed.org/Cornell_Winery_PrimerDocsDirectory.html.
[89] Randy D. Klein, Hydrologist, "Hydrologic Assessment of Low Flows in the Mattole River Basin 2004-2006," p. 1 (March 2007), *see* Appendix A.
[90] Letter from Patrick Higgins, Consulting Fisheries Biologist to SWRCB, "Comments on *Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams"* (April 2, 2008), pp. 13-15 (in Appendix A).
[91] Letter from Patrick Higgins, Consulting Fisheries Biologist to Thomas Lippe, Living Rivers Council (Aug. 17, 2010), p. 5 (included in Appendix A under "Napa River").
[92] *Id*.

be expected and built into water planning) are "depressing smolt production" due to a continued lack of attention to sufficient flows.[93]

Navarro River

As described in more detail in Appendix A, "diversions from the Navarro River and its tributaries, primarily for agricultural purposes, have significantly impaired instream fish and wildlife beneficial uses, to the point where the river was literally pumped dry" on past occasions.[94] Numerous data sets indicate growing impacts from cumulatively increasing water diversions in this already heavily-drained area.

Redwood and Maacama Creeks

As described in detail in Appendix A, in Maacama Creek "[s]tanding crops of fall fish show a major reduction in many years, suggesting that low flow conditions are limiting, and these low flow conditions are likely linked to agricultural water use."[95] "[A]lmost 70% of habitats in Redwood Creek [are] dry (Figure 12) and all other streams showed signs of dewatering related to diversion of surface water and likely contributed to by over-use of groundwater."[96] Additional assessments have found that

> in undisturbed Pacific Northwest streams, pool frequencies range from 37% to greater than 80% (Murphy et al. 1984 and Grette 1985) and CDFG (2004) rates frequencies greater than 40% as functioning for salmon and steelhead. Figure 12 shows that pool frequencies were under 10% on Redwood and Foote Creeks in some reaches and only about 25% of most Maacama Creek reaches. Pool depths are similarly compromised (Figure 13) with none over three feet deep in Foote Creek and the majority on Redwood Creek as well.[97]

This report concludes that "Coho salmon are at very high risk of extinction in the Russian River basin, yet NMFS (2008) considers their gene resources to be of extremely high importance for rebuilding of the entire CCC ESU. Expensive recovery efforts to restore Russian River coho salmon using captive broodstock from Green Valley Creek is failing to re-establish breeding populations in any Russian River tributary (NMFS 2008)."[98] Because "the biggest problem is over-consumption of water,"[99] listing of these waterways as impaired by natural flow alterations/water diversions is an important step in ensuring their return to good health.

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[93] *Id*.
[94] Letter from Patrick Higgins, Consulting Fisheries Biologist to SWRCB, "Comments on *Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams*," p. 15 (April 2, 2008).
[95] Letter from Patrick Higgins, Consulting Fisheries Biologist to Traci Tesconi, County of Sonoma, "Pelton House Winery Application #PLP05-0010," (Dec. 29, 2008), p. 12 (included in Appendix A).
[96] *Id*. at p. 13.
[97] *Id*. at pp. 12-13.
[98] *Id*. at p. 19.
[99] *Id*. at p. 20.

Russian River

As illustrated in documents attached as Appendix A[100] and elsewhere,[101] the Russian River is increasingly impaired due to flow alterations. Numerous technical analyses have found that "[l]egal and illegal diversions pose significant risk to the last streams where coho still persist in the Russian River."[102]

Salinas River

As described in more detail in Appendix A, "channel alteration and changes in flow regime have caused a virtual loss of the anadromous life history of three steelhead [distinct population segments] in the Salinas River."[103] More generally, "flows in lower reaches for adult and juvenile steelhead passage are often lacking,"[104] with "[g]roundwater pumping related to agricultural activities . . . caus[ing] the loss of surface flow in winter and spring."[105] This detailed analysis concluded that "unless the Salinas River channel and flow move back towards their more normal range of variability steelhead cannot be restored."[106]

Santa Clara River

As described in more detail in the comments submitted by Ventura Coastkeeper,[107] which are incorporated here by reference, USGS, county and local agency data show that enough water is diverted at the Vern Freeman Diversion Dam for agricultural usage, groundwater recharge, and other uses to deprive migrating steelhead of sufficient flows and juvenile steelhead of healthy estuary rearing grounds. These activities impact the beneficial uses for this river as habitat for fish, necessitating a listing caused by water diversion. Moreover, as discussed in the Ventura Coastkeeper letter, the river is also impaired for fish passage since the United Conservation Water District put in an impassable fish barrier.

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[100] *See* Letter from Patrick Higgins, Consulting Fisheries Biologist to SWRCB, "Comments on *Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams"* (April 2, 2008), pp. 16-20 (included in Appendix A under "Navarro River"). *See also* Merenlender, Adina et al, "Decision support tool seeks to aid stream-flow recovery and enhance water security," 62 *California Agriculture* 148 (Oct.-Dec. 2008), *available at*: http://ucanr.org/repository/cao/landingpage.cfm?article=ca.v062n04p148&fulltext=yes.

[101] *See supra* n. 85, "Lawsuit Imminent Over Water Diversions Killing Salmon and Steelhead in Russian and Gualala Rivers" (data associated with filing should be closely examined).

[102] Higgins, *supra* n. 100 at p. 16.

[103] Letter from Patrick Higgins, Consulting Fisheries Biologist to Curtis Weeks, Monterey County Resources Agency, Comments on Salinas River Channel Maintenance Project (CMP) 404 Permit Application and Mitigated Negative Declaration, p. 4 (Aug. 6, 2009).

[104] *Id*. at p. 5; *see also* Letter from Patrick Higgins, Consulting Fisheries Biologist to SWRCB, "Comments on *Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams"* (April 2, 2008).

[105] *Id*.

[106] *Id*. at p. 17.

[107] Letter from Jason Weiner, Ventura Coastkeeper to Jeffrey Shu, SWRCB, Public Solicitation of Water Quality Data and Information for 2012 Integrated Report (Aug. 30, 2010).

Scott River and Shasta River

In summer 2009, agricultural irrigation and dewatering caused record low flows in the Scott and Shasta River watersheds, flows that will continue to impair these waterways because they are associated with increased usage for agriculture and other, non-situational sources.[108] Extensive photo documentation of the activities producing this flow impairment and its impact on fish habitat was collected by Klamath Riverkeeper and others.[109] The Pacific Coast Federation of Fishermen's Associations and Environmental Law Foundation have already brought a public trust action[110] against the State Water Board and Siskiyou County regarding flows in the Scott River. Information associated with that lawsuit should be considered in the determination that the river is and will continue to be impaired due to low flows associated with withdrawals. Additional instream flow analyses are being conducted by Humboldt State University under the oversight of the California Ocean Protection Council.[111]

Documentation of the impacts of low flows in these waterways is extensive and included in Appendix A and other readily available data sources. For example, the Scott River Sediment and Temperature TMDL process several years ago produced substantial evidence of impaired beneficial uses resulting from low flows, including reaches that now regularly go dry, placing the Scott River salmon and steelhead stocks at "high risk of extinction"[112] Similarly, the recent Shasta River Watershed Dissolved Oxygen and Temperature process produced information supporting the conclusion that "[t]he need for a baseline minimum flow with most reaches of the Shasta River, and the importance to salmon . . . of maintaining minimum flows even during low water years, cannot be over-stated."[113] Properly listing these water bodies as impaired by flows, in addition to the other listed causes for their impairment, will ensure the appropriate attention is paid to addressing alterations in natural flow that are devastating the rivers' beneficial uses.

2. The Sacramento-San Joaquin Delta

Finally, *all* of the Delta waterways examined in the State Water Board's recently-adopted "Final Report on Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem" should be considered for flow impairments. This Report concluded unequivocally

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[108] See attached documentation in Appendix A.
[109] Klamath Riverkeeper, "Scott and Shasta Rivers 2009 Flow Emergency," available at: http://picasaweb.google.com/klamathriverkeeper/ScottAndShastaRivers2009FlowEmergency#.
[110] "Fishing and Conservation Groups Sue over Poor Water Management on Northern California's Scott River" (June 24, 2010) (press release), available at: http://www.envirolaw.org/documents/ScottRiverPTDSuitPressRelease062410.pdf; *see also* Petition for Writ of Mandamus and Complaint for Declaratory and Injunctive Relief (Sup. Ct. Sacramento, June 23, 2010), at: http://www.envirolaw.org/documents/WRITPETITIONCOMPLAINT.pdf.
[111] CA Ocean Protection Council, "Instream Flow Analysis – Shasta River," available at http://www.opc.ca.gov/2009/05/instream-flow-analysis-shasta-river/.
[112] Letter from PCFFA *et al* to Tam Doduc, SWRCB, "Joint Comments on the Proposed Action Plan for the Scott River Watershed Sediment and Temperature TMDL," Attachment A - Scott TMDL Related Data, Photos and Maps Regarding Flow and Temperature Problems (June 12, 2006) (included in Appendix A).
[113] Letter from Pacific Coast Federation of Fishermen's Associations and the Institute for Fisheries Resources to SWRCB, "Comment Letter - Shasta River Watershed DO and Temperature TMDLs," p. 4 (Oct. 29, 2006) (included in Appendix A).

that **"[r]ecent Delta flows are insufficient to support native Delta fishes for today's habitats."**[114] More specifically, the Report found that:

> In order to preserve the attributes of a natural variable system to which native fish species are adapted, many of the criteria developed by the State Water Board are crafted as percentages of natural or unimpaired flows. These criteria include:
>
> - 75% of unimpaired Delta outflow from January through June;
> - 75% of unimpaired Sacramento River inflow from November through June; and
> - 60% of unimpaired San Joaquin River inflow from February through June.
>
> It is not the State Water Board's intent that these criteria be interpreted as precise flow requirements for fish under current conditions, but rather they reflect the general timing and magnitude of flows under the narrow circumstances analyzed in this report. In comparison, historic flows over the last 18 to 22 years have been:
>
> - approximately 30% in drier years to almost 100% of unimpaired flows in wetter years for Delta outflows;
> - about 50% on average from April through June for Sacramento River inflows; and
> - approximately 20% in drier years to almost 50% in wetter years for San Joaquin River inflows.[115]

In other words: (a) the Delta is always impaired for flow in drier years and potentially impaired seasonally in wetter years, (b) the Sacramento River is regularly flow impaired, and (c) the San Joaquin River is always flow impaired. Note that this comparison is based on averages over the past two decades; flow data from more recent years (available from the citations above and other readily available sources) would likely skew these results towards more, not less, impairment, as noted in the Report quote above.

Accordingly, *all* Delta waterways for which the Report has found flow-related impairments of beneficial uses should be listed in the 2012 303(d) list as impaired by water diversion, flow alteration, and/or other appropriate cause, with the specific sources (agriculture, etc.) clearly delineated.

D. The State Must Specifically Identify and List All Surface Waters That Can No Longer Provide the Beneficial Use of "Groundwater Recharge" Due to Reduced Flows

"Groundwater recharge" is defined as the use of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers. "Groundwater recharge" is listed as a beneficial use for 2,167 hydrologic units/areas in eight out of nine of the Regional Basin Plans for surface waters around the state: North Coast: 109, San Francisco Bay: 23, Central Coast: 396, Los

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[114] Delta Flow Report, *supr*a n. 59, at p. 5 (emphasis added).
[115] *Id*.

Angeles: 222, Central Valley: 0,[116] Lahontan: 1009, Colorado River: 93, Santa Ana: 98, San Diego: 217.[117] Despite the widespread recognition of "groundwater recharge" as a beneficial use by Regional Water Boards, the protection of this use has been rarely acknowledge or addressed by the 303(d) listing process. This must be rectified in the 2012 list.

The State Water Board's map of high-use groundwater basins and hydrogeological areas depicts vulnerable groundwater recharge basins in every region of California.[118] In many of California's river basins, agricultural and other users divert surface stream flows to the extent their actions impair the groundwater recharge beneficial use. Similarly, in river basins with a hydrologically connected groundwater aquifer that is being pumped, large scale groundwater pumping depletes the connected surface waterway, further diverting percolation from the stream into the aquifer and impairing the "groundwater recharge" beneficial use of impacted surface water.[119] The State can and should incorporate such listings in the 2012 list, *i.e.* where readily available data provides the information needed to identify water bodies for which designated "groundwater recharge" uses are threatened or impaired.

IV. THE STATE WATER BOARD MUST COMPREHENSIVELY ADDRESS GROUNDWATER CONTAMINATION AND WITHDRAWALS THAT IMPAIR OR THREATEN SURFACE WATERS.

The State's 303(d) list must reflect instances where contaminated groundwater discharges to rivers, estuaries and other surface waters is the cause or source of surface water impairment. California's Section 303(d) list must also reflect instances where excessive withdrawals and pumping of groundwater impairs and threatens surface waters, including rivers, creeks, estuaries, and wetlands, such as through reduced flows.[120]

Actions to address groundwater sources of surface water impairment with specificity are feasible and have been undertaken by California and other states during the course of 303(d) listing and TMDL development. California and other states have shown that it is feasible—and often necessary—to identify and address groundwater sources of surface water impairment with high levels of specificity during the development of a TMDL. The State Water Board should require Regional Water Boards to identify the name of groundwater sources of surface water impairment, including the name of groundwater basins, point source discharges from cleanup and dewatering operations, and other relevant sources; assess and measure groundwater loading

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[116] The Central Valley Regional Water Quality Control Board explains that there are surface waters that have the beneficial use of Groundwater Recharge, but that they have not yet been identified: "NOTE: Surface waters with the beneficial uses of Groundwater Recharge (GWR),Freshwater Replenishment (FRSH), and Preservation of Rare and Endangered Species (RARE) have not been identified in this plan. Surface waters of the Sacramento and San Joaquin River Basins falling within these beneficial use categories will be identified in the future as part of the continuous planning process to be conducted by the State Water Resources Control Board." *See* http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr.

[117] *See* Chapter 2 of Basin Plans for Regions 1-9 at http://www.waterplan.water.ca.gov/waterquality/basin_plan.cfm.

[118] http://www.waterboards.ca.gov/water_issues/programs/gama/docs/hydro_areas.pdf.

[119] J. Daubert, R. Young, *Managing an Interrelated Stream-Aquifer System, Economics, Institutions, Hydrology,* Colorado Water Resources Research Institute, Technical Report #47, p. 1 (April 1985). Available at: http://www.cde.state.co.us/artemis/ucsu6/UCSU6141347INTERNET.pdf.

[120] A detailed discussion of flow impacts to water quality can be found in Section III.

to surface waters during the development of TMDLs; and assign wasteload allocations to groundwater sources of impairment to surface waters, to the extent possible. Please refer to Appendix B for a synopsis of TMDLs in California and elsewhere that address how to manage groundwater loadings with specificity.

A. The State Water Board Has a Duty to Address Groundwater-Related Sources of Impairment to Surface Waters under Section 303(d) of the Clean Water Act.

1. The hydrological connectivity of surface waters and groundwater triggers the Board's legal mandate under Section 303(d) of the Clean Water Act.

Because of the pervasive hydrological connectivity of surface waters and groundwater, polluted groundwater can substantially impact the quality of surface waters.[121] Streamflow may recharge alluvial aquifers, and groundwater conversely can provide substantial amounts of flows into lakes, streams, and rivers.[122] The hydrological connectivity is widely interpreted—by U.S. EPA, courts, and several states, including California—as triggering a regulatory duty under the Clean Water Act.

For example, U.S. EPA has stated that "in general, collected or channeled pollutants conveyed to surface water via groundwater can constitute a discharge subject to the Clean Water Act."[123] The determination of whether a discharge to ground water can be subject to regulation under the Clean Water Act is a determination that involves an ecological "judgment about the relationship between surface waters and groundwaters."[124]

Courts have also found that hydrologically connected groundwater and surface waters can trigger regulatory duties with respect to contaminated groundwater under the federal Clean Water Act.[125] In 2006, U.S. Supreme Court Justice Kennedy wrote in his concurring and oft-cited *Rapanos* opinion that water bodies will "come within the statutory phrase 'navigable

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[121] United States Geological Survey, Ground Water and Surface Water: A Single Resource, Circular 1139, available at: http://pubs.usgs.gov/circ/circ1139/ ("*USGS: Single Resource*"). *See also* R. Thomas, *Comment: The European Directive on the Protection of Groundwater, A Model for the United States,* 26 Pace Envtl. L. Rev. 259, 264 (Winter 2009) ("*Groundwater Protection Model*") ("… groundwater does not exist in isolation from other bodies of water; it is an integral part of the hydrological cycle and discharges into lakes and streams. Such "tributary" groundwater is vital for maintaining surface water supplies and sustaining surface ecosystems"); William M. Alley, "Tracking U.S. Groundwater: Reserves for the Future," *Environment*, pp. 10, 15 (Apr. 2006); *see also* William M. Alley *et al.,* "Flow and Storage in Groundwater Systems," 296 *Sci*. 1985, 1990 (2002).

[122] *See* Aiken, J. David, The Western Common Law of Tributary Groundwater: Implications for Nebraska. (2004) at p. 545, available at http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1032&context=ageconfacpub. *See also USGS: Single Resource*: USGS finds that groundwater contribution to surface waters has been shown to range from 10% to over 90% across the U.S., with an estimated average of over 40%.

[123] EPA, *National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitations Guidelines and Standards for Concentrated Animal Feeding Operations* 66 Fed. Reg. 2960, 3017 (Jan. 12, 2001).

[124] 66 Fed. Reg. at 3018 (emphasis added.)

[125] *See e.g. Greater Yellowstone Coalition v. Larson,* 641 F. Supp. 2d 1120, 1138 (D. Idaho 2009) ("[t]here is little dispute that if the ground water is hydrologically connected to surface water it can be subject to 401 certification."); *Coldani v. Hamm*, 2007 WL 2345016, at 9 (E.D. Cal. Aug. 16, 2007) ("the court finds that because Coldani has alleged that Lima Ranch polluted groundwater that is hydrologically connected to surface waters that constitute navigable waters, he has sufficiently alleged a claim within the purview of the CWA [citations]")

waters,'" and thereby fall under the Clean Water Act, if they "significantly affect the chemical, physical, and biological integrity of other covered waters more readily understood as 'navigable.'"[126]

The Ninth Circuit Court of Appeals has also repeatedly interpreted the Clean Water Act to include regulation of groundwater hydrologically connected to surface waters.[127] In *Northern Plains Resource Council v. Fidelity Exploration* the Ninth Circuit found that even the discharge of "unaltered" groundwater into a river could be considered a pollutant and subject to water quality standards where the company's discharge altered the river's water quality.[128] The *Northern Plains Resource Council* opinion went on to explain that:

> Were we to conclude otherwise, and hold that the massive pumping of salty, industrial waste water into protected waters does not involve discharge of a "pollutant," even though it would degrade the receiving waters to the detriment of farmers and ranchers, we would improperly "undermine the integrity of [the CWA's] prohibitions."[129]

Section 303(d) of the Clean Water Act, in particular, has been recognized by U.S. EPA and several states as a proper tool for addressing groundwater contaminant loading to surface waters and other groundwater-related sources of impairment. EPA has identified four potential sources of groundwater-related impairment of surface water for states' 303(d) Lists (though others are possible): "Groundwater Loadings," "Groundwater Withdrawals," "Contaminated Groundwater," and "Saltwater Intrusion."[130] EPA records reflect that several states, including California, have adopted 303(d) lists that include groundwater loadings or withdrawals as a source of impairment: **to date, 181 miles of rivers and streams, 158 square miles of bays and estuaries, 3,045 acres of wetlands, and 98,009 acres of lakes, reservoirs and ponds have been listed nationally as impaired in part due to groundwater sources of impairment.**[131]

2. <u>Public policy concerns of efficiency and public health weigh heavily in favor of proactively addressing groundwater contamination of surface waters through the 303(d) process</u>.

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[126] *Rapanos v. United States*, 547 U.S. 715, 779-780 (2006) (Kennedy, J., concurring).
[127] *N. Cal. River Watch v. City of Healdsburg*, 496 F.3d 993, 1000 (9th Cir. 2007) (court found that water that seeped into the river through both the surface wetlands and the underground aquifer and had significant effect on "the chemical, physical, and biological integrity" of the Russian River sufficient to confer jurisdiction under the Act pursuant to Justice Kennedy's substantial nexus test.); *Northern Plains Resource Council v. Fidelity Exploration and Dev. Co*., 325 F.3d 1155, 1162 (9th Cir. 2003).
[128] *Northern Plains Resource Council v. Fidelity Exploration and Dev. Co*., 325 F.3d 1155 (9th Cir. 2003).
[129] *Id*., citing *APHETI*, 299 F.3d at 1016.
[130] *See* U.S. EPA, "National Summary of State Information: National Probable Sources Contributing to Impairments," available at: http://iaspub.epa.gov/waters10/attains_nation_cy.control#causes, and U.S. EPA, "Specific State Probable Sources That Make Up the National Groundwater Loadings/Withdrawals Probable Source Group," available at: http://iaspub.epa.gov/tmdl_waters10/attains_nation_cy.source_detail?p_source_group_name=GROUNDWATER%20LOADINGS/WITHDRAWALS.
[131] *Id*. California has also recognized groundwater sources of impairment on its 303(d) List. The most recent 2010 303(d) List contains 27 waterbody-segment pollutant combinations that identify groundwater loadings as potential sources of impairment.

There are considerable practical reasons to address groundwater loadings with as much specificity as possible. For example, rapid mixing, dilution, and dispersal of pollutants, which are factors that often mitigate surface water contamination, do not occur with polluted groundwater,[132] resulting in much lengthier persistence of pollutants and their harmful effects. Moreover, the costs, difficulties, and uncertain benefits of remediation weigh strongly in favor of efficient agency action to address groundwater pollution.[133]

Additionally, addressing groundwater contamination of surface waters is necessary to protect public health.[134] Discharges from septic systems and agricultural runoff can cause waterborne diseases and chemicals found in groundwater, including pesticides, gasoline additives such as MTBE, arsenic, and other hazardous wastes, present significant threats.[135]

The state's pending public health crisis fueled by nitrate-polluted groundwater provides a particularly compelling example. Nitrate, the most common groundwater contaminant in California in drinking water can cause "blue baby syndrome," lead to miscarriages and death in infants, and may cause certain types of cancers. A recent California Watch report found that the number of California wells that exceeded the health limit for nitrates jumped from nine in 1980 to 648 in 2007. To date, the State Board has not been able to effectively regulate and ensure the cleanup of nitrates. The 303(d) process was designed to do just that and should be applied to address nitrate and other pervasive groundwater contaminants that impact surface waters. Such efforts will at the same time help establish much-needed improvements in groundwater quality itself.

B. The State Must Use All Readily Available Data to Specifically Identify Surface Waters Impaired by Contaminated Groundwater Loadings.

As discussed above, under federal law[136] and the California Listing Policy, the State and Regional Water Boards must "actively solicit, assemble, and consider all readily available data and information, including drinking water source assessments and existing and readily available water quality data and information reported by local and state agencies."[137] Information regarding groundwater impairments that contaminate surface waters, groundwater hydrological connections with surface waters, and groundwater withdrawals that impact surface waters is essential in the compilation of a complete 303(d) list that correctly identifies pollutants and sources that can then be effectively prioritized.[138] Further, groundwater data can provide valuable clues to uncover the existence of hydrologically-connected, impaired surface water bodies that the state may otherwise have missed.

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[132] 2006 Guidance.
[133] *Id*.
[134] *See* Harter, T. & Rollins, L., *Watersheds, Groundwater and Drinking Water: A Practical Guide,* University of California, Agriculture and Natural Resources, Publication 3497 (2008).
[135] *Supra* n. 121, *Groundwater Protection Model* at 263.
[136] 40 CFR 130.7(b)(5), see http://law.justia.com/us/cfr/title40/40-21.0.1.1.17.0.16.8.html
[137] *See* CA Listing Policy, Section 6.1.1 Definition of Readily Available Data and Information
[138] 40 CFR 130.7(b)(4).

The State's own 2002 305(b) Report contains an extensive catalog of efforts and available data to monitor groundwater quality in California."[139] It is worth noting that the most recent groundwater quality assessment included in the State's 305(b) Report will be a *decade* old in 2012. By contrast, EPA's 2006 Guidance contemplates the completion of such assessments every two years:

> by April 1 of all even numbered years, a description of the water quality of all waters of the state (including, rivers/stream, lakes, estuaries/oceans and wetlands). States may also include in their section 305(b) submittal a description of the nature and extent of ground water pollution and recommendations of state plans or programs needed to maintain or improve ground water quality.[140]

Updated monitoring and assessment of groundwater quality is highly relevant to the state's proper assessment of the overall health of its waterways as called for by the federal Clean Water Act. These and other readily available sources of information and data on groundwater contamination and withdrawals must be integrated into the State Water Board's analysis of impairment sources of surface waters in its biennial Integrated Report (303(d) list and 305(b) report).[141] A brief discussion of data that should be incorporated immediately in the current data scoping for the 2012 303(d) List is provided below.

First, the State Water Board should assess its own data from its Groundwater Ambient Monitoring and Assessment (GAMA) Program and Underground Storage Tank, Land Disposal, and Spills, Leaks, Investigations, and Cleanup Programs in its biennial 303(d) analysis. The GeoTracker GAMA Groundwater Database contains groundwater data searchable by chemical and is readily available, highly relevant and compatible to specify groundwater loadings to listed surface waters. Additionally, the California Water Quality Monitoring Council, which is co-chaired by Cal-EPA and the Natural Resources Agency and managed by the State Water Board, is very close to completing an interactive suite of databases to be released shortly on groundwater quality. This portal of information compiles existing groundwater quality data from USGS and others that similarly should be examined for 303(d) listing implications.

The State Water Board should also closely collaborate with and solicit groundwater quality data held by other state agencies, most notably the Department of Pesticide Regulation (DPR) and California Department of Public Health (DPH). DPR's Ground Water Protection Program[142] maintains a well inventory program that contains information about the collection and analysis of data on wells sampled for pesticides by state and local agencies, as well as DPR's own monitoring of pesticides that have the potential to pollute groundwaters.[143] Under the Safe Drinking Water Act, each state is required to assess drinking water sources, including

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[139] SWRCB, 2002 Integrated Report, Chapter IV: Groundwater Quality Assessment, available at: http://www.swrcb.ca.gov/water_issues/programs/tmdl/305b.shtml.

[140] 2006 Guidance at 9.

[141] *See* 2006 Guidance for details on U.S. EPA requirements for the inclusion of updated groundwater data in the state's biennial Integrated Report (http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/2006IRG_index.cfm).

[142] *See* California Department of Pesticide Regulation, Groundwater Protection Programs website at http://www.cdpr.ca.gov/docs/emon/grndwtr/index.htm.

[143] Well Inventory Reports on Ground Water Testing for Pesticides from 1986-2008, and other data and information is available at http://www.cdpr.ca.gov/docs/emon/grndwtr/wellinv/wirmain.htm.

groundwater wells. California DPH is currently implementing these requirements as part of the Drinking Water Source Assessment and Protection Program (DWSAP), which includes an assessment of 14,326 groundwater sources.[144] Several other state agencies implement groundwater-related monitoring and assessment programs, such as the Department of Water Resources (DWR) and Department of Toxic Substances Control (DTSC); these must be solicited for data as well.

Local groundwater management districts and banks also must be solicited for information on the contamination and overuse of groundwater basins and aquifers that are hydrologically connected to impaired surface waters. The Santa Clara Valley Water District, for example, monitors groundwater quality for common inorganic constituents and identifies which contaminants exceed Regional Water Quality Control Board agricultural water quality objectives.[145] There are also nine local groundwater management districts[146] in California that maintain groundwater data, as well as watermasters[147] and other local entities that maintain data and information about groundwater water quality.

Additionally, federal agencies that implement groundwater-related monitoring and assessment programs, such as U.S. EPA and the United States Geological Survey (USGS),[148] must be "actively solicited" for information. In 2007, USGS conducted an analysis of California's well water quality that examined the presence of 11 contaminants in groundwaters including arsenic, atrazine, benzene, nitrate, radon, and uranium.[149] California Coastkeeper Alliance created two interactive maps depicting groundwater polluted by nitrates and arsenic, primarily relying on these USGS data.[150] Other independent researchers have developed excellent maps of nitrate and other incidences of groundwater pollution that may impact surface waters.[151] This and related information should be carefully scanned for related impacts to hydrologically-connected surface water bodies.

Finally, data on groundwater withdrawals and pumping that impairs or threatens surface water beneficial uses similarly must be solicited and considered. The State Water Board's Water Rights division has such data, which could be cross-referenced with streamflow and other data from numerous other sources.[152] The Santa Clara Valley Water District monitors groundwater elevation and maintains a database of elevation data, searchable by location or well number.[153]

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[144] *See* California Department of Health, Drinking Water Source Assessment and Protection Program, January 1999. Available at http://www.cdph.ca.gov/certlic/drinkingwater/Documents/DWSAPGuidance/DWSAP_document.pdf.
[145] Table 3-3a, Santa Clara Valley Water District, 2008 Groundwater Quality Report.
[146] A list of groundwater management district can be found at DWR, Water Facts: Groundwater Management Districts or Agencies in California, available at http://www.dpla2.water.ca.gov/publications/waterfacts/water_facts_4.pdf.
[147] *See* Chino Basin Watermaster Engineering Reports: http://www.cbwm.org/rep_engineering.htm.
[148] *See, e.g.*, USGS Groundwater Information Pages, http://water.usgs.gov/ogw/ and information on what type of data USGS collects at http://www.usgs.gov/faq/index.php?action=artikel&cat=102&id=1148&artlang=en.
[149] Excerpt of California data available at http://www.cacoastkeeper.org/document/ca-domestic-well-water-quality.pdf.
[150] *See* http://www.cacoastkeeper.org/programs/mapping-initiative/nitrates-in-groundwater-maps and http://www.cacoastkeeper.org/programs/mapping-initiative/arsenic-in-groundwater-maps.
[151] *See* California Watch Report, *Nitrate Contamination Spreading in California Communities* (May 13, 2010), available at: http://www.californiawatch.org/nitrate-contamination-spreading-california-communities.
[152] *See* Section III. above for additional sources of flow- and pumping-related data. Future data collected pursuant to SB X7 6 (2009), which establishes collaborations to collect groundwater elevations statewide, will provide

If the State Water Board declines to use such readily available data and information related to groundwater loadings that threaten or impair surface waters, the Board *must* submit a formal "rationale" for the decision in its Assessment Methodology.[154] EPA requires that states' submissions of 303(d) Lists include an Assessment Methodologies section, which includes a "rationale for any decision to not use any existing and readily available data and information."[155] We urge the Water Board, however, to fully exercise its authority and mandate to comprehensively assess and report on the health of all waterways in the state, as required by the 2006 Guidance and Clean Water Act Sections 303(d) and 305(b).

C. The State Water Board Must Ensure that Groundwater Sources of Surface Water Impairment Are Specifically Identified in All Affected Regions of California.

The State Water Board has made progress in identifying groundwater "sources" of surface water impairment in its 303(d) assessment and listing process.[156] Whereas the 2006 303(d) List contained only two references to groundwater as a source of impairment,[157] the 2010 303(d) List contains 27 water body-pollutant segments which identify groundwater as a source of impairment. This type of information is extremely useful in prioritizing waters for action and setting appropriate loads.

Despite the Board's progress, though, groundwater sources of contamination are not identified consistently throughout California's nine regions, nor is there enough information included about groundwater loadings on the List as with other listed sources of impairment. The majority of groundwater-related listings in the 2010 303(d) List are limited to Regions 3 and 4, with only one listing each in Regions 5, 6, and 8. Further, where the Board has identified groundwater contamination as a source of impairment, the groundwater basins and the extent of contaminant loading has not been identified specifically.

The problem of contaminated groundwater loadings to surface waters is not limited to 27 waterbody-pollutant segments, nor is it limited to Regions 3 and 4; it is a pervasive issue that must be proactively addressed throughout the State's 303(d) Listing Process. There are myriad examples spanning the entire state of contaminated groundwater impacts to surface waters. For example, researchers working in San Francisco Bay found that excess levels of certain dissolved

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additional information (DWR is in the process of launching the California Statewide Groundwater Elevation program).

[153] Santa Clara Valley Water District Online Groundwater Elevation Query, available at: https://gis.valleywater.org/GroundwaterElevations/index.asp.

[154] 40 CFR 130.7(b)(6)(iii); U.S. EPA 2006 Guidance, Section C.2, p. 18 ("The assessment methodology should be consistent with the state's WQSs and include a description of the following as part of their section 303(d) list submissions … Rationales for any decision to not use any existing and readily available data and information."). Note that EPA's subsequent Guidance documents for 2008 and 2010 incorporate the 2006 Integrated Reporting Guidance.

[155] 2006 Guidance at 18.

[156] *See* discussion of Source versus Cause in Section III. above.

[157] "Groundwater withdrawal" was listed as a source of impairment of a surface water in only one listing in 2006 (Mendota Pool in Region 5). Lake Tahoe listed "groundwater loadings" as a source of impairment. See www.waterboards.ca.gov/water_issues/programs/tmdl/docs/303dlists2006/epa/state_06_303d_reqtmdls.pdf.

metals in the Bay resulted in large part from groundwater seepage.[158] Similarly, nitrate contamination of groundwaters in California Central Coast valleys, such as Salinas, has become a national example of how fertilizers can impact public health and water quality.[159] For example, the Salinas River is severely impaired by nutrients and nitrates, flows of which often originate from groundwater tainted by irrigation releases.[160] In 2007, the Central Coast Regional Quality Control Board staff investigated reports of heavily nutrient-contaminated discharges from greenhouses near the City of Carpinteria, finding that such discharges of groundwater contribute to existing nutrient impairments in the Carpinteria Salt Marsh and its tributary streams.[161]

Data from the Malibu Watershed,[162] Los Osos,[163] and San Francisco Bay Area[164] demonstrate another pervasive form of surface water pollution caused by groundwater: septic tank releases that reach coastal waters, estuaries and other surface waters. For example, a recent Stanford study found that contaminated groundwater discharging from a small stretch of Stinson Beach was contributing as much nutrient flux to nearshore coastal waters as *all* local creeks and streams in the Bolinas Lagoon drainage.[165]

Southern California surface waters are particularly impacted by contaminated groundwater and excessive withdrawals and pumping. In particular, a number of Orange

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[158] Spinelli, G.A. *et al*., "Groundwater seepage into northern San Francisco Bay: Implications for dissolved metals budgets," *Water Resources Research*, 38(10.1029/2001WR000827) (2002). The researchers sought to quantify groundwater seepage and bioirrigation rates in the area to determine their roles in transporting dissolved metals from benthic sediments to surface waters. After applying their groundwater flow seepage model to northern San Francisco Bay, the researchers found that "benthic fluxes of dissolved metals to the surface waters could account for a relatively large amount (<60%) of the unknown sources of dissolved cobalt and a relatively small amount (<4%) of the unknown sources of dissolved silver, cadmium, copper, nickel, and zinc." *Id*. at 1 (Abstract).

[159] Robert E. Criss "Fertilizers, water quality, and human health," *Environmental Health Perspectives*. FindArticles.com. Aug 23, 2010. http://findarticles.com/p/articles/mi_m0CYP/is_10_112/ai_n15688580/.

[160] *See* USGS, J. Kulongoski, K. Belitz, *Ground-Water Quality Data in the Monterey Bay and Salinas Valley Basins, California, 2005—Results from the California GAMA Programs*, Data Series 258, available at: http://pubs.usgs.gov/ds/2007/258/pdf/DS_258.pdf.

[161] Staff concluded that the discharges were either the result of sump pumping activities conducted by greenhouse operators or groundwater leaching into the storm drain system and then Arroyo Paradon creek. These discharges of groundwater contribute to existing nutrient impairments in the Carpinteria Salt Marsh and its tributary streams. Data and information on file with Santa Barbara Channelkeeper.

[162] Santa Monica Bay Restoration Commission, "Risk assessment of septic systems in lower Malibu Creek watershed" (2001) (Characterizes vulnerability of Malibu Creek and Lagoon and Surfrider Beach to contamination from on-site septic systems in the Malibu Civic Center).

[163] Central Coast Regional Water Quality Control Board, "Los Osos Water Quality Project and Status of Sewer Project" (October 2005), available at: http://www.swrcb.ca.gov/rwqcb3/water_issues/programs/los_osos/docs/master_docs/2005_10_los_osos_water_quality_impacts_and_status_of_sewer_project.pdf ("Los Osos septic tanks are causing severe environmental problems in Morro Bay and surrounding areas. This is a surface water (Morro Bay National Estuary) problem in addition to a groundwater problem").

[160] Alexandria B. Boehm, Gregory G. Shellenbarger, Adina Paytan, "Groundwater Discharge: Potential Association with Fecal Indicator Bacteria in the Surf Zone" *Environmental Science & Technology* 38 (13), 3558-3566 (2004) (this work establishes a mechanism for the subterranean delivery of fecal indicator bacteria pollution to the surf zone from the surficial aquifer and presents evidence that supports an association between groundwater discharge and FIB). See http://www.stanford.edu/~aboehm/research.htm for this and additional information.

[165] N. de Sieyes, *et al*., "Submarine Groundwater Discharge to a High-Energy Surf Zone at Stinson Beach, California, Estimated Using Radium Isotopes," *Estuaries and Coasts*, DOI 10.1007/s12237-010-9305-2 (Apr. 2010).

County's coastal creeks and waterways receive significant amounts of groundwater and have been seriously impacted by contamination.[166] The Chino Basin, one of the largest groundwater basins in Southern California,[167] contains a high concentration of dairies that contribute high concentrations of salts and nitrates that degrade the water quality of Orange County's groundwater basin, and ultimately, the Santa Ana River, resulting in significant water treatment costs for residents.[168]

The State Water Board's "Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List" makes clear that for each water body-pollutant combination proposed for the 303(d) list, the Regional Water Quality Control Board must prepare fact sheets. These fact sheets must identify a pollutant's potential source, and "the source category should be identified as specifically as possible."[169] As Regional Water Boards increasingly identify groundwater loadings as a source of surface water impairments, the State Water Board should encourage this progress and work to ensure that the Regional Boards specify the name, location, size, and other identifying data for the groundwater basins at issue as much as possible in the proposed 2012 303(d) list. This information is necessary in order to identify, analyze, and clean up ground water sources of surface water impairment.

This progression in increasing specificity of information is contemplated by U.S. EPA, which recommends in its 2006 Integrated Report Guidance that states use a combination of monitoring and assessment techniques to "increase the percentage and types of waters assessed,"[170] waters that "may include, but are not limited to . . . *ground water*."[171]

As described in Appendix B, there is significant precedent around the country for actively using groundwater data to ensure the proper identification of the extent and sources of surface water impairments, and cleaning up all of those sources (including the groundwater), with the goal of ensuring healthy waterways. The state can and should follow this path to healthy waterways. To do this, the state *must* update its 2002 Groundwater Quality Assessment[172] in the 2012 Integrated Report. Further, the State Water Board, in close collaboration with Regional Water Boards, must go beyond recognizing where groundwater contamination is a possible source of impairment. The State and Regional Water Boards should proactively identify, analyze, and clean up groundwater sources of surface water impairment to ensure the full health of both its groundwater and surface water bodies.

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[166] *See* "Orange County Water District adopts resolution targeted at dairies in Chino Basin" *U.S. Water News Online* (December 1999), available at http://www.uswaternews.com/archives/arcpolicy/9oracou12.html.
[167] The Chino Basin contains approximately 5,000,000 acre-feet of water. *See* Chino Basin Watermaster Overview http://www.cbwm.org/overview.htm.
[168] *Supra* note 166.
[169] 2006 Guidance at p. 19 (Section 6.1.2.2(K)).
[170] *Supra* n. 1, 2006 Guidance, at Appendix: Data Elements for 2006 Integrated Water Quality Monitoring and Assessment Report and Documentation for Defining and Linking Segments to the National Hydrography Dataset, p. A-8, available at: http://www.epa.gov/owow/tmdl/2006IRG/report/2006irg-appendix.pdf.
[171] *Id.*at A-1 (emphasis added).
[172] http://www.swrcb.ca.gov/water_issues/programs/tmdl/305b.shtml.

D. The State Must Specifically Identify Surface Waters Impaired by Excessive Groundwater Withdrawals and Pumping.

As described in detail in Section III. above, Clean Water Act Section 303(d) lists must also reflect instances where excessive withdrawals and pumping of groundwater impair and threaten surface waters, particularly through flow alterations. Large-scale pumping and withdrawals of groundwater for agricultural irrigation threaten entire hydrological systems in many areas of California and reduce surface water flows to the detriment of a waterway's beneficial uses.[173]

For example, Northern California's Scott River is so dependent on groundwater that the Legislature amended the California Water Code to formally declare that "by reason of the geology and hydrology of the Scott River, it is necessary to include interconnected ground waters in any determination of the rights to the water of the Scott River as a foundation for a fair and effective judgment of such rights."[174] The State Water Board's assessment of groundwater withdrawal impacts on surface water quality is equally necessary.

The expansion of groundwater-fed agriculture in the Scott Valley is draining the connected, once-mighty Scott River dry. Decreased base flow during summer months increases water temperature and decreases surface water depth, velocity, connectivity which prevents the necessary pollutant load reductions from being realized.[175] Severely reduced flows in the Scott River from groundwater pumping recently prompted legal action by the Pacific Coast Federation of Fisherman's Association and Environmental Law Foundation.[176] In summer 2009, reduced flows in the Scott Valley caused the salmon population to drop down to 81 adults, down from many tens of thousands decades earlier.[177] The groups filed suit against the State Water Board and Siskiyou County for violating the public trust doctrine by allowing unchecked groundwater use to the detriment of the Scott River and several dependent special status fish and wildlife. In addition to having a public trust duty, the State has a legal duty under Section 303(d) of the Clean Water Act to address all sources of surface water impairment.

The lesson of the Scott River and other affected surface waters is that when excessive groundwater withdrawals outpace water recharge, groundwater overdraft occurs, which can directly impact surface waters by diminishing the amount of groundwater that flows into surface waters.[178] Pumping groundwater without regard to streamflow can "turn gaining streams into

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[173] Macdonnel, *supra* n. 31 at 1090, citing Glennon, R., *infra* n. 179.
[174] Cal. Water Code Section 2500.5(b) (2005).
[175] *See* para. 21-22, Pet. for Writ of Mandamus and Complaint for Declaratory and Injunctive Relief filed on June 23, 2010 by Environmental Law Foundation, Pacific Coast Federation of Fisherman's Association, Institute of Fisheries Resources ("PCFFA Scott River Petition") available at http://www.envirolaw.org/documents/WRITPETITIONCOMPLAINT.pdf.
[176] *Id*.
[177] *See* entire PCFFA Scott River Petition, *supra* n. 110. *See also* text and photo accompanying "A Watery Balancing Act" http://www.sfgate.com/cgi-bin/blogs/lsheehan/detail?entry_id=66993.
[178] *See* Glennon, R., *Water Follies: Groundwater Pumping and the Fate of America's Freshwaters*, p. 32 (Island Press, Washington, D.C 2004) ("Along coastal areas, overdrafting may cause the intrusion of salt water into the aquifer, rendering the water no longer potable. This problem is quite serious in California, Florida, and South Carolina."). *See also* Howard J., Merrifield M., *Mapping Groundwater Dependent Ecosystems in California* (2010)

losing streams, and perennial streams into intermittent streams."[179] This alteration to a water body's natural flow creates a cascade of negative impacts on aquatic life and ecosystems, and can destroy a water body's beneficial uses.

Nationally, by far the largest number of groundwater-related impairments of surface waters occurs as a result of groundwater withdrawals, including 97,546 acres of lakes, reservoirs, and ponds, and 3,456 acres of wetlands.[180] As described in Appendix B, other states are taking action to protect surface waters from harmful groundwater withdrawals. For example, in 2000, the Washington Supreme Court upheld the state Department of Ecology's denial of applications for new groundwater withdrawals that would diminish protected stream flows in *Postema v. Pollution Control Hearings Board*.[181] The Michigan Legislature is currently considering a bill that would codify the applicability of the public trust doctrine to groundwater[182] to protect water supplies and connected surface waters from excessive groundwater withdrawals.[183]

Despite a growing movement nationwide to address groundwater withdrawals that affect the health of surface waters, "Groundwater withdrawal" is listed as a source of impairment of a surface water body in only two listings in the State Water Board's 2010 List (Blosser Channel in Region 3 and Mendota Pool in Region 5).[184] Belying these limited listings, satellite-based findings show that large-scale groundwater withdrawals in California[185] are draining surface waters around the state. California's annual statewide overdraft is estimated by the Department of Water Resources to be approximately 1.4 million acre-feet on average, with the majority of overdraft occurring in the San Joaquin Valley and Central Coast.[186] Since October 2003, the aquifers that supply Central Valley and the Sierra Nevada have lost nearly enough water combined to fill Lake Mead.[187] More than 75 percent of this is due to groundwater pumping in the southern Central Valley, primarily to irrigate crops.[188]

PLoS ONE 5(6): e11249. doi:10.1371/journal.pone.0011249, available at: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0011249.

179 *Supra* note 122, Aiken at 546.

180 U.S. EPA, "Specific State Probable Sources that make up the National Groundwater Loadings/Withdrawals Probable Source Group," available at: http://iaspub.epa.gov/tmdl_waters10/attains_nation_cy.source_detail?p_source_group_name=GROUNDWATER%20LOADINGS/WITHDRAWALS.

181 *Postema v. Pollution Control Hearings Board*, 11 P.3d 726 (Wash. 2000).

182 Michigan law already recognizes the doctrine's applicability to surface waters. *See e.g.*, Article IX, Sec. 40 of the Michigan Constitution of 1963; MCL 324.30111; 324.32502; 324.32505, etc.). The Great Lakes - St. Lawrence River Basin Water Resources Compact (codified at MCL 324.34201) also explicitly recognizes that "the Waters of the Basin are precious natural resources shared and held in trust by the states."

183 Proposed House Bill No. 5319, available at http://www.legislature.mi.gov/documents/2009-2010/billintroduced/House/pdf/2009-HIB-5319.pdf.

184 "Domestic ground water" use is also listed twice; *see* http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml.

185 University of California – Irvine, "California's troubled waters: Satellite-based findings reveal significant groundwater loss in Central Valley," *Science Daily* (Dec. 15, 2009), retrieved August 2, 2010, from http://www.sciencedaily.com/releases/2009/12/091214152022.htm.

186 California Department of Water Resources, "California's Ground Water," Bulletin 118, Update 2003, Sacramento, CA (2003).

187 *Id.*

188 *Id.*

The State Water Board can and must ensure full compliance with Sections 303(d) and 305(b), and the 2006 Guidance, by listing these and other surface waters impaired by low flow caused by excessive groundwater withdrawals and pumping.[189]

V. THE STATE WATER BOARD MUST INCLUDE IN ITS 2012 303(D) LIST ANTHROPOGENIC CLIMATE CHANGE-DRIVEN SOURCES AND IMPAIRMENTS OF CALIFORNIA WATERWAYS.

Global climate change is altering the biological, chemical, and physical properties of California waterways. Projected impacts in California provide an added impetus for the State Water Board to take swift action on flows and groundwater, as described above. For example, California's total water demand is projected to increase by up to 12% or more between 2000 and 2050, and the impacts of climate change will greatly increase the number of areas where water demands will exceed supplies.[190]

Climate change will not only increase the number and severity of existing waterway impairments, it will also drive new sources and causes of impairments. Data and information in the California Climate Change Adaptation Strategy[191] and other analyses generated by the state[192] strongly suggest that climate change will have demonstrable impacts on beneficial uses of California waterways. The most immediate impairments, and those with the strongest causal connection to global climate change, are driven by four principal dynamics: oceanic and estuarine carbon absorption, sea level rise, air and water temperatures increases, and shifting precipitation patterns.

We respectfully request that the State Water Board ensure that the 303(d) list identifies climate change driven-impairments to waterway health, and consider including reference data and information contained herein in your pending "Guidance Document on Climate Change."[193] An initial identification of climate change-driven impairments is provided below as a starting point for the State Water Board's analysis of surface waters that should be included on the 2012 303(d) List as either threatened or impaired:

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[189] Excessive groundwater withdrawals can also cause groundwater levels to decline below sea level, causing seawater to intrude into fresh water aquifers. Saltwater intrusion into groundwater aquifers is likely to become a pressing threat in many watersheds as sea level rises. (*See* AMEC Earth & Environmental (2005) Santa Clara River Enhancement and Management Plan. 260 p. Prepared for the Ventura County Watershed Protection District and Los Angeles Department of Public Works, Santa Barbara, Riverside, San Diego, California.) This threat is described in more detail in the climate change section below.

[190] Natural Resources Defense Council, *Water Facts: Climate Change, Water, and Risk: Current Water Demands Are Not Sustainable,* p. 2 (July 2010) ("NRDC Climate & Water Risk"). Available at http://www.nrdc.org/global-Warming/watersustainability/.

[191] The California Climate Adaptation Strategy, released in December 2009, summarizes the best known science on climate change impacts in California and outlines possible solutions that can be implemented within and across state agencies to promote resiliency. California Natural Resources Agency, "2009 California Climate Adaptation Strategy: A Report to the Governor of the State of California in Response to Executive Order S-13-2006," (CA Climate Adaptation Strategy), available at www.climatechange.ca.gov/adaptation.

[192] *See* documents referenced in Section IV.A.

[193] *See* http://www.waterboards.ca.gov/water_issues/programs/climate/index.shtml#.

Ocean Acidification:

- decreased pH of oceanic and estuarine waters
- acidification impacts to nearshore coastal waters, bays and estuaries

Sea level rise:

- salinity intrusion into groundwaters hydrologically connected to surface waters
- salinity intrusion into estuaries, bays, and coastal rivers
- increased contaminant flows in waterways surrounding wastewater treatment plants and sewer outfalls
- habitat alterations

Air and water temperature increases:

- rivers, streams, and creeks: climate change-driven temperature listings
- decrease in dissolved oxygen
- loss of temperature-dependant beneficial uses (*e.g.* cold freshwater habitat)

Shifting precipitation patterns:

- decreased reservoir levels and spring-fall flows (increased water temperature, decreased dilution of pollutants)
- increase in winter flows, flooding, and runoff (increase in sedimentation and pollutant runoff)

These and other climate change-driven impacts are discussed in more detail below.

A. The State Must Use All Readily Available Data to Identify Climate Change-Driven Sources and Causes of Surface Waters Impairment.

As noted above, the State and Regional Water Boards must "actively solicit, assemble, and consider all readily available data and information," including information reported by local, state, and federal agencies.[194] Given the global and quickly-evolving nature of climate change, the State Water Board should also consider information from international bodies, such as the Water Quality Section of the Intergovernmental Panel on Climate Change's Assessment Report, which provides a useful overview of projected and already-occurring impacts to water quality. Additionally, local, state, and federal agencies have amassed a tremendous amount of regionally-scaled studies and analyses regarding climate change impacts to California water quality that have not yet been integrated into the State's biennial 303(d) (or 305(b)) data collection. In particular, there is a significant amount of modeling and data on how climate change will impact the water quality and water supply of the San Francisco-San Joaquin Delta that should be considered.

More specifically, the State Water Board must examine and consider all readily available information that could inform 303(d) decisions related to climate change-driven impacts to California waterways, including but by no means limited to the following:

- Pertinent reports from the Department of Water Resources' (DWR) Integrated Regional Water Management Climate Change Document Clearinghouse.[195] This Clearinghouse

[194] *See* CA Listing Policy, Section 6.1.1 Definition of Readily Available Data and Information.
[195] A complete list of climate change publications written by DWR is available at http://www.water.ca.gov/climatechange/articles.cfm.

references dozens of pertinent reports that detail projected climate impacts to water quality, flow and species, including several recent DWR reports on how impaired water bodies and water quality will be impacted by climate change, including sea level rise;

- Analysis in the *California Water Plan Update 2009*[196] on how impaired water bodies and water quality will be impacted by climate change;
- Information from DWR's *Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water*[197] on waterways hydrologically connected to groundwater basins and on waterways vulnerable to sea level rise;
- Data and information in the Public Policy Institute of California's *Adapting Water Management to Climate Change*[198] on sea level rise and temperature impairments, as well as information on changes in the timing and amount of precipitation;
- Information regarding impairments stemming from salinity intrusion, inundation of wastewater treatment plants, and other impairments stemming from sea level rise in the Pacific Institute's *The Impacts of Sea-Level Rise on the California Coast*;[199]
- Ocean carbon data from NOAA's Pacific Marine Environmental Laboratory[200] and the U.S. Department of Energy's Carbon Dioxide Information Analysis Center;[201] and
- Data on changes in precipitation and temperature in the California Climate Tracker,[202] which is maintained by the Western Regional Climate Center, which would be extremely useful to identify related climate change-driven impairments as described below.

Information specific to the San Francisco-San Joaquin Delta includes, but is not limited to:

- Water quality monitoring data in the Central Valley Watershed Monitoring Directory, a joint effort by the San Francisco Estuary Institute (SFEI), the Central Valley Regional Water Quality Control Board Surface Water Ambient Monitoring Program (SWAMP) and the U.S. EPA;[203]
- Water quality and water supply studies from the CALFED Bay-Delta Program;[204] including the Delta Regional Ecosystem Restoration Implementation Plan models;[205]
- Reports and resources from the Water Quality, Supply and Reliability Workgroup of the California Partnership for the San Joaquin Valley;[206]

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[196] California Department of Water Resources (DWR), *California Water Plan Update 2009* (October 2009), available at http://www.waterplan.water.ca.gov/cwpu2009/index.cfm.
[197] DWR, *Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water* (October 2008), available at http://www.water.ca.gov/climatechange/docs/ClimateChangeWhitePaper.pdf.
[198] Public Policy Institute of California, *Adapting Water Management to Climate Change* (November 2008), available at http://www.ppic.org/content/pubs/report/R_1108JLR.pdf.
[199] California Climate Change Center, The Impacts of Sea-Level Rise on the California Coast ("Impacts of Sea Level Rise on CA"), May 2009, available at www.pacinst.org/reports/sea_level_rise/report.pdf.
[200] *See* Pacific Marine Environmental Laboratory homepage at http://www.pmel.noaa.gov/co2/OA/.
[201] Global Ocean Data Analysis Project, http://cdiac.ornl.gov/oceans/.
[202] *See* California Climate Tracker at http://www.wrcc.dri.edu/monitor/cal-mon/. Abatzoglou, J.T., K.T. Redmond, L.M. Edwards, "Classification of Regional Climate Variability in the State of California," *Journal of Applied Meteorology and Climatology*, 48, 1527-1541 (2009).
[203] Central Valley Watershed Monitoring Directory: http://www.centralvalleymonitoring.org/.
[204] CALFED Bay-Delta Program: http://www.science.calwater.ca.gov/science_index.html.
[205] Delta Regional Ecosystem Restoration Implementation Plan at http://www.science.calwater.ca.gov/drerip/drerip_index.html.
[206] California Partnership for the San Joaquin Valley Water Quality, Supply and Reliability Document Library http://www.sjvpartnership.org/wg_doc_lib.php?wg_id=10.

- The SWRCB's Final Report on Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem and studies supporting the recently-adopted Delta flow criteria;[207] and
- DFG biological opinions on Delta smelt and other endangered species.

The State Water Board should solicit, assemble and consider all readily available data relating to climate change-driven impairments for the 2012 303(d) List, with a particular focus on developing appropriate 303(d) listings for which a large amount of data currently exists, such as for ocean acidification impairments and climate change-driven Delta waterway impairments. The Board should also use and consider data regarding potential sources and causes of impairment cased by climate change-driven sea level rise, warming and shifting precipitation. Finally, the Board should augment its "Climate Change and Water Resources" website with data and information regarding the aforementioned climate change-driven impairments.[208]

B. The State Water Board Must Take Immediate Action to Ensure That the 2012 303(d) List Reflects Data on Climate Change-Driven Impairments Related to Ocean Acidification.

There is a significant amount of data and information currently available with requisite specificity for assessing which waterways are impaired by ocean acidification for the 2012 303(d) List. The State must collect data regarding the pH of bays, estuaries, the ocean, near-coastal areas, and coastal shorelines, and list waterways impaired or threatened by ocean acidification. The State Board must take action to ensure that the 2012 303(d) List contains pertinent data and lists impaired waterways as appropriate. If the State declines to do so, it must submit a "rationale" for not doing so, as required by the Clean Water Act, though we urge the State to implement its responsibilities and authorities fully in ensuring comprehensive listings.

Ocean acidification, a decrease in ocean pH fueled by the ocean's absorption of carbon dioxide, threatens the seawater quality of California's bays and estuaries. The ocean absorbs about half of all anthropogenic carbon dioxide emissions, an estimated 22 million tons of carbon dioxide (CO_2) every day.[209] When CO_2 dissolves in seawater it forms carbonic acid, which decreases ocean pH and causes "ocean acidification."[210] Global average surface pH has already decreased by approximately 0.1 units, and is expected to decrease by another 0.3-0.4 units by the end of the century, depending on future levels of atmospheric carbon dioxide.[211]

The latest science indicates that ocean acidification impacts to the seawater quality of California bays, estuaries and near coastal areas may already be occurring, and are projected to

[207] http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/
[208] *See* http://www.waterboards.ca.gov/water_issues/programs/climate/index.shtml.
[209] Feely, R. A., C. L. Sabine, K. Lee, W. Berelson, J. Kleypas, V. J. Fabry, and F. J. Millero. "Impact of anthropogenic CO2 on the CaCO3 system in the oceans," *Science* 305:362-366 (2004).
[210] Orr, J.C. *et al*. "Research Priorities for Understanding Ocean Acidification," *Oceanography*, 22(4): 182 (2009).
[211] Hauri, Claudine, Gruber, N, Lachkar, Z., Plattner, G. Abstract. "Accelerated acidification in eastern boundary current systems," Goldschmidt Conference Abstracts (2009); citing Orr, J.C., V.J. Fabry, O. Aumont, L. Bopp, S.C. Doney, R.A. Feely, A. Gnanadesikan, N. Gruber, A. Ishida, F. Joos, et al, "Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms," 437 *Nature* 681-86 (2005), http://www.nature.com/nature/journal/v437/n7059/full/nature04095.html.

accelerate.[212] In 2008, scientists discovered high levels of acidified ocean water within 20 miles of the Pacific Coast.[213] Given that atmospheric levels of carbon dioxide have increased drastically in the last half century, and are likely to increase further, such acidification trends are projected to increase, a trend that should be considered in projecting "threatened" waterways in particular.[214] Natural upwelling in nearshore waters, coupled with oceanic uptake of anthropogenic CO_2, mean that "ocean acidification has already decreased mean surface water pH in the California Current System to a level that was not expected to happen for open-ocean surface waters for several decades."[215] Projections indicate that the Humboldt Current System, another eastern boundary upwelling system that impacts ocean waters off of California, may be subject to the same conditions.[216]

There is precedent both for listing waterways impaired or threatened by atmospheric sources of pollution and for listing waterways impaired for pH. U.S. EPA maintains a list of waterways impaired for pH under the 303(d) program, with more than 3,500 waterbodies so listed as of May 2010.[217] Section 303(d) of the Clean Water Act also has been interpreted by both U.S. EPA and states to cover waterways impaired by atmospheric sources of pollution (such as carbon deposits). Specifically, in March 2007, EPA issued information on listing waters impaired by mercury from atmospheric sources under Section 303(d) of the Clean Water Act.[218] Subsequent to EPA's action, in October 2007, a group of Northeast states established the Northeast Regional Mercury TMDL, a regional cleanup plan to reduce mercury entering the states' watershed from a range of pollution sources, including atmospheric deposition of mercury.[219]

In response to legal action from the Center for Biological Diversity directly on the issue of climate change, the U.S. EPA solicited public comment on how to address listing of waters as threatened or impaired for ocean acidification under the 303(d) program.[220] <u>California need not wait for EPA's issuance of guidance on listing waters impaired by ocean acidification. The State should immediately assemble and consider all readily available evidence regarding waters impaired by ocean acidification and list waters accordingly</u>.

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[212] Byrne, R. H., S. Mecking, R. A. Feely, and X. Liu (2010), "Direct observations of basin-wide acidification of the North Pacific Ocean," 37 *Geophys. Res. Lett.* (2010), L02601, doi:10.1029/2009GL040999, http://www.agu.org/journals/ABS/2010/2009GL040999.shtml.

[213] Feely, R. A., C. L. Sabine, J. M. Hernandez-Ayon, D. Ianson, and B. Hales, "Evidence for upwelling of corrosive "acidified" water onto the continental shelf," *Science* 320:1490-1492 (2008), http://www.sciencemag.org/cgi/content/abstract/sci;320/5882/1490. *See also* Hauri *et al.* at p. 66.

[214] *Id*. *See also* http://www.sciencedaily.com/releases/2008/05/080522181511.htm.

[215] Hauri *et al*. at p. 69.

[216] *Id*.

[217] *See* Environmental Protection Agency Watershed Assessment, Tracking & Environmental Results webpage, Specific State Causes of Impairment That Make up the National pH/Acidity/Caustic Conditions Cause of Impairment, available at: http://iaspub.epa.gov/tmdl_waters10/attains_nation_cy.cause_detail_303d?p_cause_group_id=1188.

[218] Hooks, Craig, EPA Office of Wetlands, Oceans, and Watersheds, "Memorandum: Listing Waters Impaired by Atmospheric Mercury Under Clean Water Act Section 303(d): Voluntary Subcategory 5m for States with Comprehensive Reduction Programs" (March 8, 2007).

[219] New England Interstate Water Pollution Control Commission, "Northeast Regional Mercury Total Maximum Daily Load," p. 32 (October 24, 2007), available at http://www.neiwpcc.org/mercury/mercurytmdl.asp.

[220] *See* EPA's Federal Register Notice at http://www.epa.gov/owowwtr1/tmdl/oceanfrMarch_2010/.

C. The State Water Board Must Use and Consider Data on Sea Level Rise, Warming, and Precipitation Changes That Cause or Are Potential Sources of Impairments.

Projections of climate change-driven sea level rise, increased temperature, and shifting precipitation patterns will continue to have a major impact on California's water quality. The water quality impacts of climate change-driven sea level rise will be felt throughout California. In particular, a change in sea level will substantially alter San Francisco Bay-Delta conditions, where water surface elevations and associated fluctuations drive Bay-Delta hydrodynamics, which in turn dictate the location and nature of physical habitat and the quantity and quality of water.[221] Even under modest sea level rise and climate warming projections, an increase in the frequency, duration, and magnitude of water level extremes is expected in the Delta, to the detriment of numerous waterway beneficial uses.[222]

As for ocean acidification, we respectfully request that the State Water Board review and assess whether water bodies are impaired or threatened by climate change and also to list climate change as a potential source of impairment, where appropriate, on the 2012 303(d) List.[223] As outlined at the beginning of this section, we bring the following impairments to the Board's attention, although review of climate change impairments should by no means be limited to the impairments described below.

1. Sea Level Rise

Climate change is projected to result in sea level rise in California of 16 inches by 2050 and 55 inches by the end of the century.[224] In the Bay Area, 180,000 acres of shoreline are vulnerable to flooding by 2050, putting 21 wastewater treatment plants at risk of inundation.[225] Sea level rise also will substantially impair California's waterways by causing saltwater intrusion into estuaries and hydrologically connected groundwaters, inundating or eroding habitats, altering species composition, changing freshwater inflow, and impairing water quality.

a. Saltwater intrusion of hydrologically connected groundwaters.

Saltwater intrusion into aquifers is a man-made problem in many places in California, resulting from over-pumping and excessive withdrawals from groundwater aquifers.[226] Pumping coastal aquifers in excess of natural recharge rates draws down the surface of the aquifer, allowing surface water to move inland into a freshwater aquifer and contaminate it with salts.[227] When the ocean has a higher water elevation, it causes the saltwater wedge to intrude further

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[221] CALFED Bay-Delta Program Independent Science Board, Memorandum: *Sea Level Rise and Delta Planning* (September 6, 2007).
[222] *Id*. at 2.
[223] *See* discussion in Section III. above regarding "causes" versus "sources" of impairment.
[224] California Climate Change Center, "Climate Change Scenarios and Sea Level Rise Estimates for the California 2008 Climate Change Scenarios Assessment (Draft Paper)," available at www.energy.ca.gov/2009publications/CEC-500-2009-014/CEC-500-2009-014-D.PDF.
[225] *Id*.
[226] *Impacts of Sea Level Rise on CA* at 80.
[227] *Id*.

inland.[228] Seawater intrusion is already problematic in California's coastal aquifers throughout Central and Southern California, including the Pajaro and Salinas Valleys and aquifers in Orange and Los Angeles Counties. Groundwater supplies in the Santa Clara Subbasin are also vulnerable to salinity intrusion.[229]

Overdraft and saltwater intrusion into groundwater aquifers will be accelerated and made worse by sea level rise. Where these groundwater aquifers are hydrologically connected to surface waters, and thus affect the water quality of those surface waters, the State Water Board should list climate change/sea level rise as a source or cause of impairment so that appropriate remedial action can be taken.

b. Salinity intrusion into estuaries

Sea-level rise and changes in the intensity of storm events will impact low-lying coastal areas and result in the loss or inundation of coastal wetlands and dune habitat, resulting in salt water intrusion and loss of freshwater habitat for fish and wildlife.[230] Changes in salinity from reduced freshwater inflow will affect fish, wildlife and other aquatic organisms in intertidal and subtidal habitats. Increasing rates of saltwater intrusion into groundwater that impacts the beneficial uses of connected surface waters will need to be addressed in water quality management decisions, including the 303(d) List.[231]

c. Increased contamination from inundation of wastewater treatment facilities and sewer outfalls.

A recent Pacific Institute study found that a 1.4 meter sea level rise makes 28 wastewater treatment plants vulnerable to inundation: 21 plants around the San Francisco Bay and 7 other plants on the Pacific coast.[232] The combined capacity of these plants is 530 million gallons per day.[233] Some wastewater treatment plants are preparing for projected inundation,[234] but many more are not taking any action. Inundation from sea level rise, as well as an increased number of extreme weather events, could damage pumps and other treatment plant equipment and interfere with discharges from outfalls sited on coast and bay shorelines.[235] This will lead to an increased

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[228] *Id.*
[229] Santa Clara Valley Water District, "Groundwater Quality Report," p. 19 (2008) ("Saltwater intrusion of the Santa Clara Subbasin shallow aquifer zone adjacent to the southern shore of the San Francisco Bay has been studied and monitored for many years by the District. Although the contamination has been somewhat widespread in the shallow aquifer zone, fortunately, the lower aquifer has not been affected significantly.")
[230] *CA Climate Adaptation Strategy* at 73.
[231] *Id.* at 70.
[232] *Impacts of Sea Level Rise on CA* at 62-63, *see* Figure 24: Wastewater treatment plants on the Pacific coast vulnerable to a 100-year flood with a 1.4m sea-level rise.
[233] *Id.* at 63.
[234] In 2009, the City of Morro Bay commissioned a *Wastewater Treatment Plant Flood Hazard Analysis* and concluded that the existing wastewater treatment plant (WWTP) was subject to inundation from the Morro Creek watershed. The City recommended that the new site for a WWTP be developed with the placement of engineered fill to raise the new site above the 100-year flood elevation. *See* City of Morro Bay and Cayucos Sanitary District Wastewater Treatment Plant Upgrade Project, Facility Master Plan Draft Amendment No. 2, p. 12 (July 2010).
[235] *Id.* at 63.

number of untreated and partially treated sewage discharges and increased contamination and impairment of proximate waterways.

Discharges from sewage treatment plants already impair waterbodies throughout California. Pathogen impairments, which are linked to discharges from wastewater treatment plants among other sources, represent the second highest number of impairments for California waterways.[236] High concentrations of bacteria such as fecal coliform and E. coli raise the risk of waterborne diseases and starve fish of the oxygen they require, destroying several beneficial uses for affected waterbodies.

d. Sea level rise-caused habitat alterations

EPA records show 699 waterbody-segments listed nationwide as impaired due to "habitat alteration." This habitat alteration impairment group captures numerous impacts to waterways, including but not limited to alterations to wetland habitats, habitat barriers, degraded habitat and other forms of habitat alterations. Projected sea level rise similarly could result in a large number of habitat alteration impairments, both directly from sea level rise alteration to coastal wetland and other habitats, and indirectly by prompting construction of hard structures on the coastline such as seawalls and levees.

For example, according to the report *Impacts of Sea Level Rise on the California Coast* rising seas threaten to substantially modify or destroy wetland habitats.[237] More specifically:

> Vast areas of wetlands and other natural ecosystems are vulnerable to sea level rise. An estimated 550 square miles, or 350,000 acres, of wetlands exist along the California coast, but additional work is needed to evaluate the extent to which these wetlands would be destroyed, degraded, or modified over time. A sea level rise of 1.4 m would flood approximately 150 square miles of land immediately adjacent to current wetlands, potentially creating new wetland habitat if those lands are protected from further development."[238]

2. Air and water temperature increases

a. Warming of streams and rivers

New research shows that water temperatures are increasing in many streams and rivers throughout the United States,[239] with less water available for ecosystem flow and temperature needs in spring and summer.[240] In many low- and middle-elevation streams today, summer temperatures often approach the upper tolerance limits for salmon and trout; higher air and water

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[236] http://iaspub.epa.gov/waters10/state_rept.control?p_state=CA&p_cycle=.
[237] *Impacts of Sea Level Rise on CA* at 27.
[238] *Id*. at 17.
[239] Kaushal et al., "Rising stream and river temperatures in the United States," *Frontiers in Ecology and the Environment*, 2010; 100323112848094 DOI: 10.1890/090037; University of Maryland Center for Environmental Science, "Rising water temperatures found in US streams and rivers" (April 7, 2010), available at: http://www.sciencedaily.com/releases/2010/04/100406101444.htm.
[240] *CA Climate Adaptation Strategy* at 80.

temperatures will exacerbate this problem.[241] Thus, climate change might require dedication of more water, especially cold water stored behind reservoirs, to simply maintain existing fish habitat.[242] The 303(d) List should reflect instances where scientific evidence suggests that climate change is a cause or source of temperature impairments. Doing so would ensure that appropriate mitigating and prevention measures can be taken.

b. Decrease in dissolved oxygen

An inverse correlation between water temperature and the amount of dissolved oxygen in a waterbody is well-known and understood by water quality managers. Many California waterbodies that are impaired for temperature are also impaired because of low dissolved oxygen. Where waterbodies experience unnaturally high temperatures, the amount of dissolved oxygen can drop to levels that negatively impact water quality and aquatic species. Studies suggest that climate change-driven warming of streams, rivers, and other waterways could similarly decrease dissolved oxygen levels.[243] This is a phenomena the State Water Board must track and address in its 303(d) list, as appropriate.

3. <u>Shifting precipitation patterns</u>

Observational records and climate projections provide abundant evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change.[244] The decrease in precipitation and increase in potential evapotranspiration will have a significant affect on California's "available precipitation," which means water falling as rain or snow.[245] Projections suggest that precipitation will decline five inches per year by 2050 in California.[246] The Department of Water Resources projects that the Sierra Nevada snowpack may be reduced from its mid-20th century average by 25 to 40 percent by 2050.[247]

a. Longer low flow conditions

Climate change should be specifically identified as the source of low flow conditions where data so indicate. For example, projected declines in summer stream flows may impair Delta waterways through low-flow conditions and higher stream water temperatures.[248] As freshwater inputs decrease, Delta water quality may also be degraded as saltwater intrudes further upstream from the Pacific Ocean.[249] Salinity intrusion, low-flow conditions and higher

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241 *Id.*
242 *Id.*
243 *See* IPCC Assessment Report, Working Group II: "Impacts, Adaptation and Vulnerability," Section 4.3.10 available at http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=173.; B. A. Cox and P. G. Whitehead, "Impacts of climate change scenarios on dissolved oxygen in the River Thames, UK, Hydrology Research," 40(2-3): 138–152 © IWA Publishing 2009 doi:10.2166/nh.2009.096.
244 Climate Change and Water: Intergovernmental Panel on Climate Change Technical Report VI – June 2008, available at: http://www.ipcc.ch/publications_and_data/publications_and_data_technical_papers_climate_change_and_water.htm.
245 *NRDC Climate & Water Risk* at 2.
246 *Id.*
247 CA Climate Adaptation Strategy at 82.
248 *Id.* at 86.
249 *Id.*

stream water temperatures are all sources and causes of waterway impairment that could and should be addressed under the State Water Board's 2012 303(d) process.

The California Natural Resources Agency made an initial determination that mitigating these impacts requires more freshwater releases from upstream reservoirs.[250] The State Water Board should work with the Central Valley Regional Water Quality Control Board to examine data on climate change-driven impairments of Delta waterways and tributaries so that impaired waterways can be correctly identified and appropriate mitigating actions can be implemented to restore waterway health.

b. Increased contamination from stormwater runoff

Many models project higher contaminant concentrations in waterways as less frequent but more intense rainfall patterns change water quality.[251] An increased number and severity of extreme weather events and storm surges are also predicted. These climate change-driven phenomena will increase runoff and flooding, thus exacerbating levels of storm water pollution and sediment runoff.

* * *

Thank you for the opportunity to provide this information in support of a comprehensive 2012 Section 303(d) list that meets the mandates of the Clean Water Act. California's 303(s) list cannot be limited to "traditional" Category 5 listings. To comply with the Act, and to help lead the state to achieving its goals of clean waters with healthy flows and biodiverse aquatic ecosystem, the 2012 303(d) list must also include waterways impaired or threatened by: altered natural flows in surface waters, groundwater contamination and excessive groundwater withdrawals that impact surface water health, and anthropogenic climate change-caused impacts to surface waters. The data and information contained and referenced in this letter, as well as extensive other databases and peer-reviewed reports that are readily available to the State and Regional Water Boards, should provide more than adequate support for the listing of numerous waterways that are impaired and threatened and that therefore require the state's attention under the Clean Water Act and Porter-Cologne.

If you have any questions, please do not hesitate to contact us.

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[250] *Id.*
[251] *CA Climate Adaptation Strategy* at 82.

Sincerely,

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March 30, 2017

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Dr. Jun Zhu
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Jun.Zhu@waterboards.ca.gov

VIA EMAIL

Re: Revisions to the Los Angeles Region 303(d) List

Dear Dr. Zhu,

On behalf of Heal the Bay, we submit the following comments on the *Revisions to the Los Angeles Region 303(d) List* (Revised List or 303(d) List). Heal the Bay is an environmental organization with over 15,000 members dedicated to making the coastal waters and watersheds of greater Los Angeles safe, healthy, and clean. We appreciate the opportunity to provide comments on the Revised List.

Data/Information Collection and Timing Delay

In late 2014, Heal the Bay commented on the State Water Resources Control Board's (State Board's) *Proposed Amendment to the Water Quality Control Policy for Developing the Clean Water Act Section 303(d) List*. While we appreciated the chance to comment and the State Board's explanations in their Response to Comments, there are a few concerns that we continue to have regarding the new amendment and its effect on the Revised List.

First, we understand that California is an expansive state and that the State Board's resources are limited in comparison. In this sense we understand but are disappointed that California must implement the "Rotating Basin Approach," when coming into compliance with requests for biennial updates for the federal Clean Water Act's Section 303(d). This will effectively reduce regional updates on impaired waters from every two to every six years.

Compounded on this is the surprising discovery that the State Board is discussing either listing or delisting bodies of water in Region 4 with information and data collected *prior to August 30, 2010* – almost seven years ago. This would be on par with a college admissions officer selecting a prospective student for a university based on their academic performance in 5th Grade. It would have seemed wiser to have at least updated and

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appended further data and information and possibly re-solicited water quality data from regional stakeholders during the years long interim with respect to whether water bodies are placed on or removed from the Revised List.

Considering this discrepancy in timing from data submittal to listing and delisting proposals, we ask that the State Board and Environmental Protection Agency (EPA) *not* delist any bodies of water that are currently on the *2010 Integrated Report* until more current data is received. This will eliminate the possibility of delisting a water body that is currently impaired, as there is no way to know the condition of the waters in question using data solely from 2010 or before. To err on the side of caution when dealing with our state waters will be in the best interest of our water quality standards and beneficial uses. This seems like a reasonable, precautionary request and is supported by the State Board during the adoption of the policy.

Taken from the State Board Hearing Transcript from Sept. 30, 2004, Board Member Nancy H. Sutley states, "If it's on the list . . . then you have to have some information that says that they [fish] are not dying now and the waterbody is not currently impaired . . .." Though Board Member Sutley is referring to listings that were made by mistake, the principle behind it should still hold true. The intent was to say that information and data on waters should *currently* show that water quality standards are met and that the body of water is not *currently* impaired before being removed from the list. Board Member Sutley goes further to suggest that boards should affirm a lack of *current* impairment before delisting bodies of water by stating she was "Okay with not adding [additional] language [to the Listing Policy] as long as we're all in agreement and that's the direction of the regional boards that you have to look at the current conditions as well [before de-listing]."

This very point is represented in the State Board's *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (State Listing Policy)(Adopted Sept. 30, 2004 and Amended February 3, 2015) in Section 4.11, which states, "When making a delisting decision based on the situation-specific weight of evidence, the Regional Water Board must justify its recommendation by [Bullet 1] Providing any data or information including *current conditions* supporting the decision." We argue that there is no way to demonstrate current conditions with information and data that is aged seven years or more. Because of this it seems in line with State Listing Policy that no waterbodies be delisted for the current 303(d) List. During the next listing/delisting cycle, which will be in 2022, staff will be able to make a more accurate judgement on impairment simply because their information will be more up to date.

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It is Misleading to Entitle this Current Edition the "2016" 303(d) List

It seems off-track and misleading to title this 303(d) list the *2016 Los Angeles Region Clean Water Act Section 303(d) List of Impaired Waters* (Integrated Report) when it only contains information from 2010. Since the State Water Board's original 2010 solicitation for data was intended for the 2012 list we think it would be much more constructive and accurate to have the current list in question labeled exactly as such and be called the *2012 Los Angeles Region Clean Water Act Section 303(d) List of Impaired Waters*.

If any individual was filing their income taxes using tax information from a certain year, it would remain labeled as the tax return from the original time period, regardless of how long of an extension the individual received. Considering compliance with state and federal law, we could find no mention within the Federal Clean Water Act or the State Listing Policy of how the Integrated Report should be named, only how often it should submitted. Since the EPA is well aware of the new "rotating basin approach," and due to the fact that California has successfully amended its own State Listing Policy, we believe there to be no compliance issues for the more accurate renaming.

In addition, it was made clear in the Integrated Report's "Staff Report" (February 2017) that the 303(d) List for Regions from Group 2 (Regions 3, 5, and 9), which was intended to be passed in 2014, has yet to be approved by the State Board or the EPA. If the State Board were to rename the 2014 Integrated Report the 2012 Integrated Report as well because it has yet to be approved, this would make clear to everyone exactly where the listing's value lies—by titling both lists from Basin Group 2 and 3, the revised 2012 Integrated Report. This would file nicely with California's Basin Group 1 (Regions 1, 6, and 7), which would identically be called the 2012 Integrated Report. This is also consistent with the original notice and request for data, titled "Notice of Public Solicitation of Water Quality Data and Information for 2012 California Integrated Report—Surface Water Quality Assessment and List of Impaired Waters."

Further advantages of this titling would be that future inspection researchers unfamiliar with past reports would know that the listings would correspond much closer to the data from 2010. Looking towards the future, this more accurate labeling will help in clarifying reporting methods. It signifies when agencies made a clean break from when small windows of data were analyzed in favor of the current California Environmental Data Exchange Network (CEDEN) system, which uses a constant, up-to-date stream of information and allows for a more thorough and accurate 303(d) list for Region 4 in 2022. This would also make it crystal clear when the State of California "changed over" to the new "Rotating Basin Approach" in regards to fulfilling their obligations to Section 305(b) of the Clean Water Act.

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The Optimistic Possibilities of CEDEN in 303(d) Listings

As mentioned above, the State Board does have an opportunity going forward with CEDEN concerning water bodies in California. We are heartened to see that despite the fact that Region 4's 303(d) list will not be updated until 2022, that the list will be based on information up until 2021. This reduced lag time will only work to benefit the waters and beneficial uses of California's bodies of water.

Further, as the State Board mentions in its *Comment Summary and Responses for the Proposed Amendment to the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* from January 26, 2015, "Requiring the use of CEDEN will ensure the data used for the 303(d) listing process is of a high quality and includes the necessary information for efficient assessments." It is true that the use of this database is likely to streamline the process for the staff of the Regional Boards, the State Board, the EPA, and any agency that wants to submit pertinent data.

Heal the Bay noticed that the State Board scheduled CEDEN workshops in 2015 to "facilitate greater understanding of the needs of CEDEN users, develop tools to enhance the utility of CEDEN, and provide training on using the CEDEN system." We ask that the State Board provide more workshops now and in the coming years in anticipation of the current and future use of CEDEN by Region 4 Stakeholders. The people and water environment of California only stand to gain from thorough instruction given to invested stakeholders and the data they will provide.

Concerns with Individual Category 4a Delistings from the 303(d) List

Delisting Hermosa Beach and Manhattan Beach for Indicator Bacteria

Beyond our concerns mentioned above with *any* impaired water delistings from the prior 2010 303(d) List, Heal the Bay feels strongly that both Hermosa and Manhattan Beach should remain on the 303(d) List and maintain their current TMDL for Indicator Bacteria. Looking at our past Beach Report Card data, even data solely from the supposed window ending on August 30, 2010 and before, we find it puzzling that either beach would be in consideration for delisting. In 2010 itself, our Hermosa Beach site by Herondo Street outfall was noted for single sample exceedances for *Enterococcus* for 17.6% of samples taken. Averaging exceedances from 2008 to present 2016, the Herondo storm drain outfall has shown *Enterococcus* exceedances 12% of the time. Concerning Manhattan Beach, their 28th Street outfall has shown *Enterococcus* exceedances 10% of the time since 2008.

Both of these beaches are popular swimming and recreation areas and eliminating the TMDL would create the potential for impacts on human health and aquatic life. We would

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highly recommend waiting to remove both beaches from the 303(d) list until data from the past decade can be assessed. Like we discussed above, where uncertainty exists with regards to delisting bodies of water, decisions should be made in favor of protecting water quality, human health and the environment.

Heal the Bay realizes the huge endeavor these 303(d) listings are for all agencies involved. Please be assured that our organization looks forward to working with the Regional Board, the State Board, and the EPA in the future as the 303(d) listing process is further streamlined and more accurate and immediate assessments of our waterways are provided for listings.

Thank you for your consideration of these comments. If you have any questions please feel free to contact us at (310) 451-1500.

Sincerely,

Steven Johnson
Water Resources Policy Analyst
Heal the Bay

Los Angeles Department of Water & Power

ERIC GARCETTI
Mayor

Commission
MEL LEVINE, *President*
WILLIAM W. FUNDERBURK JR., *Vice President*
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BARBARA E. MOSCHOS, *Secretary*

DAVID H. WRIGHT
General Manager

March 30, 2017

Mr. Samuel Unger
Executive Officer
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

Attn: Ms. Jun Zhu

Dear Mr. Unger:

Subject: Comment Letter – Revisions to the Los Angeles Region 303(d) List

The Los Angeles Department of Water and Power (LADWP) would like to thank the Los Angeles Regional Water Quality Control Board (LARWQCB) for the opportunity to comment on the Revisions to the Los Angeles Region 303(d) List (Revisions).

LADWP is the largest municipally-owned utility in the nation, which serves a 465 square-mile area in Los Angeles with approximately four million residents and a portion of the Eastern Sierras in Owens Valley. Its mission is to provide essential public services (water and power) for grid reliability and public health and safety in an efficient and environmentally responsible manner. LADWP owns its electrical generation, distribution, and transmission systems as well as its 233-mile, gravity fed Los Angeles Aqueduct, which brings water to the City of Los Angeles (City). LADWP's Power System supplies more than 23 million megawatt hours of electricity a year, and LADWP is responsible for maintaining and replacing 3,507 miles of overhead transmission circuits spanning five western states. LADWP's Water System supplies approximately 177 billion gallons of water annually and an average of 446 million gallons per day to its residential and business customers.

LADWP has comments in several areas, as follows:

1. Elderberry Forebay should not be listed for dieldrin or PCBs.
2. The 303d listing recommendations should be updated to include current data and information.
3. The proposed listings for "benthic community effects" are premature at this time, particularly for proposed listings in modified channels.

LADWP's detailed comments can be found below.

1. Elderberry Forebay should not be listed for dieldrin or PCBs.

LADWP's largest hydroelectric facility is the Castaic Power Plant, which is critical to the reliability of the electrical grid in the Los Angeles Basin. This facility along with the Elderberry Forebay was built in 1960 as part of a Federal Energy Regulatory Commission (FERC) project with the Department of Water Resources , and is operated under a FERC license. The Elderberry Forebay was built strictly for the operation of the plant as a storage component for the water that passes through the plant to generate electricity. This hydroelectric plant is known as a pass-through facility. Water from Pyramid Lake flows down a gradient through the Los Angeles Tunnel and seven penstocks to turn seven turbines in order to produce electricity. The water enters Elderberry Forebay after the turbines where it is then either discharged to Castaic Lake or pumped back to Pyramid Lake.

LADWP has noted that the LARWQCB has proposed to add Elderberry Forebay to the revised 303(d) list for dieldrin and PCBs. However, activities at the plant do not use or add products that would contribute dieldrin or PCBs to its discharges into Elderberry. In fact, Elderberry Forebay is not open to the public and therefore does not have any beneficial uses beyond being an operating body of water for the hydro plant. Its only use is for the pushing of the turbine blades to generate electricity. In 2008 the United States Environmental Protection Agency (USEPA) released its final version of its "National Pollutant Discharge Elimination System (NPDES) Water Transfers Rule" (Water Transfer Rule) codifying (40 CFR 122.3(i)) that water transfers are excluded from the regulation of the Clean Water Act (CWA). The 40 CFR 122.3 (i) expressly states "Water transfers mean an activity that conveys or connects waters of the United States without subjecting the transferred water to intervening industrial, municipal, or commercial use. USEPA's legal interpretation of the CWA concluded that Congress did not intend to subject water transfers where there is "no addition" of pollutants to the NPDES permit process because the pollutants were already in the waters being transferred and are not added. This ruling was put in place precisely for hydroelectric plants like the Castaic Power Plant that are considered pass-through facilities. Since this body of water is isolated from all public recreation and access and the water that passes through the Castaic Power Plant is used only to generate electricity, it seems inappropriate to include the Elderberry Forebay in the new 303(d) listing.

With respect to Dieldrin, as stated in LADWP's Castaic Dieldrin Source Control Study sent to the LARWQCB in May 2010, LADWP contends that since the Castaic Power Plant has never used nor ever had a use for dieldrin, it cannot be the source of dieldrin in Elderberry Forebay. The source study points out that many of the tributaries that flow into the State Water Project, specifically those in the San Joaquin Valley, are agricultural areas where for years traditional pesticides (including dieldrin) have been used. Dieldrin was also an ingredient in several types of vector control measures used to mitigate vectors residing subsurface. These components, termed "legacy pesticides," primarily reside in the sediment/soil and are believed to be periodically liberated into the surrounding waterways. *Catskill Mountains Chapter of Trout Unlimited, Inc. v. EPA (Catskill III)* (2^{nd} Cir. 2017), states that a water being transferred through a hydroelectric plant is not a discharge of a pollutant. In addition, as has been mentioned earlier, the Elderberry Forebay is only used for the operations of the plant, and therefore discharges from the Forebay would not be considered a discharge of a pollutant.

Additionally, LADWP ceased the use of PCBs in the electrical equipment at Castaic Power Plant in the 1980s, and thus the hydroelectric plant is not a source. Furthermore, the NPDES Annual Monitoring Reports for Castaic Power Plant have shown "non-detect" for all PCB sampling over the last 20 years.

Since the Elderberry Forebay is used and was built solely for the operation of the Castaic Power Plant hydroelectric facility, and since it is a pass-through that transfers water without any addition of pollutants, it would seem appropriate to remove the Elderberry Forebay from this 303(d) list. Therefore, LADWP respectfully requests that the Elderberry Forebay be removed from the current 303(d) list.

2. The 303(d) listing recommendations should be updated to include current data and information.

The LARWQCB Staff Report supporting the current listing recommendations notes that "Due to the volume of data received during the 2010 data solicitation period, the State Water Board determined that no additional data would be solicited or analyzed until all the 2010 data are assessed. [...] Los Angeles Water Board staff estimates that the 2022 303(d) list will include data submitted through 2021." (Staff Report at p. 6)

LADWP is concerned that many of the data upon which proposed listings are based are more than ten (10) years old. However, some of the proposed listings are based on only two or three data points. Although LADWP understands and recognizes the resource limitations faced by the LARWQCB, we respectfully suggest that basing listings on datasets that do not include the most recent information, particularly when only a couple of samples are available to describe conditions in the region's water bodies, does not seem to be effective. Such limited data cannot be considered to describe current conditions appropriately.

3. The proposed listings for "benthic community effects" are premature at this time, particularly for proposed listings in modified channels.

LADWP notes that several of the proposed listings for "benthic community effects" are based upon limited data (2 or 3 samples) that were collected nine or more years ago, and that some of the proposed listings are based upon "index of biotic integrity" (IBI) scores. More importantly, many of the water bodies proposed for listing for benthic community effects are engineered or modified channels, and it is not scientifically or technically appropriate to expect that modified channels will achieve the CSCI or IBI scores that are observed in reference channels. The proposed listings do not consistently or clearly establish a link between the biological condition and the pollutant(s) that may be responsible for the biological condition; in fact, it is not clear that the pollutant measurements (available only for some proposed listings) were collected at the same time as the biological data. Finally, some of the samples upon which the proposed listings are based were collected downstream of and shortly after major wildfires; these data are likely representative of temporary disturbed conditions and may not be representative of typical conditions.

State Water Board staff are currently working on developing a statewide policy or plan for biological integrity. This process has moved away from using the IBI and is now developing metrics for the California Stream Condition Index (CSCI) and an Algae Stream Condition Index (ASCI). This process has not reached consensus on how engineered or modified channels should be assessed, or what appropriate expectations for these channels should be. In fact, the State Water Board is currently convening a Science Advisory Panel to address this issue and many others, and the State Water Board's "Wadeable Stream Biostimulatory and Biointegrity Science Plan," dated February 2017, acknowledges that "Developed landscapes are associated with an increase of many stressors in streams, such as elevated contaminant and nutrient concentrations, altered flow regimes, sedimentation, and habitat degradation. Often, these stressors are difficult to mitigate or remove under the traditional mechanisms available to the Water Boards. In these circumstances, the range of CSCI or ASCI scores may be constrained in channels in developed landscapes."

Because the State's policy is in development, no longer uses the IBI, has not clearly established a link between the presence of pollutant(s) and the biological condition, and has not produced direction regarding how benthic integrity should be assessed in modified streams, LADWP respectfully suggests that it is premature to list the region's water bodies for "benthic community effects". LADWP therefore requests that the LARWQCB decline to list the region's water bodies for benthic community effects at this time.

LADWP appreciates the opportunity to provide comments on the Revisions and looks forward to working with LARWQCB staff in this process. Should you have any questions regarding this letter, please contact me at (213) 367-0436 or Ms. Chloé Grison of the Wastewater Quality and Compliance Group at (213) 367-1339.

Sincerely,

Katherine Rubin
Manager of Wastewater Quality and Compliance

CG:vf
c: Ms. Chloé Grison

March 30, 2017

Rene Purdy, Section Chief Regional Programs
Los Angeles Regional Water Quality Control Board

Electronically Transmitted to
losangeles@waterboards.ca.gov

Attention Jun Zhu:

Subject: **Comment Letter – Revisions to the Los Angeles Region 303(d) list**

The Lower Los Angeles River (LLAR) Watershed Committee appreciates this opportunity to provide comments regarding the pending 303(d) list changes applicable to the LLAR Watershed. The LLAR Watershed Committee is limited its comments to the potential listing of Iron in Compton Creek.

The LLAR Watershed Committee requests the Regional Board suspend the recommendation on Iron because of the following:

- Reliance on data gathered during 2006-2010 is not appropriate when more recent data collected as part of the extensive monitor programs of the CIMPs is now available.
- Dissolved concentrations of iron do not exceed the narrative objectives.

The LLAR Watershed Committee appreciates the Regional Board's attention to detail and the efforts to protect the Lower Los Angeles River Watershed. Thank you for your time and consideration.

Sincerely,

Grissel Chavez, Chair Lower Los Angeles River Watershed Group

Artesia
Bellflower
Cerritos
Diamond Bar
Downey
Hawaiian Gardens
La Mirada
Lakewood
Long Beach
Norwalk
Pico Rivera
Santa Fe Springs
Whittier

Lower San Gabriel River Watershed Committee

March 30, 2017

Rene Purdy, Section Chief Regional Programs
Los Angeles Regional Water Quality Control Board

Electronically Transmitted to
losangeles@waterboards.ca.gov

Attention Jun Zhu:
Subject: **Comment Letter- Revisions to the Los Angeles Region 303(d) list**

The Lower San Gabriel River (LSGR) Watershed Committee appreciates this opportunity to provide comments regarding the pending 303(d) list changes applicable to the LSGR Watershed. Comments will be limited to three pollutants proposed to be added to the 303(d) list.

The LSGR Watershed Committee recognizes the recommendation regarding Temperature in Reach 1 and Reach 2 of the San Gabriel River and requests that the Regional Board take into consideration the characterization the of these Reaches of the San Gabriel River in its determination of temperature as a pollutant. As described as a Water Quality Objective:

> *"the natural receiving water temperature of all regional waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature d**oes not adversely affect** beneficial uses."*

Beginning upstream, Reach 2 is a 7-mile stretch from the outlet of the Whittier Narrows Dam and ends where the Sab Gabriel River crosses Firestone Blvd. Reach 2 is confined by engineered levees and rip-rap. The river remains a soft-bottom channel and during dry-weather has no measurable flow reaching Reach 1 due to having the most productive spreading grounds in Los Angeles County.

Reach 1 is a 10-mile stretch beginning at Firestone Blvd in Downey and extends to the confluence of the San Gabriel River with Coyote Creek. It is a heavily urbanized reach with a concrete bottom. Two significant POTWs discharge into this Reach. During dry weather, these POTWs discharge vastly more water than enters the river channel though the combined MS4 outfalls. The volume of the POTW discharge will quickly render any potentially elevated temperature from discharges of MS4 outfalls as negligible.

The Committee believes that a Water Quality Objective for Temperature in these Reaches is not applicable.

In regards to Iron and Malathion in Coyote Creek; the LSGR Watershed Committee requests the Regional Board suspend the recommendation of Iron and Malathion due to monitoring data inconsistent with recent water body improvements. The LSGR Watershed has made a considerable effort in developing and implementing its Coordinated Integrated Monitoring Program (CIMP) and suggest monitoring data should reflect more recent and current outfall conditions and that any conclusions should be drawn from a more current and comprehensive data set. The LSGR believes this request is justified when considering that Iron and Malathion are derived from nationally Recommended Water Quality Standards and not based on an established EPA TMDL or conditions characteristic of Southern California waters.

The LSGR Watershed Committee appreciates the Regional Board's attention to detail and the efforts to protect the Lower San Gabriel Watershed. Thank you for your time and consideration.

Sincerely,

Lower San Gabriel River Watershed

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GRACE ROBINSON HYDE
Chief Engineer and General Manager

March 30, 2017
File No. 31-370.40.4A

Via Electronic Mail

Dr. Jun Zhu
California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Dear Dr. Zhu:

Comments on the February 2017 Proposed 2016 Los Angeles Region
Clean Water Act Section 303(d) List of Impaired Waters

The Sanitation Districts of Los Angeles County (Sanitation Districts) appreciate the opportunity to comment on the February 2017 proposed 2016 Los Angeles Region Clean Water Act Section 303(d) List of Impaired Waters (Draft List) prepared by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board). The Sanitation Districts are a consortium of 24 independent special districts serving the wastewater and solid waste management needs of over five million people and 3,300 industries in Los Angeles County, California. The Sanitation Districts currently operate and maintain over 1,400 miles of trunk sewers and 11 wastewater treatment plants that collectively treat over 450 million gallons per day of wastewater. Of the 11 wastewater treatment plants, nine are located in the Los Angeles Region. Seven of the these treatment plants discharge to inland surface waters in the San Gabriel River, Santa Clara River, and Rio Hondo watersheds; one discharges to the Pacific Ocean; and one does not discharge to surface waters but instead solely supplies recycled water for irrigation.

The Sanitation Districts commend Regional Board staff for their diligent implementation of the State Water Resources Control Board's (State Board's) Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) to produce a Draft List that is generally well-documented and scientifically valid. In addition, the Sanitation Districts greatly appreciate the efforts of the Regional Board staff to make the listing process more transparent, particularly by making the data used to assess listings available on the Regional Board's website and by producing clear fact sheets on each water body/pollutant combination. Staff were also very helpful in addressing questions and meeting with us during the preparation of these comments and their assistance was greatly appreciated.

However, the Sanitation Districts have concerns on some aspects of the Draft List, particularly where the listing thresholds used in the Staff Report appear to differ from receiving water quality objectives contained in the Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) or other regulatory programs. Additionally, there appear to be data errors that impact some listing decisions. General comments relating to these concerns are provided below and detailed specific comments for each listing are provided in Attachment 1 and appendices to this letter.

1. Data Were Incorrectly Attributed to Some Reaches

The Draft List contains a number of newly proposed listings based, in part, on data collected from incorrect reaches. Specific listings where this appears to have occurred include the benthic community and toxicity listings for Santa Clara River Reach 5; the temperature listing for Santa Clara River Reach 6; the toxicity, DO, and iron listings for Rio Hondo Reach 2; and the toxicity listing for San Jose Creek Reach 2.

2. Not All of the Data Submitted for Listing Consideration Were Used in Making the Listing Decision

The Draft List contains a number of newly proposed listings where only a subset of the data submitted for listing consideration were evaluated; these data are included in the data files appended to the Staff Report but were not used in the listing analysis. Specific listings where this appears to have occurred include the toxicity listing for Santa Clara River Reach 5 and the temperature listing for Santa Clara River Reach 6.

3. The Draft List Includes Inappropriate Impairment Listings for "Benthic-Macroinvertebrate Bioassessments"

The Draft February 2017 version of the 2016 303(d) List contains a number of newly proposed listings for "Benthic-Macroinvertebrate Bioassessments." The proposed listings are based on application of the Southern California Coastal Index of Biological Integrity (SCIBI) and, in some cases, the California Stream Condition Index (CSCI). These include listings for Santa Clara River Reach 5, Los Angeles River Reach 3, and Medea Creek Reach 1. The Sanitation Districts believe these proposed listings should be removed, for the reasons listed below.

<u>Listings Based on the SCIBI and CSCI Are Inconsistent With State Policy</u>. The Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) indicates that water bodies should only be listed for degradation of biological populations if they have significant degradation **<u>relative to reference sites</u>** [emphasis added]. Although the scientists that developed the SCIBI attempted to incorporate reference conditions into the index itself, the reference conditions used to develop the index did not include any low elevation, low gradient locations in Los Angeles County similar to the Los Angeles River and the Santa Clara River reaches of concern.[1] Although the CSCI at least partially addresses some of the problems with the SCIBI by employing a modeled reference condition as opposed to the regional reference pool used by the SCIBI, the lack of any reference sites in large watersheds, low gradient, and low elevation systems still limits the identification of appropriate thresholds using the CSCI.

Section 6.1.5.8 of the Listing Policy also states that when "evaluating biological data and information, RWQCBs shall evaluate all readily available data and information and shall…**<u>evaluate physical habitat data</u>** and other water quality data, when available, to support conclusions about the status of the water segment." [Emphasis added.] All of the reaches mentioned in this comment letter represent reaches that have undergone various levels of physical habitat modifications and there is no indication that an evaluation of the physical habitat was conducted. It is well recognized by the scientific community that a single standard or threshold is not applicable to all waterbodies of the State due to unmanageable

[1] Ode, P.R., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management Vol. 35, No 4, pp. 493-504.

non-pollutant physical habitat alterations that would preclude many streams from ever having biological assemblages similar to reference. The threshold used as the listing criterion for these reaches is therefore likely inappropriate for these modified waterbodies.

Appropriate Thresholds for Interpretation of the CSCI Have Not Yet Been Determined. The State Board has not yet developed any recommended thresholds for the CSCI. The proposed threshold of 0.79 used in the Draft List is the 10th percentile of the reference pool and was used as an arbitrary point of reference for a regional monitoring program with no regulatory vetting. Use of this threshold for impairment listings would result in 10% of the unimpaired reference streams being erroneously listed as impaired. Additionally, it is well recognized by the scientific community that a single standard or threshold will not be applicable to all waterbodies of the State since unmanageable non-pollutant features such as habitat condition/modifications are likely to preclude many streams from ever having biological assemblages similar to reference.

The Sanitation Districts believe that it is inappropriate to make impairment decisions using the SCIBI and premature to rely on the improved, but still limited CSCI for making impairment decisions, particularly in reaches where surrounding development and instream physical habitat limitations are recognized. Therefore, the Sanitation Districts respectfully recommend that the Regional Board delay making decisions regarding benthic macroinvertebrate community impairments in this listing cycle, and instead continue to work with stakeholders, scientists, and the State Board that are currently engaged in efforts to address these and other issues as part of the Biointegrity/Bio-stimulatory Policy.

4. The Draft List Includes Inappropriate Impairment Listings for Temperature

The Draft List contains a number of newly proposed listings for temperature. The Sanitation Districts believe the proposed temperature listings for San Gabriel River Reach 2, San Jose Creek Reach 1, and San Gabriel River Reach 1 should be removed because the impairment listings are inconsistent with the Basin Plan water quality objective for temperature, which states, "at no time shall these WARM-designated waters be raised above 80^{o}F **as a result of waste discharges.**" [Emphasis added.] This water quality objective clearly distinguishes between exceedance of the 80^{o}F standard caused by "waste discharges" and those associated with other causes. Evidence indicates that summertime excursions greater than the 80^{o}F are not caused by wastes discharged but are likely due to elevated ambient air temperature, conductive and radiative heating associated with hardened landscapes, a lack of riparian cover, and increased ambient temperatures related to climate change. Additionally, the Draft List does not contain any analysis or evidence indicating that the elevated temperatures occurred as result of wastes discharged.

Additionally, the Sanitation Districts believe that the proposed temperature listing for Santa Clara River Reach 6 is inappropriate. Measurements for this listing were taken immediately downstream of the Saugus Water Reclamation Plant (WRP), where tertiary treated effluent is discharged along one bank of the Santa Clara River bed. The flow remains isolated from the main channel of the Santa Clara River and percolates rapidly into the soil; groundwater resurfaces downstream near Reach 5 of the Santa Clara River. The predominant natural condition of this stretch of river is dry and would not be expected to support aquatic life without the Saugus WRP discharge; therefore, application of the 80^{o}F water quality objective is unnecessary and inappropriate. The only reasonable alternative for meeting the water quality objective would be to eliminate the discharge flows; however, the California Department of Fish and Wildlife would likely prohibit that option, due to the effluent's contribution to the groundwater and subsequent downstream flows. Upon resurfacing near Reach 5, the water temperature averages 69^{o}F, demonstrating that elevated temperatures in this isolated discharge area are not detrimental to beneficial uses in reaches where water occurs naturally in the river. Finally, elevated ambient temperatures regularly exceed 90 °F during the summer months, and heavily influence both the Saugus WRP discharge and the immediate downstream receiving water location. As indicated for the other temperature listings, the water quality objective for temperature in the Los Angeles Region Basin Plan clearly distinguishes between temperature exceedances caused by "waste discharges" and those associated with other causes. However, the Draft List does not contain any analysis to distinguish the relative contributions by the temperatures of the ambient air and wastes discharged on the receiving water.

5. Thresholds Used For Toxicity Impairment Listings Are Inconsistent With Basin Plan Objectives

The Draft List contains a number of newly proposed listings for toxicity that include San Gabriel River Estuary, San Gabriel River Reach 3, Rio Hondo Reach 2, and Santa Clara River Reach 5. These listings should be removed for the reasons below.

<u>The Acute Toxicity Impairment Criterion is Inconsistent With the Basin Plan Water Quality Objective for Acute Toxicity</u>
The Staff Report fact sheets for the specific listings mentioned above state that "<100% survival (acute) was considered an exceedance." However, the Basin Plan states that "the acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board." Therefore, a single-test threshold of less than 70% survival should be used to determine impairments; even a threshold of less than 90% survival would still be more conservative than Basin plan objective.

<u>The Chronic Toxicity Impairment Criterion is Inconsistent With Water Quality Objective Interpretations Provided in NPDES Permits</u>

The Staff Report fact sheets for the specific listings mentioned above indicate that a single NOEC result of less than 100% receiving water represents an exceedance of the water quality objective. Although the Basin Plan provides no numeric chronic toxicity objectives, recently adopted Los Angeles Region NPDES permits do provide very specific direction on interpretation of the narrative water quality objectives for chronic toxicity. In a number of these permits, a footnote associated with the Receiving Water Monitoring Requirements Table of the Monitoring and Reporting Program states; "The **<u>median monthly summary result is a threshold value</u>** for a determination of meeting the narrative receiving water objective and shall be reported as 'Pass' or 'Fail'."[2] [Emphasis added.]

In addition to aligning with the NPDES permit language, use of a monthly median will also address concerns regarding false positive error rates. The USEPA has determined that the expected false positive error rate for chronic toxicity testing using the NOEC is 5%. With this error rate, on average, one in 20 individual chronic toxicity tests will be erroneously identified as "toxic" using the NOEC, and there is a nearly 34% probability that 2 or more individual chronic toxicity test exceedances would be observed within a set of 24 discrete measurements in a completely non-toxic stream reach. When there are two or more exceedances out of 24

[2] Pomona WRP - ORDER R4-2014-0212-A01 NPDES NO. CA0053619, Long Beach WRP - ORDER NO. R4-2015-0123 NPDES NO. CA0054119, Los Coyotes - ORDER NO. R4-2015-0124 NPDES NO. CA0054011, San Jose Creek WRP - ORDER R4-2015-0070 NPDES NO. CA0053911, Saugus WRP- ORDER R4-2015-0072 NPDES NO. CA0054313, Valencia WRP- ORDER R4-2015-0071 NPDES NO. CA0054216, Whittier Narrows WRP ORDER R4-2014-0213-A01 NPDES NO. CA0053716

measurements, the Listing Policy specifies that a reach be listed as impaired. Therefore, using single chronic toxicity exceedances as the 303(d) criterion would eventually result in more and more non-toxic stream reaches being erroneously listed over time. However, using a monthly median chronic toxicity exceedance threshold would reduce the likelihood of inappropriate reach listings due to false positive chronic toxicity results to less than 1%.

6. Specific Comments on Individual Reach/pollutant Listing Decisions

In addition to these general comments, the Sanitation Districts have comments on some specific listing decisions. As stated above, detailed comments are provided in the appendices to this letter. Because the implications of erroneous listings are substantial, the Sanitation Districts urge the Regional Board to consider this information in making the appropriate changes to the Draft List.

In conclusion, the Sanitation Districts would like to thank the Regional Board for its efforts up to this point in revising the proposed 2016 303(d) List. We urge the Regional Board to consider the information and analysis contained in this letter to complete the development of a scientifically and legally defensible list with a sound and consistent basis. If you have any questions regarding our comments or the information and data we are providing to you, please contact Phil Markle at (562) 908-4288, extension 2808, pmarkle@lacsd.org.

Very truly yours,

Philip L. Friess

Philip L. Friess
Department Head
Technical Services

PLF:PJM:nm
Attachments

cc: LB Nye, Jun Zhu, Kangshi Wang, Regional Board, Los Angeles Region

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Sanitation Districts of Los Angeles County
2016 303(d) List Fact Sheets

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Fact Sheet #1

Water Body:	**San Gabriel River Estuary**
Pollutant:	**Toxicity**
Listing:	**List on 303(d) List (TMDL Required List)**
Comment & Recommendation:	**Do Not List – Water Quality Objectives Being Achieved**

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is currently proposing that a new listing for toxicity be made to the 303(d) list for the San Gabriel River Estuary, based on one line of evidence: 14 of 113 samples exceeded the objective. The Districts believe this proposed listing is inappropriate and recommend not listing due to water quality objectives being achieved, for the reasons listed below; supporting evidence is provided in the sections that follow.

- Appendix A of this letter contains the full set of data applicable to this listing from Appendix G of the Regional Board Draft Staff Report. Using the temporal range indicated (June 2006 through May 2010), only six of 120 samples failed the thresholds specified in the fact sheet. According to Table 3.1 of the California Clean Water Act 303(d) Listing Policy (Listing Policy), an impairment listing is appropriate if 11 or more exceedances are observed when 120 samples are available.

- Although the Staff Report fact sheet states that "<100% survival (acute) was considered an exceedance," the Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) states that "the acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board." Therefore, a single-test threshold of less than 70% survival should be used to determine impairments; even a threshold of less than 90% survival would still be more conservative than Basin Plan objective. Applying a 90% threshold, none of the 120 samples would have exceeded the water quality objective. Therefore, this reach fails to meet the listing criteria for toxicity.

- The full set of data appended to Appendix G of the Staff Report, including those that fell outside the indicated temporal range, contain a total 151 discrete toxicity tests. Sixteen failed the <100% acute survival threshold. Using a conservative 90% acute survival threshold, there are no toxicity exceedances, and the number of measured exceedances is insufficient to place this water segment on the section 303(d) list.

Fact Sheet #1

Use of a <100% Survival Water Quality Objective Threshold Is Inappropriate and Unsupported.

All of the San Gabriel River toxicity "exceedances" indicated in the Regional Board Staff Report were acute toxicity results of <100% survival in undiluted receiving water; the lowest result in the data tables was a percent survival of 90%. However, as described in the subsections below, the 100% threshold is inconsistent with the Basin Plan and other documentation supplied by the Regional Board, with criteria used for other acute toxicity listings, and with the results of statistical testing.

Use of a <100% Survival Water Quality Objective Threshold Is Inconsistent with the Basin Plan and Other Documentation from the Regional Board.

In the Basin Plan and Sanitation Districts NPDES permits, the narrative acute toxicity receiving water quality objective is numerically defined: "the average survival in the undiluted receiving water for any three (3) consecutive 96-hour static, static-renewal, or continuous flow bioassay tests shall be at least 90%, and (ii) no single test producing less than 70% survival." Furthermore, the Water Quality Objective/Criterion reference provided in the Staff Report indicates that "the power to detect differences drops quickly below 15%, therefore care should be taken when declaring samples less than 15% different from the control as toxic." Following this reference, an exceedance of the water quality objective would be potentially questionable if the survival response was greater than 85%. Finally, the Sanitation Districts NPDES permits specify the use of a laboratory method with minimum test acceptability criteria of 90% for non-toxic control survival in the freshwater fish acute test, indicating that percent survival in undiluted receiving water of 90% or greater would be consistent with an expected response in a non-toxic sample.

Use of a <100% Survival Water Quality Objective Threshold Is Inconsistent with Criteria Used for Other Acute Toxicity Listings.

Regional Boards across California use a variety of thresholds to determine is acute toxicity water quality objectives are being met. However, based on a review of approved listing decisions from across California, a threshold of less than 100% was never used. Below is summary of criteria utilized to evaluate percent effect/response acute data:

<u>Region 2</u>
"Acute toxicity is defined as a median of less than 90 percent survival, or less than 70 percent survival, 10 percent of the time, of test organisms in a 96-hour static or continuous flow test." (Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin, Section 3.3.18).
http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/bp_ch3.shtml#3.3.18

"Statistical evaluation and a default threshold of 80% of the control value were used to establish whether the sediment exhibited significant toxicity adversely impacting aquatic organisms." (Proposed 2016 Section 303(d) and 305(b) Integrated Report, Region 2, Appendix G, Line of Evidence (LOE) for Decision ID 43948, Toxicity, Lagunitas Creek)
http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/2016_303d/00653.shtml#43948

<u>Region 3</u>
"Statistical evaluation (alpha = 0.05) and a default threshold of 80% of the control value were used to establish whether water exhibited significant toxicity adversely impacting aquatic organisms." (Final 2012 California Integrated Report (Clean Water Act Section 303(d) List / 305(b) Report, Region 3, Line of Evidence (LOE) for Decision ID 28270, Toxicity, Kirker Creek).
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01826.shtml#28270

Fact Sheet #1

Region 4

"There shall be no acute toxicity in ambient waters, including mixing zones. The acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board."
Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties, Page 3-38.
http://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/electronics_documents/Final%20Chapter%203%20Text.pdf

"Non-toxic if greater than or equal to 80% survival; moderately toxic if between 50 to 80% survival; and highly toxic if less than 50% survival." (Draft 2016 Section 303(d) and 305(b) Integrated Report, Region 4, Line of Evidence (LOE) for Decision ID 43062, Toxicity, Dominguez Channel Estuary (unlined portion below Vermont Ave).
http://www.waterboards.ca.gov/losangeles/water_issues/programs/303d/2016/Appendix_G/00134.shtml#43062

"Toxicity was defined as a reduction of the NOEC below 100% and was considered significant if the effect on the sample exposure was greater than 25%." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 4, Line of Evidence (LOE) for Decision ID 28344, Toxicity, Dominguez Channel (lined portion above Vermont Ave)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01077.shtml#28344

Region 5

"Significant toxicity is defined as a statistically significant (p<0.5) increase in mortality (>=20%) compared to the laboratory control." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 5, Line of Evidence (LOE) for Decision ID 26730, Unknown Toxicity, Feather River, Lower (Lake Oroville Dam to Confluence with Sacramento River)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01204.shtml#26730

Region 8

"Survival of organisms during toxicity bioassays no less than 80%." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 8, Line of Evidence (LOE) for Decision ID 27875, Sediment Toxicity, Elsinore, Lake)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/00489.shtml#27875

Region 9

"Samples were found to exhibit toxicity when the No Observed Effect Concentration (NOEC) or median lethal concentration (LC50) for any given species was estimated to be less than 100% of the test sample concentration." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 9, Line of Evidence (LOE) for Decision ID 28361, Toxicity, Agua Hedionda Creek)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01602.shtml#28361

Use of a <100% Survival Water Quality Objective Threshold Is Inconsistent with the Results of Statistical Testing.

Although the data summary provided as part of the 303(d) data submission included only percent survival results, control data were included when the data were submitted as part of routine NPDES compliance reports. Using the control data, the Sanitation Districts staff conducted statistical analyses for the acute toxicity data included in the Staff Report and found that no statistically significant differences were observed between the control and undiluted receiving water samples.

Fact Sheet #1

The Water Quality Objective/Threshold for Chronic Toxicity Should Be a Monthly Median.

When a sample fails a chronic toxicity test, additional samples may be collected during the same calendar month in an effort to confirm the result and identify potential toxicants. Application of a single test failure chronic toxicity water quality objective provides a disincentive for this type of proactive monitoring and is at odds with the intent of chronic toxicity testing.

Chronic toxicity is intended to assess potential aquatic life impacts associated with long-term exposures. Therefore, it is analogous to the Criterion Continuous Concentration (CCC) used for estimating “safe” chemical concentrations for long-term exposure as opposed to the Criterion Maximum Concentration (CMC) that is intended to protect against short-term exposure. In EPA’s Region 9 and 10 Toxicity Training Tool, the CCC is defined as “the highest in-stream concentration of a toxic or an effluent to which organisms can be exposed indefinitely without causing unacceptable effects such as the exceedance of a chronic water quality criterion.”[1] This same document also recommends “direct application of 1.0 TUc as the monthly compliance level for NPDES discharges without a mixing zone or dilution allowance. In conjunction and limited to this discharge situation, because: (1) there are no values below 1.0 TUc and (2) an arithmetic average is sensitive to extremely large and small values, the median is favored as the better measure of central tendency for the monthly compliance level.”

Although the Basin Plan provides no numeric chronic toxicity objectives, recently adopted Los Angeles Region NPDES permits do provide very specific direction on interpretation of the narrative water quality objectives for chronic toxicity. In the Long Beach WRP NPDES permit, footnote 25 of Table E-6 of the Monitoring and Reporting Program states; “The **median monthly summary result is a threshold value** for a determination of meeting the narrative receiving water objective and shall be reported as ‘Pass’ or ‘Fail.’”[2] [Emphasis added.]

In addition to aligning with the NPDES permit language, use of a monthly median will also address concerns regarding false positive error rates. The USEPA has determined that the expected false positive error rate for chronic toxicity testing using the NOEC is 5%. With this error rate, on average, one in 20 individual chronic toxicity tests will be erroneously identified as “toxic” using the NOEC, and there is a nearly 34% probability that 2 or more individual chronic toxicity test exceedances would be observed within a set of 24 discrete measurements in a completely non-toxic stream reach. When there are two or more exceedances out of 24 measurements, the Listing Policy specifies that a reach be listed as impaired. Therefore, using single chronic toxicity exceedances as the 303(d) criterion would, over time, result in more and more non-toxic stream reaches being erroneously listed. However, using a monthly median chronic toxicity exceedance threshold would reduce the likelihood of inappropriate reach listings due to false positive chronic toxicity results to less than 1%.

Since the data set used for assessing the San Gabriel River Estuary does not include multiple tests conducted during the same month, the individual test result is the also the monthly median. Therefore, this correction will have no impact on the listing decision for toxicity in the San Gabriel River Estuary, but may have a significant impact in other reaches.

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[1] Denton DL, Miller JM, Stuber RA. 2007. EPA Regions 9 and 10 toxicity training tool (TTT). November 2007. San Francisco, CA: https://www.epa.gov/sites/production/files/documents/ToxTrainingTool10Jan2010.pdf

[2] Pomona WRP - ORDER R4-2014-0212-A01 NPDES NO. CA0053619, Long Beach WRP - ORDER NO. R4-2015-0123 NPDES NO. CA0054119, Los Coyotes - ORDER NO. R4-2015-0124 NPDES NO. CA0054011, San Jose Creek WRP - ORDER R4-2015-0070 NPDES NO. CA0053911, Saugus WRP- ORDER R4-2015-0072 NPDES NO. CA0054313, Valencia WRP- ORDER R4-2015-0071 NPDES NO. CA0054216, Whittier Narrows WRP ORDER R4-2014-0213-A01 NPDES NO. CA0053716

Fact Sheet #2

Water Body: San Gabriel River Reach 3
Pollutant: Toxicity
Listing: List on 303(d) List (TMDL Required List)
Comment & Recommendation: Do Not List – Water Quality Objectives Being Achieved

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for toxicity be made to the 303(d) list for Reach 3 of the San Gabriel River, based on one line of evidence using two datasets: 2 of 38 samples exceeded the objective in a dataset related to a previously conducted TMDL study and 13 of 75 samples exceeded the objective in a second dataset comprised of routine receiving water tests conducted as part of an NPDES permit. The Sanitation Districts of Los Angeles County (Sanitation Districts) believe this proposed listing is inappropriate and recommend not listing due to water quality objectives being achieved, for the reasons listed below; supporting evidence is provided in the sections that follow.

- Appendix A of this letter contains the full set of data applicable to this listing from Appendix G of the Regional Board Draft Staff Report. No data related to the TMDL study were provided; therefore, the number of tests and exceedances reported (2 of 38) could not be independently verified and were assumed to be accurate. For the dates indicated (June 2006 through May 2010), 13 exceedances were associated with only 66 samples. Combining the two datasets resulted seven acute and eight chronic toxicity exceedances out of 104 samples.

- Although the Staff Report fact sheet states that “<100% survival (acute) was considered an exceedance,” the Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) states that “the acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board.” Therefore, a single-test threshold of less than 70% survival should be used to determine impairments; even a threshold of less than 90% survival would still be more conservative than Basin plan objective. Applying a 90% threshold, no acute toxicity samples in the dataset exceeded the water quality objective and 8 of 104 total samples exceeded the objective. According to Table 3.1 of the California Clean Water Act 303(d) Listing Policy (Listing Policy), an impairment listing is appropriate if 9 or more exceedances are observed when 104 samples are available. Therefore, this reach fails to meet the listing criteria for toxicity.

- The Staff Report considered each chronic toxicity test result as an independent data point, even when multiple bioassays were conducted within a single month. However, the San Jose Creek (SJCWRP) and Whittier Narrows Water Reclamation Plant (WNWRP) permits state that the water quality objective for chronic toxicity is based on a monthly median; therefore, all tests within a single month should be considered part of a monthly median, rather than independent tests. Based on appropriate application of the monthly median as the chronic water quality objective (and a 90% acute toxicity threshold), there were 6 toxicity exceedances out of a total of 96 tests. According to Table 3.1 of the California Clean Water Act 303(d) Listing Policy (Listing Policy), an impairment listing is appropriate if 9 or more exceedances are observed when 96 samples are available. Therefore, this reach fails to meet the listing criteria for toxicity.

- The full set of data (sets 1 and 2) appended to Appendix G of the Staff Report for all dates, including those outside the indicated temporal range, contain a total of 119 discrete toxicity tests. Using a conservative 90% acute survival threshold and appropriate monthly median chronic threshold, there are no acute exceedances and 6 chronic exceedances out of 110 results. This total

Fact Sheet #2

does not meet the minimum number of measured exceedances needed to place a water segment on the section 303(d) list.

Use of a <100% Survival Effect Water Quality Objective Threshold Is Inappropriate and Unsupported for Acute Toxicity Testing.

Seven of 15 San Gabriel River toxicity "exceedances" indicated in the Regional Board Staff Report were based on acute toxicity results of <100% survival in undiluted receiving water; the lowest result in the data tables was 97.5% survival. However, as described in the subsections below, the 100% threshold is inconsistent with the Basin Plan and other documentation supplied by the Regional Board, with criteria used for other acute toxicity listings, and with the results of statistical testing.

Use of a <100% Survival Water Quality Objective Threshold Is Inconsistent with the Basin Plan and Other Documentation from the Regional Board.

In the Basin Plan and Sanitation Districts NPDES permits, the narrative acute toxicity receiving water quality objective is numerically defined: "the average survival in the undiluted receiving water for any three (3) consecutive 96-hour static, static-renewal, or continuous flow bioassay tests shall be at least 90%, and (ii) no single test producing less than 70% survival." Furthermore, the Water Quality Objective/Criterion reference provided in the Staff Report indicates that "the power to detect differences drops quickly below 15%, therefore care should be taken when declaring samples less than 15% different from the control as toxic." Following this reference, an exceedance of the water quality objective would be potentially questionable if the survival response was greater than 85%. Finally, the Sanitation Districts NPDES permits specify the use of a laboratory method with minimum test acceptability criteria of 90% for non-toxic control survival in the freshwater fish acute test, indicating that percent survival in undiluted receiving water of 90% or greater would be consistent with an expected response in a non-toxic sample.

Use of a <100% Survival Water Quality Objective Threshold Is Inconsistent with Criteria Used for Other Acute Toxicity Listings.

Regional Boards across California use a variety of thresholds to determine if acute toxicity water quality objectives are being met. However, based on a review of approved listing decisions from across California, a threshold of less than 100% was never used. Below is summary of criteria utilized to evaluate percent effect/response acute data:

Region 2

"Acute toxicity is defined as a median of less than 90 percent survival, or less than 70 percent survival [in a single test], 10 percent of the time, of test organisms in a 96-hour static or continuous flow test."
(Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin, Section 3.3.18).
http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/bp_ch3.shtml#3.3.18

"Statistical evaluation and a default threshold of 80% of the control value were used to establish whether the sediment exhibited significant toxicity adversely impacting aquatic organisms." (Proposed 2016 Section 303(d) and 305(b) Integrated Report, Region 2, Appendix G, Line of Evidence (LOE) for Decision ID 43948, Toxicity, Lagunitas Creek)
http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/2016_303d/00653.shtml#43948

Fact Sheet #2

Region 3

"Statistical evaluation (alpha = 0.05) and a default threshold of 80% of the control value were used to establish whether water exhibited significant toxicity adversely impacting aquatic organisms." (Final 2012 California Integrated Report (Clean Water Act Section 303(d) List / 305(b) Report, Region 3, Line of Evidence (LOE) for Decision ID 28270, Toxicity, Kirker Creek).
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01826.shtml#28270

Region 4

"There shall be no acute toxicity in ambient waters, including mixing zones. The acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board."
Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties, Page 3-38.
http://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/electronics_documents/Final%20Chapter%203%20Text.pdf

"Non-toxic if greater than or equal to 80% survival; moderately toxic if between 50 to 80% survival; and highly toxic if less than 50% survival." (Draft 2016 Section 303(d) and 305(b) Integrated Report, Region 4, Line of Evidence (LOE) for Decision ID 43062, Toxicity, Dominguez Channel Estuary (unlined portion below Vermont Ave).
http://www.waterboards.ca.gov/losangeles/water_issues/programs/303d/2016/Appendix_G/00134.shtml#43062

"Toxicity was defined as a reduction of the NOEC below 100% and was considered significant if the effect on the sample exposure was greater than 25%." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 4, Line of Evidence (LOE) for Decision ID 28344, Toxicity, Dominguez Channel (lined portion above Vermont Ave)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01077.shtml#28344

Region 5

"Significant toxicity is defined as a statistically significant (p<0.5) increase in mortality (>=20%) compared to the laboratory control." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 5, Line of Evidence (LOE) for Decision ID 26730, Unknown Toxicity, Feather River, Lower (Lake Oroville Dam to Confluence with Sacramento River)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01204.shtml#26730

Region 8

"Survival of organisms during toxicity bioassays no less than 80%." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 8, Line of Evidence (LOE) for Decision ID 27875, Sediment Toxicity, Elsinore, Lake)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/00489.shtml#27875

Region 9

"Samples were found to exhibit toxicity when the No Observed Effect Concentration (NOEC) or median lethal concentration (LC50) for any given species was estimated to be less than 100% of the test sample concentration." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 9, Line of Evidence (LOE) for Decision ID 28361, Toxicity, Agua Hedionda Creek)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01602.shtml#28361

Fact Sheet #2

Use of a <100% Survival Water Quality Objective Threshold Is Inconsistent with the Results of Statistical Testing.

Although the data summary provided as part of the 303(d) data submission included only percent survival results, control data were included when the data were submitted as part of routine NPDES compliance reports. Using the control data, the Sanitation Districts staff conducted statistical analyses for the acute toxicity data included in the Staff Report and found that no statistically significant differences were observed between the control and undiluted receiving water samples.

The Water Quality Objective/Threshold for Chronic Toxicity Should Be a Monthly Median.

When a sample fails a chronic toxicity test, additional samples may be collected during the same calendar month in an effort to confirm the result and identify potential toxicants. Application of a single test failure chronic toxicity water quality objective provides a disincentive for this type of proactive monitoring and is at odds with the intent of chronic toxicity testing.

Chronic toxicity is intended to assess potential aquatic life impacts associated with long-term exposures. Therefore, it is analogous to the Criterion Continuous Concentration (CCC) used for estimating "safe" chemical concentrations for long-term exposure as opposed to the Criterion Maximum Concentration (CMC) that is intended to protect against short-term exposure. In EPA's Region 9 and 10 Toxicity Training Tool, the CCC is defined as "the highest in-stream concentration of a toxic or an effluent to which organisms can be exposed indefinitely without causing unacceptable effects such as the exceedance of a chronic water quality criterion."[1] This same document also recommends "direct application of 1.0 TUc as the monthly compliance level for NPDES discharges without a mixing zone or dilution allowance. In conjunction and limited to this discharge situation, because: (1) there are no values below 1.0 TUc and (2) an arithmetic average is sensitive to extremely large and small values, the median is favored as the better measure of central tendency for the monthly compliance level."

Although the Basin Plan provides no numeric chronic toxicity objectives, recently adopted Los Angeles Region NPDES permits do provide very specific direction on interpretation of the narrative water quality objectives for chronic toxicity. In the Whittier Narrows WRP NPDES permit, footnote 22 of Table E-5a of the Monitoring and Reporting Program states of the Monitoring and Reporting Program states; "The **median monthly summary result is a threshold value** for a determination of meeting the narrative receiving water objective and shall be reported as 'Pass' or 'Fail.'"[2] [Emphasis added.]

In addition to aligning with the NPDES permit language, use of a monthly median will also address concerns regarding false positive error rates. The USEPA has determined that the expected false positive error rate for chronic toxicity testing using the NOEC is 5%. With this error rate, on average, one in 20 individual chronic toxicity tests will be erroneously identified as "toxic" using the NOEC, and there is a nearly 34% probability that 2 or more individual chronic toxicity test exceedances would be observed within a set of 24 discrete measurements in a completely non-toxic stream reach. When there are two or

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[1] Denton DL, Miller JM, Stuber RA. 2007. EPA Regions 9 and 10 toxicity training tool (TTT). November 2007. San Francisco, CA: https://www.epa.gov/sites/production/files/documents/ToxTrainingTool10Jan2010.pdf

[2] Pomona WRP - ORDER R4-2014-0212-A01 NPDES NO. CA0053619, Long Beach WRP - ORDER NO. R4-2015-0123 NPDES NO. CA0054119, Los Coyotes - ORDER NO. R4-2015-0124 NPDES NO. CA0054011, San Jose Creek WRP - ORDER R4-2015-0070 NPDES NO. CA0053911, Saugus WRP- ORDER R4-2015-0072 NPDES NO. CA0054313, Valencia WRP- ORDER R4-2015-0071 NPDES NO. CA0054216, Whittier Narrows WRP ORDER R4-2014-0213-A01 NPDES NO. CA0053716

Fact Sheet #2

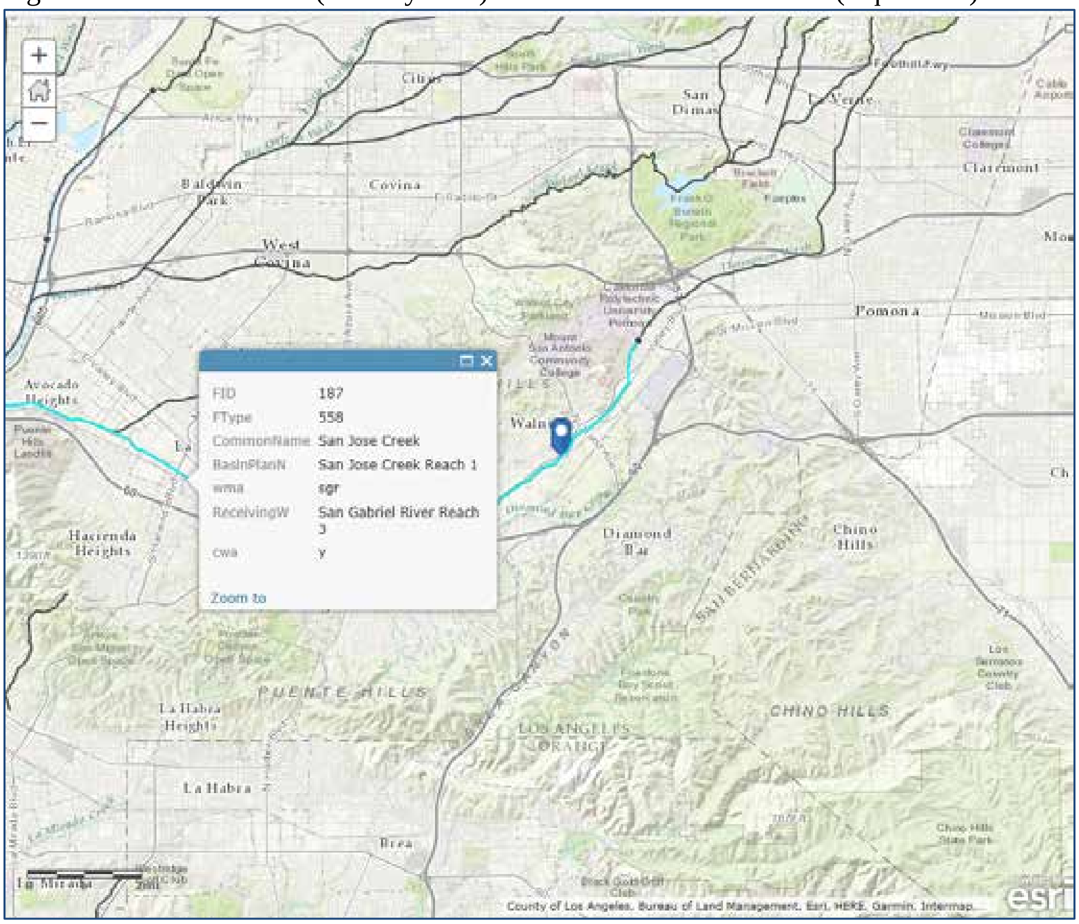
more exceedances out of 24 measurements, the Listing Policy specifies that a reach be listed as impaired. Therefore, using single chronic toxicity exceedances as the 303(d) criterion would, over time, result in more and more non-toxic stream reaches being erroneously listed. However, using a monthly median chronic toxicity exceedance threshold would reduce the likelihood of inappropriate reach listings due to false positive chronic toxicity results to less than 1%.

Fact Sheet #3

Water Body:	**San Jose Creek Reach 2**
Pollutant:	**Toxicity**
Listing:	**List on 303(d) List (TMDL Required List)**
Comment & Recommendation:	**Apply Data to Reach 1**

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for toxicity be made to the 303(d) list for Reach 2 of the San Jose Creek, based on one line of evidence: 8 of 24 samples exceeded the objective. The Sanitation Districts believe this proposed listing is inappropriate and should be moved to Reach 1. All cited toxicity data is from receiving water station RC (N 34° 01' 8.6" W 117° 50' 27.7") for the Pomona Water Reclamation Plant, which is located in Reach 1 of San Jose Creek (Figure 1). This reach is already listed for toxicity under section 303(d).

Figure 1. Station Pom-RC (Blue Symbol) and San Jose Creek Reach 1 (Aqua Line)



Fact Sheet #4

Water Body: **Rio Hondo Reach 2**
Pollutant: **Toxicity**
Listing: **List on 303(d) List (TMDL Required List)**
Comment & Recommendation: **Do Not List – Water Quality Objectives Being Achieved**

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for toxicity be made to the 303(d) list for Reach 2 of the Rio Hondo, based on one line of evidence: 5 of 31 samples exceeded the objective. The Districts believe this proposed listing is inappropriate and recommend not listing due to water quality objectives being achieved, for the reasons listed below; supporting evidence is provided in the sections that follow.

- Appendix A of this letter contains the full set of data applicable to this listing from Appendix G of the Regional Board Draft Staff Report. All cited toxicity data are from receiving water station RD1 for the Whittier Narrows Water Reclamation Plant (WNWRP). This sampling location (N 34° 02' 26.5" W 118° 04' 27") is in Reach 3 of the Rio Hondo, not Reach 2 (Figure 1).

- Using the data for the temporal range indicated (June 2006 through May 2010), 7 of 33 samples failed the thresholds specified in the fact sheet.

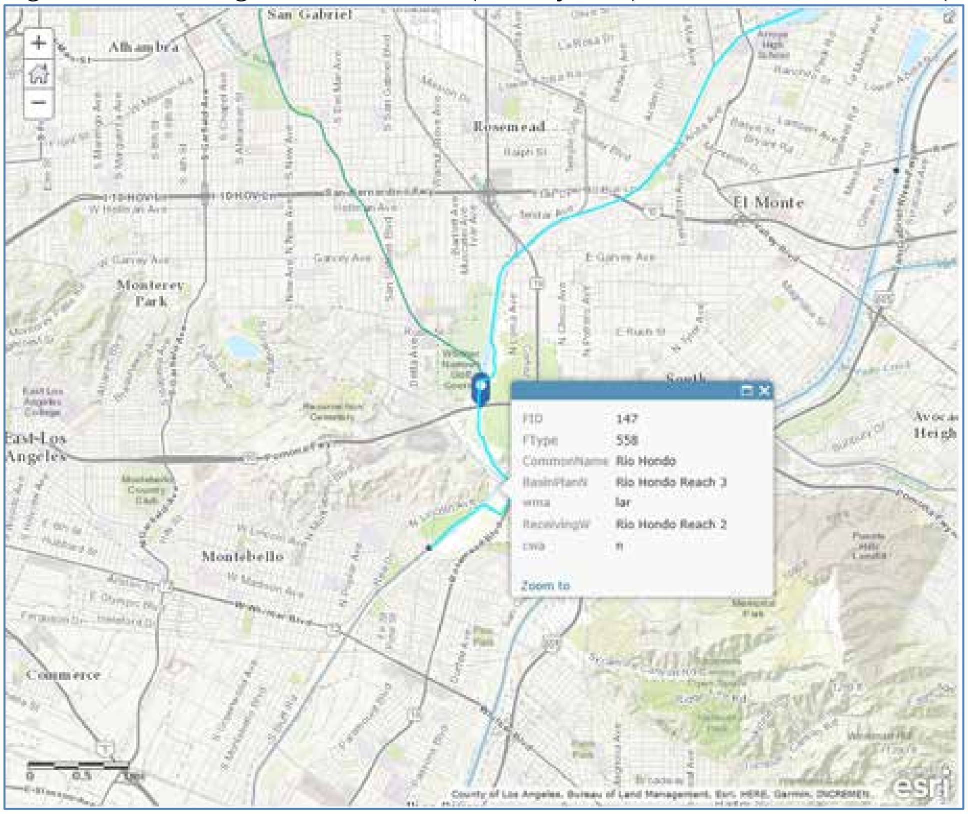
- Although the Staff Report fact sheet states that "<100% survival (acute) was considered an exceedance," the Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) states that "the acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board." Therefore, a single-test threshold of less than 70% survival should be used to determine impairments; even a threshold of less than 90% survival would still be more conservative than Basin plan objective. Applying a 90% threshold, no samples exceeded the acute toxicity water quality objective.

- The Staff Report considered each chronic toxicity test result as independent data, even when multiple bioassays were conducted within a single month. However, the WNWRP permit states that the water quality objective for chronic toxicity is based on a monthly median; therefore, all tests within a single month should be considered part of a monthly median, rather than independent tests. Based on appropriate application of the monthly median as the chronic water quality objective (and a 90% acute toxicity threshold), there were 2 toxicity exceedances out of 31 tests. According to Table 3.1 of the California Clean Water Act 303(d) Listing Policy (Listing Policy), an impairment listing is appropriate if 3 or more exceedances are observed when 31 samples are available. Therefore, Reach 2 of the Rio Hondo fails to meet the listing criteria for toxicity.

- The full set of data appended to Attachment G of the Staff Report, including those that fell outside the indicated temporal range, contains a total 38 discrete toxicity tests. Using a conservative 90% acute survival threshold and appropriate monthly median chronic threshold, there are no acute exceedances and 2 chronic exceedances out of 36 results. This total does not meet the minimum number of measured exceedances needed to place a water segment on the section 303(d) list.

Fact Sheet #4

Figure 1. Monitoring Station WN-RD1 (Blue Symbol) and Rio Hondo Reach 3 (Aqua Line)



Use of a <100% Survival Water Quality Objective Threshold Is Inappropriate and Unsupported.

Three of the Rio Hondo toxicity "exceedances" indicated in the Regional Board Staff Report were acute toxicity results of <100% survival in undiluted receiving water; the lowest result in the data tables was a percent survival of 90%. However, as described in the subsections below, the 100% threshold is inconsistent with the Basin Plan and other documentation supplied by the Regional Board, with criteria used for other acute toxicity listings, and with the results of statistical testing.

Use of a <100% Survival Water Quality Objective Threshold Is Inconsistent with the Basin Plan and Other Documentation from the Regional Board.

In the Basin Plan and Sanitation Districts NPDES permits, the narrative acute toxicity receiving water quality objective is numerically defined: "the average survival in the undiluted receiving water for any three (3) consecutive 96-hour static, static-renewal, or continuous flow bioassay tests shall be at least 90%, and (ii) no single test producing less than 70% survival." Furthermore, the Water Quality Objective/Criterion reference provided in the Staff Report indicates that "the power to detect differences drops quickly below 15%, therefore care should be taken when declaring samples less than 15% different from the control as toxic." Following this reference, an exceedance of the water quality objective would be potentially questionable if the survival response was greater than 85%. Finally, the Sanitation Districts NPDES permits specify the use of a laboratory method with minimum test acceptability criteria of 90% for non-toxic control survival in the freshwater fish acute test, indicating that percent survival in undiluted receiving water of 90% or greater would be consistent with an expected response in a non-toxic sample.

Fact Sheet #4

Use of a <100% Survival Water Quality Objective Threshold Is Inconsistent with Criteria Used for Other Acute Toxicity Listings.

Regional Boards across California use a variety of thresholds to determine is acute toxicity water quality objectives are being met. However, based on a review of approved listing decisions from across California, a threshold of less than 100% was never used. Below is summary of criteria utilized to evaluate percent effect/response acute data:

Region 2

"Acute toxicity is defined as a median of less than 90 percent survival, or less than 70 percent survival, 10 percent of the time, of test organisms in a 96-hour static or continuous flow test."
(Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin, Section 3.3.18).
http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/bp_ch3.shtml#3.3.18

"Statistical evaluation and a default threshold of 80% of the control value were used to establish whether the sediment exhibited significant toxicity adversely impacting aquatic organisms." (Proposed 2016 Section 303(d) and 305(b) Integrated Report, Region 2, Appendix G, Line of Evidence (LOE) for Decision ID 43948, Toxicity, Lagunitas Creek)
http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/2016_303d/00653.shtml#43948

Region 3

"Statistical evaluation (alpha = 0.05) and a default threshold of 80% of the control value were used to establish whether water exhibited significant toxicity adversely impacting aquatic organisms." (Final 2012 California Integrated Report (Clean Water Act Section 303(d) List / 305(b) Report, Region 3, Line of Evidence (LOE) for Decision ID 28270, Toxicity, Kirker Creek).
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01826.shtml#28270

Region 4

"There shall be no acute toxicity in ambient waters, including mixing zones. The acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board."
Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties, Page 3-38.
http://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/electronics_documents/Final%20Chapter%203%20Text.pdf

"Non-toxic if greater than or equal to 80% survival; moderately toxic if between 50 to 80% survival; and highly toxic if less than 50% survival." (Draft 2016 Section 303(d) and 305(b) Integrated Report, Region 4, Line of Evidence (LOE) for Decision ID 43062, Toxicity, Dominguez Channel Estuary (unlined portion below Vermont Ave).
http://www.waterboards.ca.gov/losangeles/water_issues/programs/303d/2016/Appendix_G/00134.shtml#43062

"Toxicity was defined as a reduction of the NOEC below 100% and was considered significant if the effect on the sample exposure was greater than 25%." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 4, Line of Evidence (LOE) for Decision ID 28344, Toxicity, Dominguez Channel (lined portion above Vermont Ave)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01077.shtml#28344

Region 5

"Significant toxicity is defined as a statistically significant (p<0.5) increase in mortality (>=20%) compared to the laboratory control." (Final California 2012 Integrated Report (303(d) List/305(b)

Fact Sheet #4

Report), Region 5, Line of Evidence (LOE) for Decision ID 26730, Unknown Toxicity, Feather River, Lower (Lake Oroville Dam to Confluence with Sacramento River)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01204.shtml#26730

Region 8
"Survival of organisms during toxicity bioassays no less than 80%." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 8, Line of Evidence (LOE) for Decision ID 27875, Sediment Toxicity, Elsinore, Lake)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/00489.shtml#27875

Region 9
"Samples were found to exhibit toxicity when the No Observed Effect Concentration (NOEC) or median lethal concentration (LC50) for any given species was estimated to be less than 100% of the test sample concentration." (Final California 2012 Integrated Report (303(d) List/305(b) Report), Region 9, Line of Evidence (LOE) for Decision ID 28361, Toxicity, Agua Hedionda Creek)
http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/01602.shtml#28361

Use of a <100% Survival Water Quality Objective Threshold Is Inconsistent with the Results of Statistical Testing.

Although the data summary provided as part of the 303(d) data submission included only percent survival results, control data were included when the data were submitted as part of routine NPDES compliance reports. Using the control data, the Sanitation Districts staff conducted statistical analyses for the acute toxicity data included in the Staff Report and found that no statistically significant differences were observed between the control and undiluted receiving water samples.

The Water Quality Objective/Threshold for Chronic Toxicity Should Be a Monthly Median.

When a sample fails a chronic toxicity test, additional samples may be collected during the same calendar month in an effort to confirm the result and identify potential toxicants. Application of a single test failure chronic toxicity water quality objective provides a disincentive for this type of proactive monitoring and is at odds with the intent of chronic toxicity testing.

Chronic toxicity is intended to assess potential aquatic life impacts associated with long-term exposures. Therefore, it is analogous to the Criterion Continuous Concentration (CCC) used for estimating "safe" chemical concentrations for long-term exposure as opposed to the Criterion Maximum Concentration (CMC) that is intended to protect against short-term exposure. In EPA's Region 9 and 10 Toxicity Training Tool, the CCC is defined as "the highest in-stream concentration of a toxic or an effluent to which organisms can be exposed indefinitely without causing unacceptable effects such as the exceedance of a chronic water quality criterion."[1] This same document also recommends "direct application of 1.0 TUc as the monthly compliance level for NPDES discharges without a mixing zone or dilution allowance. In conjunction and limited to this discharge situation, because: (1) there are no values below 1.0 TUc and (2) an arithmetic average is sensitive to extremely large and small values, the median is favored as the better measure of central tendency for the monthly compliance level."

[1] Denton DL, Miller JM, Stuber RA. 2007. EPA Regions 9 and 10 toxicity training tool (TTT). November 2007. San Francisco, CA: https://www.epa.gov/sites/production/files/documents/ToxTrainingTool10Jan2010.pdf

Fact Sheet #4

Although the Basin Plan provides no numeric chronic toxicity objectives, recently adopted Los Angeles Region NPDES permits do provide very specific direction on interpretation of the narrative water quality objectives for chronic toxicity. In the Whittier Narrows WRP NPDES permit, footnote 22 of Table E-5 of the Monitoring and Reporting Program states; "The **median monthly summary result is a threshold value** for a determination of meeting the narrative receiving water objective and shall be reported as 'Pass' or 'Fail.'"[2] [Emphasis added.]

In addition to aligning with the NPDES permit language, use of a monthly median will also address concerns regarding false positive error rates. The USEPA has determined that the expected false positive error rate for chronic toxicity testing using the NOEC is 5%. With this error rate, on average, one in 20 individual chronic toxicity tests will be erroneously identified as "toxic" using the NOEC, and there is a nearly 34% probability that 2 or more individual chronic toxicity test exceedances would be observed within a set of 24 discrete measurements in a completely non-toxic stream reach. When there are two or more exceedances out of 24 measurements, the Listing Policy specifies that a reach be listed as impaired. Therefore, using single chronic toxicity exceedances as the 303(d) criterion would, over time, result in more and more non-toxic stream reaches being erroneously listed. However, using a monthly median chronic toxicity exceedance threshold would reduce the likelihood of inappropriate reach listings due to false positive chronic toxicity results to less than 1%.

[2] Pomona WRP - ORDER R4-2014-0212-A01 NPDES NO. CA0053619, Long Beach WRP - ORDER NO. R4-2015-0123 NPDES NO. CA0054119, Los Coyotes - ORDER NO. R4-2015-0124 NPDES NO. CA0054011, San Jose Creek WRP - ORDER R4-2015-0070 NPDES NO. CA0053911, Saugus WRP- ORDER R4-2015-0072 NPDES NO. CA0054313, Valencia WRP- ORDER R4-2015-0071 NPDES NO. CA0054216, Whittier Narrows WRP ORDER R4-2014-0213-A01 NPDES NO. CA0053716

Fact Sheet #5

Water Body: **Santa Clara River Reach 5**
Pollutant: **Toxicity**
Listing: **List on 303(d) List (TMDL Required List)**
Comment & Recommendation: **Do Not List – Water Quality Objectives Being Achieved**

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for toxicity be made to the 303(d) list for Reach 5 of the Santa Clara River, based on one line of evidence: 2 of 2 samples exceeded the objective. The Sanitation Districts of Los Angeles County (Sanitation Districts) believe this proposed listing is inappropriate and recommend not listing due to water quality objectives being achieved, for the reasons listed below; supporting evidence is provided in the sections that follow.

- Inappropriate data were utilized. Toxicity results were reported for sites SCR 1272 and SCR 14156. However, SCR 14156 is in Reach 6 of the Santa Clara River and should not be included in an evaluation of Reach 5 (Figure 1).

- Incomplete data were utilized. The ”Data for Various Pollutants in Various Water Bodies in Sanitation Districts of Los Angeles County 2005-2010” dataset should be included in this analysis as it was provided in response to the call for data, readily available, and used in other current listing recommendations. Appendix A of this letter contains the full set of data applicable to this listing from Appendix G of the Regional Board Draft Staff Report.

- The Los Angeles Region Basin Plan states, “the acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board.” Therefore, a single-test threshold of less than 70% survival should be used to determine impairments. Applying this threshold (or even a more conservative 90% threshold) to the appropriate and complete dataset that excludes site SCR 14156 and includes Sanitation Districts data, there were five chronic toxicity exceedances out of 90 valid toxicity tests. This total does not meet the minimum number of measured exceedances needed to place a water segment on the section 303(d) list.

Fact Sheet #5

Figure 1. Santa Clara River Reach 5 and RWB4 Stormwater Monitoring Council CY2008 CY2009 Sampling Locations

Fact Sheet #5

The Los Angeles Region Basin Plan Establishes Acute Toxicity Thresholds

The Los Angeles Region Basin Plan states, "the acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board." Therefore, a single-test threshold of less than 70% survival should be used to determine impairments. However, even if a more conservative 90% survival single-test threshold were to be applied, no tests in the data set would exceed this threshold.

The Water Quality Objective/Threshold for Chronic Toxicity Should Be a Monthly Median.

When a sample fails a chronic toxicity test, additional samples may be collected during the same calendar month in an effort to confirm the result and identify potential toxicants. Application of a single test failure chronic toxicity water quality objective provides a disincentive for this type of proactive monitoring and is at odds with the intent of chronic toxicity testing.

Chronic toxicity is intended to assess potential aquatic life impacts associated with long-term exposures. Therefore, it is analogous to the Criterion Continuous Concentration (CCC) used for estimating "safe" chemical concentrations for long-term exposure as opposed to the Criterion Maximum Concentration (CMC) that is intended to protect against short-term exposure. In EPA's Region 9 and 10 Toxicity Training Tool, the CCC is defined as "the highest in-stream concentration of a toxic or an effluent to which organisms can be exposed indefinitely without causing unacceptable effects such as the exceedance of a chronic water quality criterion."[1] This same document also recommends "direct application of 1.0 TUc as the monthly compliance level for NPDES discharges without a mixing zone or dilution allowance. In conjunction and limited to this discharge situation, because: (1) there are no values below 1.0 TUc and (2) an arithmetic average is sensitive to extremely large and small values, the median is favored as the better measure of central tendency for the monthly compliance level."

Although the Basin Plan provides no numeric chronic toxicity objectives, recently adopted Los Angeles Region NPDES permits do provide very specific direction on interpretation of the narrative water quality objectives for chronic toxicity. In the Valencia WRP permit, footnote 30 associated with the Receiving Water Monitoring Requirements Table (Table E-5a) of the Monitoring and Reporting Program states; "The **median monthly summary result is a threshold value** for a determination of meeting the narrative receiving water objective and shall be reported as 'Pass' or 'Fail.'"[2] [Emphasis added.]

In addition to aligning with the NPDES permit language, use of a monthly median will also address concerns regarding false positive error rates. The USEPA has determined that the expected false positive error rate for chronic toxicity testing using the NOEC is 5%. With this error rate, on average, one in 20 individual chronic toxicity tests will be erroneously identified as "toxic" using the NOEC, and there is a nearly 34% probability that 2 or more individual chronic toxicity test exceedances would be observed within a set of 24 discrete measurements in a completely non-toxic stream reach. When there are two or

[1] Denton DL, Miller JM, Stuber RA. 2007. EPA Regions 9 and 10 toxicity training tool (TTT). November 2007. San Francisco, CA: https://www.epa.gov/sites/production/files/documents/ToxTrainingTool10Jan2010.pdf

[2] Pomona WRP - ORDER R4-2014-0212-A01 NPDES NO. CA0053619, Long Beach WRP - ORDER NO. R4-2015-0123 NPDES NO. CA0054119, Los Coyotes - ORDER NO. R4-2015-0124 NPDES NO. CA0054011, San Jose Creek WRP - ORDER R4-2015-0070 NPDES NO. CA0053911, Saugus WRP- ORDER R4-2015-0072 NPDES NO. CA0054313, Valencia WRP- ORDER R4-2015-0071 NPDES NO. CA0054216, Whittier Narrows WRP ORDER R4-2014-0213-A01 NPDES NO. CA0053716

Fact Sheet 5

more exceedances out of 24 measurements, the Listing Policy specifies that a reach be listed as impaired. Therefore, using single chronic toxicity exceedances as the 303(d) criterion would, over time, result in more and more non-toxic stream reaches being erroneously listed. However, using a monthly median chronic toxicity exceedance threshold would reduce the likelihood of inappropriate reach listings due to false positive chronic toxicity results to less than 1%.

Fact Sheet #6

Water Body:	**Santa Clara River Reach 5**
Pollutant:	**Benthic Community Effects**
Listing:	**List on 303(d) List (TMDL Required List)**
Comment & Recommendation:	**Do Not List – Water Quality Objectives Being Achieved**

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is currently proposing that a new listing for benthic community effects be made to the 303(d) list for Reach 5 of the Santa Clara River, based on two lines of evidence: Southern Coastal California Index of Biotic integrity (SCIBI) and California Stream Condition Index (CSCI) scores. The Districts believe this proposed listing is inappropriate and recommend not listing for the reasons listed below; supporting evidence is provided in the sections that follow.

- The SCIBI-based analysis has been demonstrated to be inadequate for use in low gradient/low elevation watersheds similar to the reaches in the upper Santa Clara River. For this and other reasons, the State Water Resources Control Board (State Board) has rejected use of the SCIBI in favor of the technically superior CSCI scoring tool.

- Although the CSCI at least partially addresses some of the problems with the SCIBI by employing a modeled reference condition as opposed to the regional reference pool used by the SCIBI, the lack of any reference sites in large watersheds, low gradient, and low elevation systems still limits the identification of appropriate thresholds using the CSCI. Specifically, several Santa Clara River sites have been shown to fall outside the experience of the CSCI model.

- Appropriate water quality thresholds for the CSCI have not been established. Although examples of approaches for developing CSCI thresholds have been published (e.g., by the Southern California Coastal Water Research Project), it is well recognized by the scientific community that a single standard should not be applicable to all water bodies because unmanageable non-pollutant features such as habitat condition are likely to preclude many streams from ever having biological assemblages similar to reference. The State Board is currently investing considerable resources to develop thresholds and should be allowed to complete the process before determination of impairment and listings.

- The CSCI analysis for this listing used data from both Reach 5 and Reach 6 of the Santa Clara River. The CSCI analysis of the data collected from the Reach 5 location actually met the 0.79 threshold proposed by the Regional Board.

- Physical habitat was not assessed, as required by the State Board Water Quality Control Board Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy). Historically unmanaged or unmanageable stressors (e.g. channel/habitat modifications) are well documented as precluding sites from achieving reference conditions.

- The proposed listing fails to associate the alleged impairment with other pollutants, namely toxicity and iron, which were listed as co-occurring.

Fact Sheet #6

SCIBI Is an Inadequate Metric for Assessing Low Gradient, Low Elevation Streams.

Section 3.9 of the Listing Policy states:

> "A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities **as compared to reference site(s)** and is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." [Emphasis added.]

While it is commonly assumed that the SCIBI inherently accounted for reference conditions, the reference conditions used to develop the SCIBI were not representative of the low elevation/low gradient streams commonly found in the alluvial plains of the Los Angeles Region.[1,2] It was developed using data from 275 sites, ranging from Monterey County to the Mexican border but not a single reference location represented low elevation and low gradient streams. Santa Clara River Reach 5 is an extremely low gradient (less than 0.5%), low elevation, large coastal water body; therefore, the reference pool used for development of the SCIBI is not representative of natural conditions relevant to this reach. As described in more detail below, technical experts have acknowledged the limitations of the SCIBI (and other IBIs) and indicated that it is critical that reference conditions represent the full range of environmental gradients where an index will be used.[3] Consequently, the State Water Board has supported and funded the development of the CSCI scoring tool; this new, predictive index represents a substantial increase in the applicability of indices.

The lead scientist for development of the SCIBI, Dr. Peter Ode, has acknowledged the limitations on application of the SCIBI. In a peer-reviewed published paper, he concluded that the SCIBI did not adequately address reference conditions in low elevation sites and was "not completely effective at controlling for an elevation gradient."[4] Dr. Ode was also the co-author of a March 2009 report on recommendations for development and maintenance of a network of reference sites to support biological assessment of California's wadeable streams, which notes that, "A crucial component to the development of assessment tools is understanding biological expectations at reference sites that consist of natural, undisturbed systems.[5] These reference systems set the biological condition benchmarks for comparisons to the site(s) being evaluated." They also clearly note that adequate reference sites have not been identified in southern California, stating, "human-dominated landscapes can be so pervasive in locations such as urban southern California and the agriculturally dominated Central Valley that no undisturbed reference sites may currently exist in these regions. A statewide framework for consistent selection of reference sites must account for this complexity."

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[1] Ode, P.R., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management Vol. 35, No 4, pp. 494, Figure 1. Copy included in Appendix B.

[2] Carter, J.L. and V.H. Resh. (2005). Pacific Coast Rivers of the Coterminous United States. pp. 541-590 *in*: A.C. Benke and C.E. Cushing (eds.), Rivers of North America. Elsevier Academic Press. Boston, MA.

[3] Mazor, R.D., A.C. Rehn, P.R. Ode, M. Engeln, K.C. Schiff, E.D. Stein, D.J. Gillett, D.B. Herbst, and C.P. Hawkins. (2016). Bioassessment in complex environments: Designing an index for consistent meaning in different settings. Freshwater Science 35(1): 249-271. Copy included in Appendix B.

[4] Ode, P.R., C.P. Hawkins, R.D. Mazor, Comparability of Biological Assessments Derived from Predictive Models and Multimetric Indices of Increasing Geographic Scope, J. N. Am. Benthol. Soc., 2008, 27(4):967-985.p. 982. Copy included in Appendix B.

[5] Ode, P.R., K. Schiff. Recommendations for the Development and Maintenance of a Reference Condition Management Program to Support Biological Assessment of California's Wadeable Streams: Report to the Surface Water Ambient Monitoring Program. Southern California Coastal Water Research Project, Technical Report 581. March 2009. Copy included in Appendix B.

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Furthermore, a memorandum prepared by Jerry Diamond of Tetra Tech, one of the leading national technical experts on bioassessments, confirmed that adequate reference sites are not available to assess benthic macroinvertebrate populations for low gradient and low elevation streams in the LA Region.[6] Dr. Diamond is the author of several technical reports prepared for the LA Regional Board on tiered aquatic life uses (TALU) based on bioassessments.[7,8] Dr. Diamond states that there is "high uncertainty regarding appropriate reference conditions for low gradient and low elevation streams in this region [Southern California]," and that "low elevation streams lacked a clear reference conditions in this region [Southern California]." He further states that a technical advisory committee for a US EPA-funded project on TALU "identified a lack of appropriate reference sites for low elevation/low gradient streams as a critical data gap." The technical advisory committee consisted of regional experts from California Fish & Wildlife, State Water Board, other Regional Boards, US EPA Region 9, and universities. Dr. Diamond also worked with SCCWRP and the LA Regional Board in facilitating two workshops on TALU for Southern California. Dr. Diamond states, "In the most recent stakeholder workshop…there was agreement that low gradient (rather than low elevation) was perhaps the most critical factor distinguishing stream biology in the region and that the reference condition for low gradient streams (many but not all of which occur at low elevation) is a critical data gap...."[9]

Other scientific experts concur with Dr. Diamond's conclusions. As part of a 2009 study examining low gradient streams in California, including sites within Reach 5 of the Santa Clara River, Raphael D. Mazor of SCCWRP stated, "Several biomonitoring efforts in California specifically target low-gradient streams, as these habitats are subject to numerous impacts and alterations…even though the applicability of assessment tools created and validated in high-gradient streams have not been tested."[10] The study found that "As a consequence of these differences [substrate material, bed morphology, and distribution of microhabitats], traditional bioassessment approaches in California that were developed in high-gradient streams with diverse microhabitats have limited applications in low-gradient reaches,"[10] and "Caution should be used when applying sampling methods for assessment tools that were calibrated for specific habitat types (e.g., high gradient streams) to new habitats (e.g., low gradient streams)."[10] The study also concluded that "…observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated margins) may account for the reduced number of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low gradient streams in California."[10] Moreover, the State Water Board, Surface Water Ambient Monitoring Program, California Department of Fish and Game, and others recognize the limitations of the SCIBI regarding reference sites. They have identified application of TALU and the selection of more representative/appropriate regional reference locations as being necessary components to the state's bioassessment program.[5,7] This sentiment was shared in an evaluation of California's bioassessment program. Specifically, "The National Research Council's review makes clear that all states need better biological endpoints, adequate monitoring and assessment, and

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[6] Diamond, Jerry. Reference Conditions and Bioassessments in Southern California Streams. July 31, 2009. Memorandum to Phil Markle of the Sanitation Districts. Copy included in Appendix B.

[7] Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix B.

[8] Tetra Tech, Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams. Prepared for EPA Region 9 and California Regional Water Quality Control Board, Los Angeles Region. 2006. Tetra Tech, Inc., Owings Mills, MD. Copy included in Appendix B.

[9] For a report summarizing the outcome of the workshops, see Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix B.

[10] Mazor, Raphael D.; Schiff, Kenneth; Ritter, Kerry; Rehn, Andy; and Ode, Peter; Bioassessment Tools in Novel Habitats: An Evaluation of Indices and Sampling Methods in Low-Gradient Streams in California, Environ. Monit. Assess., DOI 10.1007/s10661-009-1033-3. Copy included in Appendix B.

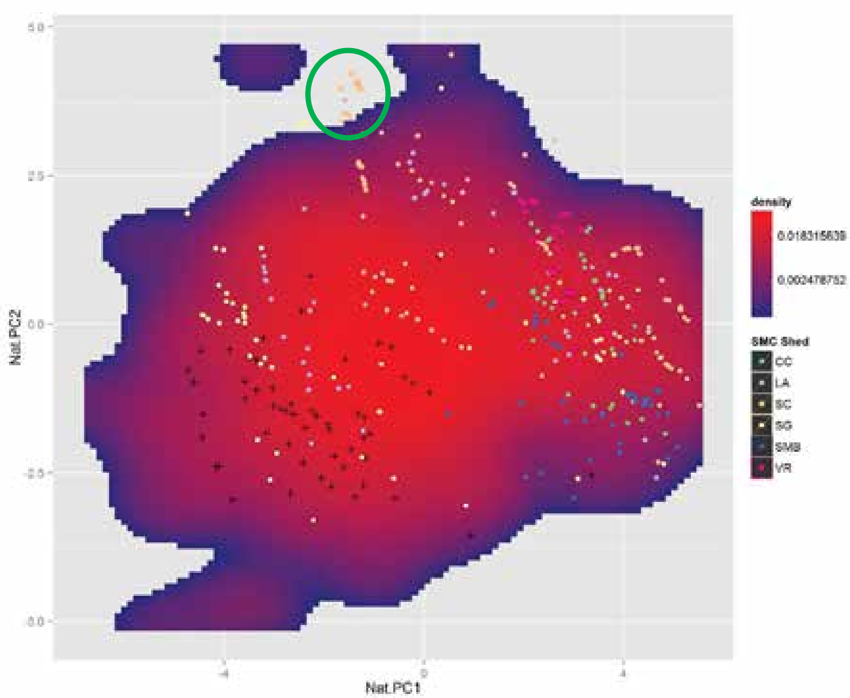
Fact Sheet #6

tiered aquatic life uses (TALU) in order to develop and refine appropriate and effective water quality standards that result in more accurate and appropriate protection for biological resources."[11]

CSCI Improves on the SCIBI But Some Limitations Remain

The State Board is developing the CSCI scoring tool that is intended to replace the flawed IBI scoring tools statewide. The CSCI at least partially addresses some of the problems with the SCIBI by employing a modeled reference condition as opposed to the regional reference pool used by the SCIBI. Reliance upon this modeled reference condition has significantly improved the applicability and resolution of the bioassessment scoring tools; however, the lack of any reference sites in large watersheds, low gradient, and low elevation systems still limits the identification of appropriate thresholds using the CSCI. A number of these environmental gradients exist, alone or in combination. Figure 1 shows the use of a data density approach to quantify the availability of data to determine reference conditions; red areas indicate a higher density of reference locations, darker/blue areas indicate fewer reference locations, and gray indicates sites that may be outside the experience of the CSCI.[12] Several of the Santa Clara River sites (orange symbols circled in Figure 1) fall outside of CSCI reference conditions. In these situations, it has been suggested that the CSCI could be used in conjunction with an alternative (i.e., non-threshold based) assessment option (i.e., upstream-downstream comparison).[13]

Figure 1. CSCI Reference Density Cloud (Santa Clara River Sites Within Green Circle).



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[11] Yoder, C.O. and Plotnikoff, R. (2009). Evaluation of the California State Water Resource Control Board's Bioassessment Program. Final Report to EPA-OST and Region IX. Copy included in Appendix B.
[12] Ode, P.R., Rehn, A.C., Mazor, R.D., and Schiff, K.C. (2012) Building the Technical Foundation for Biological Objectives. Presentation to the California Aquatic Bioassessment Workgroup, November 7, 2012. Copy included in Appendix B.
[13] California Biological Objectives Science Advisory Panel. (2012). Science Advisory Panel Response, October 18, 2012. Copy included in Appendix B.

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Appropriate Water Quality Standards (i.e. Biocriteria) Have Not Been Established

The State Board is determining numeric translators to address the narrative biological objective that includes "bioassessment." However, the State Board has not yet developed any recommended thresholds for the CSCI. The proposed threshold of 0.79 is the 10th percentile of the reference pool and was used as a point of reference for a regional monitoring program. However, by this definition, 10% of California's identified reference pool would be considered impaired.

Furthermore, it is well recognized by the scientific community that a single standard or threshold should not be applicable to all waterbodies of the State since unmanageable non-pollutant features such as habitat condition are likely to preclude many streams from ever having biological assemblages similar to reference.[14,15] In fact, as part of California's biological objectives program, SCCWRP has developed a workplan to identify and evaluate the constraint these traditionally unmanageable features may place on biological indices.[16] For example, the Southern California Stormwater Monitoring Coalition (SMC) found that engineered (i.e. modified) channels appear to be in worse ecological health than natural channels based on macroinvertebrate and algae assemblages and that tradeoffs between ecological health and flood protection may be unavoidable.[15] This impact of unmanageable stressors is not limited to engineered channels; studies have shown that hydrological alterations attributable to reaches with as little as 5% coverage by impervious surfaces in the localized watershed are associated with unhealthy biological communities.[17] These and many other examples clearly illustrate the infeasibility of a single criterion with statewide applicability.

As such, utilization of an undeveloped and unsupported standard (e.g. CSCI <0.79) is premature. Given the substantial resources the State is investing in the development of numerical translators, Regional Boards should allow the State to complete the process before determination of impairment and listings, as appropriate.

CSCI Data from Within Reach 5 of the Santa Clara River Show No Impairment

The proposed listing cites one dataset for the CSCI. This dataset inappropriately aggregates two stations (SCR 14156 and SCR 1272) that are approximately 5 miles from each other (Figure 2). Section 6.1.5.2 of the Listing Policy states:

> "Samples collected within 200 meters of each other should be considered samples from the same station or location. However, samples less than 200 meters apart may be considered to be spatially independent samples if justified in the water body fact sheet."

These two stations are too far apart to justify aggregation. Furthermore, SCR 14156 is in Reach 6 of the Santa Clara River and should not be considered as a line of evidence in any proposed Reach 5 listing. The single station with Reach 5, SCR 1272, had a CSCI score of 0.91. **Thus, the only CSCI score in this Reach is above the proposed threshold of impairment**.

[14] Waite, I.R. J.G. Kennen, J.T. May, L.R. Brown, T.F. Cuffney, K.A. Jones, and J.L. Orlando. (2012). Comparison of stream invertebrate response models for bioassessment metrics. Journal of the American Water Resources Association 48. Copy included in Appendix B.
[15] Southern California Stormwater Monitoring Coalition (SMC). 2017. 2015 Report on the Stormwater Monitoring Coalition Regional Stream Survey. SCCWRP Technical Report 963. Southern California Coastal Water Research Project. Costa Mesa, CA. Copy included in Appendix B.
[16] Mazor, R., Sutula, M., Stein, E., Rehn, A., and Ode, P. (2017) Draft Work Plan. Predicting Biological Integrity of Streams Across a Gradient of Development in California Landscapes. Copy included in Appendix B.
[17] Stein, E.D., Sengupta, A., Mazor, R.D., and McCune, K. (2016). Application of Regional Flow-ecology to Inform Management Decision in the San Diego River Watershed. Southern California Coastal Water Research Project Technical Report #948. Copy included in Appendix B.

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Figure 2. Santa Clara River Reach 5 and Monitoring Stations Used in Listing

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The Proposed Listing Fails to Evaluate Physical Habitat Data

Section 6.1.5.8 of the listing policy states:

> "When evaluating biological data and information, RWQCBs shall evaluate all readily available data and information and shall
> - Evaluate bioassessment data from other sites, and compare to reference condition.
> - Evaluate physical habitat data and other water quality data, when available, to support conclusions about the status of the water segment."

EPA's causal assessment manual cites physical habitat as a leading cause of impairment in streams on 303d lists and recommends that, in all cases where physical habitat is evaluated, stream size and channel dimensions, channel gradient, channel substrate size and type, habitat complexity and cover, vegetation cover and structure, and channel-riparian interactions should all be considered before making a decision.[18] Likewise, the SMC identified habitat stressors among the highest priority for evaluation in relation to depressed benthic community assemblages.[15] The need to consider physical habitat is apparent in the low gradient Santa Clara River where sediment and leaf litter/detritus loads are naturally deposited in the channel, filling up the available spaces between rocks. These habitats support a much different population of invertebrates (more detritus feeders and fewer predators) than the rocky/sandy reference conditions, and do not necessarily indicate an "impaired" population.

The Proposed Listing Fails to Associate the Alleged Impairment with Other Pollutants

The Listing Policy states:

> "A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities as compared to reference site(s) and **is associated with** water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." [Emphasis added.]

In the fact sheets supporting its impairment decisions for each of these listings, the LA Regional Board stated that the alleged impairment in benthic community composition in Reach 5 was justified by being "associated" with impairments for two pollutants, iron and toxicity simply because these constituents co-occurred. However, based on further investigations, it is apparent that these constituents would not be associated with benthic community impairment because the iron would not be bioavailable and no impairment exists for toxicity.

- Iron
    - The 1.0 ppm iron criterion used as the basis for the proposed iron impairment in this reach is a 4-day average threshold taken from the 1976 USEPA "Red Book" and was updated using the 1985 Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. However, iron was detected only sporadically at levels above 1.0 ppm, and concentrations below the point source discharge were consistently low, suggesting that the 4-day average threshold of 1.0 mg/L is likely achieved.

[18] U.S. EPA (Environmental Protection Agency). (2010). Causal Analysis/Diagnosis Decision Information System (CADDIS). Office of Research and Development, Washington, DC. Available online at https://www.epa.gov/caddis. Last updated September 23, 2010

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  - Furthermore, the bioavailable form of iron is ferrous iron and only exists at low pH levels. The pH in Reach 5 averages 7.9 with a 5th percentile pH of 7.5. In ambient waters with sufficient dissolved oxygen and a pH above 7.0, iron will rapidly oxidize to a non-bioavailable form and would not be responsible for impacts to aquatic life.In fact, the Red Book includes a disclaimer that "data obtained under laboratory conditions suggest a greater toxicity for iron than that obtained in natural ecosystems."
- Toxicity
  - SCCWRP has concluded that sub-lethal water column toxicity is a poor indicator of benthic community impairment.[19] Furthermore, the data do not support a toxicity listing (Fact Sheet #5). Station SCR 14156 is in Reach 6 of the Santa Clara River and should not be included in this analysis. Conversely, the readily accessible ”Data for Various Pollutants in Various Water Bodies in Sanitation Districts of Los Angeles County 2005-2010” dataset should be included in this analysis. Using the complete and appropriate dataset, six of 91 Santa Clara River Reach 5 toxicity tests exceed the objective, which fails to meet the minimum number of measured exceedances needed to place a water segment on the section 303(d) list for toxicants as specified in table 3.1 of the Listing Policy.

[19] Southern California Stormawater Monitoring Coalition (SMC). 2015. Bioassessment of Perennial Streams in Southern California: A Report on the First Five Years of the Stormwater Monitoring Coalition’s Regional Stream Survey. SCCWRP Technical Report 844. Southern California Coastal Water Research Project. Costa Mesa, CA. Copy included in Appendix B.

Fact Sheet #7

Water Body:	**Los Angeles River Reach 3**
Pollutant:	**Benthic Community Effects**
Listing:	**List on 303(d) List (TMDL Required List)**
Comment & Recommendation:	**Do Not List – Water Quality Objectives Being Achieved**

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for benthic community effects be made to the 303(d) list for Reach 3 of the Los Angeles River, based on a weight of evidence approach using Southern Coastal California Index of Biotic integrity (SCIBI) scores. The Districts believe this proposed listing is inappropriate and recommend not listing for the reasons listed below; supporting evidence is provided in the sections that follow.

- The SCIBI-based analysis has been demonstrated to be inadequate for use in low gradient/low elevation watersheds similar to Los Angeler River Reach 3. For this, and other reasons, the State Water Resources Control Board (State Board) has rejected use of the SCIBI in favor of the technically superior CSCI scoring tool. No CSCI results have been used for this listing, but a more detailed assessment of the CSCI can be found in Fact Sheet #6.

- Physical habitat was not assessed, as required by the State Board Water Quality Control Board Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy). Historically unmanaged or unmanageable stressors (e.g. channel/habitat modifications) are well documented as precluding sites from achieving reference conditions.

SCIBI Is an Inadequate Metric for Assessing Low Gradient, Low Elevation Streams.

Section 3.9 of the Listing Policy states:

> "A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities **as compared to reference site(s)** and is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." [Emphasis added.]

While it is commonly assumed that the SCIBI inherently accounted for reference conditions, the reference conditions used to develop the SCIBI were not representative of the low elevation/low gradient streams commonly found in the alluvial plains of the Los Angeles Region.[1,2] It was developed using data from 275 sites, ranging from Monterey County to the Mexican border but not a single reference location represented low elevation and low gradient streams. Los Angeles River Reach 3 is a low gradient, low elevation, large coastal water body; therefore, the reference pool used for development of the SCIBI is not representative of natural conditions relevant to this reach. As described in more detail below, technical experts have acknowledged the limitations of the SCIBI (and other IBIs) and indicated that it is critical that reference conditions represent the full range of environmental gradients where an index will be used.[3]

[1] Ode, P.R., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management Vol. 35, No 4, pp. 494, Figure 1. Copy included in Appendix B.
[2] Carter, J.L. and V.H. Resh. (2005). Pacific Coast Rivers of the Coterminous United States. pp. 541-590 *in*: A.C. Benke and C.E. Cushing (eds.), Rivers of North America. Elsevier Academic Press. Boston, MA.
[3] Mazor, R.D., A.C. Rehn, P.R. Ode, M. Engeln, K.C. Schiff, E.D. Stein, D.J. Gillett, D.B. Herbst, and C.P. Hawkins. (2016). Bioassessment in complex environments: Designing an index for consistent meaning in different settings. Freshwater Science 35(1): 249-271. Copy included in Appendix B.

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Consequently, the State Water Board has supported and funded the development of the CSCI scoring tool; this new, predictive index represents a substantial increase in the applicability of indices.

The lead scientist for development of the SCIBI, Dr. Peter Ode, has acknowledged the limitations on application of the SCIBI. In a peer-reviewed published paper, he concluded that the SCIBI did not adequately address reference conditions in low elevation sites and was "not completely effective at controlling for an elevation gradient."[4] Dr. Ode was also the co-author of a March 2009 report on recommendations for development and maintenance of a network of reference sites to support biological assessment of California's wadeable streams, which notes that, "A crucial component to the development of assessment tools is understanding biological expectations at reference sites that consist of natural, undisturbed systems".[5] These reference systems set the biological condition benchmarks for comparisons to the site(s) being evaluated." They also clearly note that adequate reference sites have not been identified in southern California, stating, "human-dominated landscapes can be so pervasive in locations such as urban southern California and the agriculturally dominated Central Valley that no undisturbed reference sites may currently exist in these regions. A statewide framework for consistent selection of reference sites must account for this complexity."

Furthermore, a memorandum prepared by Jerry Diamond of Tetra Tech, one of the leading national technical experts on bioassessments, confirmed that adequate reference sites are not available to assess benthic macroinvertebrate populations for low gradient and low elevation streams in the LA Region.[6] Dr. Diamond is the author of several technical reports prepared for the LA Regional Board on tiered aquatic life uses (TALU) based on bioassessments.[7,8] Dr. Diamond states that there is "high uncertainty regarding appropriate reference conditions for low gradient and low elevation streams in this region [Southern California]," and that "low elevation streams lacked a clear reference conditions in this region [Southern California]." He further states that a technical advisory committee for a US EPA-funded project on TALU "identified a lack of appropriate reference sites for low elevation/low gradient streams as a critical data gap." The technical advisory committee consisted of regional experts from California Fish & Wildlife, State Water Board, other Regional Boards, US EPA Region 9, and universities. Dr. Diamond also worked with SCCWRP and the LA Regional Board in facilitating two workshops on TALU for Southern California. Dr. Diamond states, "In the most recent stakeholder workshop…there was agreement that low gradient (rather than low elevation) was perhaps the most critical factor distinguishing stream biology in the region and that the reference condition for low gradient streams (many but not all of which occur at low elevation) is a critical data gap...."[9]

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[4] Ode, P.R., C.P. Hawkins, R.D. Mazor, Comparability of Biological Assessments Derived from Predictive Models and Multimetric Indices of Increasing Geographic Scope, J. N. Am. Benthol. Soc., 2008, 27(4):967-985.p. 982. Copy included in Appendix B.

[5] Ode, P.R., K. Schiff. Recommendations for the Development and Maintenance of a Reference Condition Management Program to Support Biological Assessment of California's Wadeable Streams: Report to the Surface Water Ambient Monitoring Program. Southern California Coastal Water Research Project, Technical Report 581. March 2009. Copy included in Appendix B.

[6] Diamond, Jerry. Reference Conditions and Bioassessments in Southern California Streams. July 31, 2009. Memorandum to Phil Markle of the Sanitation Districts. Copy included in Appendix B.

[7] Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix B.

[8] Tetra Tech, Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams. Prepared for EPA Region 9 and California Regional Water Quality Control Board, Los Angeles Region. 2006. Tetra Tech, Inc., Owings Mills, MD. Copy included in Appendix B.

[9] For a report summarizing the outcome of the workshops, see Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix B.

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Other scientific experts concur with Dr. Diamond's conclusions. As part of a 2009 study examining low gradient streams in California, Raphael D. Mazor of SCCWRP stated, "Several biomonitoring efforts in California specifically target low-gradient streams, as these habitats are subject to numerous impacts and alterations…even though the applicability of assessment tools created and validated in high-gradient streams have not been tested."[10] The study found that "As a consequence of these differences [substrate material, bed morphology, and distribution of microhabitats], traditional bioassessment approaches in California that were developed in high-gradient streams with diverse microhabitats have limited applications in low-gradient reaches,"[10] and "Caution should be used when applying sampling methods for assessment tools that were calibrated for specific habitat types (e.g., high gradient streams) to new habitats (e.g., low gradient streams)."[10] The study also concluded that "…observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated margins) may account for the reduced number of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low gradient streams in California."[10] Moreover, the State Water Board, Surface Water Ambient Monitoring Program, California Department of Fish and Game, and others recognize the limitations of the SCIBI regarding reference sites. They have identified application of TALU and the selection of more representative/appropriate regional reference locations as being necessary components to the state's bioassessment program.[5,7] This sentiment was shared in an evaluation of California's bioassessment program. Specifically, "The National Research Council's review makes clear that all states need better biological endpoints, adequate monitoring and assessment, and tiered aquatic life uses (TALU) in order to develop and refine appropriate and effective water quality standards that result in more accurate and appropriate protection for biological resources."[11]

CSCI Improves on the SCIBI But Some Limitations Remain

The State Board is developing the CSCI scoring tool that is intended to replace the flawed IBI scoring tools statewide. The CSCI at least partially addresses some of the problems with the SCIBI by employing a modeled reference condition as opposed to the regional reference pool used by the SCIBI. Reliance upon this modeled reference condition has significantly improved the applicability and resolution of the bioassessment scoring tools; however, the lack of any reference sites in large watersheds, low gradient, and low elevation systems still limits the identification of appropriate thresholds using the CSCI. A number of these environmental gradients exist, alone or in combination. In these situations, it has been suggested that the CSCI could be used in conjunction with an alternative (i.e., non-threshold based) assessment option (i.e., upstream-downstream comparison).[12]

The Proposed Listing Fails to Evaluate Physical Habitat Data

Section 6.1.5.8 of the listing policy states:

> "When evaluating biological data and information, RWQCBs shall evaluate all readily available data and information and shall
> - Evaluate bioassessment data from other sites, and compare to reference condition.

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[10] Mazor, Raphael D.; Schiff, Kenneth; Ritter, Kerry; Rehn, Andy; and Ode, Peter; Bioassessment Tools in Novel Habitats: An Evaluation of Indices and Sampling Methods in Low-Gradient Streams in California, Environ. Monit. Assess., DOI 10.1007/s10661-009-1033-3. Copy included in Appendix B.

[11] Yoder, C.O. and Plotnikoff, R. (2009). Evaluation of the California State Water Resource Control Board's Bioassessment Program. Final Report to EPA-OST and Region IX. Copy included in Appendix B.

[12] California Biological Objectives Science Advisory Panel. (2012). Science Advisory Panel Response, October 18, 2012. Copy included in Appendix B.

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- Evaluate physical habitat data and other water quality data, when available, to support conclusions about the status of the water segment."

EPA's causal assessment manual cites physical habitat as a leading cause of impairment in streams on 303d lists and recommends that, in all cases where physical habitat is evaluated, stream size and channel dimensions, channel gradient, channel substrate size and type, habitat complexity and cover, vegetation cover and structure, and channel-riparian interactions should all be considered before making a decision.[13] Likewise, the SMC identified habitat stressors among the highest priority for evaluation in relation to depressed benthic community assemblages.[14] The need to consider physical habitat is evident in low gradient engineered channels such as the Los Angeles River Reach 3, an environment that experts agree is unlikely to have biological assemblages similar to reference regardless of water quality.

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[13] U.S. EPA (Environmental Protection Agency). (2010). Causal Analysis/Diagnosis Decision Information System (CADDIS). Office of Research and Development, Washington, DC. Available online at https://www.epa.gov/caddis. Last updated September 23, 2010

[14] Southern California Stormawater Monitoring Coalition (SMC). 2015. Bioassessment of Perennial Streams in Southern California: A Report on the First Five Years of the Stormwater Monitoring Coalition's Regional Stream Survey. SCCWRP Technical Report 844. Southern California Coastal Water Research Project. Costa Mesa, CA. Copy included in Appendix B.

Fact Sheet #8

Water Body: Medea Creek Reach 1
Pollutant: Benthic Community Effects
Listing: List on 303(d) List (TMDL Required List)
Comment & Recommendation: Do Not List – Water Quality Objectives Being Achieved

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for benthic community effects be made to the 303(d) list for Reach 1 of the Medea Creek, based on a weight of evidence approach using California Stream Condition Index (CSCI) and Southern Coastal California Index of Biotic integrity (SCIBI) scores. The Districts believe this proposed listing is inappropriate and recommend not listing for the reasons listed below; supporting evidence is provided in the sections that follow.

- Appropriate water quality thresholds for the CSCI have not been established. Although examples of approaches for developing CSCI thresholds have been published (e.g., by the Southern California Coastal Water Research Project), it is well recognized by the scientific community that a single standard should not be applicable to all water bodies because unmanageable non-pollutant features such as habitat condition are likely to preclude many streams from ever having biological assemblages similar to reference. The State Board is currently investing considerable resources to develop thresholds and should be allowed to complete the process before determination of impairment and listings.

- Physical habitat was not assessed, as required by the State Board Water Quality Control Board Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy). Historically unmanaged or unmanageable stressors (e.g. channel/habitat modifications) are well documented as precluding sites from achieving reference conditions.

- The proposed listing fails to associate the alleged impairment with other pollutants, namely trash and selenium, which were listed as co-occurring.

Appropriate Water Quality Standards (i.e. Biocriteria) Have Not Been Established

The State Board is developing the CSCI scoring tool and numeric translators to address the narrative biological objective that includes "bioassessment." However, the State Board has not yet developed any recommended thresholds for the CSCI. The proposed threshold of 0.79 is the 10th percentile of the reference pool and was used as a point of reference for a regional monitoring program. However, by this definition, 10% of California's identified reference pool would be considered impaired.

Furthermore, it is well recognized by the scientific community that a single standard or threshold should not be applicable to all waterbodies of the State since unmanageable non-pollutant features such as habitat condition are likely to preclude many streams from ever having biological assemblages similar to reference. For example, the Southern California Stormwater Monitoring Coalition (SMC) found that engineered (i.e. modified) channels appear to be in worse ecological health than natural channels based on macroinvertebrate and algae assemblages and that tradeoffs between ecological health and flood protection may be unavoidable.[1] This impact of unmanageable stressors is not only limited to engineered channels; studies have shown that hydrological alterations attributable to reaches with as little as 5% coverage by impervious surfaces in the localized watershed is associated with unhealthy biological

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[1] Southern California Stormwater Monitoring Coalition (SMC). 2017. 2015 Report on the Stormwater Monitoring Coalition Regional Stream Survey. SCCWRP Technical Report 963. Southern California Coastal Water Research Project. Costa Mesa, CA. Copy included in Appendix B.

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communities.[2] These and many other examples clearly illustrate the infeasibility of a single criterion with statewide applicability.

As such, utilization of an undeveloped and unsupported standard (e.g. CSCI <0.79) is premature. Given the substantial resources the State is investing in the development of numerical translators, Regional Boards should allow the State to complete the process before determination of impairment and listings, as appropriate.

The Proposed Listing Fails to Evaluate Physical Habitat Data

Section 6.1.5.8 of the Listing Policy states:

> "When evaluating biological data and information, RWQCBs shall evaluate all readily available data and information and shall
> - Evaluate bioassessment data from other sites, and compare to reference condition.
> - Evaluate physical habitat data and other water quality data, when available, to support conclusions about the status of the water segment."

EPA's causal assessment manual cites physical habitat as a leading cause of impairment in streams on 303d lists and recommends that, in all cases where physical habitat is evaluated, stream size and channel dimensions, channel gradient, channel substrate size and type, habitat complexity and cover, vegetation cover and structure, and channel-riparian interactions should all be considered before making a decision.[3] Likewise, the SMC identified habitat stressors among the highest priority for evaluation in relation to depressed benthic community assemblages.[4] These stressors include features such as channel alteration, impervious surface proliferation in the watershed, and unique geological conditions. Medea Creek is impacted by at least two of these three examples. The channel is shored (Figure 1) and much of the watershed has unique geological conditions, which may impact the benthic community.[5]

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[2] Stein, E.D., Sengupta, A., Mazor, R.D., and McCune, K. (2016). Application of Regional Flow-ecology to Inform Management Decision in the San Diego River Watershed. Southern California Coastal Water Research Project Technical Report #948. Copy included in Appendix B.

[3] U.S. EPA (Environmental Protection Agency). (2010). Causal Analysis/Diagnosis Decision Information System (CADDIS). Office of Research and Development, Washington, DC. Available online at https://www.epa.gov/caddis. Last updated September 23, 2010

[4] Southern California Stormawater Monitoring Coalition (SMC). 2015. Bioassessment of Perennial Streams in Southern California: A Report on the First Five Years of the Stormwater Monitoring Coalition's Regional Stream Survey. SCCWRP Technical Report 844. Southern California Coastal Water Research Project. Costa Mesa, CA. Copy included in Appendix B.

[5] U.S. EPA Region 9 (Environmental Protection Agency). (2013). Malibu Creek & Lagoon TMDL for Sedimentation and Nutrients Impacting Benthic Community, Technical Appendices. Available at https://www3.epa.gov/region9/water/tmdl/malibu/2013-07-02-malibu-creek-lagoon-tmdl-appendices.pdf**.**

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Figure 1. Medea Creek Channel Modifications

The Proposed Listing Fails to Associate the Alleged Impairment with Other Pollutants

The Listing Policy states:

> "A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities as compared to reference site(s) and **is associated with** water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." [Emphasis added.]

In the fact sheets supporting its impairment decisions for each of these listings, the LA Regional Board stated that the alleged impairment in benthic community composition in Reach 1 was justified by being "associated" with impairments for two pollutants, trash and selenium, simply because these constituents co-occurred.

- Trash listings address non-contact recreation, not aquatic life, beneficial uses. Furthermore, the most common routes of harm to aquatic organisms by trash are due to ingestion and entanglement – problems unlikely to impact benthic macroinvertebrate larvae.
- Much of the Malibu Creek watershed is listed as impaired for selenium. However, EPA has recognized that "Sulfate and selenium concentrations are present in excess of water quality criteria, **apparently due to natural geologic background**."[5] [Emphasis Added.] As such, this should not be associated as a pollutant.

Fact Sheet #9

Water Body: San Jose Creek Reach 1
Pollutant: Temperature, Water
Listing: List on 303(d) List (TMDL Required List)
Comment & Recommendation: Do Not List – Meets Water Quality Objective

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for impairment due to water temperature be made to the 303(d) list for Reach 1 of San Jose Creek. The Sanitation Districts of Los Angeles County (Sanitation Districts) believe this proposed listing is inappropriate and recommend not listing due to water quality objectives being achieved.

Failure to Meet Water Quality Objectives Has Not Been Demonstrated

The Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) states that:

> "At no time shall these WARM-designated waters be raised above 80ºF **as a result of waste discharges**." [Emphasis added.]

This water quality objective clearly distinguishes between exceedance of the 80ºF standard caused by "waste discharges" and those associated with other causes. Evidence indicates that summertime excursions greater than the 80ºF are not caused by waste discharges but are likely due to elevated ambient air temperature, conductive and radiative heating associated with hardened landscapes, a lack of riparian cover, and increased ambient temperatures related to climate change (details below). Additionally, the Draft List does not contain any analysis or evidence indicating that the elevated temperatures occurred as result of wastes discharged.

The Regional Board Fact Sheet states that a single line of evidence was used in the assessment of temperature. Specifically, 42 of 301 samples from Pom-RD, Pom-RC, SJC-C1, and SJC-C2 exceeded the objective from July 2005 to November 2010 using the "Data for Various Pollutants in Various Water Bodies in Sanitation Districts of Los Angeles County, 2005-2010" dataset. Appendix A of this letter contains the full set of data applicable to this listing from Appendix G of the Regional Board Draft Staff Report.

Based on a review of the dataset utilized for the listing evaluation, the Sanitation Districts identified 339 discrete temperature measurements, not 301. The dataset contains 368 results (Appendix 1); however, 29 samples were duplicates. Of the 339 unique temperature measurements, 46 exhibited a temperature that exceeded 80 ºF, not 42. However, 14 of the 46 temperature exceedances were demonstrably caused by conduction and radiation (details below), not waste discharges. Conduction and radiative heating likely also caused the remaining 32 exceedances out of 339 measurements; this total does not meet the minimum number of measured exceedances needed to place a water segment on the section 303(d) list.

Pom-RC and Pom-RD Excursions Above 80 ºF Are Demonstrably Not a Result of Waste Discharges

Tertiary treated water from the Pomona Water Reclamation Plant is discharged to the south fork of San Jose Creek and flows into Reach 1. Receiving water stations Pom-RC, Pom-RD, and SJC-C1 are located approximately 3, 12, and 12.5 miles from the upstream border of Reach 1, respectively. Reach 1 is fully lined in concrete from the upstream border to just upstream of SJC-C1 (Figure 1).

As observed by Sanitation Districts staff and corroborated by EPA staff, groundwater exudes from relief structures distributed throughout the concrete-lined bottom, even in mid-summer (August) after several

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years of drought (Figure 2).[1] In the absence of discharge from the Pomona Water Reclamation Plant or other observed discharges, flows in SJC between Pom-RC and Pom-RD increase by 200% to greater than 400% (Figure 3) due to the release of this groundwater, which has a localized average temperature of approximately 67 ºF.[2] As this groundwater-dominated flow travels downstream, the temperature naturally rises (Figure 4) due to heat conduction through the warm concrete lining and solar radiation exposure in the unshaded channel (Figure 5 shows ambient air temperature as a proxy for solar radiation[3]). When the concrete channel ends upstream of SJC-C1, the water leaves the heat source (concrete channel) and mixes with additional groundwater, resulting in consistently cooler temperatures. The observed spatial and temporal temperature profile, coupled with no identifiable waste discharges and substantial groundwater contributions, clearly demonstrates that the temperature excursions in Reach 1 of San Jose Creek are not a result of waste discharges.

[1] Fleming, Terrence. 2009. Selenium Data from San Jose Creek. Email to Phil Markle. Copy included in Appendix 1.
[2] https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/ex/jne_henrys_map.html
[3] PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu/explorer/, created 24 Feb 2017.

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Figure 2. Manhole Exuding Groundwater into San Jose Creek

Figure 3. Measured Flow at Pom-RC and Pom-RD in the Absence of Discharge from Pomona WRP

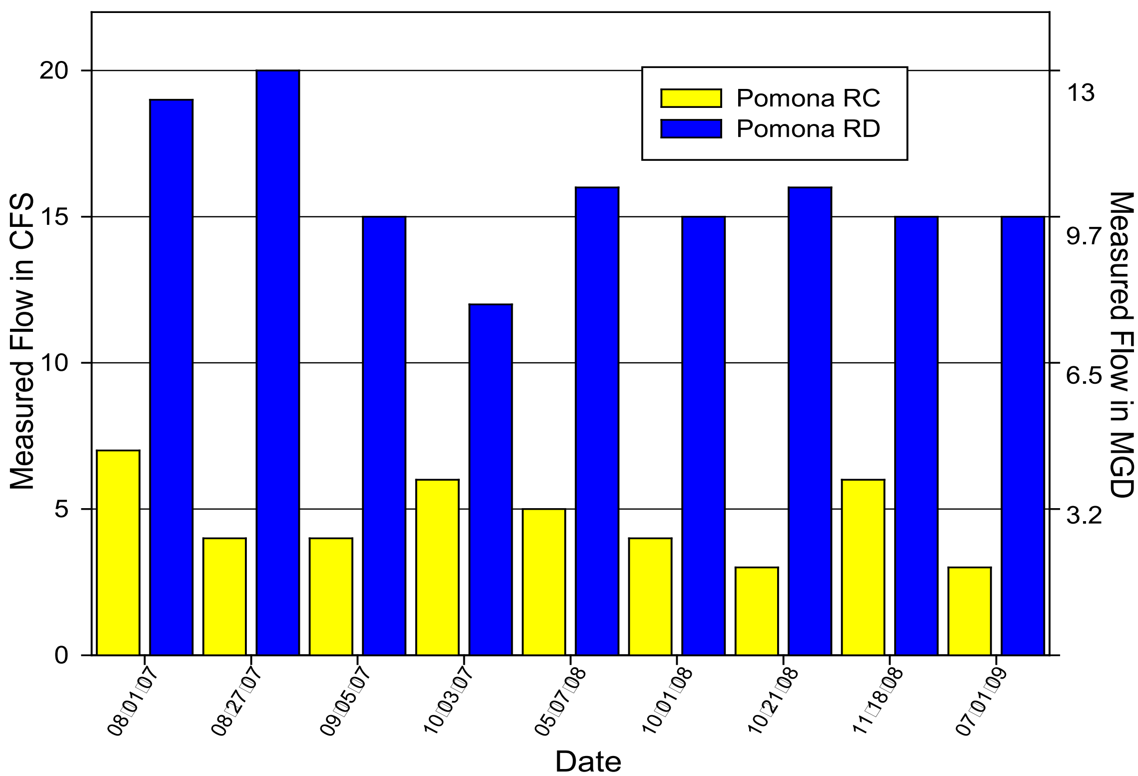

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Figure 4. Monthly Average Water Temperatures Between July 2005 and November 2010 in the Absence of Discharge from the Pomona WRP at

- Pom-RC: Upstream Location in the Concrete-Lined Portion of the Reach
- Pom-RD: Downstream Location in the Concrete-Lined Portion of the Reach
- SJC-C1: Unlined Portion of the Reach

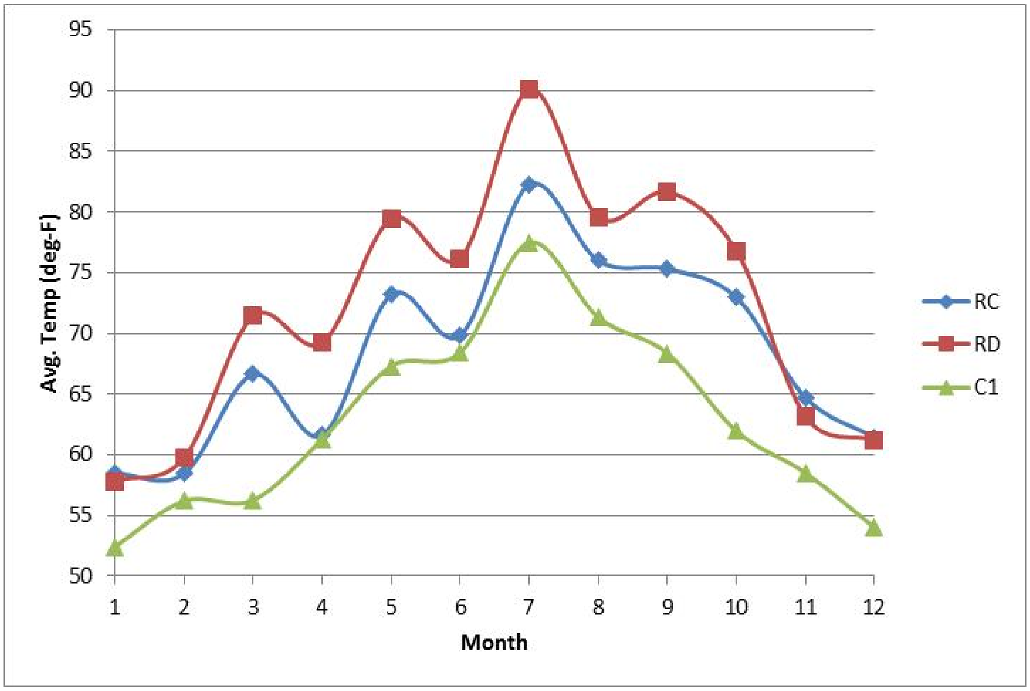
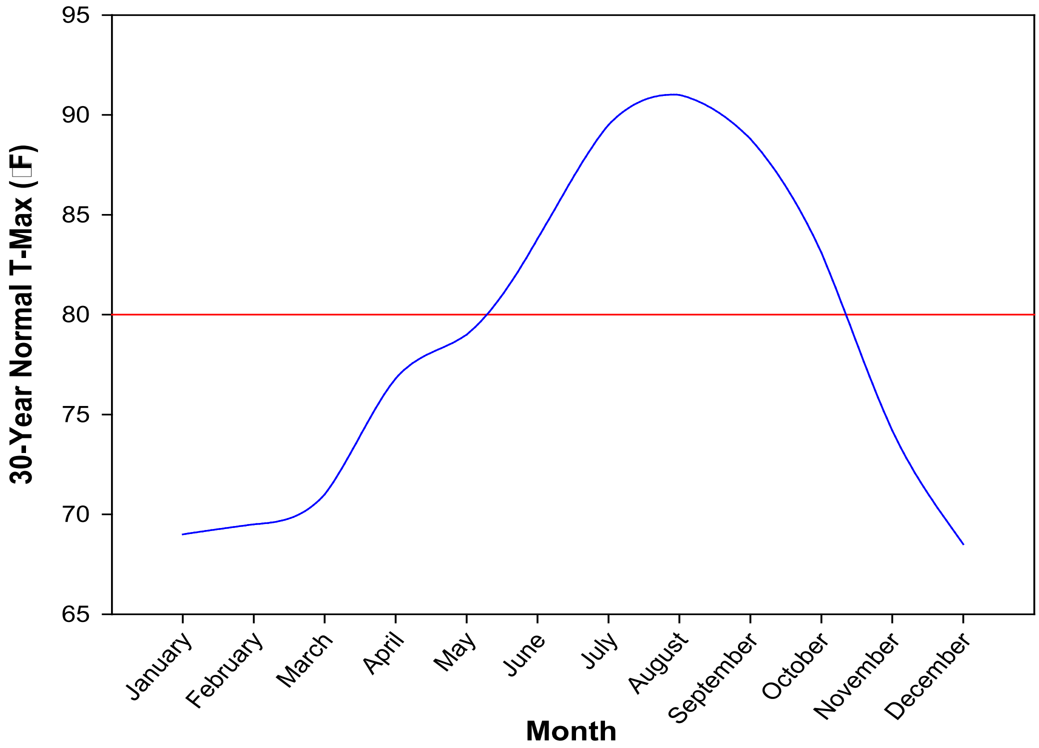


Figure 5. 30-Year Normal Monthly Maximum Air Temperature at Pom-RD[3]



Fact Sheet #10

Water Body: San Gabriel River Reach 1
Pollutant: Temperature, Water
Listing: List on 303(d) List (TMDL Required List)
Comment & Recommendation: Do Not List – Meets Water Quality Objective

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for impairment due to water temperature be made to the 303(d) list for Reach 1 of the San Gabriel River. The Sanitation Districts of Los Angeles County (Sanitation Districts) believe this proposed listing is inappropriate and recommend not listing due to water quality objectives being achieved.

Failure to Meet Water Quality Objectives Has Not Been Demonstrated

The Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) states that:

> "At no time shall these WARM-designated waters be raised above 80ºF **as a result of waste discharges**." [Emphasis added.]

This water quality objective clearly distinguishes between exceedance of the 80ºF standard caused by "waste discharges" and those associated with other causes. Evidence indicates that summertime excursions greater than the 80 ºF are not caused by waste dischargefs but are likely due to elevated ambient air temperature, conductive and radiative heating associated with hardened landscapes, a lack of riparian cover, and increased ambient temperatures related to climate change (details below). Additionally, the Draft List does not contain any analysis or evidence indicating that the elevated temperatures occurred as result of wastes discharged.

The Regional Board Fact Sheet states that a single line of evidence was used in the assessment of temperature. Specifically, 93 of 234 samples from LC-R4, R3-1, and R3-1b exceeded the objective from July 2005 to November 2009 using the "Data for Various Pollutants in Various Water Bodies in Sanitation Districts of Los Angeles County, 2005-2010" dataset.

Based on a review of the entire dataset utilized for the listing evaluation,[1] the Sanitation Districts identified 288 discrete temperature measurements, 117 of which exhibited a temperature that exceeded 80ºF. However, these temperature exceedances were not as a result of waste discharges, but were directly associated with high elevated ambient air temperatures as well as conduction and radiation (details below). Therefore, under the definition in the Basin Plan, no exceedances of the water quality objective were observed.

San Gabriel River Reach 1 Excursions Above 80 ºF Are a Result of Radiative and Conductive Heating

Tertiary treated water from the San Jose Creek and Los Coyotes Water Reclamation Plants (WRPs) is discharged to the main stem of the San Gabriel River. Reach 1 is a fully lined concrete channel from approximately 0.25 miles downstream of the San Jose Creek WRP discharge point 001 to the San Gabriel River estuary. As explained in Fact Sheet #9, elevated temperatures in Reach 1 of San Jose Creek occurred even in the absence of observable waste discharges and were caused by conductive heating through the concrete lining and solar radiation exposure. Although a comprehensive assessment of flows, in the absence of WRP discharge, cannot be conducted along the San Gabriel River, the same conditions

[1] Data available from Los Angeles Regional Board at http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/region_4/2010/ref3966.zip. Accessed 03/21/2017.

Fact Sheet #10

associated with the radiative and conductive heating exist in San Gabriel River Reach 1. This is supported by a significant correlation between ambient air temperature and receiving water temperature ($R^2 = 0.61$) and the fact that 90% of excursions above 80ºF in the receiving water environment occurred during summer months, between June and September. The weight of evidence supports the contention that receiving water temperatures above 80ºF were a result of ambient and environmental conditions (i.e., summer weather and a concrete channel) and not waste discharges.

Fact Sheet #11

Water Body: San Gabriel River Reach 2
Pollutant: Temperature, Water
Listing: List on 303(d) List (TMDL Required List)
Comment & Recommendation: Do Not List – Meets Water Quality Objective

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for impairment due to water temperature be made to the 303(d) list for Reach 2 of the San Gabriel River. The Sanitation Districts of Los Angeles County (Sanitation Districts) believe this proposed listing is inappropriate and recommend not listing due to water quality objectives being achieved.

Failure to Meet Water Quality Objectives Has Not Been Demonstrated

The Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) states that:

> "At no time shall these WARM-designated waters be raised above 80ºF **<u>as a result of waste discharges</u>**." [Emphasis added.]

This water quality objective clearly distinguishes between exceedance of the 80ºF standard caused by "waste discharges" and those associated with other causes. Evidence indicates that summertime excursions greater than the 80ºF are not caused by waste discharges but are likely due to elevated ambient air temperature, conductive and radiative heating associated with hardened landscapes, a lack of riparian cover, and increased ambient temperatures related to climate change (details below). Additionally, the Draft List does not contain any analysis or evidence indicating that the elevated temperatures occurred as result of wastes discharged.

The Regional Board Fact Sheet states that a single line of evidence was used in the assessment of temperature. Specifically, 81 of 224 samples from SJC-R2 and SJC-R12 exceeded the objective from July 2005 to November 2009 using the "Data for Various Pollutants in Various Water Bodies in Sanitation Districts of Los Angeles County, 2005-2010" dataset.

Based on a review of the entire dataset utilized for the listing evaluation,[1] the Sanitation Districts identified 81 excursions above 80 ºF out of 232 discrete temperature measurements, not 224. However, these temperature exceedances were not as a result of waste discharges, but were directly associated with high elevated ambient air temperatures as well as conduction and radiation (details below). Therefore, under the definition in the Basin Plan, no exceedances of the water quality objective were observed.

San Gabriel River Reach 2 Excursions Above 80 ºF Are a Result of Radiative and Conductive Heating

Tertiary treated water from the San Jose Creek Water Reclamation Plant (WRP) is discharged to the main stem of the San Gabriel River. The uppermost ¼ mile of Reach 2 is a fully lined concrete channel, containing the R2 receiving water station. Data from this station represents 215 of 232 data points. As explained in Fact Sheet #9, elevated temperatures in Reach 1 of San Jose Creek occurred even in the absence of observable waste discharges and were caused by conductive heating through the concrete lining and solar radiation exposure. Although a comprehensive assessment of flows, in the absence of

[1] Data available from Los Angeles Regional Board at http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/region_4/2010/ref3966.zip. Accessed 03/21/2017.

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WRP discharge, cannot be conducted along the San Gabriel River, the same conditions associated with the radiative and conductive heating exist in San Gabriel River Reach 2. This is supported the fact that 99% of excursions above 80 ºF in the receiving water environment occurred during summer months, between June and October. The weight of evidence supports the contention that receiving water temperatures above 80 ºF were a result of ambient and environmental conditions (i.e., summer weather and a concrete channel) and not waste discharges.

Fact Sheet #12

Water Body: Santa Clara River Reach 6
Pollutant: Temperature, Water
Listing: List on 303(d) List (TMDL Required List)
Comment & Recommendation: Do Not List

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) is proposing that a new listing for impairment due to water temperature be made to the 303(d) list for Reach 6 of Santa Clara River. The Sanitation Districts of Los Angeles County (Sanitation Districts) believe this proposed listing is inappropriate and recommend not listing.

Incorrect Datasets Were Used for Listing

The Regional Board Fact Sheet states that a single line of evidence was used in the assessment of temperature. Specifically, 40 of 152 samples from Sa-RA, Sa-RB, and SCR-14 exceeded the objective from June 2005 to October 2010 using the "Data for Various Pollutants in Various Water Bodies in Sanitation Districts of Los Angeles County, 2005-2010" dataset.

Temperature data from location SCR-14 (34.42833333N 118.5394444W) was evaluated as part of Reach 6 of the Santa Clara River. However, SCR-14 is located on Bouquet Canyon Creek, which is recognized as a distinct waterbody by the Region 4 Basin Plan. Figure 1 utilizes a reach delineation layer provided to the Sanitation Districts by Regional Board staff that clearly places SCR-14 in the Bouquet Canyon Creek Reach and not Reach 6. Therefore, temperature measurements from SCR-14 should not be included in the Reach 6 evaluation.

Figure 1. Stations Sa-RB (1), Sa-RA (2), SCR-14 (14), and Bouquet Canyon Creek (Aqua Line)

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Locations Sa-RA and Sa-RB were correctly associated with Reach 6, but results were averaged in the listing evaluation based on the assessment that they were “not spatially independent.” However, as highlighted in Figure 2, Sa-RA is located within the main channel of the Santa Clara River and is typically dry; all 25 temperature measurements at Sa-RA utilized in the Staff Report were associated with upstream dewatering activities or extreme storm events. Sa-RB is located in an isolated pool at the southern edge of the Reach 6 channel that receives recycled water discharges from the Saugus Water Reclamation Plant (WRP). Surface flows from this location travel less than a half-mile downstream in a disconnected side channel before percolating into the dry riverbed. Therefore, even though the two locations are relatively close to each other, Sa-RA is hydrologically isolated from Sa-RB except during extreme rainfall events. Consequently, the two locations would be expected to have very different temperature profiles and should therefore be considered spatially independent, with no averaging of results.

Figure 2. Satellite Imagery of Saugus WRP Ambient Monitoring Stations

The 80ºF Water Quality Temperature Objective Is Unnecessary and Inappropriate for Santa Clara River Reach 6

The only dry weather surface flows within this stretch of Reach 6 are associated with recycled water discharges from the Saugus WRP, which percolate into the dry riverbed and eventually resurface downstream near the Reach 5 boundary. At the point of resurfacing, the water temperature averages 69°F and this perennial surface flow supports a diverse aquatic life community in Reach 5.[1] However, the predominant natural condition of Reach 6 is dry and would not be expected to support any aquatic life

[1] Hovey, T. (2007) Update: Convict cichlids (*Archocentrus nigrofasciatus*) in the Santa Clara River. Copy included in Appendix B.

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without the Saugus WRP discharge. In addition, the cool temperatures in the water that resurfaces near the Reach 5 boundary demonstrate that elevated temperatures in the isolated discharge area are not detrimental to beneficial uses. Therefore, application of the 80°F water quality objective in Santa Clara Reach 6 is unnecessary and inappropriate, as the presence of water exceeding the 80°F water quality objective would not result in any impairment to naturally occurring aquatic life.

Mitigating the Elevated Temperature at Sa-RB Is Not Feasible

The only reasonable alternative to address the temperature water quality objective below the Saugus WRP at location Sa-RB during dry weather would be to eliminate the discharge. However, it is highly unlikely that the California Department of Fish and Wildlife would support any discharge reductions or elimination, because this action would remove all dry weather surface flows in that stretch of Santa Clara Reach 6 and could potentially reduce the amount of resurfacing groundwater flows that actually support a diverse aquatic community in Santa Clara River Reach 5.

An Evaluation of the Relative Contribution of Radiative and Convective Heating Was Not Conducted

Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) states that:

> "At no time shall these WARM-designated waters be raised above 80ºF **as a result of waste discharges**." [Emphasis added.]

This objective clearly distinguishes between temperature exceedances caused by "waste discharges" and those associated with other causes. Both the Saugus WRP discharge and the immediate downstream receiving water location (Sa-RB) are heavily influenced by ambient air temperature. Figure 3 includes a plot of the 15-day average values of the maximum air temperature along with the individual water temperature measurements collected at the Sa-RB location. Nearly all of the 80°F temperature exceedances were associated with the higher summer time air temperatures and the two have a statistically significant correlation (R^2 = 0.76). Because exceedances of the Basin Plan temperature objective are limited to those "as a result of waste discharges," an evaluation of the contribution of ambient air temperature to the receiving water should have been conducted before identifying receiving water excursions above 80°F as exceedances of the objective.

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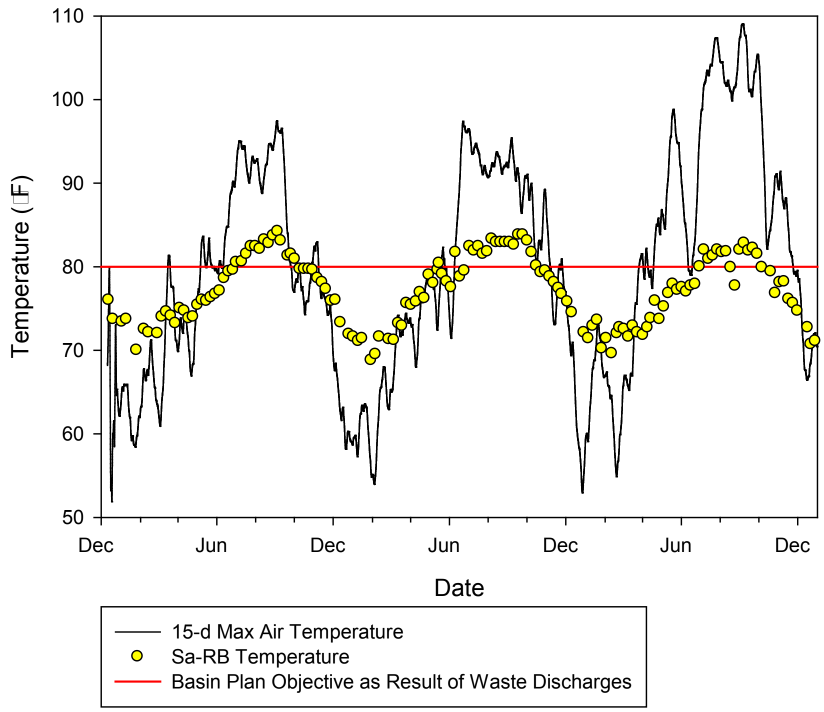
Figure 3. Sa-RB Temperature vs. Maximum Ambient Air Temperature (15-Day Average Value)



Appendix A: Data Tables

Data Table	Pages
1. San Gabriel River Estuary – Toxicity	A2 – A6
2. San Gabriel River Reach 3 – Toxicity	A7 – A9
3. Rio Hondo Reach 2 – Toxicity	A10 – A11
4. Santa Clara River Reach 5 – Toxicity	A12 – A14
5. San Jose Creek Reach 1 – Temperature	A15 – A22

Data used in LACSD analysis of San Gabriel River Estuary Toxicity listing.
Accessed via Fact Sheet at http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/region_4/2010/ref3966.

Within Data Set but Excluded From Water Board Analysis (n=31)
Single Test/Monthly Median Chronic Toxcity Exceedances (NOEC <100%) (n=0)
Acute Test with <100% Survival (n=6)

Date	ID	Location	Test Name	Single Test Result	Unit
20050601	SJ30206	R9W	Cerio. Chronic-Survival	100	%EFFL
20050601	SJ30206	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20050718	SJ33266	R9W	Cerio. Chronic-Survival	100	%EFFL
20050718	SJ33266	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20050718	SJ33295	R9W	Fathead Acute (Pimphales Prome	100	%SURV
20050801	SJ34396	R9W	Cerio. Chronic-Survival	100	%EFFL
20050801	SJ34396	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20050823	SJ35945	RA2	Topsmelt Acute	97.5	%SURV
20050823	SJ35944	R6	Topsmelt Acute	95	%SURV
20050823	SJ35943	R7	Topsmelt Acute	95	%SURV
20050823	SJ35942	R8	Topsmelt Acute	97.5	%SURV
20050907	SJ36944	R9W	Cerio. Chronic-Survival	100	%EFFL
20050907	SJ36944	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20051102	SJ41229	R9W	Cerio. Chronic-Survival	100	%EFFL
20051102	SJ41229	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20051201	SJ43223	R9W	Cerio. Chronic-Survival	100	%EFFL
20051201	SJ43223	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20060105	SJ50383	R9W	Cerio. Chronic-Survival	100	%EFFL
20060105	SJ50383	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20060105	SJ50285	R9W	Fathead Acute (Pimphales Prome	100	%SURV
20060118	SJ51126	RA2	90 Menidia Acute	90	%SURV
20060118	SJ51129	R8	90 Menidia Acute	97.5	%SURV
20060125	SJ51588	RA2	Menidia-Survival	100	%EFFL
20060125	SJ51588	RA2	Menidia-Growth	100	%EFFL
20060125	SJ51587	R6	Menidia-Survival	100	%EFFL
20060125	SJ51587	R6	Menidia-Growth	100	%EFFL
20060125	SJ51589	R7	Menidia-Survival	100	%EFFL
20060125	SJ51589	R7	Menidia-Growth	100	%EFFL
20060125	SJ51590	R8	Menidia-Survival	100	%EFFL
20060125	SJ51590	R8	Menidia-Growth	100	%EFFL
20060131	SJ52355	RA2	90 Menidia Acute	97.5	%SURV
20060131	SJ52356	R6	90 Menidia Acute	97.5	%SURV
20060131	SJ52357	R7	90 Menidia Acute	95	%SURV
20060131	SJ52358	R8	90 Menidia Acute	97.5	%SURV
20060202	SJ52190	R9W	Cerio. Chronic-Survival	100	%EFFL
20060202	SJ52190	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20060306	SJ55042	R9W	Cerio. Chronic-Survival	100	%EFFL
20060306	SJ55042	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20060410	SJ57296	R9W	Cerio. Chronic-Survival	100	%EFFL
20060410	SJ57296	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20060428	SJ58518	R6	Topsmelt Chronic Survival	100	%EFFL
20060428	SJ58518	R6	Topsmelt Chronic Growth	100	%EFFL
20060428	SJ58517	R7	Topsmelt Chronic Survival	100	%EFFL
20060428	SJ58517	R7	Topsmelt Chronic Growth	100	%EFFL
20060428	SJ58516	R8	Topsmelt Chronic Survival	100	%EFFL
20060428	SJ58516	R8	Topsmelt Chronic Growth	100	%EFFL
20060429	SJ58519	RA2	Topsmelt Chronic Survival	100	%EFFL

20060429	SJ58519	RA2	Topsmelt Chronic Growth	100	%EFFL
20060503	SJ58913	R9W	Cerio. Chronic-Survival	100	%EFFL
20060503	SJ58913	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20060705	SJ62086	R9W	Cerio. Chronic-Survival	100	%EFFL
20060705	SJ62086	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20060710	SJ62487	R9W	90 Fathead Acute	100	%EFFL
20060717	SJ64093	R6	Topsmelt Chronic Survival	100	%EFFL
20060717	SJ64093	R6	Topsmelt Chronic Growth	100	%EFFL
20060717	SJ63725	R7	Topsmelt Acute	100	%SURV
20060717	SJ64092	R7	Topsmelt Chronic Survival	100	%EFFL
20060717	SJ64092	R7	Topsmelt Chronic Growth	100	%EFFL
20060717	SJ63724	R8	Topsmelt Acute	100	%SURV
20060717	SJ64091	R8	Topsmelt Chronic Growth	100	%EFFL
20060717	SJ63723	RA2	Topsmelt Acute	100	%SURV
20060717	SJ64094	RA2	Topsmelt Chronic Survival	100	%EFFL
20060717	SJ64094	RA2	Topsmelt Chronic Growth	100	%EFFL
20060814	SJ64571	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20060814	SJ64571	R9W	Cerio. Chronic-Survival	100	%EFFL
20060911	SJ66183	R9W	Cerio. Chronic-Survival	100	%EFFL
20060911	SJ66183	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20061011	SJ68407	R9W	Cerio. Chronic-Survival	100	%EFFL
20061011	SJ68407	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20061101	SJ69224	R9W	Cerio. Chronic-Survival	100	%EFFL
20061101	SJ69224	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20061204	SJ70941	R9W	Cerio. Chronic-Survival	100	%EFFL
20061204	SJ70941	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20070108	SJ81063	R6	Topsmelt Chronic Survival	100	%EFFL
20070108	SJ81063	R6	Topsmelt Chronic Growth	100	%EFFL
20070108	SJ81066	R6	Topsmelt Acute	100	%SURV
20070108	SJ81062	R7	Topsmelt Chronic Survival	100	%EFFL
20070108	SJ81062	R7	Topsmelt Chronic Growth	100	%EFFL
20070108	SJ81065	R7	Topsmelt Acute	100	%SURV
20070108	SJ81061	R8	Topsmelt Chronic Survival	100	%EFFL
20070108	SJ81061	R8	Topsmelt Chronic Growth	100	%EFFL
20070108	SJ81074	R8	Topsmelt Acute	100	%SURV
20070108	SJ80358	R9W	Cerio. Chronic-Survival	100	%EFFL
20070108	SJ80358	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20070108	SJ80649	R9W	90 Fathead Acute	100	%SURV
20070108	SJ81064	RA2	Topsmelt Chronic Survival	100	%EFFL
20070108	SJ81064	RA2	Topsmelt Chronic Growth	100	%EFFL
20070108	SJ81067	RA2	Topsmelt Acute	100	%SURV
20070226	SJ83442	R9W	Cerio. Chronic-Survival	100	%EFFL
20070226	SJ83442	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20070312	SJ83843	R9W	Cerio. Chronic-Survival	100	%EFFL
20070312	SJ83843	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20070411	SJ85623	R9W	Cerio. Chronic-Survival	100	%EFFL
20070411	SJ85623	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20070430	SJ88059	R6	Topsmelt Chronic Survival	100	%EFFL
20070430	SJ88059	R6	Topsmelt Chronic Growth	100	%EFFL
20070430	SJ88058	R7	Topsmelt Chronic Survival	100	%EFFL
20070430	SJ88058	R7	Topsmelt Chronic Growth	100	%EFFL
20070430	SJ88057	R8	Topsmelt Chronic Survival	100	%EFFL
20070430	SJ88057	R8	Topsmelt Chronic Growth	100	%EFFL
20070430	SJ88060	RA2	Topsmelt Chronic Survival	100	%EFFL
20070430	SJ88060	RA2	Topsmelt Chronic Growth	100	%EFFL

20070611	SJ88456	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20070611	SJ88456	R9W	Cerio. Chronic-Survival	100	%EFFL
20070709	SJ90526	R6	Topsmelt Chronic Survival	100	%EFFL
20070709	SJ90526	R6	Topsmelt Chronic Growth	100	%EFFL
20070709	SJ90594	R6	Topsmelt Acute	100	%SURV
20070709	SJ90525	R7	Topsmelt Chronic Survival	100	%EFFL
20070709	SJ90525	R7	Topsmelt Chronic Growth	100	%EFFL
20070709	SJ90593	R7	Topsmelt Acute	100	%SURV
20070709	SJ90524	R8	Topsmelt Chronic Survival	100	%EFFL
20070709	SJ90524	R8	Topsmelt Chronic Growth	100	%EFFL
20070709	SJ90592	R8	Topsmelt Acute	100	%SURV
20070709	SJ89637	R9W	Cerio. Chronic-Survival	100	%EFFL
20070709	SJ89637	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20070709	SJ89890	R9W	90 Fathead Acute	**95**	%SURV
20070709	SJ90527	RA2	Topsmelt Chronic Survival	100	%EFFL
20070709	SJ90527	RA2	Topsmelt Chronic Growth	100	%EFFL
20070709	SJ90596	RA2	Topsmelt Acute	100	%SURV
20070801	SJ91186	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20070801	SJ91186	R9W	Cerio. Chronic-Survival	100	%EFFL
20070912	SJ93350	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20070912	SJ93350	R9W	Cerio. Chronic-Survival	100	%EFFL
20071008	SJ95043	R6	Fathead Chronic-Survival	100	%EFFL
20071008	SJ95043	R6	Fathead Chronic-Growth	100	%EFFL
20071008	SJ95042	R7	Fathead Chronic-Survival	100	%EFFL
20071008	SJ95042	R7	Fathead Chronic-Growth	100	%EFFL
20071008	SJ95041	R8	Fathead Chronic-Survival	100	%EFFL
20071008	SJ95041	R8	Fathead Chronic-Growth	100	%EFFL
20071008	SJ94573	R9W	Cerio. Chronic-Survival	100	%EFFL
20071008	SJ94573	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20071008	SJ95040	RA2	Fathead Chronic-Survival	100	%EFFL
20071008	SJ95040	RA2	Fathead Chronic-Growth	100	%EFFL
20080102	SJ00349	R6	Topsmelt Acute	100	%SURV
20080102	SJ00348	R7	Topsmelt Acute	100	%SURV
20080102	SJ00347	R8	Topsmelt Acute	100	%SURV
20080102	SJ00151	R9W	90 Fathead Acute	100	%SURV
20080102	SJ00350	RA2	Topsmelt Acute	100	%SURV
20080109	SJ00527	R9W	Cerio. Chronic-Reproduction	100	%EFFL
20080109	SJ00527	R9W	Cerio. Chronic-Survival	100	%EFFL
20080114	SJ01165	R6	Topsmelt Chronic Survival	100	%EFFL
20080114	SJ01165	R6	Topsmelt Chronic Growth	100	%EFFL
20080114	SJ01166	R7	Topsmelt Chronic Survival	100	%EFFL
20080114	SJ01166	R7	Topsmelt Chronic Growth	100	%EFFL
20080114	SJ01167	R8	Topsmelt Chronic Survival	100	%EFFL
20080114	SJ01167	R8	Topsmelt Chronic Growth	100	%EFFL
20080114	SJ01164	RA2	Topsmelt Chronic Survival	100	%EFFL
20080114	SJ01164	RA2	Topsmelt Chronic Growth	100	%EFFL
20080414	SJ06491	R6	Topsmelt Chronic Survival	100	%EFFL
20080414	SJ06491	R6	Topsmelt Chronic Growth	100	%EFFL
20080414	SJ06490	R7	Topsmelt Chronic Survival	100	%EFFL
20080414	SJ06490	R7	Topsmelt Chronic Growth	100	%EFFL
20080414	SJ06489	R8	Topsmelt Chronic Survival	100	%EFFL
20080414	SJ06489	R8	Topsmelt Chronic Growth	100	%EFFL
20080414	SJ06097	R9W	Fathead Chronic-Survival	100	%EFFL
20080414	SJ06097	R9W	Fathead Chronic-Growth	100	%EFFL
20080414	SJ06492	RA2	Topsmelt Chronic Survival	100	%EFFL

20080414	SJ06492	RA2	Topsmelt Chronic Growth	100	%EFFL
20080707	SJ10883	R6	Topsmelt Acute	100	%SURV
20080707	SJ11389	R6	Topsmelt Chronic Survival	100	%EFFL
20080707	SJ11389	R6	Topsmelt Chronic Growth	100	%EFFL
20080707	SJ10885	R7	Topsmelt Acute	100	%SURV
20080707	SJ11390	R7	Topsmelt Chronic Survival	100	%EFFL
20080707	SJ11390	R7	Topsmelt Chronic Growth	100	%EFFL
20080707	SJ10884	R8	Topsmelt Acute	100	%SURV
20080707	SJ11391	R8	Topsmelt Chronic Survival	100	%EFFL
20080707	SJ11391	R8	Topsmelt Chronic Growth	100	%EFFL
20080707	SJ10641	R9W	90 Fathead Acute	**95**	%SURV
20080707	SJ10656	R9W	Fathead Chronic-Survival	100	%EFFL
20080707	SJ10656	R9W	Fathead Chronic-Growth	100	%EFFL
20080707	SJ10886	RA2	Topsmelt Acute	100	%SURV
20080707	SJ11388	RA2	Topsmelt Chronic Survival	100	%EFFL
20080707	SJ11388	RA2	Topsmelt Chronic Growth	100	%EFFL
20081013	SJ16365	R6	Topsmelt Chronic Survival	100	%EFFL
20081013	SJ16365	R6	Topsmelt Chronic Growth	100	%EFFL
20081013	SJ16366	R7	Topsmelt Chronic Survival	100	%EFFL
20081013	SJ16366	R7	Topsmelt Chronic Growth	100	%EFFL
20081013	SJ16367	R8	Topsmelt Chronic Survival	100	%EFFL
20081013	SJ16367	R8	Topsmelt Chronic Growth	100	%EFFL
20081013	SJ15771	R9W	Fathead Chronic-Survival	100	%EFFL
20081013	SJ15771	R9W	Fathead Chronic-Growth	100	%EFFL
20081013	SJ16364	RA2	Topsmelt Chronic Survival	100	%EFFL
20081013	SJ16364	RA2	Topsmelt Chronic Growth	100	%EFFL
20090112	SJ20906	R6	Topsmelt Acute	100	%SURV
20090112	SJ20987	R6	Topsmelt Chronic Survival	100	%EFFL
20090112	SJ20987	R6	Topsmelt Chronic Growth	100	%EFFL
20090112	SJ20907	R7	Topsmelt Acute	100	%SURV
20090112	SJ20989	R7	Topsmelt Chronic Survival	100	%EFFL
20090112	SJ20989	R7	Topsmelt Chronic Growth	100	%EFFL
20090112	SJ20908	R8	Topsmelt Acute	100	%SURV
20090112	SJ20990	R8	Topsmelt Chronic Survival	100	%EFFL
20090112	SJ20990	R8	Topsmelt Chronic Growth	100	%EFFL
20090112	SJ20583	R9W	Fathead Chronic-Survival	100	%EFFL
20090112	SJ20583	R9W	Fathead Chronic-Growth	100	%EFFL
20090112	SJ20725	R9W	90 Fathead Acute	100	%EFFL
20090112	SJ20905	RA2	Topsmelt Acute	100	%SURV
20090112	SJ20988	RA2	Topsmelt Chronic Survival	100	%EFFL
20090112	SJ20988	RA2	Topsmelt Chronic Growth	100	%EFFL
20090406	SJ25094	R9W	Fathead Chronic-Survival	100	%EFFL
20090406	SJ25094	R9W	Fathead Chronic-Growth	100	%EFFL
20090408	SJ25626	R6	Topsmelt Chronic Survival	100	%EFFL
20090408	SJ25626	R6	Topsmelt Chronic Growth	100	%EFFL
20090408	SJ25627	R7	Topsmelt Chronic Survival	100	%EFFL
20090408	SJ25627	R7	Topsmelt Chronic Growth	100	%EFFL
20090408	SJ25628	R8	Topsmelt Chronic Survival	100	%EFFL
20090408	SJ25628	R8	Topsmelt Chronic Growth	100	%EFFL
20090408	SJ25625	RA2	Topsmelt Chronic Survival	100	%EFFL
20090408	SJ25625	RA2	Topsmelt Chronic Growth	100	%EFFL
20090713	SJ29873	R6	Topsmelt Acute	100	%SURV
20090713	SJ30167	R6	Topsmelt Chronic Survival	100	%EFFL
20090713	SJ30167	R6	Topsmelt Chronic Growth	100	%EFFL
20090713	SJ29874	R7	Topsmelt Acute	100	%SURV

20090713	SJ30168	R7	Topsmelt Chronic Survival	100	%EFFL
20090713	SJ30168	R7	Topsmelt Chronic Growth	100	%EFFL
20090713	SJ29875	R8	Topsmelt Acute	100	%SURV
20090713	SJ30169	R8	Topsmelt Chronic Survival	100	%EFFL
20090713	SJ30169	R8	Topsmelt Chronic Growth	100	%EFFL
20090713	SJ29601	R9W	90 Fathead Acute	**97.5**	%SURV
20090713	SJ29685	RA2	Topsmelt Acute	100	%SURV
20090713	SJ30166	RA2	Topsmelt Chronic Survival	100	%EFFL
20090713	SJ30166	RA2	Topsmelt Chronic Growth	100	%EFFL
20090715	SJ29589	R9W	Fathead Chronic-Survival	100	%EFFL
20091019	SJ34121	R9W	Fathead Chronic-Survival	100	%EFFL
20091019	SJ34121	R9W	Fathead Chronic-Growth	100	%EFFL
20100111	10011200149	R6	Survival NOEC	100	%EFFL
20100111	10011200150	R7	Topsmelt Acute	97.5	%SURV
20100111	10011200151	R8	Topsmelt Acute	97.5	%SURV
20100111	10011100410	R9W	90 Fathead Acute	97.5	%SURV
20100111	10011200148	RA2	Survival NOEC	100	%EFFL
20100129	10012900379	R6	Topsmelt Chronic Survival	100	%EFFL
20100129	10012900380	R7	Topsmelt Chronic Survival	100	%EFFL
20100129	10012900381	R8	Topsmelt Chronic Survival	100	%EFFL
20100129	10012900370	R9W	90 Fathead Acute	100	%EFFL
20100129	10012900378	RA2	Topsmelt Chronic Survival	100	%EFFL
20100416	10041600443	R9W	Reproduction NOEC	100	%EFFL
20100416	10041600443	R9W	Survival NOEC	100	%EFFL
20100421	10042200126	R6	Topsmelt Chronic Survival	100	%EFFL
20100421	10042200127	R7	Topsmelt Chronic Survival	100	%EFFL
20100421	10042200128	R8	Topsmelt Chronic Survival	100	%EFFL
20100421	10042200125	RA2	Topsmelt Chronic Survival	100	%EFFL

Data used in LACSD analysis of San Gabriel River Reach 3 Toxicity listing.
Accessed via Fact Sheet at http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/region_4/2010/ref3966.zip

Within Data Set but Excluded from Water Board Analysis (n=14 median values, 15 single tests)
Single Test Chronic Toxcity Exceedances (NOEC <100%) (n=6)
Monthly Median Chronic Toxicity Exceedance (n=4)
Acute Test with <100% Survival (n=7)

Date	ID	Location	Test Name	Symbol	Single Test Result	UNIT	Final Result	UNIT
20050808	SJ34856	RA	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20050808	SJ34856	RA	Fathead Chronic-Growth		100	%EFFL		
20050808	SJ34889	RA	90 Fathead Acute		100	%SURV	100	%SURV
20050808	SJ34892	R11	90 Fathead Acute		100	%SURV	100	%SURV
20050815	SJ35409	R11	90 Fathead Acute		100	%SURV	100	%SURV
20050826	SJ36208	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20050826	SJ36208	R11	Fathead Chronic-Growth		100	%EFFL		
20051102	SJ42240	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20051102	SJ42240	R11	Fathead Chronic-Growth		100	%EFFL		
20051114	SJ42613	RA	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20051114	SJ42613	RA	Fathead Chronic-Growth		100	%EFFL		
20060201	SJ52180	RA	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20060201	SJ52180	RA	Fathead Chronic-Growth		100	%EFFL		
20060201	SJ52182	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20060201	SJ52182	R11	Fathead Chronic-Growth		100	%EFFL		
20060206	SJ52435	RA	90 Fathead Acute		100	%SURV	100	%SURV
20060206	SJ52437	R11	90 Fathead Acute		100	%SURV	100	%SURV
20060306	SJ54863	RA	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20060306	SJ54863	RA	Fathead Chronic-Growth		100	%EFFL		
20060314	SJ55356	RA	Fathead Chronic-Survival		100	%EFFL		
20060314	SJ55356	RA	Fathead Chronic-Growth		100	%EFFL		
20060510	SJ59336	RA	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20060510	SJ59336	RA	Fathead Chronic-Growth		100	%EFFL		
20060525	SJ60114	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20060525	SJ60114	R11	Fathead Chronic-Growth		100	%EFFL		
20060807	SJ64179	RA	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20060807	SJ64179	RA	Fathead Chronic-Growth		100	%EFFL		
20060807	SJ64176	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20060807	SJ64176	R11	Fathead Chronic-Growth		100	%EFFL		
20060807	SJ64235	RA	90 Fathead Acute		100	%SURV	100	%SURV
20060807	SJ64231	R11	90 Fathead Acute		97.5	%SURV	97.5	%SURV
20061108	SJ69865	RA	Fathead Chronic-Survival		100	%EFFL	100	100
20061108	SJ69865	RA	Fathead Chronic-Growth		100	%EFFL		
20061108	SJ69858	R11	Fathead Chronic-Survival		100	%EFFL	100	100
20061108	SJ69858	R11	Fathead Chronic-Growth		100	%EFFL		
20070205	SJ81874	R11	Fathead Chronic-Survival		100	%EFFL	100	100
20070205	SJ81874	R11	Fathead Chronic-Growth		100	%EFFL		
20070205	SJ81875	RA	Cerio. Chronic-Survival		100	%EFFL	100	100
20070205	SJ81875	RA	Cerio. Chronic-Reproduction		100	%EFFL		

20070205	SJ81878	R11	Cerio. Chronic-Survival		100	%EFFL	100	100
20070205	SJ81878	R11	Cerio. Chronic-Reproduction		100	%EFFL		
20070205	SJ81819	RA	90 Fathead Acute		100	%SURV	100	%SURV
20070205	SJ81822	R11	90 Fathead Acute		100	%SURV	100	%SURV
20070502	SJ86664	R11	Fathead Chronic-Survival		100	%EFFL	100	100
20070502	SJ86664	R11	Fathead Chronic-Growth		100	%EFFL		
20070502	SJ86669	R11	Cerio. Chronic-Survival		100	%EFFL	100	100
20070502	SJ86669	R11	Cerio. Chronic-Reproduction		100	%EFFL		
20070808	SJ91575	R11	Fathead Chronic-Survival		100	%EFFL	100	100
20070808	SJ91575	R11	Fathead Chronic-Growth		100	%EFFL		
20070808	SJ91310	RA	90 Fathead Acute		97.5	%SURV	97.5	%SURV
20070808	SJ91312	R11	90 Fathead Acute		100	%SURV	100	100
20070925	SJ93977	RA	Cerio. Chronic-Survival		100	%EFFL	100	100
20070925	SJ93977	RA	Cerio. Chronic-Reproduction		100	%EFFL		
20070925	SJ93976	R11	Cerio. Chronic-Survival		100	%EFFL	100	100
20070925	SJ93976	R11	Cerio. Chronic-Reproduction		100	%EFFL		
20071105	SJ95889	RA	Cerio. Chronic-Survival		100	%EFFL	100	100
20071105	SJ95889	RA	Cerio. Chronic-Reproduction		100	%EFFL		
20071105	SJ95891	R11	Cerio. Chronic-Survival		100	%EFFL	100	100
20071105	SJ95891	R11	Cerio. Chronic-Reproduction		100	%EFFL		
20071105	SJ95898	R11	Fathead Chronic-Survival		100	%EFFL	80	%EFFL
20071105	SJ95898	R11	Fathead Chronic-Growth		80	%EFFL		
20071116	SJ96726	R11	Fathead Chronic-Survival		100	%EFFL		
20071116	SJ96726	R11	Fathead Chronic-Growth		100	%EFFL		
20071126	SJ97079	R11	Fathead Chronic-Survival		100	%EFFL		
20071126	SJ97079	R11	Fathead Chronic-Growth		80	%EFFL		
20071211	SJ97715	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20071211	SJ97715	R11	Fathead Chronic-Growth		100	%EFFL		
20071226	SJ98390	R11	Fathead Chronic-Survival		100	%EFFL		
20071226	SJ98390	R11	Fathead Chronic-Growth		100	%EFFL		
20080109	SJ00538	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20080109	SJ00538	R11	Fathead Chronic-Growth		100	%EFFL		
20080116	SJ00997	R11	Fathead Chronic-Survival		40	%EFFL		
20080116	SJ00997	R11	Fathead Chronic-Growth		40	%EFFL		
20080131	SJ01357	R11	Fathead Chronic-Survival		100	%EFFL		
20080131	SJ01357	R11	Fathead Chronic-Growth		100	%EFFL		
20080206	SJ02088	R10	Fathead Chronic-Survival		100	%EFFL	<100	%EFFL
20080206	SJ02088	R10	Fathead Chronic-Growth	<	100	%EFFL		
20080206	SJ02096	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20080206	SJ02096	R11	Fathead Chronic-Growth		100	%EFFL		
20080206	SJ02090	R11	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
20080206	SJ02090	R11	Cerio. Chronic-Reproduction		100	%EFFL		
20080213	SJ02600	R11	Fathead Chronic-Survival		100	%EFFL		
20080213	SJ02600	R11	Fathead Chronic-Growth		100	%EFFL		
20080227	SJ02986	R11	Fathead Chronic-Survival		100	%EFFL		
20080227	SJ02986	R11	Fathead Chronic-Growth		100	%EFFL		
20080206	SJ02084	RA	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
20080206	SJ02084	RA	Cerio. Chronic-Reproduction		100	%EFFL		
20080206	SJ01675	RA	90 Fathead Acute		100	%SURV	100	%SURV
20080206	SJ01679	R11	90 Fathead Acute		97.5	%SURV	97.5	%SURV
20080305	SJ03503	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20080305	SJ03503	R11	Fathead Chronic-Growth		100	%EFFL		
20080312	SJ04454	R11	Fathead Chronic-Survival		100	%EFFL		
20080312	SJ04454	R11	Fathead Chronic-Growth		100	%EFFL		
20080505	SJ06886	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL

20080505	SJ06886	R11	Fathead Chronic-Growth		100	%EFFL	100	%EFFL
20080609	SJ08468	RA	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
20080609	SJ08468	RA	Cerio. Chronic-Reproduction		100	%EFFL		
20080609	SJ08470	R11	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
20080609	SJ08470	R11	Cerio. Chronic-Reproduction		100	%EFFL		
20080804	SJ11926	R10	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20080804	SJ11926	R10	Fathead Chronic-Growth		100	%EFFL		
20080804	SJ11917	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20080804	SJ11917	R11	Fathead Chronic-Growth		100	%EFFL		
20080804	SJ11923	R11	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
20080804	SJ11923	R11	Cerio. Chronic-Reproduction		100	%EFFL		
20080804	SJ12066	RA	90 Fathead Acute		100	%SURV	100	%SURV
20080804	SJ12076	R10	90 Fathead Acute		100	%SURV	100	%SURV
20080804	SJ12070	R11	90 Fathead Acute		97.5	%SURV	97.5	%SURV
20081112	SJ17321	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20081112	SJ17321	R11	Fathead Chronic-Growth		100	%EFFL		
20081112	SJ17324	RA	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
20081112	SJ17324	RA	Cerio. Chronic-Reproduction		100	%EFFL		
20081112	SJ17327	R11	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
20081112	SJ17327	R11	Cerio. Chronic-Reproduction		100	%EFFL		
20090202	SJ21563	RA	90 Fathead Acute		97.5	%SURV	97.5	%SURV
20090202	SJ21566	R11	90 Fathead Acute		97.5	%SURV	97.5	%SURV
20090303	SJ22953	RA	Fathead Chronic-Survival	<	100	%EFFL	<100	%EFFL
20090303	SJ22953	RA	Fathead Chronic-Growth	<	100	%EFFL		
20090303	SJ22951	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20090303	SJ22951	R11	Fathead Chronic-Growth		100	%EFFL		
20090511	SJ26787	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20090511	SJ26787	R11	Fathead Chronic-Growth		100	%EFFL		
20090527	SJ27141	RA	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20090527	SJ27141	RA	Fathead Chronic-Growth		100	%EFFL		
20090810	SJ31132	RA	Fathead Chronic-Survival		100	%EFFL	<100	%EFFL
20090810	SJ31132	RA	Fathead Chronic-Growth	<	100	%EFFL		
20090810	SJ31129	R11	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
20090810	SJ31129	R11	Fathead Chronic-Growth		100	%EFFL		
20090810	SJ30785	RA	90 Fathead Acute		97.5	%SURV	97.5	%SURV
20090810	SJ30781	R11	90 Fathead Acute		100	%SURV	100	%SURV
20091109	09110900445	R11	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
20100216	10021600440	R11	90 Fathead Acute		100	%SURV	100	%SURV
20100216	10021600447	RA	90 Fathead Acute		100	%SURV	100	%SURV
20100310	10031000460	RA	Cerio. Chronic-Reproduction		100	%EFFL	100	%EFFL
20100310	10031000460	RA	Cerio. Chronic-Survival		100	%EFFL		
20100324	10032400521	R11	Cerio. Chronic-Reproduction		100	%EFFL	100	%EFFL
20100324	10032400521	R11	Cerio. Chronic-Survival		100	%EFFL		
20100510	10051100160	R11	Cerio. Chronic-Reproduction		100	%EFFL	100	%EFFL
20100510	10051100160	R11	Cerio. Chronic-Survival		100	%EFFL		

*Final result is the monthly median value for chronic toxicity and the single test value for acute toxicity.

Data used in LACSD analysis of Rio Hondo Reach 2 Toxicity listing.
Accessed via Fact Sheet at http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/region_4/2010/ref3966.zip

Within Data Set but Excluded from Water Board Analysis (n=5)
Single Test Chronic Toxcity Exceedances (NOEC <100%) (n=4)
Monthly Median Chronic Toxicity Exceedance (n=2)
Acute Test with <100% Survival (n=3)

Date	ID	Location	Test Name	Symbol	Single Test Result	UNIT	Final Result*	UNIT
8/8/2005	SJ34891	RD1	90 Fathead Acute		100	%SURV	100	%SURV
11/2/2005	SJ41223	RD1	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
11/2/2005	SJ41223	RD1	Fathead Chronic-Growth		100	%EFFL		
2/1/2006	SJ52185	RD1	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
2/1/2006	SJ52185	RD1	Fathead Chronic-Growth		100	%EFFL		
2/6/2006	SJ52434	RD1	90 Fathead Acute		100	%SURV	100	%SURV
5/10/2006	SJ59344	RD1	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
5/10/2006	SJ59344	RD1	Fathead Chronic-Growth		100	%EFFL		
8/7/2006	SJ64238	RD1	90 Fathead Acute		100	%SURV	100	%SURV
8/7/2006	SJ64415	RD1	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
8/7/2006	SJ64415	RD1	Fathead Chronic-Growth		100	%EFFL		
11/20/2006	SJ70373	RD1	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
11/20/2006	SJ70373	RD1	Fathead Chronic-Growth		100	%EFFL		
2/5/2007	SJ81821	RD1	90 Fathead Acute		100	%SURV	100	%SURV
2/5/2007	SJ81873	RD1	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
2/5/2007	SJ81873	RD1	Cerio. Chronic-Reproduction		100	%EFFL		
5/2/2007	SJ86670	RD1	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
5/2/2007	SJ86670	RD1	Cerio. Chronic-Reproduction		100	%EFFL		
8/8/2007	SJ91309	RD1	90 Fathead Acute		100	%SURV	100	%SURV
9/25/2007	SJ93974	RD1	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
9/25/2007	SJ93974	RD1	Cerio. Chronic-Reproduction		100	%EFFL		
11/5/2007	SJ95892	RD1	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
11/5/2007	SJ95892	RD1	Cerio. Chronic-Reproduction		100	%EFFL		
2/6/2008	SJ01678	RD1	90 Fathead Acute		95	%SURV	95	%SURV
2/6/2008	SJ02089	RD1	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
2/6/2008	SJ02089	RD1	Cerio. Chronic-Reproduction		100	%EFFL		
6/9/2008	SJ08471	RD1	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
6/9/2008	SJ08471	RD1	Cerio. Chronic-Reproduction		100	%EFFL		
8/4/2008	SJ11922	RD1	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
8/4/2008	SJ11922	RD1	Cerio. Chronic-Reproduction		100	%EFFL		
8/4/2008	SJ12068	RD1	90 Fathead Acute		100	%SURV	100	%SURV
11/12/2008	SJ17326	RD1	Cerio. Chronic-Survival		100	%EFFL	100	%EFFL
11/12/2008	SJ17326	RD1	Cerio. Chronic-Reproduction		100	%EFFL		
2/2/2009	SJ21565	RD1	90 Fathead Acute		95	%SURV	95	%SURV
3/3/2009	SJ22952	RD1	Fathead Chronic-Survival	<	100	%EFFL	<100	%EFFL
3/3/2009	SJ22952	RD1	Fathead Chronic-Growth	<	100	%EFFL		
3/11/2009	SJ23743	RD1	Fathead Chronic-Survival		100	%EFFL		
3/11/2009	SJ23743	RD1	Fathead Chronic-Growth	<	100	%EFFL		
3/23/2009	SJ24217	RD1	Fathead Chronic-Survival	<	100	%EFFL		
3/23/2009	SJ24217	RD1	Fathead Chronic-Growth	<	100	%EFFL		
5/11/2009	SJ26795	RD1	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
5/11/2009	SJ26795	RD1	Fathead Chronic-Growth		100	%EFFL		
8/10/2009	SJ30779	RD1	90 Fathead Acute		100	%SURV	100	%SURV
8/10/2009	SJ31130	RD1	Fathead Chronic-Survival		100	%EFFL	100	%EFFL
8/10/2009	SJ31130	RD1	Fathead Chronic-Growth		100	%EFFL		
11/09/2009	09110900470	RD1	Cerio. Chronic-Survival		100	%EFFL	100	%SURV
11/09/2009	09110900478	RD	Cerio. Chronic-Survival		100	%EFFL	100	%SURV
02/16/2010	10021600426	RD1	90 Fathead Acute		100	%SURV	100	%SURV
02/16/2010	10021600430	RD	90 Fathead Acute		97.5	%SURV	97.5	%SURV
03/10/2010	10031000461	RD1	Cerio. Chronic-Reproduction		100	%EFFL	100	%EFFL

03/10/2010	10031000461	RD1	Cerio. Chronic-Survival		100 %EFFL	100	%EFFL
03/10/2010	10031000462	RD	Cerio. Chronic-Reproduction		100 %EFFL	100	%EFFL
03/10/2010	10031000462	RD	Cerio. Chronic-Survival		100 %EFFL		
05/10/2010	10051100166	RD	Cerio. Chronic-Reproduction		100 %EFFL	100	%EFFL
05/10/2010	10051100166	RD	Cerio. Chronic-Survival		100 %EFFL		
05/10/2010	10051100168	RD1	Cerio. Chronic-Reproduction		100 %EFFL	100	%EFFL
05/10/2010	10051100168	RD1	Cerio. Chronic-Survival		100 %EFFL		
03/10/2010	10031000467	RDB	Survival TUc		1.0 TUc	>1.0	TUc
03/10/2010	10031000467	RDB	Reprod TUc	>	1.0 TUc		
05/10/2010	10051100165	RDB	Survival TUc		1.0 TUc	1.0	TUc
05/10/2010	10051100165	RDB	Reprod TUc		1.0 TUc		
11/09/2009	09110900469	RDB	Survival TUc		1.0 TUc	1.0	TUc
11/09/2009	09110900469	RDB	Growth TUc		1.0 TUc		

*Final result is the monthly median value for chronic toxicity and the single test value for acute toxicity.

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Data used in LACSD analysis of Santa Clara River Reach 5 Toxicity listing.
Accessed via Fact Sheet at http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/region_4/2010/ref3966.zip

Single Test/Monthly Median Chronic Toxcity Exceedances (NOEC <100%) (n=5)
Acute Test with <100% Survival (n=10)

Date	ID	Location	Test Name	Symbol	Single Test Result	UNIT
7/11/2005	SJ32723	RC	Fathead Chronic-Survival	<	100	%EFFL
7/11/2005	SJ32723	RC	Fathead Chronic-Growth	<	100	%EFFL
7/11/2005	SJ32724	RD	Fathead Chronic-Survival		100	%EFFL
7/11/2005	SJ32724	RD	Fathead Chronic-Growth		100	%EFFL
7/11/2005	SJ32728	RC	90 Fathead Acute		97.5	%SURV
7/11/2005	SJ32729	RD	90 Fathead Acute		100	%SURV
7/11/2005	SJ32730	RE	90 Fathead Acute		97.5	%SURV
7/25/2005	SJ33924	RE	Fathead Chronic-Survival		100	%EFFL
7/25/2005	SJ33924	RE	Fathead Chronic-Growth		100	%EFFL
10/3/2005	SJ38690	RE	Fathead Chronic-Survival		100	%EFFL
10/3/2005	SJ38690	RE	Fathead Chronic-Growth		100	%EFFL
10/3/2005	SJ38691	RC	Fathead Chronic-Survival		100	%EFFL
10/3/2005	SJ38691	RC	Fathead Chronic-Growth		100	%EFFL
10/3/2005	SJ38692	RD	Fathead Chronic-Survival		100	%EFFL
10/3/2005	SJ38692	RD	Fathead Chronic-Growth		100	%EFFL
1/9/2006	SJ50891	RE	90 Fathead Acute		100	%SURV
1/9/2006	SJ50892	RD	90 Fathead Acute		100	%SURV
1/9/2006	SJ50893	RC	90 Fathead Acute		100	%SURV
1/9/2006	SJ51551	RC	Fathead Chronic-Survival		100	%EFFL
1/9/2006	SJ51551	RC	Fathead Chronic-Growth		100	%EFFL
1/9/2006	SJ51552	RD	Fathead Chronic-Survival		100	%EFFL
1/9/2006	SJ51552	RD	Fathead Chronic-Growth		100	%EFFL
1/9/2006	SJ51553	RE	Fathead Chronic-Survival		100	%EFFL
1/9/2006	SJ51553	RE	Fathead Chronic-Growth		100	%EFFL
4/17/2006	SJ57771	RC	Fathead Chronic-Survival		100	%EFFL
4/17/2006	SJ57771	RC	Fathead Chronic-Growth		100	%EFFL
4/17/2006	SJ57772	RE	Fathead Chronic-Survival		100	%EFFL
4/17/2006	SJ57772	RE	Fathead Chronic-Growth		100	%EFFL
4/17/2006	SJ57776	RD	Fathead Chronic-Survival		100	%EFFL
4/17/2006	SJ57776	RD	Fathead Chronic-Growth		100	%EFFL
7/5/2006	SJ62082	RE	Fathead Chronic-Survival		100	%EFFL
7/5/2006	SJ62082	RE	Fathead Chronic-Growth		100	%EFFL
7/5/2006	SJ62083	RD	Fathead Chronic-Survival		100	%EFFL
7/5/2006	SJ62083	RD	Fathead Chronic-Growth		100	%EFFL
7/5/2006	SJ62084	RC	Fathead Chronic-Survival		100	%EFFL
7/5/2006	SJ62084	RC	Fathead Chronic-Growth		100	%EFFL
7/10/2006	SJ62478	RC	90 Fathead Acute		100	%SURV
7/10/2006	SJ62479	RD	90 Fathead Acute		100	%SURV
7/10/2006	SJ62480	RE	90 Fathead Acute		100	%SURV
10/16/2006	SJ68391	RD	Fathead Chronic-Survival		100	%EFFL
10/16/2006	SJ68391	RD	Fathead Chronic-Growth		100	%EFFL
10/16/2006	SJ68392	RC	Fathead Chronic-Survival		100	%EFFL
10/16/2006	SJ68392	RC	Fathead Chronic-Growth		100	%EFFL
10/16/2006	SJ68393	RE	Fathead Chronic-Survival		100	%EFFL
10/16/2006	SJ68393	RE	Fathead Chronic-Growth		100	%EFFL
1/3/2007	SJ80157	RC	Fathead Chronic-Survival		100	%EFFL

1/3/2007	SJ80157	RC	Fathead Chronic-Growth		100	%EFFL
1/3/2007	SJ80160	RE	Fathead Chronic-Survival		100	%EFFL
1/3/2007	SJ80160	RE	Fathead Chronic-Growth	<	100	%EFFL
1/3/2007	SJ80161	RD	Fathead Chronic-Survival		100	%EFFL
1/3/2007	SJ80161	RD	Fathead Chronic-Growth		100	%EFFL
1/8/2007	SJ80643	RE	90 Fathead Acute		100	%SURV
1/8/2007	SJ80644	RD	90 Fathead Acute		97.5	%SURV
1/8/2007	SJ80645	RC	90 Fathead Acute		100	%SURV
4/2/2007	SJ85062	RD	Fathead Chronic-Survival		100	%EFFL
4/2/2007	SJ85062	RD	Fathead Chronic-Growth		100	%EFFL
4/2/2007	SJ85063	RE	Fathead Chronic-Survival		100	%EFFL
4/2/2007	SJ85063	RE	Fathead Chronic-Growth		100	%EFFL
4/2/2007	SJ85064	RC	Fathead Chronic-Survival		100	%EFFL
4/2/2007	SJ85064	RC	Fathead Chronic-Growth		100	%EFFL
7/16/2007	SJ90059	RC	90 Fathead Acute		100	%SURV
7/16/2007	SJ90060	RD	90 Fathead Acute		100	%SURV
7/16/2007	SJ90061	RE	90 Fathead Acute		100	%SURV
7/16/2007	SJ90118	RC	Fathead Chronic-Survival		100	%EFFL
7/16/2007	SJ90118	RC	Fathead Chronic-Growth		100	%EFFL
7/16/2007	SJ90119	RD	Fathead Chronic-Survival		100	%EFFL
7/16/2007	SJ90119	RD	Fathead Chronic-Growth		100	%EFFL
7/16/2007	SJ90120	RE	Fathead Chronic-Survival		100	%EFFL
7/16/2007	SJ90120	RE	Fathead Chronic-Growth		100	%EFFL
10/15/2007	SJ95013	RC	Fathead Chronic-Survival		100	%EFFL
10/15/2007	SJ95013	RC	Fathead Chronic-Growth	<	100	%EFFL
10/15/2007	SJ95014	RD	Fathead Chronic-Survival		100	%EFFL
10/15/2007	SJ95014	RD	Fathead Chronic-Growth		100	%EFFL
10/15/2007	SJ95015	RE	Fathead Chronic-Survival		100	%EFFL
10/15/2007	SJ95015	RE	Fathead Chronic-Growth		100	%EFFL
1/9/2008	SJ00535	RD	Fathead Chronic-Survival		100	%EFFL
1/9/2008	SJ00535	RD	Fathead Chronic-Growth		100	%EFFL
1/9/2008	SJ00536	RC	Fathead Chronic-Survival		100	%EFFL
1/9/2008	SJ00536	RC	Fathead Chronic-Growth		100	%EFFL
1/9/2008	SJ00537	RE	Fathead Chronic-Survival		100	%EFFL
1/9/2008	SJ00537	RE	Fathead Chronic-Growth		100	%EFFL
1/9/2008	SJ00567	RC	90 Fathead Acute		100	%SURV
1/9/2008	SJ00568	RD	90 Fathead Acute		95	%SURV
1/9/2008	SJ00569	RE	90 Fathead Acute		90	%SURV
4/7/2008	SJ05704	RD	Fathead Chronic-Survival		100	%EFFL
4/7/2008	SJ05704	RD	Fathead Chronic-Growth		100	%EFFL
4/7/2008	SJ05707	RC	Fathead Chronic-Survival		100	%EFFL
4/7/2008	SJ05707	RC	Fathead Chronic-Growth		100	%EFFL
4/7/2008	SJ05708	RE	Fathead Chronic-Survival		100	%EFFL
4/7/2008	SJ05708	RE	Fathead Chronic-Growth		100	%EFFL
7/14/2008	SJ10962	RC	90 Fathead Acute		97.5	%SURV
7/14/2008	SJ10963	RD	90 Fathead Acute		95	%SURV
7/14/2008	SJ10964	RE	90 Fathead Acute		97.5	%SURV
7/14/2008	SJ10993	RE	Fathead Chronic-Survival		100	%EFFL
7/14/2008	SJ10993	RE	Fathead Chronic-Growth		100	%EFFL
7/14/2008	SJ10997	RC	Fathead Chronic-Survival		100	%EFFL
7/14/2008	SJ10997	RC	Fathead Chronic-Growth		100	%EFFL
7/14/2008	SJ10998	RD	Fathead Chronic-Survival		100	%EFFL
7/14/2008	SJ10998	RD	Fathead Chronic-Growth		100	%EFFL
10/6/2008	SJ15483	RC	Fathead Chronic-Survival		100	%EFFL
10/6/2008	SJ15483	RC	Fathead Chronic-Growth		100	%EFFL

10/6/2008	SJ15484	RD	Fathead Chronic-Survival		100	%EFFL
10/6/2008	SJ15484	RD	Fathead Chronic-Growth		100	%EFFL
10/6/2008	SJ15485	RE	Fathead Chronic-Survival		100	%EFFL
10/6/2008	SJ15485	RE	Fathead Chronic-Growth		100	%EFFL
1/5/2009	SJ20232	RC	Fathead Chronic-Survival		100	%EFFL
1/5/2009	SJ20232	RC	Fathead Chronic-Growth		100	%EFFL
1/5/2009	SJ20233	RD	Fathead Chronic-Survival		100	%EFFL
1/5/2009	SJ20233	RD	Fathead Chronic-Growth		100	%EFFL
1/5/2009	SJ20240	RC	90 Fathead Acute		100	%SURV
1/5/2009	SJ20241	RD	90 Fathead Acute		100	%SURV
1/6/2009	SJ20234	RE	Fathead Chronic-Survival		100	%EFFL
1/6/2009	SJ20234	RE	Fathead Chronic-Growth	<	100	%EFFL
1/6/2009	SJ20242	RE	90 Fathead Acute		100	%SURV
4/13/2009	SJ25146	RC	Fathead Chronic-Survival		100	%EFFL
4/13/2009	SJ25146	RC	Fathead Chronic-Growth		100	%EFFL
4/13/2009	SJ25148	RE	Fathead Chronic-Survival		100	%EFFL
4/13/2009	SJ25148	RE	Fathead Chronic-Growth		100	%EFFL
4/20/2009	SJ25586	RD	Fathead Chronic-Survival		100	%EFFL
4/20/2009	SJ25586	RD	Fathead Chronic-Growth		100	%EFFL
7/6/2009	SJ29167	RC	Fathead Chronic-Survival		100	%EFFL
7/6/2009	SJ29167	RC	Fathead Chronic-Growth	<	100	%EFFL
7/6/2009	SJ29167	RC	90 Fathead Acute		100	%SURV
7/6/2009	SJ29168	RD	Fathead Chronic-Survival		100	%EFFL
7/6/2009	SJ29168	RD	Fathead Chronic-Growth		100	%EFFL
7/6/2009	SJ29168	RD	90 Fathead Acute		100	%SURV
7/6/2009	SJ29169	RE	Fathead Chronic-Survival		100	%EFFL
7/6/2009	SJ29169	RE	Fathead Chronic-Growth		100	%EFFL
7/6/2009	SJ29169	RE	90 Fathead Acute		100	%SURV
10/5/2009	SJ33437	RD	Fathead Chronic-Survival		100	%EFFL
10/5/2009	SJ33437	RD	Fathead Chronic-Growth		100	%EFFL
10/5/2009	SJ33438	RC	Fathead Chronic-Survival		100	%EFFL
10/5/2009	SJ33438	RC	Fathead Chronic-Growth		100	%EFFL
10/5/2009	SJ33439	RE	Fathead Chronic-Survival		100	%EFFL
10/5/2009	SJ33439	RE	Fathead Chronic-Growth		100	%EFFL
01/04/2010	10010400421	RC	90 Fathead Acute		97.5	%SURV
01/04/2010	10010400422	RD	90 Fathead Acute		100	%SURV
01/04/2010	10010400423	RE	90 Fathead Acute		97.5	%SURV
02/16/2010	10021600412	RC	Survival NOEC		100	%EFFL
02/16/2010	10021600413	RD	Survival NOEC		100	%EFFL
02/16/2010	10021600414	RE	Survival NOEC		100	%EFFL
04/19/2010	10041900436	RC	Survival NOEC		100	%EFFL
04/19/2010	10041900438	RD	Survival NOEC		100	%EFFL
04/19/2010	10041900440	RE	Survival NOEC		100	%EFFL

Data used in LACSD analysis of San Jose Creek Reach 1 Temperature listing.
Accessed via Fact Sheet at http://www.waterboards.ca.gov/water_issues/programs/tmdl/records/region_4/2010/ref3966.zip

Duplicate Sample - Removed from Analyses (n=29)
Discrete Sample with T> 80 ºF Not Attributable to Waste Discharges (n=14)
Discrete Sample with T> 80 ºF, Possibly Due to Waste Discharges (n=32)
Discrete Samples with T<80 ºF (n=293)

SDATE	Month	JOB	LOC	SUBLOC	Test Name	S	VALUE
20050706	7	SJ32503	SG	C2	Temperature		72.5
20050713	7	SJ32895	SG	C2	Temperature		79.6
20050713	7	SJ32894	SG	C1	Temperature		73.1
20050713	7	SJ32894	SG	C1	Temperature		73.1
20050713	7	SJ32895	SG	C2	Temperature		79.6
20050719	7	SJ33430	POM	RC	Temperature		84.4
20050719	7	SJ33431	POM	RD	Temperature		87.6
20050720	7	SJ33620	SG	C2	Temperature		80.4
20050727	7	SJ34108	SG	C2	Temperature		79.2
20050803	8	SJ34650	SG	C2	Temperature		78.8
20050810	8	SJ35094	SG	C1	Temperature		70.2
20050810	8	SJ35094	SG	C1	Temperature		70.2
20050810	8	SJ35095	SG	C2	Temperature		75
20050810	8	SJ35095	SG	C2	Temperature		75
20050816	8	SJ35444	POM	RC	Temperature		73.8
20050816	8	SJ35445	POM	RD	Temperature		75.9
20050817	8	SJ35605	SG	C2	Temperature		73.9
20050824	8	SJ35973	SG	C2	Temperature		66.4
20050831	8	SJ36563	SG	C2	Temperature		69.4
20050907	9	SJ36923	SG	C2	Temperature		69.1
20050914	9	SJ37388	SG	C1	Temperature		63.5
20050914	9	SJ37388	SG	C1	Temperature		63.5
20050914	9	SJ37389	SG	C2	Temperature		67.1
20050914	9	SJ37389	SG	C2	Temperature		67.1
20050923	9	SJ38029	SG	C2	Temperature		75.9
20050927	9	SJ38223	POM	RC	Temperature		68
20050927	9	SJ38224	POM	RD	Temperature		75.2
20050928	9	SJ38352	SG	C2	Temperature		68.5
20051005	10	SJ38887	SG	C2	Temperature		66
20051012	10	SJ39320	SG	C2	Temperature		67.1
20051025	10	SJ40108	POM	RC	Temperature		66.4
20051025	10	SJ40109	POM	RD	Temperature		64.9
20051026	10	SJ40280	SG	C1	Temperature		58.8
20051026	10	SJ40280	SG	C1	Temperature		58.8
20051026	10	SJ40281	SG	C2	Temperature		69.4
20051026	10	SJ40281	SG	C2	Temperature		69.4
20051102	11	SJ40946	SG	C2	Temperature		76.1
20051109	11	SJ41478	SG	C2	Temperature		72
20051115	11	SJ41779	POM	RC	Temperature		70

20051115	11	SJ41780	POM	RD	Temperature	67.7
20051116	11	SJ41944	SG	C1	Temperature	57.4
20051116	11	SJ41945	SG	C2	Temperature	72.1
20051121	11	SJ42189	SG	C2	Temperature	58.1
20051130	11	SJ42673	SG	C2	Temperature	55.6
20051207	12	SJ43176	SG	C2	Temperature	57.7
20051213	12	SJ43482	POM	RC	Temperature	56.1
20051213	12	SJ43483	POM	RD	Temperature	56.7
20051214	12	SJ43677	SG	C2	Temperature	58.8
20051221	12	SJ44026	SG	C1	Temperature	55.8
20051221	12	SJ44026	SG	C1	Temperature	55.8
20051221	12	SJ44027	SG	C2	Temperature	64
20051221	12	SJ44027	SG	C2	Temperature	64
20051228	12	SJ44249	SG	C2	Temperature	63
20060105	1	SJ50229	SG	C2	Temperature	55.6
20060111	1	SJ50626	SG	C1	Temperature	52.5
20060111	1	SJ50626	SG	C1	Temperature	52.5
20060111	1	SJ50627	SG	C2	Temperature	62.4
20060111	1	SJ50627	SG	C2	Temperature	62.4
20060117	1	SJ50934	POM	RC	Temperature	55.8
20060117	1	SJ50935	POM	RD	Temperature	56.7
20060118	1	SJ51099	SG	C2	Temperature	51.1
20060125	1	SJ51604	SG	C2	Temperature	50.7
20060201	2	SJ52119	SG	C1	Temperature	54.9
20060201	2	SJ52119	SG	C1	Temperature	54.9
20060201	2	SJ52120	SG	C2	Temperature	60.8
20060201	2	SJ52120	SG	C2	Temperature	60.8
20060208	2	SJ52741	SG	C2	Temperature	58.3
20060215	2	SJ53448	SG	C2	Temperature	64
20060221	2	SJ53771	POM	RC	Temperature	54.5
20060221	2	SJ53772	POM	RD	Temperature	60.4
20060222	2	SJ54012	SG	C2	Temperature	51.5
20060227	2	SJ54354	SG	C2	Temperature	62.4
20060309	3	SJ55095	SG	C2	Temperature	68.5
20060315	3	SJ55542	SG	C1	Temperature	54.5
20060315	3	SJ55542	SG	C1	Temperature	54.5
20060315	3	SJ55543	SG	C2	Temperature	67.3
20060315	3	SJ55543	SG	C2	Temperature	67.3
20060323	3	SJ56066	SG	C2	Temperature	60.4
20060323	3	SJ56091	POM	RC	Temperature	76.6
20060323	3	SJ56092	POM	RD	Temperature	79.5
20060327	3	SJ56406	SG	C2	Temperature	62.4
20060403	4	SJ56845	SG	C2	Temperature	61.3
20060412	4	SJ57490	SG	C2	Temperature	62.2
20060418	4	SJ57802	POM	RC	Temperature	65.7
20060418	4	SJ57803	POM	RD	Temperature	72.5
20060419	4	SJ57896	SG	C1	Temperature	60.8
20060419	4	SJ57896	SG	C1	Temperature	60.8

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20060419	4	SJ57897	SG	C2	Temperature	70.7
20060419	4	SJ57897	SG	C2	Temperature	70.7
20060426	4	SJ58301	SG	C2	Temperature	64.2
20060503	5	SJ58739	SG	C2	Temperature	69.3
20060510	5	SJ59211	SG	C2	Temperature	73.6
20060517	5	SJ59631	SG	C1	Temperature	68.9
20060517	5	SJ59632	SG	C2	Temperature	70.1
20060525	5	SJ60106	SG	C2	Temperature	72.3
20060530	5	SJ60233	POM	RC	Temperature	73.4
20060530	5	SJ60234	POM	RD	Temperature	90
20060531	5	SJ60319	SG	C2	Temperature	68.9
20060607	6	SJ60703	SG	C1	Temperature	68.9
20060607	6	SJ60703	SG	C1	Temperature	68.9
20060607	6	SJ60704	SG	C2	Temperature	76.1
20060607	6	SJ60704	SG	C2	Temperature	76.1
20060614	6	SJ61114	SG	C2	Temperature	61.9
20060620	6	SJ61419	POM	RC	Temperature	75.9
20060620	6	SJ61420	POM	RD	Temperature	86.5
20060621	6	SJ61520	SG	C2	Temperature	66.2
20060628	6	SJ61849	SG	C2	Temperature	74.7
20060705	7	SJ62025	SG	C2	Temperature	76.8
20060712	7	SJ62387	SG	C1	Temperature	89.8
20060712	7	SJ62387	SG	C1	Temperature	89.8
20060712	7	SJ62388	SG	C2	Temperature	74.5
20060712	7	SJ62388	SG	C2	Temperature	74.5
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20091021	10	SJ34087	SG	C1	Temperature	62.5
20091021	10	SJ34088	SG	C2	Temperature	77.5

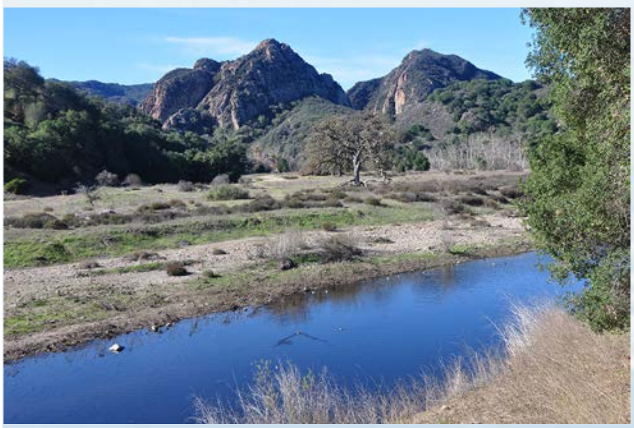
Appendix B: References

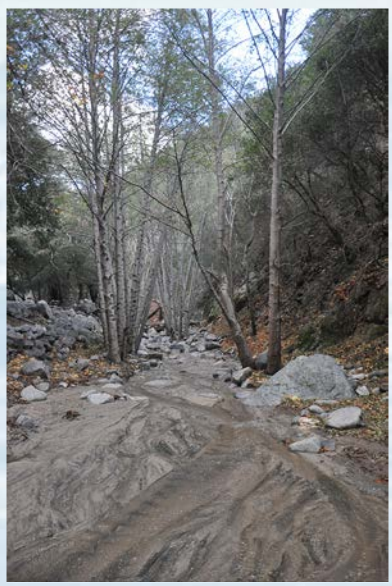
Reference Title	Pages
1. Bioassessment of Perennial Streams in Southern California: A Report on the First Five Years of the Stormwater Monitoring Coalition's Regional Stream Survey.	B2 – B115
2. A Quantitative Tool For Assessing the Integrity of Southern Coastal California Streams	B116 – B128
3. Bioassessment in Complex Environments: Designing an Index For Consistent Meaning in Different Settings	B129 – B158
4. Comparability of Biological Assessments Derived From Predictive Models and Multimetric Indices of Increasing Geographic Scope	B159 – B180
5. Recommendations For the Development and Maintenance of a Reference Condition Management Program to Support Biological Assessment of California's Wadeable Streams: Report to the Surface Water Ambient Monitoring Program	B181 – B228
6. Reference Conditions and Bioassessments in Southern California Streams	B229 – B231
7. Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California	
8. Revised Analyses of Biological Data To Evaluate Tiered Aquatic Life Uses (TALU) For Southern California Coastal Streams	B232 – B261
9. Bioassessment Tools in Novel Habitats: An Evaluation Of Indices and Sampling Methods in Low-Gradient Streams in California	B293 – B307
10. Evaluation of The California State Water Resource Control Board's Bioassessment Program	B308 – B352
11. 2015 Report on the Stormwater Monitoring Coalition Regional Stream Survey	B353 – B373
12. Application of Regional Flow-Ecology to Inform Management Decision in the San Diego River Watershed	B374 – B439
13. Building the Technical Foundation For Biological Objectives	B440 – B474
14. Science Advisory Panel Response, October 18, 2012	B475 – B484
15. Draft Work Plan: Predicting Biological Integrity of Streams Across a Gradient of Development in California Landscapes	B485 – B494
16. Comparison of Stream Invertebrate Response Models For Bioassessment Metrics	B495 – B507

Appendix 1

B3

Bioassessment of Perennial Streams in Southern California: A Report on the First Five Years of the Stormwater Monitoring Coalition's Regional Stream Survey





Raphael D. Mazor

Southern California Coastal Water Research Project

SCCWRP Technical Report 844

SMC
Southern California
STORMWATER MONITORING
Coalition

SWAMP
Surface Water
Ambient Monitoring
Program

SCCWRP
Established 1969

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Ventura Countywide
Stormwater Quality
Management Program

LOS ANGELES COUNTY FLOOD CONTROL DISTRICT

Council for
Watershed Health

COUNTY OF SAN BERNARDINO
DEPARTMENT OF PUBLIC WORKS

COUNTY OF ORANGE CALIFORNIA

Riverside County Flood Control
Water Conservation District

THE NOBLEST MOTIVE IS THE PUBLIC GOOD
COUNTY OF SAN DIEGO
MDCCCLI

CALIFORNIA
DEPARTMENT OF
FISH & WILDLIFE

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

STATE OF CALIFORNIA
SANTA ANA REGION
REGIONAL WATER QUALITY CONTROL BOARD

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION (9)

A REGIONAL APPROACH TO EVALUATING THE BIOLOGICAL CONDITION OF SOUTHERN CALIFORNIA'S WADEABLE STREAMS

2009-2013: THE FIRST FIVE YEARS OF THE STORMWATER MONITORING COALITION'S REGIONAL MONITORING PROGRAM

Southern California Stormwater Monitoring Coalition

OVERVIEW

In 2009, the Southern California Stormwater Monitoring Coalition embarked on an ambitious effort to evaluate the biological condition of 4,300 miles of wadeable streams in the region's coastal watersheds. Over the ensuing five years, the coalition's participating agencies conducted extensive survey and sampling work at more than 500 randomly selected sites encompassing 15 major watersheds in California's South Coast region. Monitoring efforts that had historically been done with minimal coordination were unified around a cohesive, shared vision for the first time, generating high-quality data sets that have painted a powerful picture of regional stream condition. The SMC survey is a regional enhancement of the statewide Perennial Stream Assessment.

The mature riparian plants and biological complexity observed in upper portions of Trabuco Creek in the Santa Ana Mountains reflect a stream that is in good biological condition. 25% of wadeable stream-miles in Southern California were found to be in good condition in the five-year survey.

Caballero Creek, a channelized, algae-filled tributary to the Los Angeles River, reflects severe habitat degradation and impacts of elevated nutrient concentrations. The survey found that both types of stressors were widespread in Southern California streams.

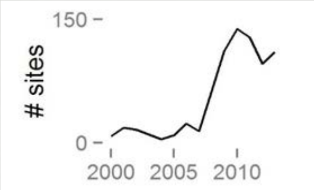
PROGRAM BENEFITS AND IMPACTS

- **Relevant to managers**: Comprehensive data sets inform decisions about priorities and resource allocation, and identify opportunities for causal assessment follow-up studies.
- **Cost-effective:** Each participant realizes approximately 10 times the data value relative to costs.
- **More influential**: Regional collaborations provide more data to inform statewide policymaking, and highlight local concerns.
- **Conversation-altering**: Provides a starting point for developing innovative management strategies that consider and go beyond water chemistry.

KEY FINDINGS

25% of the region's wadeable stream-miles are in good biological condition, including:

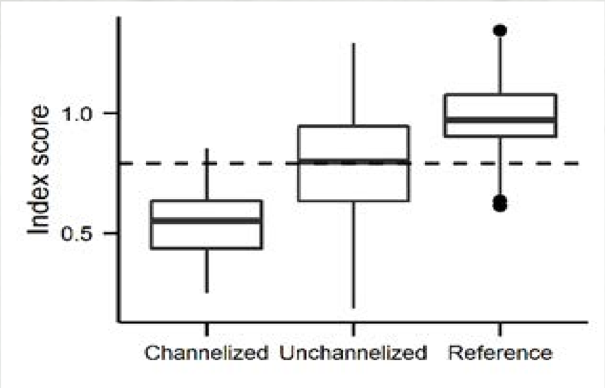
- **60%** of stream-miles in open-space
- **9%** in agricultural areas
- **2%** in urban areas



The Regional Monitoring Program stream survey, which began in 2009, significantly increased the number of stream sites sampled in the region.

HIGH-PRIORITY STRESSORS ON WADEABLE STREAMS

Stressors affecting more than 25% of stream-miles	Stressors affecting 10% to 25% of stream-miles
• Nutrients (Nitrogen and Phosphorus) • Physical habitat degradation • Sulfates • Total dissolved solids	• Chloride • Total suspended solids • pH



Index scores based on benthic macroinvertebrates were lower in channelized streams than non-channelized and reference streams; however, high scores for algal indices were observed in channelized streams where water quality was good. These findings provide a basis for regulators and stormwater agencies to discuss management strategies for channelized streams.

FOUR ECOLOGICAL CONDITION INDICATORS

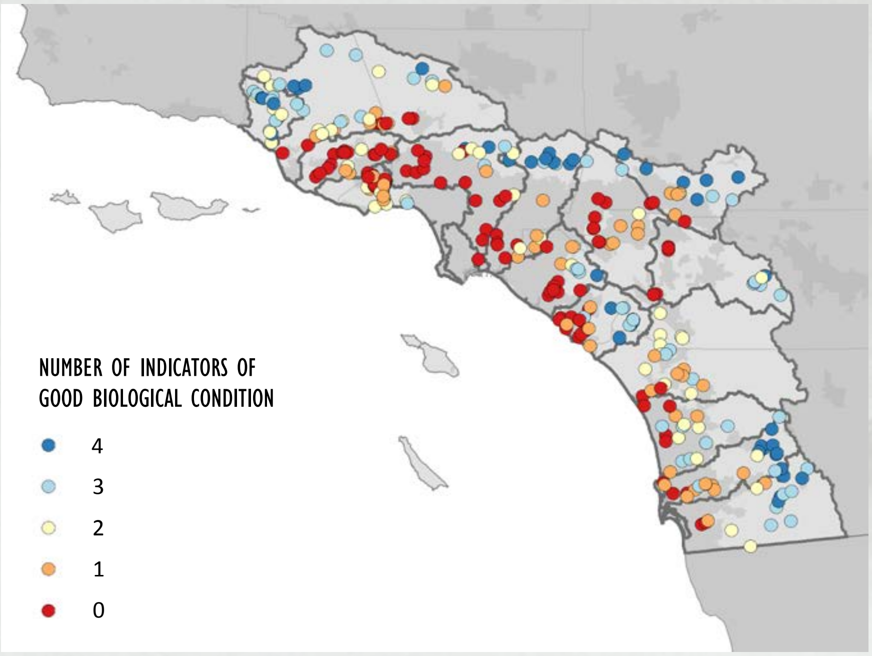
The biological condition of streams was assessed by collecting data for four biological indicators. Each indicator is sensitive to a unique combination of stream stressors, allowing it to provide different types of information about a stream's overall health. Collectively, the four indicators provide comprehensive, direct evidence of a stream's capacity to support aquatic life, a more revealing approach than measuring the chemical concentrations of pollutants.

1 **Benthic macro-invertebrates**, such as aquatic insects, snails, and worms, respond to changes in habitat or water quality over their lifespans.

2 **Soft algae**, such as *Vaucheria*, may form clumps or filaments on submerged rocks. Some species proliferate when nutrients are elevated, while others thrive when nutrients are scarce.

3 **Diatoms**, such as *Navicula*, respond strongly to changes in water chemistry and sedimentation.

4 **Riparian habitats**, which support both terrestrial and in-stream wildlife, may be degraded by habitat alteration, upstream discharges, and hydrologic modification.



At the 500+ randomly selected sampling sites in the stream survey, anywhere from 0 to all 4 biological indicators indicated that a site was in good biological condition. The four indicators – benthic macroinvertebrates, diatoms, soft algae, and riparian habitat condition – collectively were used to assess a site's biological condition.

WATERSHEDS WITH MANY STREAMS IN GOOD CONDITION

- Ventura River
- Upper Santa Ana River
- Tijuana + Sweetwater + Otay Rivers

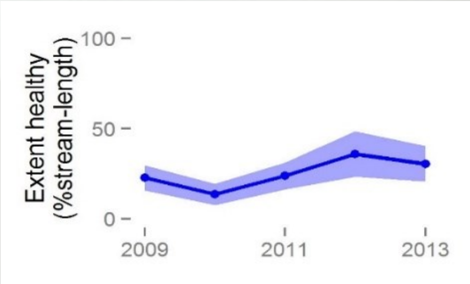
WATERSHEDS WITH FEW STREAMS IN GOOD CONDITION

- Calleguas Creek
- Lower Santa Ana River
- San Dieguito River + Carlsbad Hydrologic Unit

NO APPARENT TRENDS

Although there was some year-over-year variability, the survey did not find a change in the health of the streams over the five-year sampling period, from 2009 to 2013.

Urban streams tended to be in consistently poor biological condition, whereas open-space and agricultural streams tended to experience greater year-to-year variability.



The portion of healthy stream-miles fluctuated over the five-year sampling period, but overall showed no clear trends in either direction. The blue shading represents the 95% confidence interval.

A NEW SURVEY UNDERWAY

The success of the SMC's Regional Monitoring Program has paved the way for a second round of the program, which began in spring 2015. The first five-year survey will serve as a baseline for detecting trends over time.

The second cycle includes nonperennial streams, a critical habitat that makes up more than half of the region's stream-miles, and will seek to clarify the linkage between stressors and biotic integrity.

STORMWATER MONITORING COALITION MEMBERS

County of Los Angeles Department of Public Works, County of Orange Public Works, County of San Diego Department of Public Works, Riverside County Flood Control and Water Conservation District, San Bernardino County Flood Control District, Ventura County Watershed Protection District, City of Long Beach Public Works Department, City of Los Angeles Department of Public Works, California Regional Water Quality Control Board—Santa Ana Region, Los Angeles Region, and San Diego Region, State Water Resources Control Boards, California Department of Transportation, Southern California Coastal Water Research Project (SCCWRP). Collaborating organization: U.S. Environmental Protection Agency Office of Research and Development | www.socalsmc.org

DEVELOPED IN COLLABORATION WITH THE SURFACE WATER AMBIENT MONITORING PROGRAM

SWAMP Surface Water Ambient Monitoring Program

Bioassessment of Perennial Streams in Southern California: A Report on the First Five Years of the Stormwater Monitoring Coalition's Regional Stream Survey

Stormwater Monitoring Coalition Bioassessment Workgroup

Prepared by Raphael D. Mazor
Southern California Coastal Water Research Project

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Acronyms

Acronym	Definition
AFDM	Ash-free dry mass
CI	Confidence interval
CMAP	California Monitoring and Assessment Program
CRAM	California Rapid Assessment Method
CSCI	California Stream Condition Index
CTR	California Toxics Rule
D18	Diatom Index of Biotic Integrity
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency
IBI	Southern and Central California Index of Biotic Integrity
NHD	National Hydrography Dataset
NRSA	National Rivers and Streams Assessment
O□E	Ratio of Observed to Expected Taxa
PCT□BIGR	□ large substrate (□128 mm)
PCT□CPOM	□ cover by coarse particulate organic matter
PCT□FAST	□ fast-water habitat
PCT□MAP	□ macroalgae cover
PCT□MCP	□ macrophyte cover
PCT□MIAT1	□ cover by thick (□1 mm) microalgae
PCT□SAFN	% sands and fines (≤2 mm)
pMMI	Predictive Multi-Metric Index
PSA	Perennial Stream Assessment
S2	Soft Algae Index of Biotic Integrity
SD	Standard Deviation
SMC	Stormwater Monitoring Coalition
TDS	Total Dissolved Solids
TN	Total Nitrogen
TP	Total Phosphorous
XEMBED	Mean □ cobble embeddedness
XFC□NAT□SWAMP	Natural fish cover
XMIATP	Mean microlagae thickness (where present)

EXECUTIVE SUMMARY

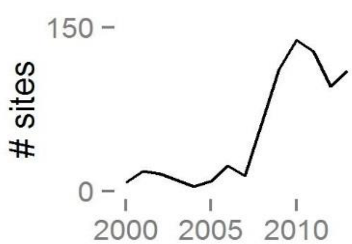
Streams are important natural resources in the South Coast of California, a region that extends from Ventura to San Diego counties. Competing needs for aquatic resources are intense and growing. Assessing the biological condition of these streams has been the focus of considerable monitoring activity. However, until 2009 these efforts were minimally coordinated and provided only limited information about the health of streams in the region, as a result of an emphasis on end-of-watershed monitoring. The Stormwater Monitoring Coalition (SMC) regional perennial stream survey was created in response to the need for a more holistic and coordinated approach. This report provides the results of a five-year probability-based bioassessment of southern California's perennial wadeable streams and represents one of the most comprehensive assessments of stream conditions in the United States.

The five-year survey was designed to answer key questions that are essential to watershed management:

1) What is the biological condition of perennial streams in the region?

2) What stressors are associated with poor condition?

3) Are conditions changing over time?



The Stormwater Monitoring Coalition has greatly increased the number of sites sampled in southern California.

Answering these questions at the regional scale provides resource managers with the ability to contextualize their programs and improve understanding of the effectiveness of management actions, prioritization of streams most in need of protection, and identification of stressors that are likely to pose the greatest risk to stream health.

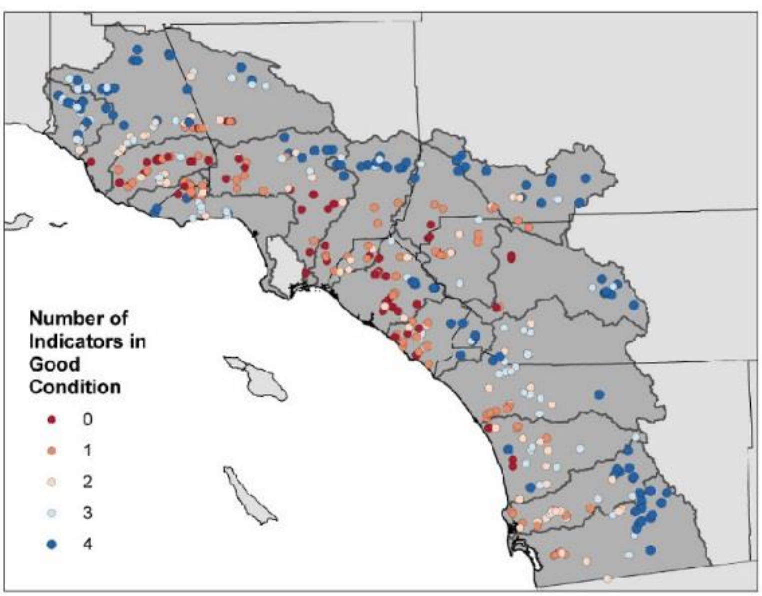
Prior to the initiation of the SMC perennial stream survey, bioassessment efforts in southern California had a limited ability to answer any of these questions. Lead monitoring agencies worked with little coordination, typically addressing site-specific problems with sometimes incomparable methodologies and rarely sharing data. Targeted monitoring mandated by permits did not provide the regional context needed to inform management decisions. Earlier probabilistic sampling efforts in southern California were limited (rarely more than a handful of sites per year), and were conducted as a small part of a statewide or national assessment.

Since the initiation of the SMC perennial stream survey in 2009, stormwater agencies have been able to coordinate their monitoring efforts with regulatory agencies, reallocate resources, and generate the needed data in a cost-neutral way, while simultaneously allowing regulated agencies to fulfill their permit obligations. This survey serves as the regional component of the statewide Perennial Stream Assessment, allowing both the SMC and the State Water Resources Control Board to leverage resources and support each other's surveys.

To answer key management questions, over 500 sites were sampled for four key indicators of biological condition: benthic macroinvertebrates, diatoms, soft algae, and riparian wetlands. These indicators were used to assess the biological health of over 7000 km of streams. In addition, water chemistry, water column toxicity, and physical habitat were examined in order to identify stressors affecting biological conditions in the region. Furthermore, because the survey spanned five years, initial estimates of regional trends are now possible.

Key Findings

Biologically healthy perennial streams are a scarce resource, comprising only 25% of perennial wadeable stream-miles in the region. Based on four biological indicators (i.e., benthic macroinvertebrates, diatoms, soft algae, and riparian wetlands), perennial streams in good biological condition (i.e., scores above the 10th percentile of reference sites) were largely confined to undeveloped portions of watersheds; most indicators identified slightly better conditions at agricultural streams relative to urban streams. Ventura, Santa Clara, Upper Santa Ana, and Southern San Diego watersheds were in better condition than other watersheds for most indicators, whereas perennial streams in poor condition (i.e., scores below the 10th percentile of reference sites) were most extensive in Calleguas, Los Angeles, San Gabriel, and Lower and Middle Santa Ana watersheds.



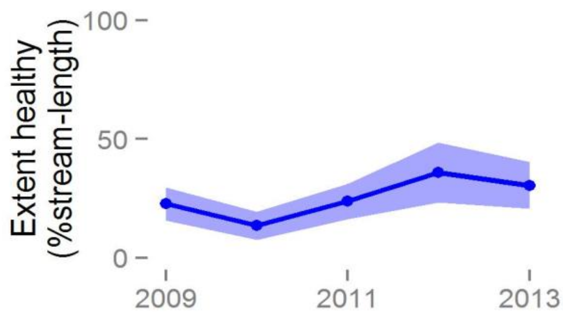
Perennial stream condition was evaluated with four biological indicators: benthic macroinvertebrates, diatoms, soft algae, and riparian condition. In general, these components of the stream community rarely indicated good health in developed portions of watersheds.

Nutrients, sulfates, and habitat degradation were extensive, high-risk stressors associated with poor biological condition. Future investigations should consider these possible candidate stressors as potential causes of poor biological condition. In contrast, metals, pyrethroids, and toxicity were either rarely above threshold or weakly associated with biological condition.

A large extent of the South Coast region was at risk from physical habitat degradation, elevated nutrients, and major ions. Pyrethroids and metals were either weakly or rarely associated with poor health.

Very high priority **(Affects more than 25% of region)**	**High priority** **(Affects more than 10% of region)**	**Moderate or low priority** **(Limited extent or low risk)**
Nitrogen Phosphorus Physical habitat Sulfates Dissolved solids	Chloride Suspended solids pH	Pyrethroids Metals Biomass Toxicity

No changes in biological condition were detected. Although mean condition estimates fluctuated from year to year, conditions in 2013 were similar to those observed in 2009; fluctuations were primarily driven by variability in undeveloped streams, as urban streams were consistently in poor condition, varying little from year to year. At no time during the survey were more than 35% or less than 14% of streams estimated to be intact for all indicators. Moving forward, the ability to detect trends could be improved by minor changes to the study design, such as revisiting sites over several years and by extending the survey for additional years.



Extent of perennial streams in good biological condition for all four indicators (benthic macroinvertebrates, diatoms, soft algae, and riparian condition) fluctuated from year to year, but was always limited to less than 35% of perennial stream-miles in the region. The band indicates the 95% confidence interval.

How can this survey support management decisions?

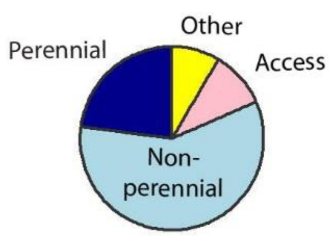
Evaluate steps to protect healthy streams and improve unhealthy streams. Given the small extent of healthy perennial stream-miles in the southern California, protecting such streams may be a priority for resource managers. Additionally, the relatively large extent of stream-miles in poor condition suggests that managers will need to prioritize actions to address stressors affecting unhealthy streams. Prioritization should focus on likelihood of success, achievability of objectives, breadth of impact, and costs associated with management activities, as well as local objectives and needs for each waterbody. Although most of the actions required will be site-specific, a regionally coordinated approach will aid in priority ranking and enable leveraging of efforts across sites or watersheds.

Use regional context in site-specific evaluations. The primary application of survey data is to provide context in evaluating site-specific questions. Comparing the condition of a specific site to conditions at sites with similar land use within the region may provide more useful benchmarks for management objectives than comparison to reference sites, which may not provide an achievable management objective.

Use survey data in causal assessments to identify candidate stressors. Because of the breadth of information collected at each site, the comparability of methods used, and the diversity of sites sampled, data from this survey are well suited to causal assessment applications. With some investment in tool development, regional watershed managers will be able to overcome the data limitations (such as difficulties in identifying comparison sites with information on stressors) that often hinder effective causal assessments.

Recommendations for future monitoring

Although this survey successfully produced preliminary answers to key questions, important knowledge gaps remain. Continuing the survey with modifications will address these gaps.



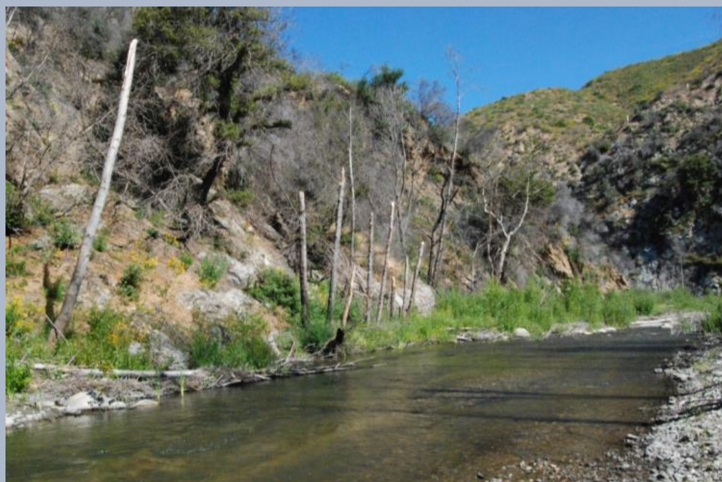
Include stream types that were previously excluded from the survey. The chief limitation of this survey is that it was restricted to perennial, wadeable streams, 2nd order and higher. The condition of nonperennial and headwater streams represents the largest gap in our regional assessment. Perennial streams account for only 25% of stream-miles in the region as a whole, and as little as 5% in certain watersheds; this variation is caused by both natural factors (such as climate) and land use. Because perennial and higher-order streams are more abundant in developed regions, it is likely that the surveyed portion of the region is in worse condition than the region as a whole. Expanding the survey to include assessment of nonperennial streams (approximately 59% of stream-miles in the region), and exploring ways to map them will help fill these knowledge gaps. Existing assessment tools may be appropriate to assess condition of nonperennial streams, and new tools should be developed as needed.

Improve trend detection through site revisits. Probabilistic sites that are revisited for several years can be used to estimate the extent of improving, degrading, or stable streams in the region. Additionally, management practices associated with changes in conditions can be identified.

Use survey data and special studies to support causal assessments and investigate high-priority stressors. Stressor prioritizations are strictly associative and cannot identify with certainty causal relationships between stressors and biological condition. In some cases, stressors that were identified as high priority (e.g., nutrients) might not directly affect biological condition. Instead, the high risk may reflect a correlation with an unmeasured stressor. The frequent co-occurrence of multiple stressors can make it difficult to disentangle the relationships between individual stressors and biological condition. The SMC can address these limitations in several ways:

- Analyze existing data to explore the diagnostic potential of biological indicators to identify specific stressors.
- Enhance the stream survey with new indicators related to habitat degradation (e.g., hydromodification indicators) or nutrient enrichment (e.g., continuous water quality loggers, algae biomass), or other stressors of emerging concern (e.g., sediment pyrethroids).
- Conduct special studies to distinguish biological constraints imposed by habitat degradation, channel engineering, water chemistry, and natural factors.

SURVEY OVERVIEW



This survey provides the best estimate of the extent of perennial (e.g., Big Tujunga Creek, upper photo) and nonperennial streams (e.g., San Juan Creek, lower photo) in the South Coast region.

Introduction

Southern California's coastal watersheds contain important aquatic resources that support a variety of ecological functions and environmental values. Comprising over 7,000 stream-kilometers, both humans and wildlife depend on these watersheds for habitat, drinking water, agriculture, and industrial uses. In order to assess the health of streams in these watersheds, the Stormwater Monitoring Coalition (SMC), a coalition of multiple state, federal, and local agencies, initiated a regional monitoring program in 2009. Using multiple indicators of ecological health, including benthic macroinvertebrates, benthic algae, riparian wetland condition, water chemistry, water column toxicity, and physical habitat, the SMC has led the first comprehensive assessment of southern California's watersheds based on a probabilistic survey design. Through the re-allocation of permit-required monitoring efforts, the SMC has developed a cooperative sampling program that is efficient and cost-effective for participants. This report represents a summary of data collected in the first five years of the SMC's stream survey. Data from previous surveys, such as the Environmental Protection Agency (EPA) Environmental Monitoring and Assessment Program (EMAP) and California's Perennial Stream Assessment (PSA), are included as well.

The SMC monitoring program was designed to address three main questions:

1) What is the biological condition of perennial streams in the region?
2) What stressors are associated with poor condition?
3) Are conditions changing over time?

The first question is addressed by estimating the extent of biologically intact streams, as determined by key biological indicators. The second question is addressed by estimating the extent of streams with stressors above key thresholds, and by associating stress levels with biological indicators through correlation and relative risk analyses (Van Sickle *et al.* 2006). The third question is addressed by comparing condition across years of the survey.

Regional assessments provide critical information to complement site-specific monitoring at sites of interest. Regional surveys that use a probabilistic design provide statistically valid and unbiased assessments of large geographic areas (Gibson *et al.* 1996). Crucially, regional assessments provide context to site-specific problems and allow sites to be prioritized for protection or restoration (Barbour *et al.* 1996). Furthermore, regional assessments provide a comprehensive perspective on reference conditions (Reynoldson *et al.* 1997). Although regional programs do not replace the need for monitoring at sites of interest (such as below discharges or within sensitive wildlife areas), the context provided by a regional assessment is essential for effective watershed management (Barbour *et al.* 1996, Gibson *et al.* 1996).

Methods

Study Area

Coastal southern California (i.e., the South Coast) is a semi-arid region with a Mediterranean climate, which experiences nearly all of its precipitation as rainfall during winter months. Lower elevations are characterized by chaparral, oak woodlands, grasslands, and coastal sage scrub. The region is bordered by the Transverse Ranges to the North, and the Peninsular Ranges to the East, and continues to the Mexican border to the South. Both Transverse and Peninsular ranges contain peaks that exceed 10,000 feet and regularly experience snow, although contributions to stream flow are limited. Much of the higher elevations are undeveloped and remain protected in a network of national, state, and county parks and forests. The lower elevations have been largely urbanized or converted to agriculture. Wildfires and drought are frequent in the region, with extensive fires occurring in 2007, 2009, and 2013 throughout much of the area. By area, the overall region is 59% undeveloped open space, 28% urban, and 13% agricultural (National Oceanic and Atmospheric Administration (NOAA) 2001).

Survey Design

The target population of the survey was defined as perennial, wadeable second-order and higher streams located in the six southern California counties draining into the Southern California Bight. The study area was divided into fifteen management units (hereafter referred to as watersheds) based on a combination of hydrologic and political boundaries (Table S-1, Figure S-1). The National Hydrography Dataset Plus stream network (NHD Plus; US Geological Survey and US Environmental Protection Agency 2005) was used as the sample frame. Stream segments in the NHD Plus typically represent lengths of streams between two confluences, although particularly long reaches are often split into shorter lengths. In order to assign land-use to each segment of the NHD Plus frame, a 500-m buffer was drawn around each stream segment and overlain in a GIS onto a landcover layer (NOAA 2001). If the buffer was more than 75% natural or open land, the segment was considered open space; if not, it was considered urban or agricultural, depending on which land use was relatively more dominant. Very short segments were occasionally hand corrected if the buffers were too small to adequately capture the adjacent land use; these corrections were most typically used for segments representing individual channels in complex braided systems, such as the mainstem of the Santa Clara River.

The study employed the “master list” approach to integrate sampling efforts by multiple agencies and to facilitate collaboration with other monitoring programs (Larsen *et al.* 2008). A master list was generated, containing over 50,000 sites randomly distributed across the entire stream network using a spatially balanced generalized random-tessellation design (Stevens and Olsen 2004). Sites were then assigned to a watershed using a geographic information system (GIS). Sites were attributed with Strahler stream order from the NHD Plus dataset, and with land use based on the designation of the stream segment, as described above. Sites were then attributed with watershed, stream order, and land-use of the corresponding stream segment of the sample frame. First order streams were excluded from the survey, because these sites typically have a higher rejection rate based on nonperenniality or inaccessibility in mountainous regions. A target sample of 30 sites was selected from each watershed, with heavier representation in relatively uncommon strata (e.g., agricultural streams) to improve balance among the sampled stream types. Large oversamples (ranging from 5x to 20x) were selected as well because of high rejection rates in certain strata. Sites in the sample draw and oversamples were distributed to field crews for evaluation for sampling suitability.

Sites were evaluated for sampling using both desktop and field reconnaissance. Field crews attempted to locate a reach suitable for sampling within 300 m of the target coordinates. Sites with no nearby suitable reaches were rejected for sampling. Reasons for rejection included nonperenniality (see box below), inaccessibility (defined as sites that cannot be safely reached and sampled within one day), refusal or lack of response from landowners, map errors (e.g., no channel near the target coordinates), nonwadeability (i.e., >1 m deep for at least 50% of the reach) and inappropriate waterbody types (e.g., tidally influenced, impounded, etc.). Sites with temporary accessibility or permission issues (e.g., road closures, late responses from landowners) were re-evaluated for sampling in subsequent years.

Defining and Determining Perennial Streams

Perennial streams were defined as those with continuous flow that lasts until the end of the hydrologic year (i.e., September 30) in most years. Determining if a site met these criteria required that field crews find the best available data, including stream gauges, field indicators, historical imagery, consultation with local experts, and best professional judgment. Although all reasonable efforts were made to confirm the perenniality of the sampled sites, it is likely that some of them do not meet the survey's criteria for perennial streams during the years of the study. Therefore, the survey reflects the condition of a mixture in unknown proportions of perennial and long-lasting nonperennial streams. Development of an objective tool to characterize hydrologic regimes remains a priority research area for the SMC.

Sampling Methods

Biological Indicators

Benthic Macroinvertebrates

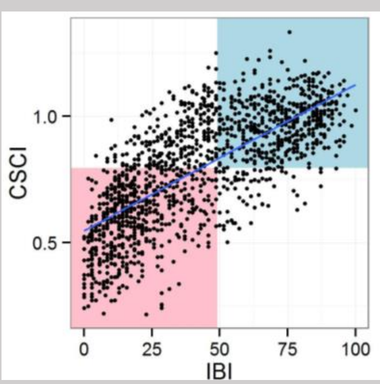
Benthic macroinvertebrates were collected using protocols described by Ode (2007). At each transect established for physical habitat sampling, a sample was collected using a D-frame kicknet at 25, 50, or 75% of the stream width. A total of 11 ft^2 (~1.0 m^2) of streambed was sampled. This method was identical to the Reach-Wide Benthos method used by EMAP (Peck *et al.* 2006). However, in low-gradient streams (i.e., gradient <1%), sampling locations were adjusted to 0, 50, and 100% of the stream width, because traditional sampling methods fail to capture sufficient organisms for bioassessment indices in these types of streams (Mazor *et al.* 2010). Benthic macroinvertebrates were collected and preserved in 95% ethanol (final concentration 70%), and sent to one of five labs for identification. At all labs, a target number of at least 600 organisms were removed from each sample and identified to the highest taxonomic resolution that can be consistently achieved (i.e., SAFIT Level 2 in Richards and Rogers 2011); in general, most taxa were identified to species and Chironomidae (i.e., midges) were identified to genus. Benthic macroinvertebrate data was used to calculate the California Stream Condition Index (CSCI; Mazor et al. In Press). Samples from streams in reference condition are expected to have a mean CSCI score of 1.

CSCI vs. IBI

Like the Southern and Central California Index of Biotic Integrity (IBI), the CSCI was designed to measure the biological condition of streams, as indicated by benthic macroinvertebrate assemblage structure. The CSCI characterizes benthic macroinvertebrate assemblage structure in two ways: 1) As the ratio of observed-to-expected taxa (an O/E index), and 2) as a multi-metric index (MMI), where biological metrics related to important ecological attributes (e.g., number of sensitive taxa) are compared with expected values. Both components are compared to expectations that vary from site to site, and these expectations are derived from reference sites in similar environmental settings.

The CSCI was developed specifically to address some of the shortcomings of traditional indices like the IBI and provides a better measure of stream health than its predecessor because of two key features. First, the CSCI was developed with a much larger, more representative data set. For example, 473 reference sites were used to calibrate the CSCI (including 27 from lower elevation South Coast xeric sites), versus 88 for the IBI (of which only 9 were from South Coast xeric regions). More importantly, the CSCI sets biological benchmarks for a site based on its environmental setting (determined by environmental factors, like climate, geology, watershed area, and elevation) whereas the IBI makes minimal adjustments for natural environmental influences on stream communities.

Overall, the CSCI and IBI have similar performance, and samples that score high for one index usually score high for the other (Pearson's $r^2 = 0.54$). In general, the CSCI is more accurate, and is less likely than the IBI to give false indications of nonreference condition. However, it is also less sensitive, and is less likely to indicate nonreference conditions at severely stressed sites. If a threshold based on the 10th percentile of reference sites is applied to both indices (i.e., 0.79 for the CSCI and 49 for the IBI), approximately one-third of streams below the IBI threshold would be above the CSCI threshold; in contrast, only 2% of streams below the CSCI threshold would be above the IBI threshold.



Correlation between IBI and CSCI scores for sites in southern California. The pink area indicates sites where both indices suggest likely altered biological condition (i.e., Class 3 and 4), and the blue area indicates sites where both indices suggest intact or possibly altered biological condition (i.e., Class 1 and 2). The blue line represents a linear regression between the two indices.

Benthic Algae

Benthic algae samples were collected using the protocols of Fetscher *et al.* (2009), approximately 1 foot upstream of each location where benthic macroinvertebrates were collected. Diatom samples were preserved in formalin, and soft algae samples were preserved in glutaraldehyde. Unpreserved, qualitative soft algae samples were also collected to produce fruiting bodies that facilitate identification of soft algae species. Benthic algae samples were identified to the best taxonomic resolution possible, which was typically species. Benthic algae was assessed using two indices from Fetscher *et al.* (2014): a soft algae index (S2), and a diatom index (D18). Calculations were completed using custom scripts in the statistical software R. Samples from streams in reference condition are expected to have a mean D18 score of 79 and a mean S2 score of 69. Although these indices are not "predictive" like the CSCI score, little bias from natural gradients was evident at reference sites (Fetscher *et al.*2014).

Riparian Wetlands

Riparian wetland condition was assessed using the California Rapid Assessment Method (CRAM; Collins *et al.* 2008). Briefly, the CRAM method assesses four attributes of wetland condition: buffer and landscape, hydrologic connectivity, physical structure, and biotic structure. Each of these attributes is comprised of a number of metrics and submetrics that are evaluated in the field for a prescribed assessment area. Streams in reference condition are expected to have a mean CRAM score of 84.

Water Chemistry

Field crews measured pH, specific conductance, dissolved oxygen, salinity, and alkalinity at each site visit using digital field sensors (or by collecting samples for lab analyses, where appropriate). In addition, samples of stream water were collected for measurements of 36 different analytes, including: total suspended solids, total hardness (as $CaCO_3$), silica, sulfate and other major ions, nutrients, dissolved and total metals, and pyrethroid pesticides. Analytical methods and quality assurance protocols are described in SWAMP QAT (2008).

Toxicity

At each site, ~4 L of water were collected for toxicity assays, primarily using the water flea *Ceriodaphnia dubia*. Six to eight day exposures to undiluted field-collected stream water were conducted, and both survival (acute toxicity as percent mortality) and reproduction (chronic toxicity as young per female) endpoints were recorded. In samples with specific conductivity ≥2500 μS/cm, a 10-day survival assay using the amphipod *Hyalella azteca* was used instead, with no reproductive endpoint (USEPA 2002, SWAMP QAT 2008).

Physical Habitat

At each site, physical habitat was evaluated using a physical habitat assessment as specified in Ode (2007) and Fetscher *et al.* (2009), which were adapted from EMAP (Peck *et al.* 2006). Briefly, a 150-m reach (250-m for streams over 10 m wide) was divided into 11 equidistant transects, with 10 inter-transects located halfway between them. At each transect, the following parameters were measured: bank dimensions, wetted width, water depth in five locations, substrate size, cobble embeddedness, bank stability, microalgae thickness, presence of coarse particulate organic matter, presence of attached or unattached macroalgae, presence of macrophytes, riparian vegetation, instream habitat complexity, canopy cover using a densiometer, human influence, and flow habitats. A subset of these variables were measured at each inter-transect as well. The slope of the water surface was measured across the entire reach at each site. Metrics based on physical habitat data were calculated using custom scripts in R, based on those presented in Kaufmann *et al.* (1999).

Challenges in Assessing Physical Habitat

Although many studies point to a crucial role for physical habitat in supporting healthy streams, assessing the condition of physical habitat remains a challenge for bioassessments. There are four parts to this challenge: 1) measuring the right variables, 2) calculating meaningful metrics from these variables, 3) comparing these metrics to benchmarks that are appropriate for the environmental setting of a site, and 4) ensuring that the metrics are comprehensive enough to characterize important aspects of habitat degradation. To some extent, the first two problems have been addressed. The protocol developed by SWAMP, based on methods developed by the EPA (Peck *et al.* 2006), encompasses over 1000 individual measurements per site, and these measurements are converted into more than 150 metrics that characterize the physical habitat, again based on earlier efforts of the EPA (Kaufmann *et al.* 1999). However, most of these metrics vary widely among reference sites, based on environmental factors like climate and watershed size. Predictive models to set reference-based expectations for physical habitat metrics are in development, but are not yet available. Once such models are developed, a remaining challenge will be to select which metrics (and in which combinations) are most useful in characterizing the overall condition of the physical habitat of a site.

Landscape Variables

Landscape variables were calculated for three purposes: CSCI calculation (see Mazor *et al.* In review), reference site screening (see Ode *et al.* In review), and biological relationships. Using a GIS, watersheds were delineated for each site from 30-m digital elevation models (USGS 1999), and visually corrected to reflect local conditions. For sites draining ambiguous watersheds with minimal topography, delineations were modified using CALWATER boundaries (California Department of Forestry and Fire Protection 2004) or by consulting local experts. Watersheds were clipped at 5 km and 1 km to evaluate local conditions, creating a total of three scales (abbreviated as WS, 5k, and 1k). A fourth scale (i.e., point), based only on the site location, was used to calculate distance-based metrics. These delineations were then used to calculate metrics from source layers relating to landcover (NOAA 2001), transportation (CDFG custom roads layer, P. Ode, unpublished data), geology (J. Olson and C. Hawkins, unpublished data), and hydrology (National Inventory of Dams and NHD Plus). For sites sampled in 2013, only variables related to the CSCI were calculated.

Summary of Data from Other Surveys

Data from other surveys were included in this report, where possible. In order to be included, these surveys had to meet the several criteria: 1) benthic macroinvertebrates were collected using similar protocols (e.g., EMAP), 2) benthic macroinvertebrates were identified to equivalent taxonomic resolution, 3) survey design documentation (including stratifications) and site evaluation data were available, and 4) compatible sample frames were used for survey design (specifically, the NHD Plus or its predecessor RF3). These surveys are summarized in Table S-2. Note that some sites, although selected for sampling for a probabilistic survey, were revisited under other programs (such as reference sampling, fire studies, or other targeted designs), and these data were included in the current assessment as well. With few exceptions, limited data types (generally, benthic macroinvertebrates and physical habitat) were collected for these surveys.

Climate Data

Monthly rainfalls for stations throughout the region were downloaded from The National Oceanic and Atmospheric Administration's California and Nevada River Forecast Center (www.cnrfc.noaa.gov/rainfall_data.php). Annual totals were then calculated and plotted to evaluate the conditions during the study period relative to longer term trends. Three representative stations were selected for plotting (i.e., downtown Los Angeles, Big Bear Lake, and Lindbergh Field).

Data Analysis

Weighted Magnitudes and Extent Estimates

Adjusted sample weights were calculated for each site. Because multiple surveys with different designs were included in analysis, weights needed to be recalculated for each site. Stratification approaches from all surveys were combined to create "cross-strata" in which all evaluated sites have an equal probability of being sampled. Adjusted weights were recalculated as the total stream length within each strata, divided by the number of sites evaluated in that stratum. Strata with no evaluations were excluded from analysis. Because these strata comprised less than 2% of the total stream length, these exclusions are unlikely to affect condition estimates. These weights were used to estimate distribution points for selected variables and extents (e.g., % of stream-length in classes of interest) using the Horvitz-Thompson estimator (Horvitz-Thompson 1952). These estimates were calculated for reporting units of interest, including watersheds, land use classes, and (for trend estimates) years. Confidence intervals (CIs) were based on local neighborhood variance estimators (Stevens and Olsen 2004). All calculations were conducted using the spsurvey package (Kincaid and Olsen 2013) in R version 3.0.3 (R Core Team 2012).

Extent Estimates

When surveys use a probabilistic design, the data they produce can be used to make inferences about the region as a whole, and not just about sampled sites. Therefore, statements about the extent of perennial wadeable streams, or about the average CSCI score in a watershed can be made. Probabilistic surveys provide context about ambient condition, which can be used to compare against sites of interest.

The key benefit of a probabilistic survey is its ability to estimate the true extent of a resource of interest, such as perennial, wadeable streams. Sites sampled under a targeted design provide valuable information about local conditions, but cannot be used to estimate the condition of the region as a whole. Because targeted studies are typically designed to assess known impacts (e.g., downstream of discharges), the sites may be in worse condition than the average site in the region; therefore, estimates of regional condition from targeted sites may be biased.

When sites are sampled according to a probabilistic design, measurements represent not just local conditions, but also reflect conditions of a much larger population. The condition of each probabilistic site therefore contributes to condition estimates of the region as a whole. The weight (i.e., the contribution to regional estimates) of each site varies; sites in large, sparsely sampled regions (e.g., open streams) make a larger contribution to regional estimates than sites in small or densely sampled regions (e.g., agricultural streams).

Results

A total of 760 probabilistic sites were sampled in the South Coast region, of which 515 were sampled by the SMC or affiliated programs (Table S-2). To attain this sample size, 4330 unique sites were evaluated, yielding a rejection rate of 82%. The most common cause for rejecting a site was nonperenniality (75% of rejected sites), followed by physical barriers (9% of rejected sites). Determinations of nonperenniality were made during both office and field reconnaissance. Other causes for rejection (e.g., map errors, inappropriate waterbody types, nonwadeability) were infrequently encountered (≤5% of rejected sites; Table S-3; Figure S-2).

Analysis of rejected sites indicated large differences in the extent of perennial streams by watershed and land use. For example, perennial streams made up 53% of stream-miles in the Los Angeles watershed, but only 6% of the San Jacinto watershed (median watershed extent: 26%). Land-use was strongly associated with perenniality, as 35% of urban stream-length, but 12% of agricultural stream-length and 16% of open stream-length were perennial (Figures S-2, S-3, S-4).

Overall, the survey occurred in a drier than normal period. Rainfall during 2011 was slightly above average, although most other years were well below normal. Notably, the survey occurred shortly after one of the driest years on record (i.e., 2007), when even the rainier weather stations (e.g., Big Bear Lake) reported extremely low precipitation (Figure S-5).

Discussion

Perennial wadeable streams are a small component of the region, and protecting this limited resource may be a high priority for watershed managers, particularly because of their importance to a variety of beneficial uses (such as fisheries, wildlife, and swimming). At the same time, the need to expand attention to nonperennial streams is apparent: A comprehensive assessment of the coastal watersheds of southern California should not exclude the large extent of nonperennial streams. Ongoing research in the region addresses the question of whether the condition indices used in this survey are valid in nonperennial streams. However, it is likely that assessment tools currently available to watershed managers are adequate to include at least some portion of nonperennial streams in future surveys.

The observed extents of perennial streams in urban and agricultural areas are probably elevated by imported water sources (either as wastewater effluent or as runoff). Because nonperennial streams are so extensive in undeveloped areas, it is likely that this survey excludes many of the healthiest, least disturbed streams in the region. Therefore, although this survey provides an unbiased assessment of the perennial portion of southern California streams, extrapolation to the nonperennial portion may lead to incorrect conclusions about the health of the region as a whole.

Climatic trends may have also influenced the extent and location of perennial streams. Frequently, field crews were unable to sample reaches that were historically perennial, suggesting that long-term drought or changes in water management may have converted some perennial streams to nonperennial. The variability of flow regimes in southern California streams has been documented in special studies commissioned by the SMC (e.g., Mazor *et al.* 2014), and this variability underscores the need for a flexible approach towards characterizing stream hydrology.

The widespread conversion of streams from nonperennial to perennial (and vice versa) presents a question about setting appropriate ecological objectives. Should a converted stream be compared to perennial reference streams? Or is it more appropriate to compare them to their historical conditions? This survey used the former approach, although in certain applications, such as setting restoration objectives, different goals may be appropriate.

However objectives are set for streams with altered hydrology, managing flows may be an important tool in supporting their ecological health. The causes of elevated water flows were not investigated in this survey. In major tributaries and mainstems of large rivers, elevated flows may be driven by effluent from treatment plants managed by sanitation districts. In smaller streams, runoff may be an important driver, where flood control agencies manage stream flows. Diversions and groundwater extraction are particularly important in streams in agricultural areas. Therefore, if flow regime management needs to change to support ecological health, coordination among several agencies working under different permits may be required.

Table S-1. Characteristics of each watershed.

Watersheds	Stream Order	Area (km^2)	Total Stream Length (km)	Land Use (%)		
				Open	**Agricultural**	**Urban**
Ventura	6	642	236	68	15	17
Santa Clara	7	4327	1429	81	14	6
Calleguas	5	891	315	28	35	36
Santa Monica Bay	4	1171	200	73	2	25
Los Angeles	5	2160	519	41	1	59
San Gabriel	5	1758	487	50	0	50
Santa Ana River	6	7092	1708	49	15	36
–Lower Santa Ana	6	1253	298	36	10	53
–Middle Santa Ana	6	2135	519	38	14	48
–Upper Santa Ana	5	1721	523	64	12	24
–San Jacinto	4	1984	367	55	24	21
San Juan	4	1019	337	66	5	29
Northern San Diego	6	3640	1055	58	28	14
Central San Diego	5	1725	430	38	12	51
Mission Bay–San Diego River	5	1270	322	64	4	32
Southern San Diego	5	2355	535	80	6	14
Entire Region	7	28051	7574	59	13	28

Table S-2. Probabilistic surveys included in the study. Note that the SMC program includes sites sampled under nested programs that used the same master sample draw, such as the San Gabriel River Regional Monitoring Program, the Los Angeles Watershed Monitoring Program, and Region 4 Probabilistic Sampling; sites from these surveys were included only if they were part of the SMC's target population of second-order or higher perennial, wadeable streams.

Survey	Years	Sites
Environmental Monitoring and Assessment Program (EMAP)	2000 to 2003	42
California Monitoring and Assessment Program (CMAP)	2004 to 2007	12
National Rivers and Streams Assessment (NRSA)	2009 and 2013	1
Perennial Streams Assessment (PSA)	2008	11
Stormwater Monitoring Coalition (SMC)	2008 through 2013	515
Region 8 Trend Monitoring (R8T)	2006 through 2013	102

Table S-3. Extent (in percent stream-miles) of perennial and non-perennial streams by subpopulation.

Subpopulation	Perennial, sampled (n sampled)	Perennial, not sampled	Rejected		
			Nonperennial	Physical Barrier	Other
South Coast	20.7 (682)	2.3	58.5	10.0	8.4
Land Use					
Agricultural	11.9 (92)	4.0	70.7	1.2	12.3
Open	15.9 (306)	1.4	61.1	16.3	5.3
Urban	35.3 (284)	3.4	47.2	0.8	13.4
Watershed					
Region 4					
Ventura	25.3 (37)	0.8	62.6	7.1	4.3
Santa Clara	16.2 (94)	2.1	55.2	24.0	2.6
Calleguas	30.2 (38)	6.0	48.2	3.0	12.6
Santa Monica Bay	23.6 (72)	2.1	52.7	9.6	11.9
Los Angeles	47.1 (44)	5.6	25.3	13.2	8.8
San Gabriel	43.7 (39)	1.1	23.0	16.6	15.5
Region 8					
Lower Santa Ana	16.3 (45)	3.1	46.6	8.2	25.8
Middle Santa Ana	13.1 (57)	4.0	61.3	4.7	16.9
Upper Santa Ana	25.1 (67)	2.8	44.6	22.2	5.3
San Jacinto	5.3 (28)	0.7	77.5	8.6	7.9
Region 9					
San Juan	27.5 (30)	1.0	68.0	1.1	2.5
Northern San Diego	7.1 (36)	0.7	81.0	1.5	9.6
Central San Diego	37.1 (35)	3.1	54.3	0.5	5.2
Mission Bay and San Diego River	14.5 (29)	2.8	74.6	1.3	6.8
Southern San Diego	8.3 (31)	0.8	83.7	0.8	6.3

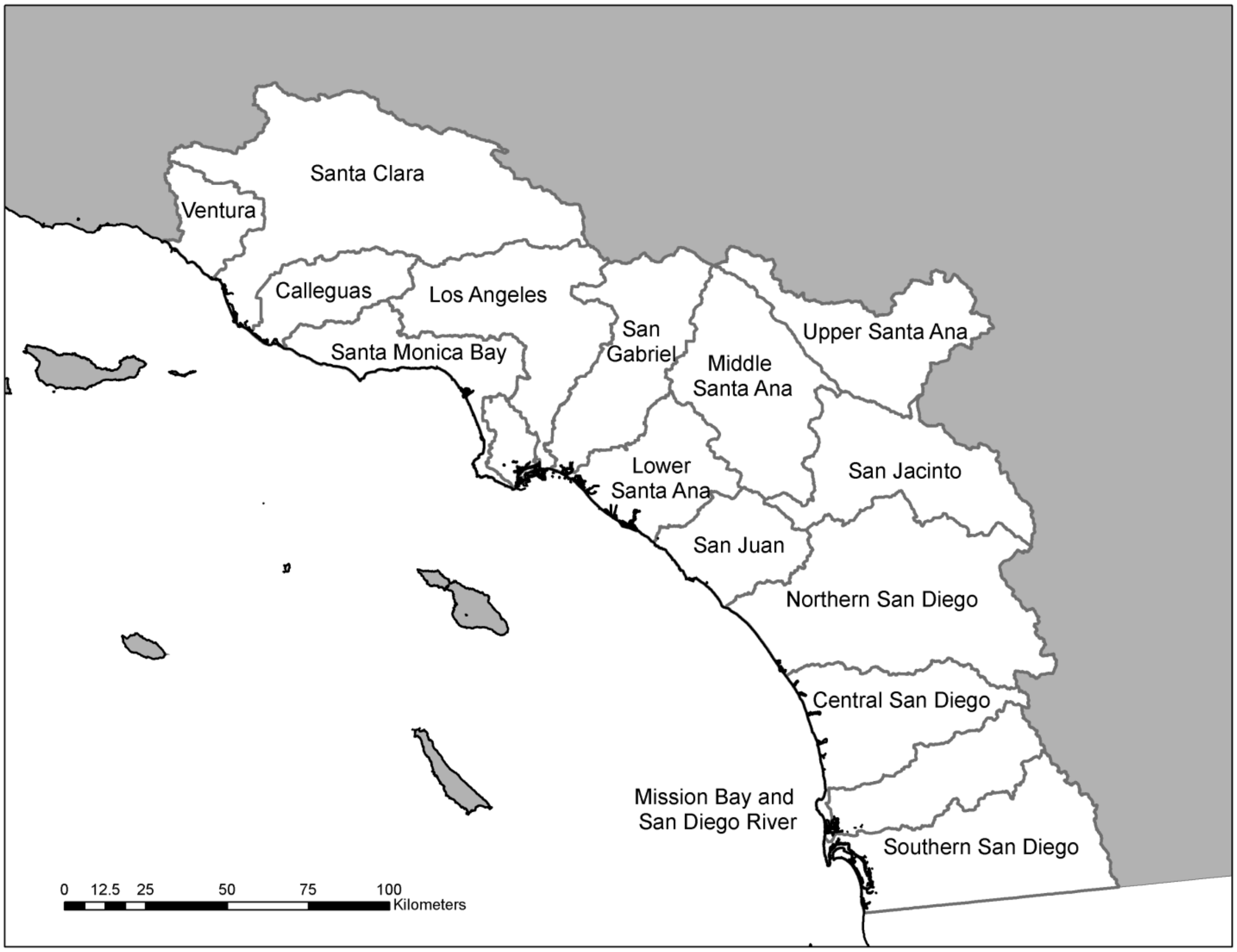


Figure S-1. Major watersheds in the South Coast survey area.

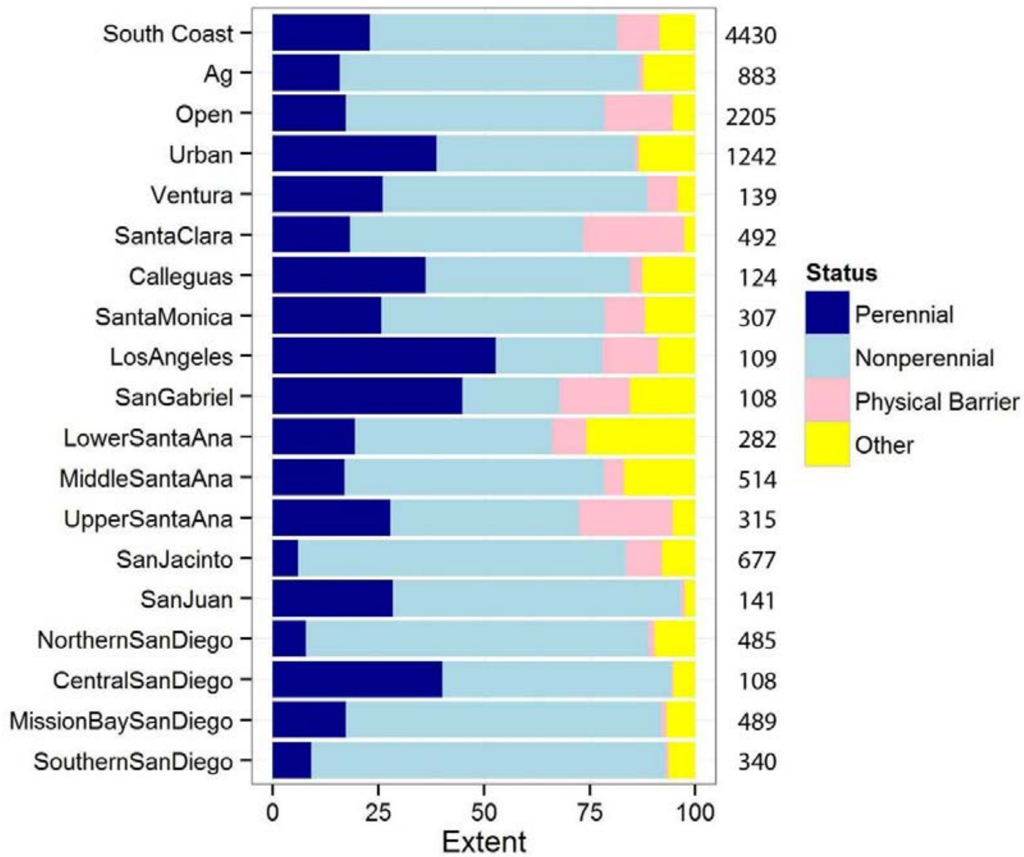


Figure S-2. Site evaluation results by watershed or land use. Numbers to the right of each bar represent the total number of sites evaluated for inclusion in the SMC and other survey.

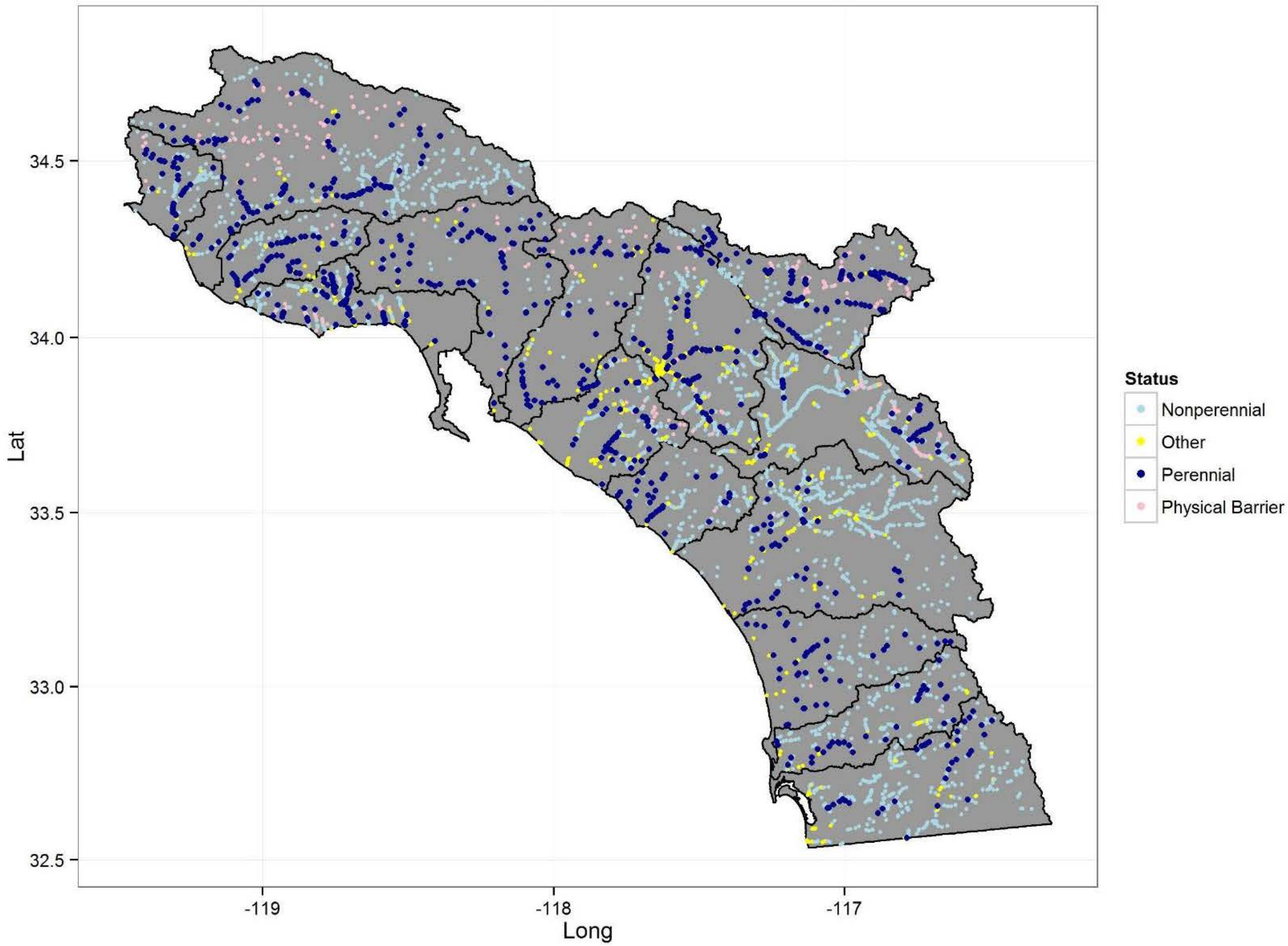


Figure S-3. Map of site evaluation results.

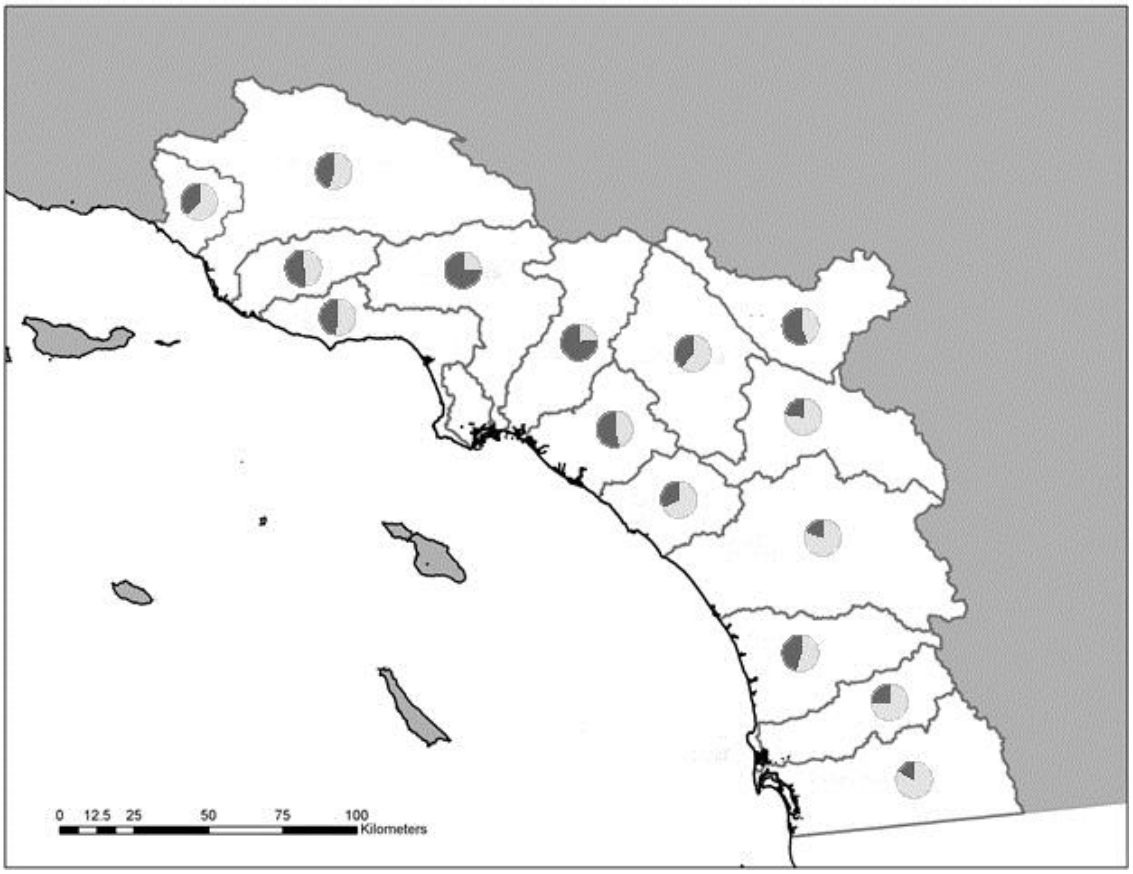


Figure S-4. Percent of nonperennial stream-miles (shown in light gray) for each watershed.

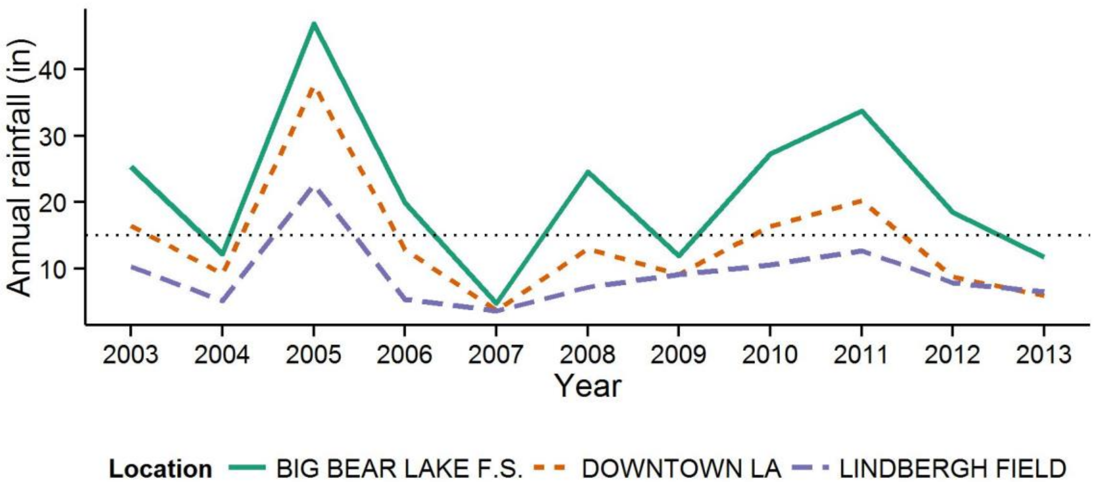


Figure S-5. Annual precipitation at three weather stations in the South Coast. The horizontal line reflects the average for downtown Los Angeles between 1877 and 2012.

QUESTION 1: WHAT IS THE BIOLOGICAL CONDITION OF PERENNIAL STREAMS IN THE SOUTH COAST REGION?

Healthy perennial streams, like this site on the North Fork of the San Jacinto River, are a scarce resource in the South Coast region.

Introduction

Surveys of ambient biological condition provide essential context for watershed management. At larger geographic scales, ambient surveys allow watershed managers to identify regional priorities. At local scales, ambient surveys allow managers to compare sites of interest to typical ranges in the region. This context informs decisions about which sites need protection or rehabilitation.

The biological condition of perennial streams was assessed by sampling four key biological indicators (i.e., benthic macroinvertebrates, diatoms, soft algae, and CRAM) at sites throughout the region, and comparing them to thresholds benchmarked to the distribution of scores at reference sites. These biological indicators provide a direct measurement of ecological health, and are an effective tool to determine if streams are supporting aquatic life or other beneficial uses. Additionally, their ability to integrate multiple stressors across both time and space make them a superior measure of biological condition to direct measures of stressors.

Methods

Data Collection

Data were collected as described in the Survey Overview.

Data Aggregation

Where multiple biological samples were collected at a single site within a year, data were aggregated as the maximum value within a site (with the assumption that index scores may be spuriously low, but not spuriously high). Multi-year mean values for each site were then calculated from these aggregated values if sites were revisited in multiple years. Missing values were ignored for all relevant analyses, where appropriate.

Thresholds

Biological indicators were compared to the 30th, 10th, and 1st percentile of reference sites (Table 1-1); these percentiles correspond to different probabilities that a score is from a site in reference condition. This approach creates four biological condition-classes that may be interpreted as indicating a stream's biology is likely intact (Class 1), possibly altered (Class 2), likely altered (Class 3), and very likely altered (Class 4). These percentiles were selected to reflect a range of conditions. Because this approach is consistent across indicators, it is possible to compare results from one index to another. Means and standard deviations were from published sources (CSCI: Mazor et al. In review; algae IBIs: Fetscher *et al.* 2014) or unpublished data (CRAM). Each threshold has an associated error rate; for example, 10% of reference sites are in Class 3 or 4, despite the fact that they are, by definition, intact.

Integrating Multiple Indicators

In order to determine a stream's overall condition, the four biological indicators were evaluated together to provide a comprehensive assessment of ecological health. To be considered intact for multiple indicators, all four indicators need to suggest that a stream is in reference condition. A single indicator below this threshold suggests that a stream is not in reference condition. To maintain an overall error rate of 10%, a site had to have scores above the 2.5th percentile of reference sites for each indicator (Table 1-1).

Weighted Magnitudes and Extent Estimates

Adjusted sample weights were calculated for each site. Because multiple surveys with different designs were included in analysis, weights needed to be recalculated for each site. Stratification approaches from all surveys were combined to create "cross-strata" in which all evaluated sites have an equal probability of being sampled. Adjusted weights were recalculated as the total stream length within each strata, divided by the number of sites evaluated in that stratum. Strata with no evaluations were excluded from analysis. Because these strata comprised less than 2% of the total stream length, these exclusions are unlikely to affect condition estimates. These weights were used to estimate distribution points for selected variables and extents for selected categories using the Horvitz-Thompson estimator (Horvitz-Thompson 1952). These estimates were calculated for reporting units of interest, including watersheds, land use classes, and (for trend estimates) years. Confidence intervals (CIs) were based on local neighborhood variance estimators (Stevens and Olsen 2004). All calculations were conducted using the spsurvey package (Kincaid and Olsen 2013) in R version 3.0.3 (R Core Team 2012).

Results

All data used in this report can be downloaded from
ftp.sccwrp.org/pub/download/SMCReport/SMCDataFor5yearReport.zip.

Benthic Macroinvertebrates

Biological indicators suggested that most stream-kilometers in the survey's target population (i.e., perennial wadeable streams in southern coastal California) do not support healthy biology (Table 1-2a to c; Figures 1-1 and 1-2). For example, the mean CSCI score for the region was 0.77 and only 29% of stream-miles were in the top biological condition class for this indicator. Of the two components of the CSCI, the pMMI (which measures ecological structure) was more sensitive; the pMMI indicated that only 22% of South Coast stream-miles were in Class 1, whereas the O/E (which measures taxonomic completeness) indicated 46% were in Class 1.

The CSCI indicated that open streams were in better condition than agricultural streams, which were in turn better than urban streams. In fact, at open sites, mean CSCI scores were close to reference (i.e., 0.93), and only 5% of open stream-miles was in Class 4 (i.e., the worst condition class). In contrast, 31% of agricultural streams and 58% of urban streams were in Class 4.

Although this ranking of land use classes was evident with both components of the CSCI, the O/E generally categorized agricultural streams as intermediate between open and urban classes, whereas the difference was small when examined with the pMMI.

The watersheds with the greatest proportion of streams in Class 1 were located, roughly, in the northern and southern ends of the region, while the middle portions of the region had streams in poorer health. For example, the greatest extent of Class 1 stream-miles was located in the Ventura watershed (68%), followed by Southern San Diego (65%). These watersheds, along with the Santa Clara, all had mean CSCI scores greater than 0.9. The smallest extents of Class 1 stream-miles were observed in the Calleguas (9%), Central San Diego (10%), Lower Santa Ana (11%) and Middle Santa Ana (11%) watersheds.

Benthic Algae

In general, the algae indices showed similar patterns of regional stream condition as the CSCI (Table 1-2d and e; Figures 1-1 and 1-2). For example, the diatom index (D18) showed that 27% of stream-miles were in Class 1, while the soft algae index (S2) showed that 25% were in this class; these numbers are only slightly less than the estimate for the CSCI (i.e., 29%).

In contrast with the CSCI, algae-based indices only weakly differentiated between urban and agricultural streams, and estimated both to be in far worse condition than open streams. For example, D18 rarely identified developed streams as Class 1 (Agricultural: 11%; Urban: 2%). Uniquely, S2 scores were generally lower at agricultural streams (mean: 26) than urban streams (mean: 32). In contrast, mean D18 scores were similar in both urban (43) and agricultural (45) streams.

Although there were some differences among the two algae indices, they both showed that the watersheds in the northern portions of the region had the greatest extent of streams in Class 1. For example, D18 indicated the greatest extent of streams in Class 1 in the Ventura (84%) and Upper Santa Ana (63%,) watersheds, whereas S2 indicated the greatest extent of stream-miles in Class 1 in the Upper Santa Ana (47%) and Santa Clara (46%) watersheds. Depending on the index used, Class 1 streams were rarely or never observed in the Calleguas, Santa Monica Bay, Lower Santa Ana, San Juan, and Central San Diego watersheds.

Riparian Condition

Most streams in southern California did not support healthy riparian communities, as only 30% of stream-miles in the region had CRAM scores in the top condition class (i.e., a CRAM score ≥ 79), and the mean CRAM score (64) was much lower than the reference mean (i.e., 84). However, the extent of stream-miles in Class 1 was greater for individual attributes (e.g., 40% for the landscape and buffer attribute), indicating that different attributes limit overall riparian condition at different sites (Table 1-2f; Figures 1-1 and 1-2).

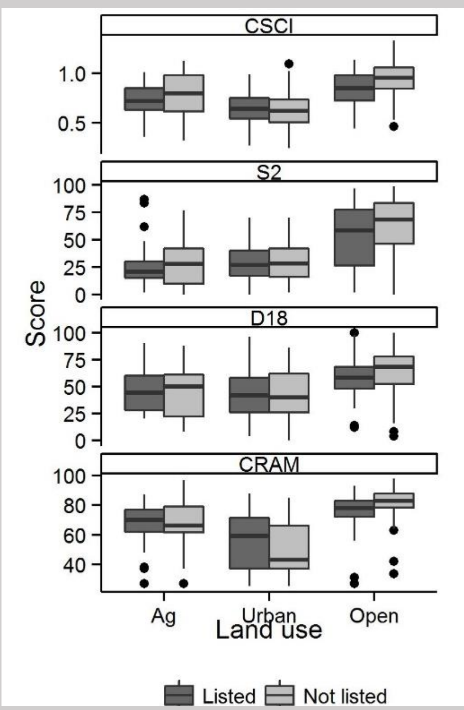
Land use was strongly associated with CRAM scores, even more so than with other indicators. For example, Class 1 CRAM scores were observed at 65% of open stream-miles (mean: 81), but only 20% of agricultural streams (mean: 68) and 7% of urban stream-miles (mean: 51). This contrast was particularly strong at the attribute level (especially the buffer and landscape attribute). For example, hydrologic conditions were in the top class at 57% of open stream-miles, but only 17% of agricultural stream-miles and 17% of urban stream-miles.

Class 1 riparian conditions were observed at the majority of stream-miles within five watersheds that were geographically dispersed across the region, with the greatest extents in the San Jacinto (63%) and Northern San Diego (57%) watersheds, followed by Ventura (54%) and Southern San Diego (52%). Streams with Class 1 riparian condition were scarce in the Calleguas (3%) and Los Angeles (14%) watersheds. Across the four attributes, four watersheds ranked among the worst in terms of the extent of streams in Class 4: Los Angeles, San Gabriel, Lower Santa Ana and Middle Santa Ana. All attributes were in the worst condition class for at least 50% of these watersheds (Table 1-2g to j) with the exception of the biotic structure attribute in the Lower Santa Ana (36% in Class 4).

303(d)-Listed Streams

The State Water Resources Control Board has designated approximately 2000 stream-kilometers in southern California as impaired for water quality pursuant to Section 303(d) of the Clean Water Act. Streams are usually listed as “impaired” due to exceedances of a chemical water quality standard. The potential relationship between designated impairments and instream biological condition was evaluated by comparing biological index scores from streams listed as impaired to streams from comparable land use categories that are not listed. Listed streams were obtained from the State Water Board 303(d) list; in Ventura and Riverside counties, agency staff modified this list by reclassifying listings believed to be unrelated to aquatic life uses (e.g., bacteria) as “not listed” for this analysis.

Land use was more strongly associated with scores than with status on the 303(d) list. For example, scores at urban and agricultural sites were lower than scores at open sites, whether or not the sites were included on the 303(d) list. There was no significant difference in scores between listed and unlisted streams at urban or agricultural sites. Scores at open listed sites were slightly lower than at open unlisted sites; however, this difference was small, and the proportion of Class 3 or 4 sites was no greater at open listed sites than open unlisted sites.



Index scores based on benthic macroinvertebrates (CSCI), soft algae (S2), diatoms (D18) and riparian condition (CRAM) for 303(d)-listed and unlisted streams, by land use.

Condition of Engineered Channels: Exploring options for alternative thresholds

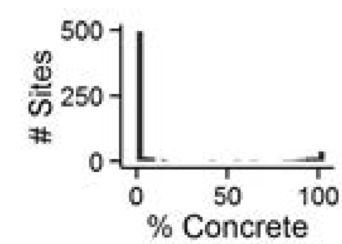
Many of the streams in this survey have been engineered to some degree for flood management purposes, and these engineered features may constrain biological condition. Therefore, we estimated the biological condition of streams with engineered channels relative to those with natural channels. The best condition observed in engineered channels may be a more realistic threshold than a reference-based threshold, assuming that the effects of channel engineering cannot be mitigated. If the best observed condition in engineered channels is substantially below a reference-based threshold, an alternative threshold may be appropriate.

Because consistently derived region-wide maps identifying the location of engineered channels are not available, habitat data was used to classify streams as likely concrete-lined (i.e., at least 5% concrete in the streambed), or likely non-concrete lined (i.e., less than 5% concrete in the streambed). This approach overlooks forms of engineered channels that do not use concrete, such as ungrouted rock, while also misclassifying streams affected by other types of concrete structures, such as road crossings. It also ignores the substantial variation of channel forms in engineered systems, which may affect biological condition. But despite these shortcomings, this approach represents a useful starting point until better data are available about engineered channels.

Overall, approximately 26% of perennial stream-miles were estimated to be concrete-lined. About half of urban streams were concrete lined and 13% of agricultural streams, but only 2% of open streams. Concrete-lined streams comprised a majority of stream-miles in the Los Angeles and San Gabriel watersheds, but none were sampled in the Northern and Southern San Diego watersheds.

Extent of concrete channels in southern California

Subpopulation	Concrete-Lined Channels	
	# sites	% stream-miles
South Coast	130	26
Land use		
Urban	107	53
Open	10	2
Agricultural	13	13
Watershed		
Los Angeles Region		
Ventura	2	4
Santa Clara	3	3
Calleguas	12	29
Santa Monica Bay	13	19
Los Angeles	22	51
San Gabriel	23	69
Santa Ana Region		
Lower Santa Ana	11	26
Middle Santa Ana	22	41
Upper Santa Ana	1	2
San Jacinto	5	19
Northern San Diego		
San Juan	6	24
Northern San Diego	0	0
Mission Bay and San Diego River	6	24
Central San Diego	4	14
Southern San Diego	0	0



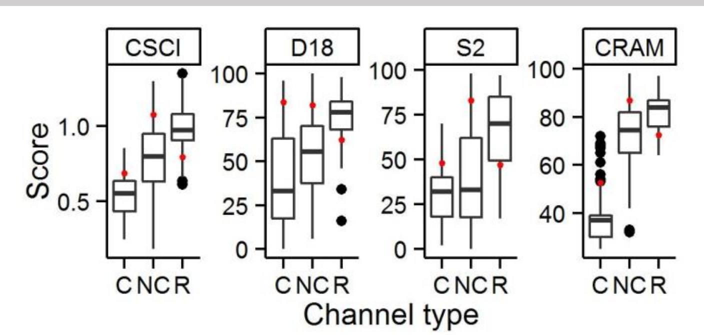
% concrete substrate at each sampled site. Concrete was absent from most sites, but comprised nearly 100% for a small handful of sites. Intermediate values were rarely observed.

Condition of Engineered Channels (Continued)

To investigate the constraints concrete lining imposes on biological condition, sites were divided into three classes: concrete-lined, no concrete, and reference. The range of index scores within each class was examined by creating boxplots. For indices where the 90th percentile of concrete-lined channels is less than the 10th percentile of reference streams, lower thresholds may be appropriate.

In general, scores of all indices were lower in concrete-lined channels than in reference streams, suggesting that these streams were typically in poor condition. For most indices the highest scores in concrete-lined channels were lower than lowest scores observed at reference sites (estimated at the 90th and 10th percentiles, respectively). For example, the 90th percentile of CSCI scores was 0.69 (i.e., "Class 3"), suggesting that an alternative threshold may reflect a more attainable management objective than the 10th percentile of reference sites. Additional data and analyses (particularly on channel type) are needed if alternative thresholds for concrete-lined channels are used for regulatory purposes.

In contrast, this analysis did not support alternative thresholds for algae indices. High scores were frequently observed in concrete-lined channels. In fact, the 90th percentile of D18 scores in concrete-lined channels was 84, which is substantially higher than the threshold based on the 10th percentile of reference sites (i.e., 62). Therefore, it is probable that low D18 and S2 scores in concrete-lined channels are attributable to impacts not directly related to channelization, and may instead be related to water quality impacts.



Distribution of scores at concrete-lined channels (C), nonconcrete-lined channels (NC), and reference streams (R). The red dot represents the 90th percentile of scores of concrete- and nonconcrete-lined channels and the 10th percentile of reference streams.

Options for setting thresholds in concrete-lined channels. A traditional approach is based on the distribution of scores at reference sites, whereas an alternative approach is based on the distribution of scores at concrete-lined channels. These numbers reflect preliminary analyses.

Index	Option 1: Threshold based on reference	Option 2: Threshold based on concrete-lined channels
CSCI	0.79	0.68
D18	62	84
S2	47	48
CRAM	72	53

Multiple indicators

Only 25% of streams-miles in the region were intact for all four indices, and these conditions were almost exclusively observed at streams with undeveloped watersheds (Table 1-3, Figures 1-3 and 1-4). Overall, 60% of open stream-miles were in this category. Streams with index scores above the multi thresholds were absent from the Calleguas watershed and scarce in Santa Monica Bay, Los Angeles, Middle Santa Ana, and Central San Diego watersheds. In contrast, a majority of stream-miles were intact for multiple indicators in the Upper Santa Ana (62%), Southern San Diego (61%), San Jacinto (53%) and Ventura (50%) watersheds.

Most commonly, streams were limited (i.e., below the "multi" threshold) for multiple indicators, and all four indicators were identified as limiting for 15% of stream-miles region-wide (Table 1-3; Figures 1-3 and 1-4). More than a quarter of stream-miles were limited for all indicators in certain watersheds (specifically, Calleguas, Los Angeles, Lower Santa Ana, and San Jacinto watersheds) and in urban streams, but this situation was rare in other watersheds (specifically, Ventura, Upper Santa Ana, Northern San Diego, and Mission Bay and San Diego watersheds), and in open streams. Streams limited for single indicators were more extensive in these open streams, and algae indices (D18, S2, or both) were most commonly the only limiting indicator. For example, 41% of stream-miles in the Northern San Diego and 37% in the Ventura watersheds were limited for D18 or S2, but not CRAM or CSCI.

Discussion

The scarcity of streams with intact biology may prompt managers to evaluate ways to protect these streams, or improve the condition of streams where indicators suggest altered biological condition. The emphasis may vary from protection in one part of the region to rehabilitation in another, depending on local needs and interests. However, many watershed managers in southern California would benefit from a coordinated approach towards prioritizing local objectives, given the extent of streams with altered biology. Uncoordinated efforts to address pervasive challenges have historically met with little success (Bernstein and Schiff 2002).

Multiple indicators proved valuable for several reasons. 1) Redundancy improves precision and guards against incorrect conclusions from sampling error or natural variability. 2) The different life histories of each indicator provided a broader assessment of ecosystem function. 3) The unique properties of the indices increase overall sensitivity to different stressors. 4) The different responsiveness of the indices allows better discrimination among condition-classes along the biological condition gradient.

The identification of "limiting indicators" may provide initial steps towards diagnosing stressors or prioritizing sites for rehabilitation. The fact that so many streams were limited for multiple indicators (frequently all four indicators used in the survey) suggests that pressures on many streams are diverse, severe, or both, and fixing these streams may be major challenge. But 19% of the region was limited for a single indicator, and this may indicate that pressures are less severe or more similar in action; rehabilitating these streams may be a more surmountable challenge than streams with fewer indicators in intact condition.

Table 1-1. Thresholds for identifying non-reference condition for biological indicators. Ref mean: Mean of reference sites. Ref SD: Standard deviation of reference sites. Numbers in parentheses refer to the percentiles used to set boundaries between classes. "Multi" refers to the threshold used in multiple-indicator analyses (i.e., the 2.5th percentile); samples with scores above all "multi" thresholds are considered to be in reference condition, with a 10% error rate.

Index	Ref N	Ref mean	Ref SD	Class 1 (≥30th Intact)	Class 2 (10th to 30th)	Class 3 (1st to 10th)	Class 4 (<1st Altered)	Multi
Benthic Macroinvertebrates								
CSCI	479	1.00	0.16	≥0.92	0.79 to 0.92	0.63 to 0.79	□0.63	0.69
-pMMI	479	1.00	0.18	≥0.91	0.77 to 0.91	0.58 to 0.77	□0.58	--
-OE	479	1.00	0.19	≥0.90	0.76 to 0.90	0.56 to 0.76	□0.56	--
Benthic Algae								
D18	122	79	13	≥72	62 to 72	49 to 62	□49	54
S2	122	69	17	≥60	47 to 60	29 to 47	□29	69
CRAM								
Overall Score	86	84	9	≥79	72 to 79	63 to 72	□63	66
Buffer and Landscape	86	95	10	≥90	82 to 90	72 to 82	□72	--
Hydrologic Connectivity	86	81	13	≥74	64 to 74	51 to 64	□51	--
Physical Structure	86	81	16	≥73	60 to 73	44 to 60	□44	--
Biotic Structure	86	75	16	≥67	54 to 67	38 to 54	□38	--

Table 1-2a: Mean CSCI scores and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	682	0.76	0.24	29	16	23	31
Land Use							
Agricultural	92	0.74	0.19	20	17	31	31
Open	306	0.93	0.17	59	21	15	5
Urban	284	0.59	0.16	2	11	30	58
Watershed							
Region 4							
Ventura	37	0.95	0.15	68	17	15	0
Santa Clara	94	0.91	0.21	54	20	15	11
Calleguas	38	0.65	0.15	9	3	38	49
Santa Monica Bay	72	0.70	0.20	18	9	31	43
Los Angeles	44	0.70	0.23	15	23	29	33
San Gabriel	39	0.62	0.25	17	11	15	57
Region 8							
Lower Santa Ana	45	0.59	0.21	11	14	10	65
Middle Santa Ana	57	0.64	0.23	11	16	30	43
Upper Santa Ana	67	0.88	0.20	49	16	26	10
San Jacinto	28	0.72	0.19	14	24	31	31
Region 9							
San Juan	30	0.72	0.18	15	20	27	38
Northern San Diego	36	0.83	0.19	55	11	13	21
Central San Diego	35	0.72	0.17	10	17	37	35
Mission Bay and San Diego	29	0.78	0.27	33	9	25	33
Southern San Diego	31	0.91	0.16	65	19	5	11

Table 1-2b. Mean pMMI scores and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	682	0.68	0.25	22	10	24	44
Land Use							
Agricultural	92	0.62	0.17	4	16	36	45
Open	306	0.87	0.20	47	19	27	7
Urban	284	0.49	0.12	0	1	18	81
Watershed							
Region 4							
Ventura	37	0.83	0.22	32	26	27	15
Santa Clara	94	0.86	0.22	49	16	25	11
Calleguas	38	0.54	0.09	0	0	32	68
Santa Monica Bay	72	0.64	0.19	13	13	24	50
Los Angeles	44	0.61	0.23	10	1	35	53
San Gabriel	39	0.57	0.25	15	9	6	70
Region 8							
Lower Santa Ana	45	0.50	0.18	0	12	19	68
Middle Santa Ana	57	0.59	0.21	9	9	24	58
Upper Santa Ana	67	0.86	0.23	39	19	34	8
San Jacinto	28	0.62	0.19	12	10	27	51
Region 9							
San Juan	30	0.56	0.22	13	4	6	76
Northern San Diego	36	0.72	0.21	32	14	21	33
Central San Diego	35	0.60	0.18	10	2	34	54
Mission Bay and San Diego	29	0.72	0.27	27	10	11	52
Southern San Diego	31	0.81	0.19	41	33	9	18

Table 1-2c. Mean O/E scores and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	682	0.85	0.27	46	20	17	18
Land Use							
Agricultural	92	0.86	0.24	47	14	29	10
Open	306	1.00	0.21	71	18	7	4
Urban	284	0.69	0.23	20	23	24	33
Watershed							
Region 4							
Ventura	37	1.09	0.15	94	3	3	0
Santa Clara	94	0.96	0.23	67	15	11	6
Calleguas	38	0.76	0.23	21	20	45	15
Santa Monica Bay	72	0.77	0.24	28	20	35	17
Los Angeles	44	0.80	0.27	31	36	5	28
San Gabriel	39	0.68	0.28	19	25	17	39
Region 8							
Lower Santa Ana	45	0.68	0.27	22	15	32	31
Middle Santa Ana	57	0.70	0.29	28	17	21	34
Upper Santa Ana	67	0.91	0.26	60	15	8	17
San Jacinto	28	0.82	0.27	46	11	24	19
Region 9							
San Juan	30	0.87	0.18	42	33	18	7
Northern San Diego	36	0.96	0.24	70	7	17	6
Central San Diego	35	0.83	0.23	51	10	21	17
Mission Bay and San Diego	29	0.85	0.28	38	29	19	15
Southern San Diego	31	1.01	0.18	75	14	11	0

Table 1-2d. Mean D18 and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	525	53	25	27	13	18	42
Land Use							
Agricultural	70	45	23	11	15	27	47
Open	221	67	21	47	19	16	18
Urban	234	43	24	12	9	18	62
Watershed							
Region 4							
Ventura	35	79	11	84	11	4	2
Santa Clara	63	59	18	28	16	31	25
Calleguas	38	34	16	0	1	19	80
Santa Monica Bay	54	45	18	3	12	36	48
Los Angeles	40	41	26	15	13	12	60
San Gabriel	32	69	23	52	9	19	21
Region 8							
Lower Santa Ana	33	39	23	3	19	12	66
Middle Santa Ana	30	63	25	41	17	14	28
Upper Santa Ana	27	72	23	63	14	7	16
San Jacinto	21	58	25	24	37	10	29
Region 9							
San Juan	30	41	25	10	16	17	57
Northern San Diego	33	58	19	30	23	17	30
Central San Diego	29	46	23	16	8	14	62
Mission Bay and San Diego	30	56	27	28	18	17	37
Southern San Diego	30	58	22	21	32	19	28

Table 1-2e. Mean S2 scores and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	524	44	25	25	16	27	32
Land Use							
Agricultural	71	26	18	5	6	27	61
Open	217	62	24	59	13	15	12
Urban	236	32	16	2	19	35	43
Watershed							
Region 4							
Ventura	36	49	25	39	4	33	24
Santa Clara	60	58	27	46	16	23	15
Calleguas	38	26	15	0	13	28	59
Santa Monica Bay	54	37	24	20	19	15	46
Los Angeles	41	41	20	21	11	35	33
San Gabriel	32	49	21	26	23	27	24
Region 8							
Lower Santa Ana	33	32	22	11	10	26	53
Middle Santa Ana	30	36	16	8	13	46	33
Upper Santa Ana	26	53	28	47	10	19	23
San Jacinto	21	54	24	51	10	21	19
Region 9							
San Juan	30	45	29	27	6	35	32
Northern San Diego	33	45	26	36	15	12	37
Central San Diego	30	33	19	4	31	22	43
Mission Bay and San Diego	30	49	31	39	11	22	29
Southern San Diego	30	57	27	41	21	21	17

Table 1-2f. Mean CRAM and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	529	64	21	30	13	16	41
Land Use							
Agricultural	77	68	15	20	19	29	32
Open	203	81	10	65	20	12	2
Urban	249	51	18	7	7	16	70
Watershed							
Region 4							
Ventura	32	79	9	54	19	25	2
Santa Clara	69	76	11	48	24	16	12
Calleguas	31	57	18	3	22	17	59
Santa Monica Bay	67	64	19	25	15	22	38
Los Angeles	41	50	19	14	4	16	66
San Gabriel	37	52	22	24	6	2	68
Region 8							
Lower Santa Ana	33	56	18	11	12	20	57
Middle Santa Ana	29	52	23	24	6	4	67
Upper Santa Ana	23	74	10	34	19	30	17
San Jacinto	18	79	13	63	10	10	16
Region 9							
San Juan	31	66	21	38	6	11	45
Northern San Diego	31	81	10	57	19	21	4
Central San Diego	29	63	17	17	14	28	41
Mission Bay and San Diego	30	70	21	50	13	13	25
Southern San Diego	28	76	15	52	19	13	16

Table 1-2g. Mean CRAM Buffer and Landscape attribute scores and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	529	75	24	40	10	11	39
Land Use							
Agricultural	77	81	18	44	13	21	21
Open	203	92	13	81	12	4	4
Urban	249	62	22	10	8	14	67
Watershed							
Region 4							
Ventura	32	91	12	71	16	11	2
Santa Clara	69	91	12	70	13	10	7
Calleguas	31	65	21	7	15	27	52
Santa Monica Bay	67	72	26	38	8	21	34
Los Angeles	41	67	23	26	9	5	61
San Gabriel	37	68	21	27	5	0	68
Region 8							
Lower Santa Ana	33	59	26	11	12	14	62
Middle Santa Ana	29	53	28	16	0	14	69
Upper Santa Ana	23	86	23	69	8	0	23
San Jacinto	18	79	23	43	13	16	27
Region 9							
San Juan	31	71	24	33	6	10	52
Northern San Diego	31	93	8	74	12	12	2
Central San Diego	29	71	24	29	13	26	31
Mission Bay and San Diego	30	77	24	50	8	7	35
Southern San Diego	28	87	21	67	11	10	12

Table 1-2h. Mean CRAM Hydrologic structure attribute scores and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	529	63	21	25	18	24	33
Land Use							
Agricultural	77	66	15	17	28	34	22
Open	203	81	15	57	22	18	3
Urban	249	51	17	4	15	26	55
Watershed							
Region 4							
Ventura	32	80	15	52	26	19	4
Santa Clara	69	74	13	35	30	28	7
Calleguas	31	54	16	8	9	32	51
Santa Monica Bay	67	63	17	25	16	30	30
Los Angeles	41	52	22	20	6	22	52
San Gabriel	37	53	24	22	8	9	61
Region 8							
Lower Santa Ana	33	53	20	12	6	28	53
Middle Santa Ana	29	50	20	11	6	26	57
Upper Santa Ana	23	75	19	48	12	31	10
San Jacinto	18	76	22	58	19	0	23
Region 9							
San Juan	31	65	21	18	30	17	35
Northern San Diego	31	79	15	44	28	25	2
Central San Diego	29	65	15	12	28	41	19
Mission Bay and San Diego	30	69	19	30	28	20	22
Southern San Diego	28	78	16	46	25	22	7

Table 1-2i. Mean CRAM Physical structure attribute scores and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	529	56	25	38	12	15	35
Land Use							
Agricultural	77	59	20	32	23	20	25
Open	203	75	17	71	14	10	4
Urban	249	43	22	16	9	17	58
Watershed							
Region 4							
Ventura	32	76	21	65	15	16	4
Santa Clara	69	73	17	60	22	13	5
Calleguas	31	52	25	31	7	21	41
Santa Monica Bay	67	63	22	46	23	13	19
Los Angeles	41	39	20	17	1	18	64
San Gabriel	37	44	26	21	13	2	64
Region 8							
Lower Santa Ana	33	49	26	29	10	5	56
Middle Santa Ana	29	40	22	18	2	17	63
Upper Santa Ana	23	55	18	22	26	32	20
San Jacinto	18	59	22	50	0	24	26
Region 9							
San Juan	31	66	25	58	5	15	22
Northern San Diego	31	71	16	63	21	8	9
Central San Diego	29	55	20	28	11	29	32
Mission Bay and San Diego	30	64	24	50	23	2	25
Southern San Diego	28	67	17	63	10	17	10

Table 1-2j. Mean CRAM Biotic structure attribute scores and extent estimates for each condition class. n: number of sites used in the analysis. SD: Standard deviation. Class 1: % of streams with scores above the 30% percentile of reference sites. Class 2: % of streams with scores between the 10th and 30th percentiles of reference sites. Class 3: % of streams with scores between the 1st and 10th percentiles of reference sites. Class 4: % of streams with scores below the 1st percentile of reference sites.

Subpopulation	n	Mean	SD	Class 1	Class 2	Class 3	Class 4
South Coast	529	57	24	42	17	11	30
Land Use							
Agricultural	77	63	19	46	27	13	13
Open	203	72	17	69	19	8	4
Urban	249	45	22	22	15	13	50
Watershed							
Region 4							
Ventura	32	66	12	50	29	18	2
Santa Clara	69	66	16	53	24	17	6
Calleguas	31	55	20	35	30	7	28
Santa Monica Bay	67	59	19	42	28	14	16
Los Angeles	41	41	22	19	14	6	61
San Gabriel	37	42	24	24	6	9	62
Region 8							
Lower Santa Ana	33	51	23	33	8	23	36
Middle Santa Ana	29	43	26	21	13	10	56
Upper Santa Ana	23	58	24	38	25	16	22
San Jacinto	18	75	21	73	12	4	11
Region 9							
San Juan	31	63	23	52	7	16	26
Northern San Diego	31	81	13	84	14	2	0
Central San Diego	29	62	19	41	32	15	13
Mission Bay and San Diego	30	69	23	74	4	0	22
Southern San Diego	28	70	16	70	16	6	8

Table 1-3. Percent of stream-miles intact for multiple indicators, or limiting for specific indicators, for each subpopulation. Note that, in contrast to Table 1-2, these results are based on an adjusted "multi" threshold in Table 1-1, which reduces the error associated with multiple comparisons. CI: Confidence interval.

Subpopulation	n	% Intact			Indicators of Poor Condition						
		Estimate	95% CI		CSCI Alone	D18 Alone	S2 Alone	D18 or S2	All Benthic Indicators	CRAM Alone	All Four Indicators
South Coast	453	25	21	28	2	6	7	18	4	3	15
Land Use											
Agricultural	66	9	4	15	1	6	15	29	6	3	22
Open	172	60	51	68	4	11	10	25	1	6	0
Urban	215	2	0	4	1	3	4	10	6	0	25
Watershed											
Region 4											
Ventura	31	50	31	69	9	5	32	37	0	0	0
Santa Clara	51	43	30	55	5	17	6	25	1	3	7
Calleguas	30	0	0	0	0	0	12	29	11	0	32
Santa Monica Bay	47	10	3	16	5	10	6	25	10	0	12
Los Angeles	33	13	5	21	0	0	4	4	0	10	34
San Gabriel	31	28	19	37	0	0	3	3	0	3	7
Region 8											
Lower Santa Ana	32	15	7	23	0	3	6	15	0	0	46
Middle Santa Ana	25	5	0	13	4	0	7	12	3	1	13
Upper Santa Ana	19	62	42	82	0	0	0	5	9	8	0
San Jacinto	14	53	35	70	13	0	0	0	7	0	27
Region 9											
San Juan	29	18	9	27	10	7	6	13	7	0	16
Northern San Diego	31	33	4	62	2	8	23	41	9	2	0
Central San Diego	25	6	0	15	0	15	9	28	4	0	19
Mission Bay and San Diego	29	32	22	41	0	10	0	14	13	0	0
Southern San Diego	26	61	53	70	0	10	0	20	0	2	2

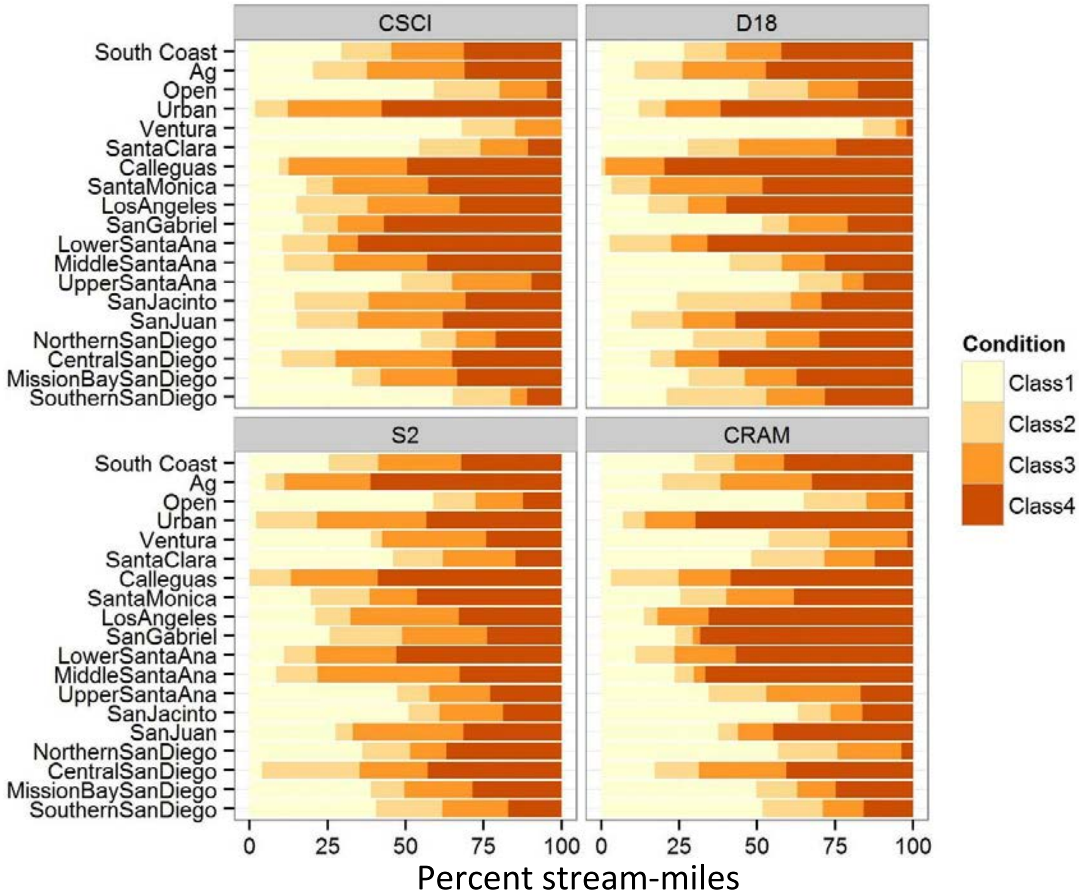


Figure 1-1. Percent of stream-miles in each condition class for each indicator by subpopulation.

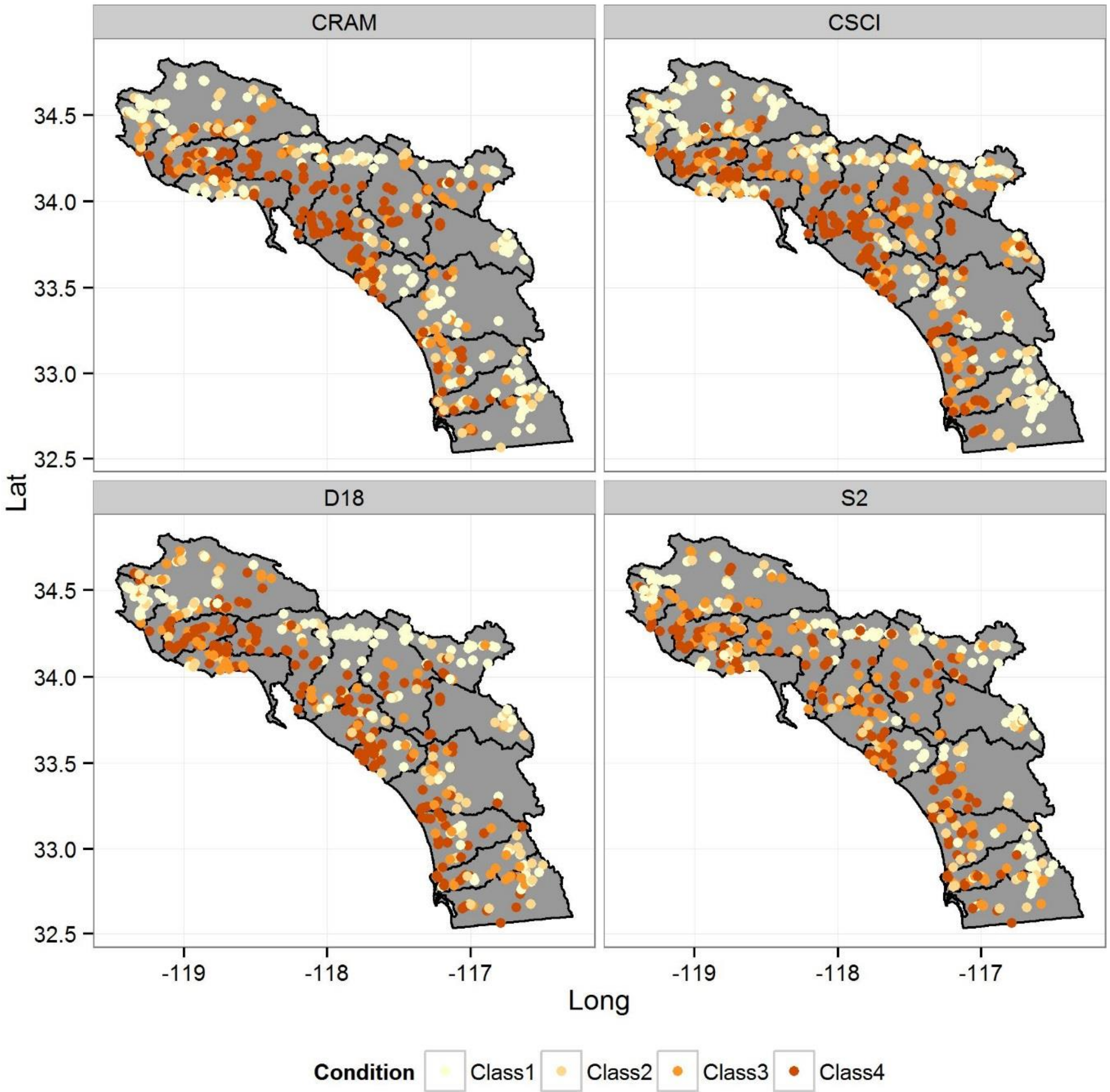


Figure 1-2. Map of scores for key indicators.

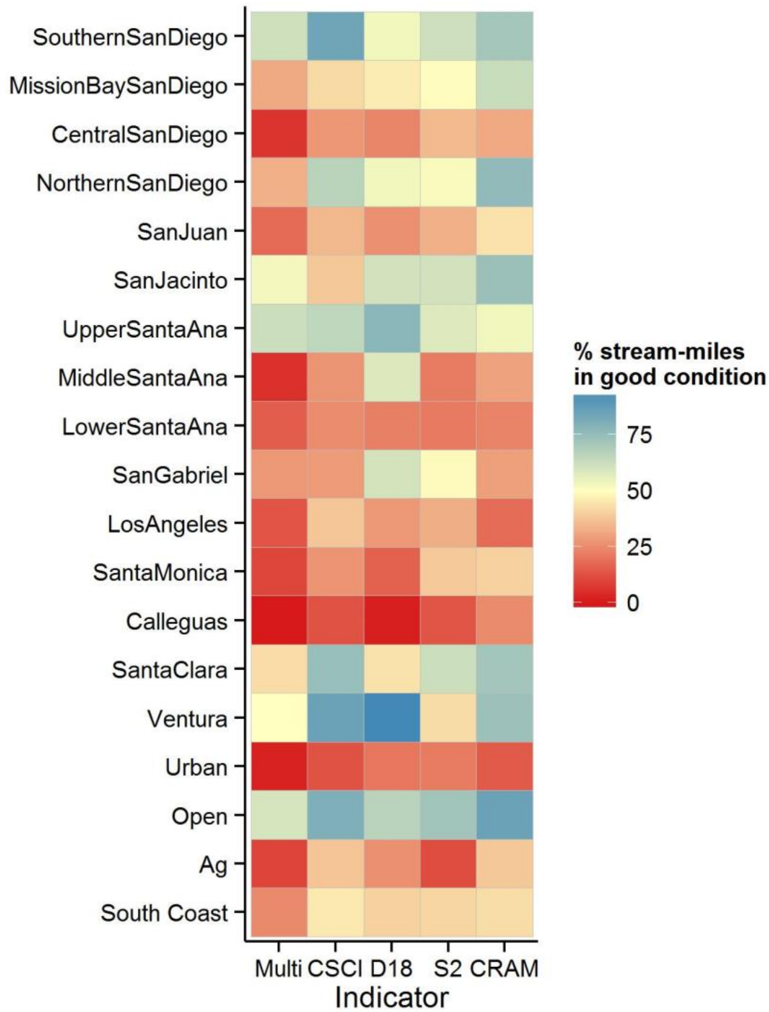


Figure 1-3. Percent of stream-miles in good condition by subpopulation. For the "multi" column, the number reflects the percent of stream-miles with scores for all indicators above the 2.5th percentile of reference sites; all other columns reflect the percent of stream-miles with scores above the 10th percentile of reference sites.

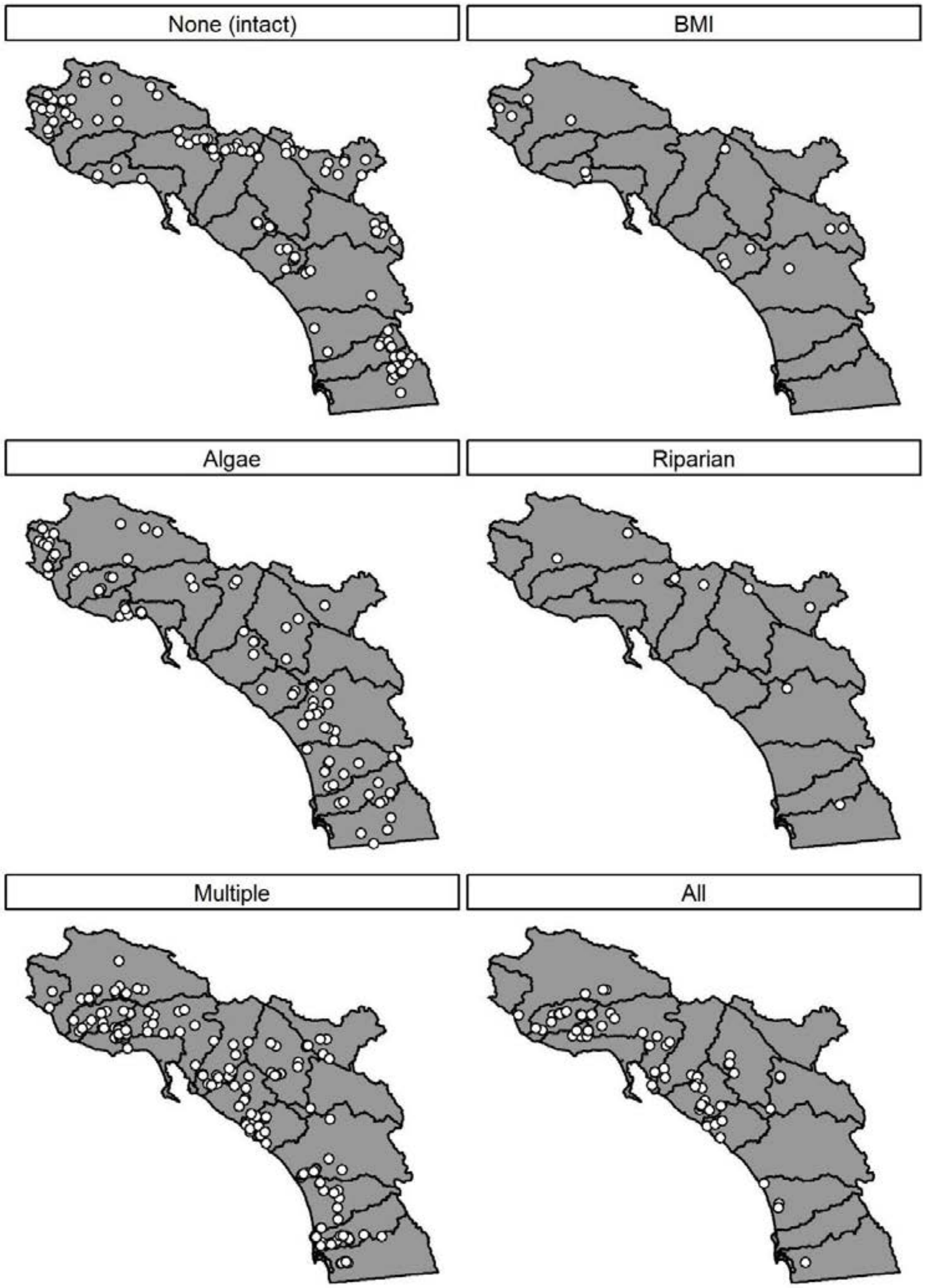


Figure 1-4. Map of limiting indicators. In the top left panel, points represent sites where scores for all four indicators above the 2.5th percentile of reference sites. For all other panels, points represent sites where scores for the specified indicator or indicators were below the 2.5th percentile of reference sites.

QUESTION 2: WHICH STRESSORS ARE ASSOCIATED WITH POOR BIOLOGICAL CONDITION?

Caballero Creek, in the Los Angeles watershed, exemplifies both the severe habitat alteration and nutrient enrichment that affects many streams in southern California.

Introduction

Although the direct measurement of stressors cannot determine the ecological health of a stream, it is essential in determining which factors may limit its health, and provides essential data to inform causal assessment at degraded sites. The SMC stream survey took a notably broad approach towards assessing stressors, measuring nutrients, total and dissolved metals, major ions, water column toxicity, and physical habitat. For some constituents, this survey represents the first unbiased estimate of the extent and magnitude of stressors in aquatic systems. By assessing the extent of these stressors and assessing their associations with biological condition, this survey allows the prioritization of stressors of regional interest, which can then inform local management decisions.

Methods

Data Collection

Data were collected as described in the Survey Overview.

Data Aggregation

Where multiple samples were collected at a single site within a year, data were aggregated as the maximum value within a site. Multi-year mean values for each site were then calculated from these aggregated values if sites were revisited in multiple years. Missing values were ignored for all relevant analyses, where appropriate.

Thresholds

Our goal in setting stressor thresholds was to prioritize stressors in terms of their associated risks to biological condition, as opposed to validating the adequacy of existing regulatory thresholds or assessing compliance with permit requirements. Therefore, the best threshold for this goal is one that is associated with the biggest change in biological condition. Stressor thresholds do not necessarily reflect the most appropriate water quality standards for a given site, which may vary based on site-specific conditions. Therefore, exceeding one of the stressor thresholds used in this analysis may not necessarily indicate impairment or noncompliance with permit requirements.

Stressor thresholds were derived from values published in relevant literature or regulations, where possible (Tables 2-1, 2-2). For chemical nutrients and for most habitat metrics (which are occur naturally and do not have regionally applicable regulatory thresholds), thresholds were established at the 90^{th} or 10^{th} percentile of the distribution among reference sites (as per Ode *et al.* In review). For pyrethroids without published thresholds, a threshold of zero was used.

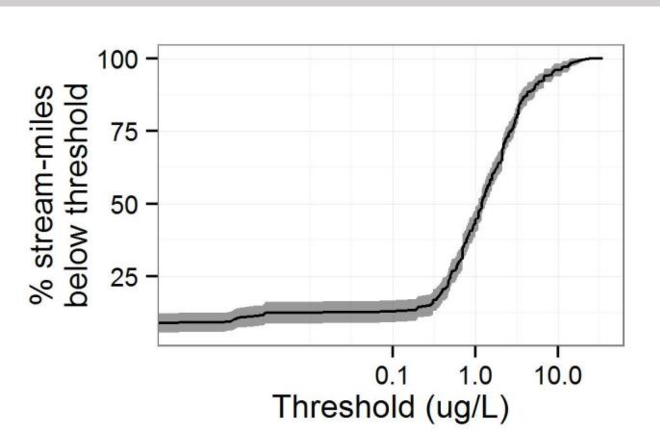
Toxicity tests were compared against controls. If endpoints were significantly different from controls and had values that were 80% of control values or lower, the samples were considered toxic. Toxic survival endpoints were given precedence over nonlethal endpoints (e.g., depressed reproduction).

Reference-Based Thresholds

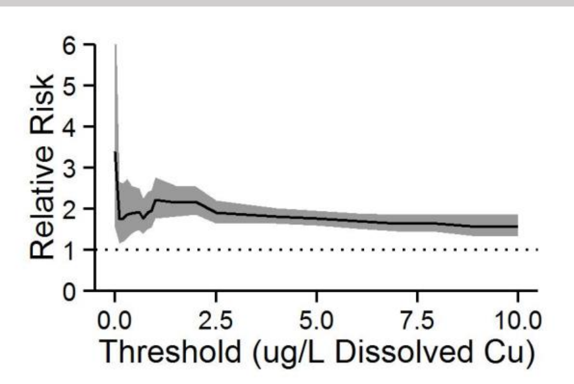
Reference-based thresholds, while appropriate for assessing whether biological indices reflect reference condition, may not be appropriate for water chemistry or physical habitat variables, as they may be excessively stringent. Because of uncertainty about the applicability of certain water chemistry thresholds, a number of alternative thresholds recommended by participating agencies were evaluated.

Copper

To evaluate the impacts of metals on stream condition, this survey used hardness-adjusted thresholds from the California Toxics Rule (EPA 2000). These thresholds are intended to prevent toxic effects on a variety of aquatic species based on the concentration of bio-available toxicants. However, because many of these metals have natural geological sources in the region (e.g., Yoon and Stein 2008), a reference-based threshold, such as those used for nutrients, would better identify sites that exceed natural concentrations. Therefore, a reference-based threshold for copper was calculated as the 90th percentile of concentrations at reference sites within the South Coast region (i.e., 3.4 ug/L), and the extent of stream-miles below this threshold was estimated. Whereas 96% of stream-miles across the region were below the hardness-adjusted threshold for total copper, only 67% were below the reference-based threshold. The difference was even greater for dissolved Copper: 99% of stream-miles were below the hardness-adjusted CTR threshold, whereas only 39% were below the reference threshold of 0.8. Relative risk estimates were only marginally affected (e.g., risk to CSCI scores went up from 1.7 to 1.9 for dissolved copper). However, attributable risks increased considerably (e.g., from 0.004 to 0.360), reflecting the larger number of stream-miles exceeding the reference-based threshold, which would have increased the priority given to this stressor.



Effects of varying thresholds on the percent of perennial stream-miles below threshold for dissolved copper. The gray band indicates the 95% confidence interval.

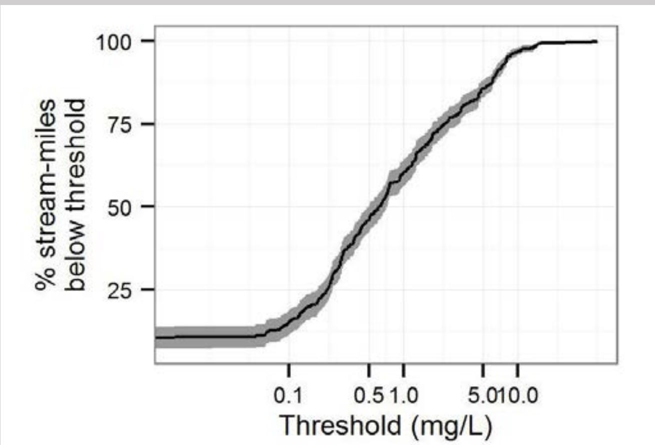


Risk to CSCI scores remain high at all levels of dissolved copper analyzed. The gray band represents the 95% confidence interval. Relative risks greater than 1 (represented by the dotted line) indicate that the stressor is associated with poor biological condition.

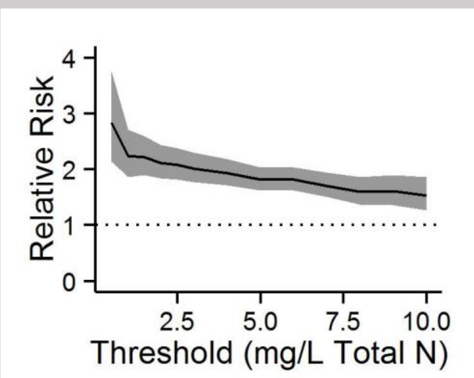
Reference-Based Thresholds (Continued)

Total Nitrogen

This study and others (see Herlihy and Sifneos 2008) have shown a strong association between nutrient concentrations and poor biological condition. However, the reference based thresholds used here are much lower than those used in basin plans or TMDLs throughout the region. For example, the reference-based threshold for total nitrogen (TN) was 0.37 mg/L, whereas the San Diego Basin Plan specifies a threshold of 1 mg/L. The Los Angeles Basin Plan sets a much higher threshold of 10 mg/L (although this threshold is explicitly linked to risks to human health and municipal water uses, not aquatic life). Although 39% of stream-miles across the region were below the reference threshold, this number increased to 60% if a threshold of 1 mg/L was used, and to 98% if a threshold of 10 mg/L was used.



Effect of varying thresholds on the percent of perennial stream-miles below threshold for total nitrogen. The gray band indicates the 95% confidence interval.



Risk to CSCI scores remain high at all levels of total N analyzed. The gray band represents the 95% confidence interval. Relative risks greater than 1 (represented by the dotted line) indicate that the stressor is associated with poor biological condition.

Stressor Extent Estimates

Extent estimates and related distribution points were calculated as described in the Survey Overview. These estimates were calculated for land use classes and for the region as a whole, but not for individual watersheds.

Stressor Associations and Prioritization

Relative risk analysis was used to estimate the likelihood of poor biological condition given the presence of a stressor, relative to the likelihood in the absence of a stressor (Van Sickle *et al.* 2006). Attributable risk analysis was then used to estimate the proportion of streams in the region where biological condition may improve if a stressor were removed. Biological condition was determined as described in the section on Question 1, except that Class 1 and 2 streams (Table 1-1) were both treated as “good”, and Class 3 and 4 streams were both treated as “poor”.

Stressors were then designated as very high priority (attributable risk > 25% of the region for any indicator), high priority (attributable risk between 10% and 25% for any indicator), moderate (attributable risk <10%, but relative risk > 1 for any indicator), and low (relative risk <1 for all indicators).

Relative and Attributable Risk

Relative risk assessment is statistical method of associating the increased risk associated with a stressor (Van Sickle *et al.* 2006). Originally developed for public health studies, relative risk analysis has become popular in environmental assessment because it facilitates prioritization of stressors by identifying which ones are most strongly associated with poor condition. Relative risk compares the odds of observing poor biological condition when a stressor is present to the odds of observing it when the stressor is absent:

$$\text{Relative risk} = \frac{Proportion\ of\ stressed\ stream\text{–}miles\ in\ poor\ condition}{Proportion\ \ of\ unstressed\ stream\text{–}miles\ in\ poor\ condition}$$

Stressors with relative risks greater than 1 are considered to be associated with poor condition; larger relative risks indicate stronger associations, although any stressor with a risk greater than 1 is a good candidate for further study (e.g., causal analysis).

Relative risk analysis can be extended through attributable risk analysis, which accounts for the fact that low-risk but extensive stressors may be higher regional priorities than high-risk stressors that affect few stream miles (Van Sickle and Paulsen 2008). Attributable risk is calculated as follows:

$$\text{Attributable risk} = \frac{(Proportion\ of\ stressed\ stream\text{–}miles)\times(Relative\ risk-1)}{1+(Proportion\ of\ stressed\ stream\text{–}miles)\times(Relative\ risk-1)}$$

Thus, the attributable risk of a stressor is large if a stressor is extensive and has a relative risk greater than 1. If one assumes a perfect causal relationship between the stressor and poor condition, the attributable risk represents the proportion of the region that would be improved if the stressor were eliminated (Van Sickle and Paulsen 2008). But even when this assumption is violated, attributable risk is a useful metric for ranking stressors by regional importance because it accounts for both stressor extent and strength of association with biological condition.

Both relative risk and attributable risk require stressor thresholds for calculation, and modifying the threshold may alter estimates of risk. If stressor thresholds are set too high, relative risk estimates will go down as the proportion of unstressed stream-miles in poor condition increases. Similarly, if stressor thresholds are set too low, relative risk estimates will also go down as the proportion of stressed stream-miles in poor condition decreases. Ideally, stressor thresholds are set at the level where streams are most likely to switch from poor to good condition (or vice-versa), thereby allowing more direct comparisons of risk across stressors.

Results

All data used in this report can be downloaded from ftp.sccwrp.org/pub/download/SMCReport/SMCDataFor5yearReport.zip.

Stressor Extents

Regional results for all analytes are presented, but only subpopulations where at least 5% of the stream-miles exceeded the threshold are included.

Water Chemistry

In general, nutrients and sulfate exceeded the threshold in extensive portions of the region, while exceedances of pyrethroids and metals were rare (Table 2-3a, Figures 2-1 and 2-2). For example, total Nitrogen exceeded the reference benchmark of 0.37 mg/L in 61% of stream-miles across the region, and sulfates exceeded the benchmark of 250 mg/L in 45% of stream-miles. In contrast, Bifenthrin, the most commonly detected pyrethroid, exceeded the benchmark of 0.0006 ug/L in only 16% of stream-miles, and Selenium exceeded the threshold of 5 ug/L in only 13% of stream-miles. Even within urban areas, pyrethroid and metal exceedances were observed in fewer than 24% of stream-miles (Table 2-3b). Several analytes (e.g., Alkalinity, Arsenic, Nickel, and Zinc) were within thresholds at all sites in the survey. Nonetheless, exceedances of certain constituents were extensive in individual watersheds (Table 2-3c). For example, Bifenthrin exceeded the benchmark in 35% of stream-miles in the Santa Monica Bay watershed, and 30% of the Lower Santa Ana, whereas Selenium exceeded its threshold in 40% of the Calleguas and 55% of the Santa Monica Bay watersheds. Geographic clustering of exceedances was evident for both Selenium and Chloride (Figure 2-2), suggesting a localized (perhaps geological) source for these constituents. Exceedances of the reference-based threshold for total dissolved solids (TDS; i.e., 498 mg/L) were also widespread, affecting 76% of stream-miles region-wide, and nearly all agricultural (97%) and urban (99%) stream-miles. However, a large extent (50%) of open stream-miles also exceeded this threshold, as did 100% of certain watersheds (i.e., Calleguas, Santa Monica, and Lower Santa Ana).

With the exception of Ammonia (whose threshold is based on its toxicity to aquatic invertebrates), nutrients frequently exceeded their benchmarks, based on concentrations observed at reference sites, and these extents were closely related to land use. For example, 71% of open streams were below the threshold for total nitrogen (TN), yet only 12% of urban and 13% of agricultural streams had similarly low concentrations of nitrogen. Exceedances for TN were relatively limited in the Ventura (26%) and Santa Clara (30%) watersheds, but pervasive within the Calleguas (94%). and Lower Santa Ana (90%) watersheds. Total phosphorous (TP) exceedances exhibited similar patterns. For example, 57% of stream-miles exceeded the reference-based benchmark of 0.03 mg/L. As with nitrogen, phosphorous exceedances were pervasive in urban (83% of stream-miles) and agricultural (72%) land uses, and were relatively common in open streams (29%).

Toxicity

Toxicity was detected in surprising geographic patterns. Sublethal toxicity (i.e., depressed reproduction) was somewhat common (evident in 25% of stream-length), and was more extensive in open (33%) than agricultural (30%) or urban (19%) streams (Table 2-4, Figure 2-3). Sublethal toxicity was particularly extensive in the Los Angeles (57%) and Santa Clara (49%) watersheds, but rare within neighboring watersheds, like the San Gabriel (6%) and Calleguas (8%) watersheds. In contrast, toxicity to survival endpoints was evident in only 6% of streams region-wide, and was less extensive in open streams (2%) than urban (8%) or agricultural (15%). Lethal toxicity was most extensive in the Central San Diego watershed (26%), but was fairly limited (extent <10%) in most other watersheds.

Physical habitat

Region-wide, the majority of stream-miles were within the reference distribution for all habitat variables examined, although the more aggregated measures of habitat condition tended to show the most extensive alteration (Table 2-5). For example, the three diversity metrics (i.e., Shannon_Flow, Shannon_Habitat, and Shannon_Substrate), as well as the fish cover metric (i.e., XFC_NAT_SWAMP) were depressed for more than 25% of stream-miles in the region (Figures 2-4 and 2-5).

With the exception of algal biomass variables, the extent of open streams exceeding a benchmark was typically close to the expected distribution at reference sites (i.e., 10%). For example, the Shannon flow metric was outside threshold in 32% of urban stream-miles, 20% of agricultural stream-miles, and only 7% of open stream-miles. This pattern, with the greatest extent of streams exceeding thresholds in urban, followed by agricultural streams, was typical of most habitat variables. A notable exception includes variables directly related to fine sediment (e.g., % sands and fines (PCT_SAFN) and % cobble embeddedness (XEMBED)) were more extensively above threshold in agricultural streams than in urban streams; these metrics may reflect channelization or other flood-control activities that reduce particulate substrates (such as cobbles and sand grains) in urban streams.

Biomass variables frequently exceeded reference-based thresholds across different land-use types, including undeveloped streams. For example, macroalgae cover (i.e., PCT_MAP) exceeded the threshold in 42% of urban streams, 31% of agricultural streams, and 17% of open streams. In contrast, variables related to habitat complexity or riparian vegetation showed a more familiar pattern across land use types.

The extent of altered habitat varied widely by watershed. For example, the extent of exceedances of biomass thresholds was about a third or less for most watersheds, with the notable exception of benthic Chlorophyll a and ash-free dry mass, where exceedances affected nearly two-thirds of the Santa Monica Bay watershed. The exceedances of the Shannon habitat metric affected 3% or less of the Ventura and Northern San Diego watersheds, but more than half of the Los Angeles, San Gabriel, and Middle Santa Ana watersheds. In fact, exceedances affected more than 50% of these three watersheds for many habitat variables.

Stressor prioritization

Nutrients, variables related to ionic concentration (e.g., TDS, sulfates), and several habitat variables were classified as very high priority stressors, having both high relative and attributable risks for several indicators (Tables 2-6 and 2-7, Figure 2-6). For example, TN had an attributable risk of 0.51 for the CSCI. Total dissolved solids and sulfate were also high priority because of their high attributable risk for the CSCI and S2. In contrast, metals and pyrethroids were typically classified as moderate priority. Some, like Bifenthrin or copper, had comparatively high relative risks (>1.5), but because of their limited extents, were estimated to affect less than 10% of the region. Variables related to biomass were also classified as moderate, but for the opposite reason: low risk, but extensive exceedances of threshold contributed to elevated attributable risks.

While there was general agreement among indices, risks were overall greater for the CSCI, followed by S2, with D18 showing the lowest risks. The same five stressors (TDS, PCT_BIGR, W1_HALL, TP, and TN) had the highest attributable risk for all indices. Copper and XEMBED had relatively high attributable risk for the algae indices, compared to the CSCI, which in turn had higher risk for several habitat complexity measures (e.g., Shannon_Substrate, XPCMG).

Discussion

Nutrients, altered physical habitat, and major ions were both widespread and strongly associated with altered biology. Although metals and pyrethroids may be important stressors at specific sites, they should be considered a lower priority for regional programs (generally because they affected only a limited extent of streams).

Although physical habitat was repeatedly identified as a high-risk stressor, it was not possible to characterize these impacts in a precise, unbiased manner. Many physical habitat variables show large site-to-site variability within undisturbed areas, reflecting the influence of environmental gradients, like watershed size, climate, and geology. Establishing site-specific benchmarks based on environmental setting would probably yield a more accurate assessment of physical habitat. Data collected at reference sites could be used to develop models that can set these benchmarks for different stream types. Additionally, integrating multiple physical habitat variables into one or more indices would probably provide a more comprehensive characterization of habitat condition than the metric-by-metric approach used here.

Why were nutrients so strongly associated with poor biology if elevated biomass, the presumed mechanism of impact, had only a moderately high risk? This apparent conflict could result from several possible reasons: 1) timing of sampling, which may miss peak algae biomass; 2) co-occurrence with other stressors (such as habitat alteration; Bernal *et al.* 2013), or 3) other mechanisms of impact, such as cyanotoxins or microsystins (e.g., Aboal *et al.* 2002). Because nutrients are such a high priority for the region, further investigation of these explanations may be warranted.

Table 2-1. Analyte threshold by category. Asterisks indicate thresholds that were used when hardness data were unavailable.

Category	Analyte	Threshold	Unit	Source
Ions	Alkalinity as CaCO3	20000	mg/L	EPA (1986)
Ions	Chloride	260	mg/L	EPA (1986)
Ions	Sulfate	250	mg/L	EPA (1986)
Field	pH	6.5 and 8.5		EPA (1986)
Field	Turbidity	3.8	NTU	Ref (n=47)
Field	Specific conductance	878	uS/cm	Ref (n=77)
Solids	Suspended solids	9.5	mg/L	Ref (n=65)
Solids	Dissolved solids	498	mg/L	Ref (n=19)
Metals	Arsenic	150	ug/L	EPA (2000)
Metals	Cadmium	2.2	ug/L	EPA (2000)
Metals	Copper	9*	ug/L	EPA (2000)
Metals	Nickel	2.5*	ug/L	EPA (2000)
Metals	Lead	52*	ug/L	EPA (2000)
Metals	Selenium	5	ug/L	EPA (2000)
Metals	Zinc	120*	ug/L	EPA (2000)
Nutrients	TN	0.42	mg/L	Ref (n=65)
Nutrients	Ammonia-N	1.71	mg/L	EPA 2000
Nutrients	TP	0.03	mg/L	Ref (n=64)
Pyrethroids	Allethrin	0	ug/L	Detection
Pyrethroids	Bifenthrin	0.0006	ug/L	Central Valley draft TMDL (2014)
Pyrethroids	Cyfluthrin	0.00005	ug/L	Central Valley draft TMDL (2014)
Pyrethroids	Cyhalothrin Lambda	0.0005	ug/L	Central Valley draft TMDL (2014)
Pyrethroids	Cypermethrin	0.0002	ug/L	Central Valley draft TMDL (2014)
Pyrethroids	Deltamethrin/Tralomethrin	0	ug/L	Detection
Pyrethroids	Esfenvalerate/Fenvalerate	0.003	ug/L	Central Valley draft TMDL (2014)
Pyrethroids	Permethrin	0.002	ug/L	Central Valley draft TMDL (2014)

Table 2-2. Thresholds for physical habitat variables. n: number of reference sites used to estimate reference distribution. Ref: estimated from reference distribution. RCMP: Reference Condition Monitoring Program, from Ode *et al.* (In review).

Variable	Description	Direction	Threshold	Units	n	Source
Biomass						
Chlorophyll□a	Benthic chlorophyll a	Increase	56	ug□cm^2	66	Ref
AFDM	Benthic ash-free dry mass	Increase	37	mg□cm^2	64	Ref
PCT□MAP	□ macro-algae cover	Increase	41	□	49	Ref
XMIATP	Mean microalgae thickness (where present)	Increase	1.0	mm	53	Ref
PCT□MIAT1	□ thick (□1 mm) microalgae cover	Increase	18	□	53	Ref
PCT□MCP	□ macrophyte cover	Increase	37	□	49	Ref
PCT□CPOM	□ coarse particulate organic matter cover	Increase	71	□	60	Ref
Instream habitat						
XFC□NAT□SWAMP	Natural fish cover	Decrease	18	□	73	Ref
Shannon□Habitat	Fish cover diversity	Decrease	1.1		73	Ref
Shannon□Flow	Flow habitat diversity	Decrease	2.4		61	Ref
PCT□FAST	□ fast-water habitat	Decrease	7	□	61	Ref
Riparian						
XCDENMID	□ shading	Decrease	17	□	72	Ref
XCMG	Mean riparian vegetation cover	Decrease	32	□	62	Ref
XPCMG	Proportion of reach with all three layers present	Decrease	0.09	Proportion	62	Ref
XPMGVEG	Mean vegetative cover	Decrease	0.23	Proportion	73	Ref
W1□HALL□SWAMP	Human activity metric	Decrease	1.5		60	RCMP
Substrate						
PCT□BIGR	□ large substrate (□128 mm)	Decrease	27	□	73	Ref
PCT□SAFN	□ sands and fines (□2 mm)	Increase	57	□	73	Ref
Shannon□Substrate	Substrate diversity	Decrease	0.53		73	Ref
XEMBED	□ cobble embeddedness	Increase	55	□	73	Ref

Table 2-3a. Regional extent and distributions for chemical stressors.

Stressor	n	% Below Threshold			Concentration		
		Estimate	95% CI		Median	Mean	SD
Ions							
Alkalinity as CaCO3	558	100	100	100	200	217	100
Chloride	513	81	77	84	108	182	316
Sulfate	507	55	51	59	228	294	327
Metals (dissolved)							
Arsenic (d)	443	100	100	100	1.9	2.3	2.7
Copper (d)	443	99	99	100	1.2	2.3	3.3
Nickel (d)	443	100	100	100	2.2	4.3	15.4
Lead (d)	443	100	100	100	0.00	0.05	0.17
Selenium (d)	469	89	86	91	0.99	2.59	6.51
Zinc (d)	486	100	100	100	2.0	4.1	7.2
Metals (total)							
Arsenic (t)	458	100	100	100	2.3	2.9	7.5
Copper (t)	458	96	94	98	2.0	5.2	9.6
Nickel (t)	458	100	100	100	2.6	5.9	18.1
Lead (t)	458	95	93	97	0.08	1.57	3.85
Selenium (t)	458	87	84	89	1.20	3.33	13.24
Zinc (t)	458	100	100	100	3.9	15.8	31.1
Nutrients							
TN	503	39	35	43	0.6	2.2	4.1
Ammonia-N	516	99	97	100	0.01	1.58	19.52
TP	513	43	39	47	0.05	3.91	65.11
Pyrethroids							
Bifenthrin	430	84	81	88	0	0.8	4.2
Cyfluthrin	430	93	90	96	0	0.2	1.6
Cyhalothrin lambda	430	95	92	97	0	0.022	0.228
Cypermethrin	430	92	88	95	0	0.20	1.32
Deltamethrin	169	89	84	94	0	0.0001	0.0022
Esfenvalerate/Fenvalerate	406	98	97	100	0	0.0282	0.3271
Permethrin	430	97	95	99	0	0.146	1.769
Solids							
Suspended solids	528	75	71	79	4	16	57
Dissolved solids	226	24	19	28	856	1034	774
Field							
pH	645	85	82	88	8.05	8.07	0.62
Turbidity	418	76	72	81	1.7	7.9	48.7
Specific conductance	656	75	72	78	1034	1259	1210

Table 2-3b. Extent and distributions for chemical stressors in each land use class. Only analytes with extents greater than 5% exceeding a threshold are shown.

Stressor	n	% Below Threshold			Concentration		
		Estimate	95% CI		Median	Mean	SD
Agricultural							
Ions							
Chloride	73	84	77	90	133	209	280
Sulfate	74	31	22	39	324	424	344
Metals (dissolved)							
Selenium	68	74	64	85	3.06	6.23	12.00
Metals (total)							
Selenium	67	77	66	88	3.31	6.34	11.83
Nutrients							
TN	72	13	7	20	2.5	6.5	9.9
TP	73	28	21	35	0.08	0.50	0.78
Pyrethroids							
Bifenthrin	62	90	82	97	0	0.2	1.1
Cyfluthrin	62	95	86	100	0	0.2	0.7
Cypermethrin	62	90	80	100	0	0.08	0.45
Esfenvalerate/Fenvalerate	58	89	78	99	0	0.31	1.07
Solids							
Suspended solids	73	79	69	89	5	43	144
Dissolved solids	25	3	0	9	983	1037	383
Field							
pH	87	94	91	97	7.98	8.03	0.45
Turbidity	56	70	58	81	2.4	45.0	159.0
Specific conductance	87	69	61	78	1322	1542	888
Open							
Ions							
Sulfate	220	73	68	77	71	170	214
Metals (total)							
Lead	178	93	89	97	0.03	1.40	3.37
Selenium	178	92	88	96	0.78	1.52	2.22
Nutrients							
TN	219	71	65	77	0.2	0.5	1.2
TP	225	71	66	76	0.02	0.09	0.43
Pyrethroids							
Bifenthrin	163	95	92	98	0	0.0	0.1
Deltamethrin	74	92	86	97	0	0	0
Solids							
Suspended solids	227	89	85	93	2	4	7
Dissolved solids	108	50	42	58	493	678	490

Stressor	n	% Below Threshold			Concentration		
		Estimate	95% CI		Median	Mean	SD
Field							
Turbidity	187	87	83	92	0.9	2.3	6.8
Specific conductance	291	91	88	94	478	672	570
Urban							
Ions							
Chloride	223	66	60	72	190	303	397
Sulfate	213	42	35	48	289	391	369
Metals (dissolved)							
Selenium	207	84	80	89	1.20	3.27	7.36
Metals (total)							
Selenium	213	84	80	88	1.30	4.17	17.41
Nutrients							
TN	212	12	6	19	1.5	3.0	3.4
TP	215	17	11	22	0.11	8.35	96.04
Pyrethroids							
Bifenthrin	205	76	69	83	0	1.4	5.7
Cyfluthrin	205	90	85	95	0	0.4	2.2
Cyhalothrin lambda	205	93	88	97	0	0.041	0.313
Cypermethrin	205	88	82	93	0	0.36	1.79
Deltamethrin	74	85	75	95	0	0	0
Solids							
Suspended solids	228	61	54	69	8	22	56
Dissolved solids	93	1	0	3	1093	1388	885
Field							
pH	272	72	66	79	8.17	8.24	0.69
Turbidity	175	65	57	74	2.3	7.2	19.8
Specific conductance	278	62	56	67	1397	1800	1439

Table 2-3c. Extent and distributions for chemical stressors in each watershed. Only analytes with extents greater 5% exceeding a threshold are shown. Physical habitat variable abbreviations are provided in Table 2-2.

Stressor		n	% Below Threshold			Concentration		
			Estimate	95% CI		Median	Mean	SD
Region 4								
Ventura								
Ions	Sulfate	38	36	23	50	270	262	66
Nutrients	TN	38	74	64	84	0.1	0.5	1.0
Nutrients	TP	36	92	87	97	0	0.02	0.06
Pyrethroids	Bifenthrin	35	93	86	100	0	0.0	0.0
Solids	Dissolved solids	5	50	4	97	477	560	96
Field	Turbidity	8	76	39	100	0.5	1.9	1.7
Santa Clara								
Ions	Sulfate	75	59	50	68	221	305	333
Metals (dissolved)	Selenium	70	92	86	97	0.81	1.69	3.25
Metals (total)	Copper	59	91	85	98	0.8	6.3	16.1
Metals (total)	Lead	59	91	86	97	0.01	2.17	4.21
Metals (total)	Selenium	59	90	83	97	0.89	3.15	12.17
Nutrients	TN	70	70	61	78	0.2	0.9	2.4
Nutrients	TP	73	82	75	89	0.02	0.10	0.41
Pyrethroids	Bifenthrin	53	93	86	99	0	0.0	0.0
Pyrethroids	Cyfluthrin	53	92	85	100	0	0.1	0.6
Pyrethroids	Cypermethrin	53	94	87	100	0	0.00	0.02
Pyrethroids	Deltamethrin	33	84	73	95	0	0	0
Pyrethroids	Esfenvalerate/Fenvalerate	50	94	87	100	0	0.1178	0.6286
Solids	Suspended solids	73	91	84	98	2	16	83
Solids	Dissolved solids	45	28	15	42	667	751	467
Field	Turbidity	72	89	84	94	1.5	16.9	98.9
Calleguas								
Ions	Chloride	34	86	70	100	182	193	54
Ions	Sulfate	40	25	13	38	419	484	347
Metals (dissolved)	Selenium	38	60	46	74	4.16	7.14	11.46
Metals (total)	Selenium	37	60	47	74	4.18	7.12	11.01
Nutrients	TN	38	6	0	14	4.4	6.7	9.9
Nutrients	Ammonia-N	35	95	87	100	0.06	0.23	0.70
Nutrients	TP	37	23	6	39	0.13	0.83	1.02
Pyrethroids	Bifenthrin	37	86	76	97	0	0.2	1.0
Pyrethroids	Cypermethrin	37	92	82	100	0	0.15	0.53
Pyrethroids	Esfenvalerate/Fenvalerate	31	94	87	100	0	0.1290	0.7575
Solids	Suspended solids	33	72	56	88	6	27	89
Field	pH	34	86	75	98	7.94	8.04	0.47

Stressor		n	% Below Threshold			Concentration		
			Estimate	95% CI		Median	Mean	SD
Field	Turbidity	9	73	43	100	1.4	2.9	3.0
Field	Specific conductance	34	60	43	77	1691	1785	597
Santa Monica Bay								
Ions	Chloride	47	86	80	93	190	199	72
Ions	Sulfate	54	8	4	12	884	954	570
Metals (dissolved)	Selenium	53	41	34	49	6.61	13.76	20.47
Metals (total)	Selenium	54	45	38	53	5.33	21.80	58.27
Nutrients	TN	50	30	22	39	0.6	1.3	2.0
Nutrients	TP	49	18	11	24	0.10	0.15	0.18
Pyrethroids	Bifenthrin	42	65	52	78	0	3.5	15.6
Pyrethroids	Cyfluthrin	42	89	81	97	0	1.0	4.7
Pyrethroids	Cyhalothrin lambda	42	74	62	86	0	0.237	1.083
Pyrethroids	Cypermethrin	42	83	73	93	0	0.42	1.73
Pyrethroids	Deltamethrin	24	71	56	87	0	0	0
Pyrethroids	Esfenvalerate/Fenvalerate	42	93	86	100	0	0.0291	0.1146
Pyrethroids	Permethrin	42	86	76	95	0	1.119	4.593
Solids	Suspended solids	47	88	81	96	2	10	44
Field	Turbidity	65	70	61	80	1.8	10.9	46.0
Field	Specific conductance	69	59	52	67	1640	1899	1265
Los Angeles								
Ions	Sulfate	32	86	76	96	84	137	152
Metals (total)	Copper	26	82	67	98	7.0	10.4	10.1
Metals (total)	Lead	26	92	82	100	0.65	1.60	2.26
Nutrients	TN	31	34	19	49	1.1	2.5	2.6
Nutrients	TP	22	18	0	36	0.17	0.20	0.16
Pyrethroids	Bifenthrin	26	73	57	89	0	0.5	1.1
Pyrethroids	Cypermethrin	26	92	80	100	0	0.55	1.90
Solids	Suspended solids	19	63	43	84	5	22	35
Solids	Dissolved solids	9	28	4	52	653	1061	837
Field	pH	42	66	53	78	8.25	8.45	0.79
Field	Turbidity	8	67	33	100	0.4	7.6	11.7
Field	Specific conductance	44	91	83	100	570	838	561
San Gabriel								
Ions	Chloride	29	89	76	100	146	127	97
Ions	Sulfate	28	79	59	99	168	151	115
Metals (total)	Copper	27	94	86	100	2.7	7.0	11.4
Metals (total)	Lead	27	91	81	100	0.16	2.04	5.39
Metals (total)	Selenium	27	88	80	97	1.29	2.16	2.00
Nutrients	TN	29	36	20	52	0.6	1.6	2.1
Nutrients	TP	30	44	26	62	0.06	0.12	0.24

Stressor		n	% Below Threshold			Concentration		
			Estimate	95% CI		Median	Mean	SD
Pyrethroids	Bifenthrin	24	87	72	100	0	1.7	6.3
Pyrethroids	Cyfluthrin	24	87	72	100	0	0.8	2.9
Pyrethroids	Cyhalothrin lambda	24	87	72	100	0	0.105	0.371
Pyrethroids	Cypermethrin	24	87	72	100	0	0.82	3.10
Solids	Suspended solids	30	69	51	86	8	37	96
Solids	Dissolved solids	14	13	5	22	859	823	262
Field	pH	33	59	42	76	8.25	8.39	0.65
Field	Turbidity	17	67	44	90	2.1	4.3	4.3
Region 8								
Lower Santa Ana								
Ions	Chloride	29	81	68	94	179	186	91
Ions	Sulfate	24	40	22	58	300	372	248
Metals (dissolved)	Selenium	28	86	76	97	1.30	5.38	10.38
Metals (total)	Selenium	28	86	76	97	1.40	5.37	10.17
Nutrients	TN	24	10	0	20	2.2	3.4	3.5
Nutrients	TP	27	20	8	31	0.12	157.2	398.9
Pyrethroids	Bifenthrin	27	70	55	85	0	0.9	2.0
Pyrethroids	Cyhalothrin lambda	27	93	86	100	0	0.000	0.000
Pyrethroids	Permethrin	27	87	75	99	0	0.121	0.727
Solids	Suspended solids	36	63	52	75	6	11	15
Field	pH	41	87	80	94	7.98	7.97	0.64
Field	Turbidity	36	87	79	95	1.9	2.7	3.6
Field	Specific conductance	41	68	57	80	1408	1587	580
Middle Santa Ana								
Metals (dissolved)	Copper	10	89	70	100	3.1	3.9	3.5
Metals (total)	Copper	15	93	80	100	3.7	5.1	4.4
Nutrients	TN	23	16	2	30	2.0	4.1	4.4
Nutrients	TP	33	14	7	21	0.19	0.52	0.59
Solids	Suspended solids	35	72	62	83	5	8	8
Field	pH	55	65	54	75	8.20	8.29	0.90
Field	Turbidity	23	63	45	81	3.1	5.4	6.2
Field	Specific conductance	55	78	68	88	935	866	416
Upper Santa Ana								
Metals (dissolved)	Copper	12	93	81	100	0.9	1.8	2.8
Nutrients	TN	31	50	37	64	0.3	0.6	0.9
Nutrients	Ammonia-N	43	91	77	100	0.01	23.61	75.91
Nutrients	TP	42	54	42	67	0.02	0.29	0.66
Pyrethroids	Bifenthrin	15	90	77	100	0	0.0	0.0
Solids	Suspended solids	44	75	62	88	3	9	20

Stressor		n	% Below Threshold			Concentration		
			Estimate	95% CI		Median	Mean	SD
Field	pH	67	83	75	91	7.98	7.66	0.96
Field	Turbidity	32	88	77	99	0.4	1.5	2.6
San Jacinto								
Ions	Chloride	16	83	73	94	16	90	142
Nutrients	TN	14	53	41	65	0.3	0.8	1.1
Nutrients	TP	17	18	2	36	0.08	0.17	0.23
Solids	Suspended solids	17	82	70	95	2	6	9
Field	pH	27	81	73	89	7.48	7.67	0.84
Field	Turbidity	6	66	32	99	2.3	38.1	57.4
Field	Specific conductance	27	84	75	94	192	451	568
Region 9								
San Juan								
Ions	Chloride	31	65	51	79	151	205	149
Ions	Sulfate	31	43	31	56	289	450	432
Metals (dissolved)	Selenium	30	76	62	90	1.96	5.00	6.85
Metals (total)	Lead	30	94	88	100	0.00	1.83	2.68
Metals (total)	Selenium	30	75	61	89	1.99	5.10	6.75
Nutrients	TN	30	56	40	71	0.3	0.7	1.1
Nutrients	TP	27	29	18	41	0.06	1.26	4.27
Pyrethroids	Bifenthrin	30	77	64	90	0	0.7	2.0
Pyrethroids	Cyfluthrin	30	86	75	97	0	0.2	0.6
Pyrethroids	Cyhalothrin lambda	30	92	84	100	0	0.017	0.097
Pyrethroids	Cypermethrin	30	86	75	97	0	0.08	0.24
Pyrethroids	Deltamethrin	13	92	84	100	0	0	0
Solids	Suspended solids	30	87	76	97	3	7	12
Solids	Dissolved solids	30	27	18	37	1193	1331	1061
Field	Turbidity	29	83	70	96	0.9	1.8	2.6
Field	Specific conductance	31	59	47	71	1394	1690	1191
Northern San Diego								
Ions	Chloride	31	74	61	87	120	161	141
Ions	Sulfate	31	58	41	75	220	203	190
Nutrients	TN	31	16	1	31	1.2	2.3	3.3
Nutrients	TP	29	51	36	67	0.03	0.07	0.10
Solids	Suspended solids	33	86	76	97	4	6	11
Solids	Dissolved solids	7	22	0	51	780	767	268
Field	Turbidity	28	83	70	96	0.7	6.0	17.5
Field	Specific conductance	33	63	49	77	834	1046	772
Central San Diego								
Ions	Chloride	36	42	29	55	289	507	631
Ions	Sulfate	36	23	13	32	330	359	273

Stressor		n	% Below Threshold			Concentration		
			Estimate	95% CI		Median	Mean	SD
Metals (dissolved)	Selenium	31	89	78	100	1.09	1.65	1.85
Metals (total)	Selenium	31	89	78	100	1.14	1.74	2.03
Nutrients	TN	33	16	6	25	1.3	3.5	4.3
Nutrients	TP	29	12	3	21	0.09	0.10	0.06
Pyrethroids	Bifenthrin	31	77	62	92	0	2.2	5.7
Pyrethroids	Cyfluthrin	31	88	75	100	0	0.2	0.5
Pyrethroids	Cyhalothrin lambda	31	93	83	100	0	0.007	0.029
Pyrethroids	Cypermethrin	31	87	75	99	0	0.01	0.03
Pyrethroids	Deltamethrin	21	83	68	99	0	0	0
Pyrethroids	Permethrin	31	94	85	100	0	0.114	0.462
Solids	Suspended solids	35	52	36	67	9	15	23
Solids	Dissolved solids	9	16	0	38	1306	1112	517
Field	pH	36	95	86	100	7.89	7.90	0.32
Field	Turbidity	30	63	45	80	2.6	8.6	17.1
Field	Specific conductance	37	25	14	35	2112	2469	2151
Mission Bay and San Diego								
Ions	Chloride	30	37	32	42	447	398	332
Ions	Sulfate	30	41	35	46	314	345	334
Metals (dissolved)	Selenium	30	93	84	100	0.77	1.25	1.71
Metals (total)	Selenium	30	93	84	100	0.82	1.34	1.74
Nutrients	TN	28	28	19	37	1.1	2.2	3.4
Nutrients	TP	28	35	21	49	0.05	0.11	0.13
Pyrethroids	Bifenthrin	30	86	75	97	0	0.0	0.2
Pyrethroids	Cyfluthrin	30	93	86	100	0	0.0	0.1
Pyrethroids	Cyhalothrin lambda	30	91	83	99	0	0.004	0.020
Pyrethroids	Cypermethrin	30	89	79	99	0	0.00	0.02
Pyrethroids	Deltamethrin	19	94	85	100	0	0	0
Solids	Suspended solids	31	66	52	80	4	11	14
Solids	Dissolved solids	9	88	72	100	333	450	368
Field	pH	30	93	86	100	7.95	7.94	0.40
Field	Turbidity	26	64	50	77	2.5	4.8	5.1
Field	Specific conductance	30	39	32	47	2385	1933	1532
Southern San Diego								
Ions	Chloride	33	78	72	84	60	308	538
Ions	Sulfate	33	81	75	87	68	128	145
Metals (total)	Lead	30	93	84	100	0.09	1.21	2.36
Nutrients	TN	33	60	49	70	0.3	0.9	1.7
Nutrients	TP	30	38	22	54	0.04	0.23	0.83
Pyrethroids	Bifenthrin	30	98	95	100	0	0.0	0.1
Pyrethroids	Cypermethrin	30	98	95	100	0	0.00	0.03

Stressor		n	% Below Threshold			Concentration		
			Estimate	95% CI		Median	Mean	SD
Solids	Suspended solids	33	83	71	94	4	6	10
Solids	Dissolved solids	10	63	40	86	479	510	219
Field	Turbidity	29	71	55	86	1.6	3.5	4.1
Field	Specific conductance	33	54	42	65	671	1500	1911

Table 2-4. Extent of toxicity by subpopulation.

Subpopulation	n	% stream-miles with toxicity to survival	% stream-miles with toxicity to reproduction	% stream-miles with no toxicity
South Coast	431	6	25	67
Land Use				
Agricultural	67	15	30	55
Open	171	2	33	61
Urban	193	8	19	73
Watershed				
Region 4				
Ventura	34	1	15	77
Santa Clara	56	8	42	45
Calleguas	36	1	8	91
Santa Monica	38	7	33	60
Los Angeles	34	2	57	42
San Gabriel	26	1	6	90
Region 8				
Lower Santa Ana	28	0	26	67
Middle Santa Ana	22	0	4	96
Upper Santa Ana	14	11	12	77
San Jacinto	14	0	12	88
Region 9				
San Juan	25	8	23	69
Northern San Diego	30	3	23	74
Central San Diego	24	26	12	61
Mission Bay and San Diego River	26	4	31	65
Southern San Diego	24	13	11	76

Table 2-5a. Extent and mean values of selected physical habitat variables within the region. Abbreviations are provided in Table 2-2.

Variable	n	% Within Threshold			Median	Mean	SD
		Estimate	95% CI				
Biomass							
AFDM	526	82	78	85	7	652	2877
Chlorophyll a	531	83	79	87	10	165	880
PCT□CPOM	599	90	88	92	28	33	26
PCT□MAP	481	69	65	74	26	30	25
PCT□MCP	481	89	86	92	5	13	18
PCT□MIAT1	519	92	90	94	0	4	11
XMIATP	519	91	89	94	0.10	0.32	0.63
Instream habitat							
PCT□FAST	601	75	72	79	28	37	33
Shannon□Flow	601	80	76	83	2.7	2.7	0.3
Shannon□Habitat	634	68	65	72	1.4	1.2	0.5
XFC□NAT□SWAMP	634	73	69	76	51	54	41
Riparian							
W1□HALL□SWAMP	597	55	52	59	1.2	1.8	1.9
XCDENMID	617	69	66	73	43	45	35
XCMG	602	68	65	72	80	80	60
XPCMG	602	71	68	74	0.65	0.53	0.42
XPMGVEG	634	70	67	73	0.75	0.59	0.41
Substrate							
PCT□BIGR	634	49	45	52	25	30	28
PCT□SAFN	634	78	75	81	25	33	27
Shannon□Substrate	634	73	69	77	1.0	0.9	0.5
XEMBED	485	89	86	92	35	36	18

Table 2-5b. Extent and mean values of selected physical habitat variables by land use. Only variables with exceedances greater than 5% of a subpopulation are shown.

Variable		n	% Within Threshold			Median	Mean	SD
			Estimate	95% CI				
Agricultural								
Biomass	AFDM	75	72	62	81	13	703	2427
Biomass	Chlorophyll a	75	74	64	84	20	486	1837
Biomass	PCT_CPOM	76	86	79	94	36	38	27
Biomass	PCT_MAP	69	69	60	79	28	30	22
Biomass	PCT_MCP	69	88	81	95	12	18	18
InstreamHab	PCT_FAST	76	71	61	81	24	37	33
InstreamHab	Shannon_Flow	76	80	72	89	2.6	2.6	0.3
InstreamHab	Shannon_Habitat	81	80	73	87	1.4	1.3	0.4
InstreamHab	XFC_NAT_SWAMP	81	79	72	87	49	61	47
Riparian	W1_HALL_SWAMP	76	70	63	78	0.6	1.0	1.2
Riparian	XCDENMID	76	58	49	67	23	35	35
Riparian	XCMG	76	80	72	88	104	94	59
Riparian	XPCMG	76	76	68	84	0.79	0.61	0.41
Riparian	XPMGVEG	81	85	78	91	0.81	0.70	0.35
Substrate	PCT_BIGR	81	24	16	32	9	18	21
Substrate	PCT_SAFN	81	40	30	49	63	60	27
Substrate	Shannon_Substrate	81	78	69	88	0.8	0.9	0.4
Substrate	XEMBED	54	81	71	92	40	41	22
Open								
Biomass	AFDM	224	82	77	87	11	173	672
Biomass	Chlorophyll a	227	85	80	90	12	62	201
Biomass	PCT_CPOM	261	88	85	92	34	38	25
Biomass	PCT_MAP	203	83	78	88	14	21	21
Biomass	PCT_MCP	203	87	83	91	7	14	16
Biomass	PCT_MIAT1	217	94	90	97	0	4	9
Biomass	XMIATP	217	94	90	97	0.10	0.26	0.49
InstreamHab	PCT_FAST	263	92	89	95	40	46	29
InstreamHab	Shannon_Flow	263	93	90	95	2.8	2.8	0.3
InstreamHab	Shannon_Habitat	290	90	87	93	1.5	1.4	0.3
InstreamHab	XFC_NAT_SWAMP	290	93	89	97	71	72	35
Riparian	W1_HALL_SWAMP	261	91	87	94	0.2	0.5	0.8
Riparian	XCDENMID	289	85	82	89	61	58	31
Riparian	XCMG	264	93	89	98	108	106	45
Riparian	XPCMG	264	93	90	95	0.86	0.70	0.33
Riparian	XPMGVEG	290	93	90	96	0.91	0.78	0.29
Substrate	PCT_BIGR	290	82	78	86	54	49	24

Variable		n	% Within Threshold			Median	Mean	SD
			Estimate	95% CI				
Substrate	PCT□SAFN	290	88	84	91	24	29	21
Substrate	Shannon□Substrate	290	92	87	96	1.2	1.2	0.4
Substrate	XEMBED	276	91	88	94	35	36	16
Urban								
Biomass	AFDM	227	83	77	89	5	1089	3944
Biomass	Chlorophyll a	229	83	77	89	7	206	991
Biomass	PCT□CPOM	262	92	89	96	17	27	27
Biomass	PCT□MAP	209	58	50	65	37	38	27
Biomass	PCT□MCP	209	91	87	95	2	12	20
Biomass	PCT□MIAT1	232	90	86	94	0	5	12
Biomass	XMIATP	232	89	84	93	0.11	0.37	0.68
InstreamHab	PCT□FAST	262	62	55	69	14	30	34
InstreamHab	Shannon□Flow	262	68	62	74	2.6	2.6	0.2
InstreamHab	Shannon□Habitat	263	44	38	50	0.9	0.9	0.6
InstreamHab	XFC□NAT□SWAMP	263	50	45	56	19	34	36
Riparian	W1□HALL□SWAMP	260	23	87	98	2.9	3.0	1.8
Riparian	XCDENMID	252	54	48	60	20	32	35
Riparian	XCMG	262	44	39	49	22	54	62
Riparian	XPCMG	262	51	46	57	0.10	0.37	0.42
Riparian	XPMGVEG	263	44	39	49	0.09	0.37	0.42
Substrate	PCT□BIGR	263	20	15	24	1	13	21
Substrate	PCT□SAFN	263	74	69	79	25	33	30
Substrate	Shannon□Substrate	263	53	47	59	0.6	0.6	0.5
Substrate	XEMBED	155	86	80	92	35	35	20

Table 2-5c. Extent and mean values of selected physical habitat variables by watershed. Only variables with exceedances greater than 5% of a subpopulation are shown.

Variable		n	% within Threshold			Median	Mean	SD
			Estimate	95% CI				
Region 4								
Ventura								
Biomass	AFDM	37	89	79	100	4	786	3883
Biomass	Chlorophyll a	37	89	79	100	5	88	384
Biomass	PCT_MAP	24	78	60	96	19	25	22
Biomass	PCT_MCP	24	93	85	100	1	7	14
InstreamHab	PCT_FAST	36	95	90	99	36	45	26
Riparian	W1_HALL_SWAMP	36	93	87	98	0.5	0.6	0.6
Riparian	XCDENMID	37	87	75	98	58	59	32
Riparian	XPMGVEG	38	90	78	100	0.69	0.66	0.23
Substrate	PCT_BIGR	38	86	79	94	62	62	22
Santa Clara								
Biomass	AFDM	73	78	70	86	23	153	917
Biomass	Chlorophyll a	75	83	75	92	18	64	200
Biomass	PCT_CPOM	72	73	63	83	54	54	26
Biomass	PCT_MAP	66	75	66	84	28	29	21
Biomass	PCT_MCP	66	84	76	92	18	19	18
Biomass	PCT_MIAT1	70	93	87	99	0	3	8
Biomass	XMIATP	70	91	84	98	0.02	0.24	0.43
InstreamHab	PCT_FAST	72	87	80	94	28	37	27
InstreamHab	Shannon_Flow	72	92	86	98	2.8	2.8	0.3
InstreamHab	Shannon_Habitat	83	86	78	93	1.5	1.4	0.3
InstreamHab	XFC_NAT_SWAMP	83	94	89	99	61	69	34
Riparian	W1_HALL_SWAMP	72	92	87	97	0.0	0.4	0.8
Riparian	XCDENMID	83	72	63	80	37	44	32
Riparian	XCMG	72	93	90	97	112	108	44
Riparian	XPCMG	72	89	84	94	0.86	0.69	0.35
Riparian	XPMGVEG	83	94	91	98	0.90	0.81	0.25
Substrate	PCT_BIGR	83	74	67	81	47	44	24
Substrate	PCT_SAFN	83	83	77	90	30	35	23
Substrate	Shannon_Substrate	83	92	86	98	1.3	1.2	0.4
Substrate	XEMBED	75	87	81	93	34	36	17
Calleguas								
Biomass	AFDM	40	73	59	88	9	1435	3373
Biomass	Chlorophyll a	40	68	53	83	23	1035	2807
Biomass	PCT_MAP	27	61	43	80	37	36	22
InstreamHab	PCT_FAST	37	84	73	94	30	37	25
InstreamHab	Shannon_Flow	37	89	80	98	2.7	2.7	0.2

Variable		n	% within Threshold			Median	Mean	SD
			Estimate	95% CI				
InstreamHab	Shannon□Habitat	39	73	60	86	1.4	1.2	0.5
InstreamHab	XFC□NAT□SWAMP	39	74	62	86	41	38	27
Riparian	W1□HALL□SWAMP	37	28	14	43	2.7	2.6	1.3
Riparian	XCDENMID	39	60	47	72	25	33	30
Riparian	XCMG	37	67	54	81	58	56	40
Riparian	XPCMG	37	71	58	83	0.25	0.42	0.38
Riparian	XPMGVEG	39	67	55	79	0.40	0.44	0.36
Substrate	PCT□BIGR	39	27	14	41	8	18	23
Substrate	PCT□SAFN	39	62	49	76	43	42	29
Substrate	Shannon□Substrate	39	69	57	80	0.8	0.8	0.5
Substrate	XEMBED	26	89	80	99	32	38	19
Santa Monica Bay								
Biomass	AFDM	53	36	25	47	55	59	40
Biomass	Chlorophyll a	54	39	28	49	67	107	109
Biomass	PCT□CPOM	66	43	33	53	77	71	24
Biomass	PCT□MAP	60	53	42	63	40	40	26
Biomass	PCT□MCP	60	91	85	97	6	13	17
Biomass	PCT□MIAT1	60	91	85	98	0	5	13
Biomass	XMIATP	60	94	89	100	0.08	0.40	1.19
InstreamHab	PCT□FAST	66	77	70	85	17	21	17
InstreamHab	Shannon□Flow	66	86	79	93	2.7	2.8	0.3
InstreamHab	Shannon□Habitat	66	86	80	92	1.6	1.5	0.4
InstreamHab	XFC□NAT□SWAMP	66	90	85	95	84	82	44
Riparian	W1□HALL□SWAMP	66	69	61	78	0.6	1.1	1.3
Riparian	XCDENMID	66	88	82	94	83	71	31
Riparian	XCMG	66	86	81	92	138	124	54
Riparian	XPCMG	66	91	87	96	0.98	0.85	0.31
Riparian	XPMGVEG	66	85	79	91	0.95	0.81	0.34
Substrate	PCT□BIGR	66	70	63	76	43	44	28
Substrate	PCT□SAFN	66	92	87	96	17	24	20
Substrate	Shannon□Substrate	66	88	83	93	1.3	1.2	0.5
Los Angeles								
Biomass	AFDM	31	80	67	92	4	907	2294
Biomass	Chlorophyll a	31	74	61	87	7	133	364
Biomass	PCT□MAP	33	67	52	82	28	33	23
InstreamHab	PCT□FAST	44	77	65	89	53	51	37
InstreamHab	Shannon□Flow	44	72	61	83	2.6	2.6	0.2
InstreamHab	Shannon□Habitat	47	49	39	60	0.9	0.9	0.6
InstreamHab	XFC□NAT□SWAMP	47	45	33	57	14	32	36
Riparian	W1□HALL□SWAMP	44	45	33	56	2.8	2.7	2.4
Riparian	XCDENMID	47	58	45	70	21	31	34

Variable		n	% within Threshold			Median	Mean	SD
			Estimate	95% CI				
Riparian	XCMG	44	32	20	43	16	32	36
Riparian	XPCMG	44	53	40	65	0.09	0.26	0.35
Riparian	XPMGVEG	47	37	26	48	0.00	0.27	0.38
Substrate	PCT□BIGR	47	40	30	50	1	21	26
Substrate	Shannon□Substrate	47	52	38	65	0.5	0.6	0.5
San Gabriel								
Biomass	AFDM	28	72	53	92	5	1758	3644
Biomass	Chlorophyll a	28	75	57	94	6	279	550
Biomass	PCT□MAP	28	52	35	68	36	40	33
InstreamHab	PCT□FAST	40	62	46	77	27	42	39
InstreamHab	Shannon□Flow	40	69	54	83	2.5	2.6	0.3
InstreamHab	Shannon□Habitat	40	39	28	50	0.7	0.8	0.6
InstreamHab	XFC□NAT□SWAMP	40	42	29	55	14	33	40
Riparian	W1□HALL□SWAMP	38	26	19	34	3.2	3.0	1.9
Riparian	XCDENMID	40	50	38	61	11	28	33
Riparian	XCMG	40	35	25	44	9	36	45
Riparian	XPCMG	40	39	28	49	0.00	0.27	0.39
Riparian	XPMGVEG	40	29	19	40	0.00	0.24	0.35
Substrate	PCT□BIGR	40	28	18	39	0	21	30
Substrate	PCT□SAFN	40	91	82	100	6	15	20
Substrate	Shannon□Substrate	40	47	34	60	0.5	0.6	0.6
Substrate	XEMBED	24	91	77	100	34	33	18
Region 8								
Lower Santa Ana								
Biomass	AFDM	29	91	82	99	4	193	754
Biomass	Chlorophyll a	29	91	82	99	9	89	354
Biomass	PCT□MAP	27	57	43	71	39	36	18
InstreamHab	PCT□FAST	38	57	43	71	16	23	28
InstreamHab	Shannon□Flow	38	59	45	74	2.5	2.5	0.3
InstreamHab	Shannon□Habitat	38	66	55	77	1.3	1.2	0.4
InstreamHab	XFC□NAT□SWAMP	38	71	60	82	53	53	45
Riparian	W1□HALL□SWAMP	38	17	7	26	2.3	2.7	1.5
Riparian	XCDENMID	38	50	36	65	18	36	38
Riparian	XCMG	38	46	31	60	27	47	41
Riparian	XPCMG	38	52	38	66	0.10	0.34	0.40
Riparian	XPMGVEG	38	53	38	68	0.28	0.45	0.42
Substrate	PCT□BIGR	38	35	22	47	7	21	25
Substrate	PCT□SAFN	38	69	55	82	48	45	27
Substrate	Shannon□Substrate	38	78	67	88	0.8	0.8	0.4
Substrate	XEMBED	28	87	73	100	37	37	20
Middle Santa Ana								

Variable		n	% within Threshold			Median	Mean	SD
			Estimate	95% CI				
Biomass	AFDM	28	91	79	100	3	11	17
Biomass	PCT□CPOM	52	95	90	100	21	23	21
Biomass	PCT□MAP	32	87	79	95	15	21	20
Biomass	PCT□MCP	32	89	80	98	0	9	14
Biomass	PCT□MIAT1	32	77	63	91	1	13	21
Biomass	XMIATP	32	77	63	91	0.37	0.98	1.66
InstreamHab	PCT□FAST	53	42	31	53	2	22	32
InstreamHab	Shannon□Flow	53	39	29	50	2.3	2.4	0.4
InstreamHab	Shannon□Habitat	54	29	19	40	0.9	0.8	0.6
InstreamHab	XFC□NAT□SWAMP	54	41	32	49	11	28	35
Riparian	W1□HALL□SWAMP	52	49	40	58	1.6	2.0	1.7
Riparian	XCDENMID	54	39	29	48	2	27	36
Riparian	XCMG	53	54	46	62	42	51	49
Riparian	XPCMG	53	47	37	57	0.00	0.36	0.42
Riparian	XPMGVEG	54	58	51	66	0.41	0.46	0.43
Substrate	PCT□BIGR	54	23	17	29	0	17	29
Substrate	PCT□SAFN	54	63	56	69	31	41	40
Substrate	Shannon□Substrate	54	43	33	53	0.4	0.6	0.5
Substrate	XEMBED	28	94	86	100	33	33	20
Upper Santa Ana								
Biomass	PCT□MAP	27	90	82	98	3	13	19
Biomass	PCT□MCP	27	93	85	100	1	8	16
Biomass	XMIATP	27	94	87	100	0.14	0.28	0.52
InstreamHab	PCT□FAST	47	93	87	99	81	66	33
InstreamHab	Shannon□Flow	47	69	57	81	2.6	2.6	0.2
InstreamHab	Shannon□Habitat	52	58	47	68	1.2	1.1	0.5
InstreamHab	XFC□NAT□SWAMP	52	88	81	95	58	63	39
Riparian	W1□HALL□SWAMP	47	96	91	100	0.2	0.4	0.5
Riparian	XCDENMID	52	68	58	78	66	55	38
Riparian	XCMG	47	75	65	86	73	79	54
Riparian	XPCMG	47	63	51	74	0.68	0.51	0.42
Riparian	XPMGVEG	52	79	70	89	0.72	0.64	0.37
Substrate	PCT□BIGR	52	82	74	90	60	55	24
Substrate	PCT□SAFN	52	92	87	98	25	29	17
Substrate	Shannon□Substrate	52	92	86	99	1.1	1.1	0.4
Substrate	XEMBED	49	88	80	96	38	41	11
San Jacinto								
Biomass	AFDM	17	91	79	100	12	19	24
Biomass	PCT□MAP	22	88	76	99	5	13	15
Biomass	PCT□MCP	22	77	62	92	16	20	20
InstreamHab	PCT□FAST	26	44	31	58	5	20	28

Variable		n	% within Threshold			Median	Mean	SD
			Estimate	95% CI				
InstreamHab	Shannon□Flow	26	53	38	69	2.4	2.5	0.2
InstreamHab	Shannon□Habitat	27	72	58	85	1.3	1.2	0.4
Riparian	W1□HALL□SWAMP	26	65	52	77	1.0	1.4	1.4
Riparian	XCDENMID	27	81	74	89	85	69	33
Riparian	XCMG	26	95	87	100	80	93	49
Riparian	XPCMG	26	79	67	91	0.77	0.67	0.39
Riparian	XPMGVEG	27	90	81	99	0.86	0.75	0.30
Substrate	PCT□BIGR	27	65	55	74	39	34	26
Substrate	PCT□SAFN	27	70	56	84	44	46	26
Substrate	Shannon□Substrate	27	83	71	95	1.1	1.0	0.4
Substrate	XEMBED	23	90	79	100	41	41	9
Region 9								
San Juan								
Biomass	AFDM	31	76	62	90	6	1916	7004
Biomass	Chlorophyll a	31	75	60	90	18	123	333
Biomass	PCT□MAP	28	48	31	65	42	41	25
Biomass	PCT□MCP	28	92	85	99	3	10	14
Biomass	PCT□MIAT1	30	82	70	93	0	7	12
Biomass	XMIATP	30	85	75	95	0.04	0.45	0.95
InstreamHab	PCT□FAST	31	83	72	94	31	36	26
InstreamHab	Shannon□Habitat	31	76	63	90	1.4	1.2	0.5
InstreamHab	XFC□NAT□SWAMP	31	74	59	88	46	43	29
Riparian	W1□HALL□SWAMP	31	46	33	58	2.1	2.5	2.1
Riparian	XCDENMID	31	77	62	91	53	50	29
Riparian	XCMG	31	71	56	87	77	74	53
Riparian	XPCMG	31	79	67	92	0.57	0.54	0.36
Riparian	XPMGVEG	31	69	54	83	0.72	0.57	0.42
Substrate	PCT□BIGR	31	54	39	69	29	29	23
Substrate	PCT□SAFN	31	88	80	97	39	36	21
Substrate	Shannon□Substrate	31	69	54	83	0.7	0.8	0.4
Substrate	XEMBED	25	90	80	99	34	34	14
Northern San Diego								
Biomass	AFDM	36	91	84	99	4	12	18
Biomass	Chlorophyll a	36	94	88	100	4	13	26
Biomass	PCT□CPOM	31	90	79	100	41	45	16
Biomass	PCT□MAP	29	76	63	89	13	21	23
Biomass	PCT□MCP	29	79	66	92	15	21	19
InstreamHab	PCT□FAST	31	73	61	85	26	25	24
InstreamHab	Shannon□Flow	31	82	68	96	2.7	2.6	0.3
Riparian	W1□HALL□SWAMP	31	96	91	100	0.1	0.4	0.5
Riparian	XCDENMID	29	93	87	100	70	71	25

Variable		n	% within Threshold			Median	Mean	SD
			Estimate	95% CI				
Substrate	PCT_BIGR	33	55	38	72	28	31	26
Substrate	PCT_SAFN	33	45	20	70	58	57	24
Substrate	Shannon_Substrate	33	84	72	96	1.1	1.0	0.4
Substrate	XEMBED	21	75	54	97	35	40	21
Central San Diego								
Biomass	PCT_CPOM	27	78	62	94	55	55	22
Biomass	PCT_MAP	26	87	76	98	21	22	22
Biomass	PCT_MCP	26	86	74	99	12	20	26
Biomass	PCT_MIAT1	26	78	62	93	9	13	14
Biomass	XMIATP	26	69	51	88	0.66	0.76	0.64
InstreamHab	PCT_FAST	27	70	53	88	12	21	25
InstreamHab	Shannon_Flow	27	85	74	97	2.7	2.7	0.2
InstreamHab	Shannon_Habitat	31	74	58	91	1.5	1.4	0.5
InstreamHab	XFC_NAT_SWAMP	31	80	68	93	70	62	38
Riparian	W1_HALL_SWAMP	27	28	12	44	2.1	2.1	1.1
Riparian	XCMG	28	94	87	100	137	132	55
Riparian	XPCMG	28	90	78	100	0.90	0.77	0.34
Riparian	XPMGVEG	31	94	89	100	0.95	0.88	0.24
Substrate	PCT_BIGR	31	27	13	41	13	18	20
Substrate	PCT_SAFN	31	43	27	59	62	56	29
Substrate	Shannon_Substrate	31	80	65	95	1.1	1.0	0.5
Substrate	XEMBED	23	77	61	93	42	42	23
Mission Bay and San Diego								
Biomass	AFDM	30	95	87	100	4	10	13
Biomass	PCT_CPOM	27	90	82	97	47	48	18
Biomass	PCT_MAP	27	81	68	94	12	21	21
Biomass	PCT_MCP	27	72	58	86	15	22	18
Biomass	PCT_MIAT1	27	77	63	91	2	12	18
Biomass	XMIATP	27	77	62	91	0.44	0.71	0.68
InstreamHab	PCT_FAST	27	66	54	77	17	29	30
InstreamHab	Shannon_Flow	27	78	66	90	2.8	2.8	0.3
InstreamHab	Shannon_Habitat	27	84	75	94	1.5	1.4	0.4
InstreamHab	XFC_NAT_SWAMP	27	88	81	95	82	75	39
Riparian	W1_HALL_SWAMP	27	52	42	62	0.4	1.6	1.8
Riparian	XCDENMID	23	85	76	94	66	53	29
Riparian	XCMG	27	84	75	94	131	110	54
Riparian	XPCMG	27	84	75	94	0.86	0.69	0.35
Riparian	XPMGVEG	27	92	84	100	0.99	0.78	0.31
Substrate	PCT_BIGR	27	51	37	65	28	29	26
Substrate	PCT_SAFN	27	66	51	82	40	44	26
Substrate	Shannon_Substrate	27	88	81	95	1.1	1.1	0.5

Variable		n	% within Threshold			Median	Mean	SD
			Estimate	95% CI				
Substrate	XEMBED	21	91	82	100	39	38	18
Biomass	AFDM	32	76	62	90	5	23	35
Southern San Diego								
Biomass	PCT_CPOM	25	76	62	90	49	50	23
Biomass	PCT_MAP	25	66	50	82	10	24	28
Biomass	PCT_MCP	25	56	36	76	35	34	23
Biomass	PCT_MIAT1	25	89	80	99	4	8	9
Biomass	XMIATP	25	92	82	100	0.51	0.55	0.37
InstreamHab	PCT_FAST	26	85	77	92	29	32	21
InstreamHab	Shannon_Flow	26	94	87	100	2.9	2.8	0.2
InstreamHab	Shannon_Habitat	28	85	74	96	1.4	1.4	0.3
InstreamHab	XFC_NAT_SWAMP	28	94	85	100	60	67	36
Riparian	W1_HALL_SWAMP	25	93	87	99	0.3	0.5	0.6
Riparian	XCDENMID	24	90	77	100	53	58	28
Riparian	XPCMG	26	91	80	100	0.76	0.64	0.33
Substrate	PCT_BIGR	28	48	30	66	25	28	22
Substrate	PCT_SAFN	28	51	33	68	51	52	23
Substrate	Shannon_Substrate	28	95	88	100	1.1	1.0	0.3
Substrate	XEMBED	20	86	72	100	37	39	16

Table 2-6. Relative (RR) and attributable (AR) risks for selected indicators. n: number of sites included in the analysis. 95% CI: 95% confidence interval around estimate. (t) indicates that the total fraction of metals were used in the analysis. (d) indicates that the dissolved fraction of metals were used in the analysis. VH: Very high priority (i.e., attributable risk ≥ 0.25 for at least 1 indicator). H: High priority (i.e., attributable risk ≥ 0.1 for at least 1 indicator). M: Moderate priority (i.e., relative risk > 1). L: Low priority (relative risk ≤ 1). Physical habitat variable abbreviations are provided in Table 2-2. *Some chemistry variables are excluded because they had too few exceedances of thresholds to permit relative risk analysis.

Stressor	Priority	CSCI							D18							S2						
		RR	95% CI		AR	95% CI		n	RR	95% CI		AR	95% CI		n	RR	95% CI		AR	95% CI		n
Chemistry																						
Nutrients																						
TP	VH	2.8	2.1	3.7	0.51	0.39	0.61	469	2.4	1.8	3.1	0.46	0.34	0.56	411	2.1	1.7	2.6	0.08	0.06	0.11	411
TN	VH	2.7	2.0	3.8	0.51	0.36	0.63	473	1.7	1.4	2.2	0.32	0.18	0.43	439	2.7	1.9	3.8	0.53	0.37	0.65	439
NH4	M	1.1	0.5	2.5	0.00	0.00	0.01	473	1.0	0.5	2.4	0.00	0.00	0.01	412	0.6	0.1	2.9	0.00	0.00	0.00	412
Metals																						
Se (d)	M	1.8	1.6	2.0	0.08	0.05	0.11	454	1.5	1.4	1.7	0.06	0.04	0.09	437	1.5	1.3	1.8	0.06	0.03	0.09	438
Cu (d)	M	1.7	1.6	1.8	0.00	0.00	0.01	428	1.6	1.5	1.7	0.00	0.00	0.00	435	1.7	1.5	1.8	0.00	0.00	0.00	437
Se (t)	M	1.5	1.3	1.7	0.06	0.03	0.09	441	1.4	1.2	1.6	0.05	0.02	0.08	450	1.4	1.2	1.6	0.05	0.02	0.08	452
Cu (t)	M	1.4	1.1	1.8	0.02	0.00	0.04	441	1.2	0.9	1.7	0.01	0.00	0.03	450	1.6	1.4	1.9	0.02	0.01	0.04	452
Pb (t)	L	0.8	0.5	1.3	0.00	0.00	0.01	441	0.6	0.4	1.1	0.00	0.00	0.00	450	1.0	0.7	1.4	0.00	0.00	0.02	452
Pyrethroids																						
Bifenthrin	M	1.6	1.4	1.9	0.09	0.05	0.13	415	1.4	1.2	1.7	0.06	0.03	0.10	423	1.5	1.2	1.7	0.07	0.03	0.10	425
Delta Tralomethrin	M	1.6	1.1	2.3	0.05	0.00	0.11	162	1.1	0.7	1.5	0.01	0.00	0.04	168	0.4	0.2	0.9	0.00	0.00	0.00	168
Cypermethrin	M	1.5	1.3	1.8	0.04	0.01	0.07	415	1.2	0.9	1.6	0.01	0.00	0.04	423	1.4	1.1	1.8	0.03	0.00	0.06	425
Cyfluthrin	M	1.4	1.2	1.8	0.03	0.00	0.06	415	1.3	1.0	1.7	0.02	0.00	0.04	423	1.3	0.9	1.7	0.02	0.00	0.04	425
Cyhalothrin	M	1.3	1.0	1.6	0.01	0.00	0.03	415	1.1	0.8	1.6	0.01	0.00	0.03	423	1.0	0.7	1.5	0.00	0.00	0.02	425
Esfenvalerate Fenvalerate	M	1.3	0.8	2.1	0.01	0.00	0.02	391	1.2	0.8	2.0	0.00	0.00	0.01	399	1.2	0.7	2.0	0.00	0.00	0.01	401
Permethrin	M	1.1	0.7	1.6	0.00	0.00	0.02	415	1.6	1.5	1.7	0.02	0.01	0.03	423	0.8	0.5	1.4	0.00	0.00	0.01	425
Other chemistry																						
TDS	VH	5.2	2.1	12.6	0.76	0.44	0.90	221	1.8	1.3	2.6	0.38	0.16	0.55	222	3.1	1.9	5.3	0.62	0.39	0.76	222
pH	H	1.9	1.7	2.1	0.12	0.08	0.16	593	1.2	1.0	1.5	0.03	0.00	0.07	492	1.6	1.4	1.8	0.08	0.05	0.12	491
Cl	H	1.9	1.6	2.1	0.14	0.09	0.19	489	1.3	1.1	1.5	0.05	0.01	0.09	436	1.1	0.9	1.3	0.02	0.00	0.06	437
SO4	VH	1.8	1.5	2.1	0.26	0.17	0.34	489	1.5	1.3	1.7	0.19	0.11	0.26	459	1.4	1.2	1.7	0.17	0.08	0.24	459
SpCond	H	1.7	1.5	1.9	0.14	0.10	0.18	603	1.5	1.3	1.7	0.13	0.08	0.18	494	1.5	1.3	1.8	0.13	0.08	0.18	493
TSS	H	1.7	1.4	2.0	0.14	0.08	0.19	485	1.3	1.1	1.6	0.07	0.03	0.12	422	1.2	1.0	1.4	0.04	0.00	0.10	423

Stressor	Priority	CSCI							D18							S2						
		RR	95% CI		AR	95% CI		n	RR	95% CI		AR	95% CI		n	RR	95% CI		AR	95% CI		n
Turbidity	H	1.5	1.2	1.8	0.10	0.04	0.16	379	1.2	1.0	1.5	0.06	0.00	0.12	292	0.9	0.7	1.2	0.00	0.00	0.05	289
PHAB																						
Biomass																						
PCT□MAP	H	1.5	1.3	1.8	0.15	0.08	0.21	433	1.3	1.1	1.5	0.08	0.02	0.14	432	1.5	1.3	1.7	0.14	0.08	0.19	431
PCT□CPOM	M	1.2	1.0	1.5	0.02	0.00	0.04	534	1.1	0.9	1.4	0.01	0.00	0.04	494	1.0	0.8	1.2	0.00	0.00	0.02	493
Chl a	M	1.2	0.9	1.4	0.03	0.00	0.07	495	1.2	1.0	1.4	0.03	0.00	0.06	480	1.3	1.1	1.5	0.05	0.02	0.09	479
PCT□MIAT1	M	1.1	0.9	1.5	0.01	0.00	0.04	470	0.9	0.7	1.2	0.00	0.00	0.01	469	0.8	0.6	1.2	0.00	0.00	0.01	468
XMIATP	M	1.1	0.9	1.5	0.01	0.00	0.04	470	0.9	0.7	1.2	0.00	0.00	0.01	469	1.0	0.7	1.3	0.00	0.00	0.02	468
AFDM	M	1.0	0.8	1.3	0.01	0.00	0.05	490	1.1	0.9	1.3	0.02	0.00	0.06	477	1.2	1.0	1.4	0.04	0.00	0.08	476
PCT□MCP	L	0.9	0.7	1.2	0.00	0.00	0.02	433	0.9	0.7	1.2	0.00	0.00	0.02	432	0.8	0.6	1.1	0.00	0.00	0.00	431
Substrate																						
PCT□BIGR	VH	3.1	2.5	3.9	0.51	0.42	0.59	568	2.0	1.7	2.4	0.34	0.26	0.42	494	2.0	1.7	2.4	0.35	0.26	0.42	493
Shannon□Substrate	VH	2.4	2.1	2.7	0.27	0.21	0.32	568	1.4	1.2	1.7	0.11	0.05	0.16	494	1.6	1.4	1.8	0.14	0.09	0.19	493
XEMBED	M	1.3	0.9	1.9	0.04	0.00	0.08	432	1.5	1.3	1.9	0.04	0.01	0.07	374	1.7	1.3	2.3	0.04	0.02	0.07	372
PCT□SAFN	H	1.3	1.1	1.5	0.06	0.02	0.10	568	1.5	1.3	1.7	0.11	0.07	0.14	494	1.3	1.1	1.5	0.06	0.02	0.10	493
Instream habitat																						
XFC□NAT	VH	2.5	2.2	2.9	0.30	0.24	0.35	568	1.3	1.1	1.5	0.07	0.02	0.12	494	1.6	1.4	1.9	0.15	0.10	0.20	493
Shannon□Habitat	VH	2.3	2.0	2.6	0.28	0.22	0.34	568	1.3	1.1	1.5	0.09	0.04	0.15	494	1.6	1.4	1.9	0.17	0.11	0.22	493
PCT□FAST	H	1.7	1.4	1.9	0.14	0.09	0.19	536	1.3	1.1	1.5	0.07	0.02	0.11	494	1.3	1.1	1.5	0.07	0.02	0.11	493
Shannon□Flow	H	1.6	1.4	1.9	0.11	0.07	0.16	536	1.3	1.1	1.5	0.05	0.01	0.09	494	1.4	1.2	1.7	0.07	0.03	0.11	493
Riparian																						
W1□HALL	VH	3.0	2.5	3.6	0.47	0.40	0.54	534	1.8	1.5	2.1	0.25	0.18	0.32	494	1.8	1.6	2.1	0.26	0.19	0.33	493
XCMG	VH	2.4	2.1	2.7	0.30	0.25	0.36	537	1.4	1.2	1.6	0.11	0.06	0.16	494	1.5	1.3	1.8	0.14	0.09	0.20	493
XPMGVEG	VH	2.1	1.9	2.5	0.25	0.19	0.30	568	1.4	1.3	1.7	0.12	0.07	0.17	494	1.5	1.3	1.7	0.14	0.08	0.19	493
XPCMG	H	2.0	1.8	2.3	0.23	0.17	0.28	537	1.3	1.1	1.5	0.07	0.02	0.12	494	1.4	1.2	1.6	0.11	0.06	0.15	493
XCDENMID	H	1.9	1.7	2.3	0.22	0.16	0.28	551	1.2	1.0	1.4	0.05	0.00	0.10	478	1.3	1.1	1.5	0.08	0.03	0.14	477
Toxicity																						
Toxicity (lethal)	M	1.3	1.0	1.7	0.02	0.00	0.04	420	1.2	1.0	1.6	0.02	0.00	0.03	437	1.3	1.1	1.7	0.02	0.00	0.04	438
Toxicity (all endpoints)	M	1.0	0.8	1.2	0.00	0.00	0.05	420	1.2	1.0	1.4	0.05	0.00	0.11	437	1.0	0.8	1.2	0.01	0.00	0.06	438

Table 2-7. Summary of stressor prioritization.

Very high (AR > 0.25)	High (AR 0.1 to 0.25)	Moderate (RR >1)	Low (RR <1)
Water Chemistry	Water Chemistry	Water Chemistry	Water Chemistry
Nutrients	*Other chemistry*	*Nutrients*	*Metals*
TP	Cl	NH4	Pb (t)
TN	pH	*Metals*	Habitat
Habitat	TSS	As (t)	*Biomass*
Instream habitat	SpCond	Se (t, d)	PCT□MCP
XFC□NAT	Habitat	Cu (t, d)	
Shannon□Habitat	*Biomass*	*Pyrethroids*	
Substrate	PCT□MAP	Delta□Tralomethrin	
Shannon□Substrate	*Instream habitat*	Esfenvalerate□Fenvalerate	
PCT□BIGR	Shannon□Flow	Permethrin	
Riparian	PCT□FAST	Cyhalothrin	
XPMGVEG	*Substrate*	Cyfluthrin	
XCMG	PCT□SAFN	Cypermethrin	
W1□HALL	*Riparian*	Bifenthrin	
	XCDENMID	Habitat	
	XPCMG	*Biomass*	
		PCT□MIAT1	
		XMIATP	
		PCT□CPOM	
		AFDM	
		Chl a	
		Substrate	
		XEMBED	
		Toxicity	
		Reproduction	
		Survival	

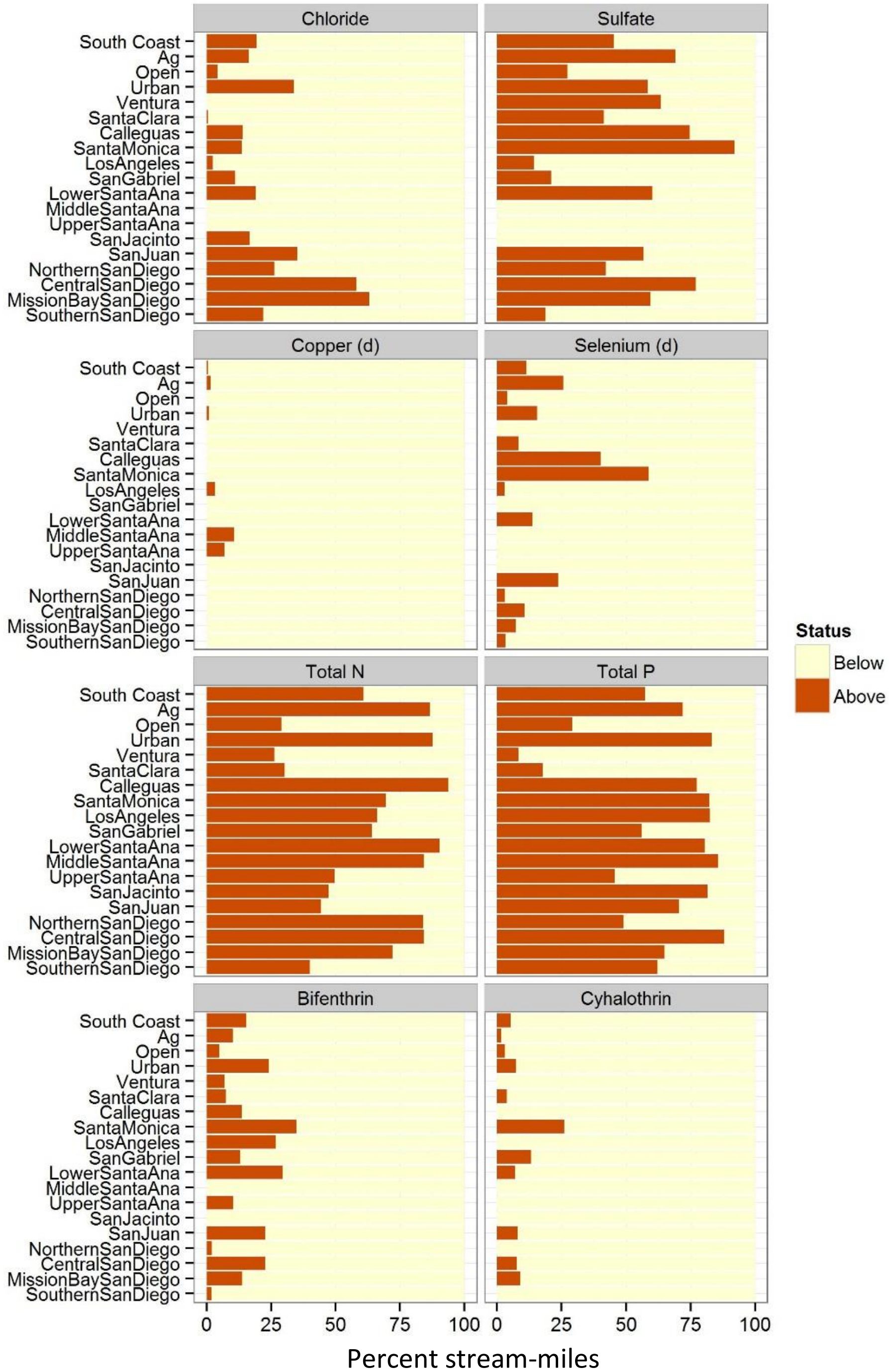


Figure 2-1. Extents of selected water-chemistry variables exceeding thresholds.

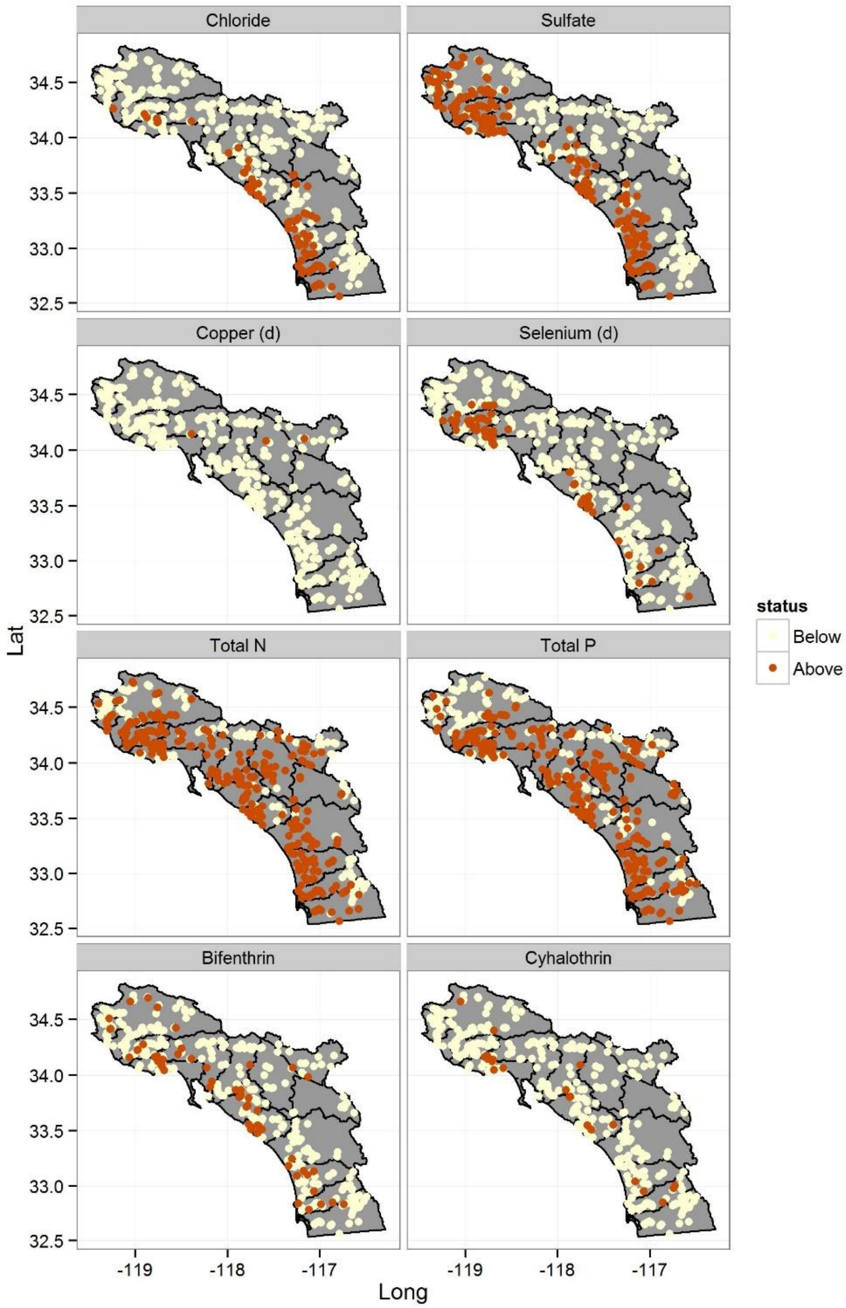


Figure 2-2. Maps of selected water-chemistry variables

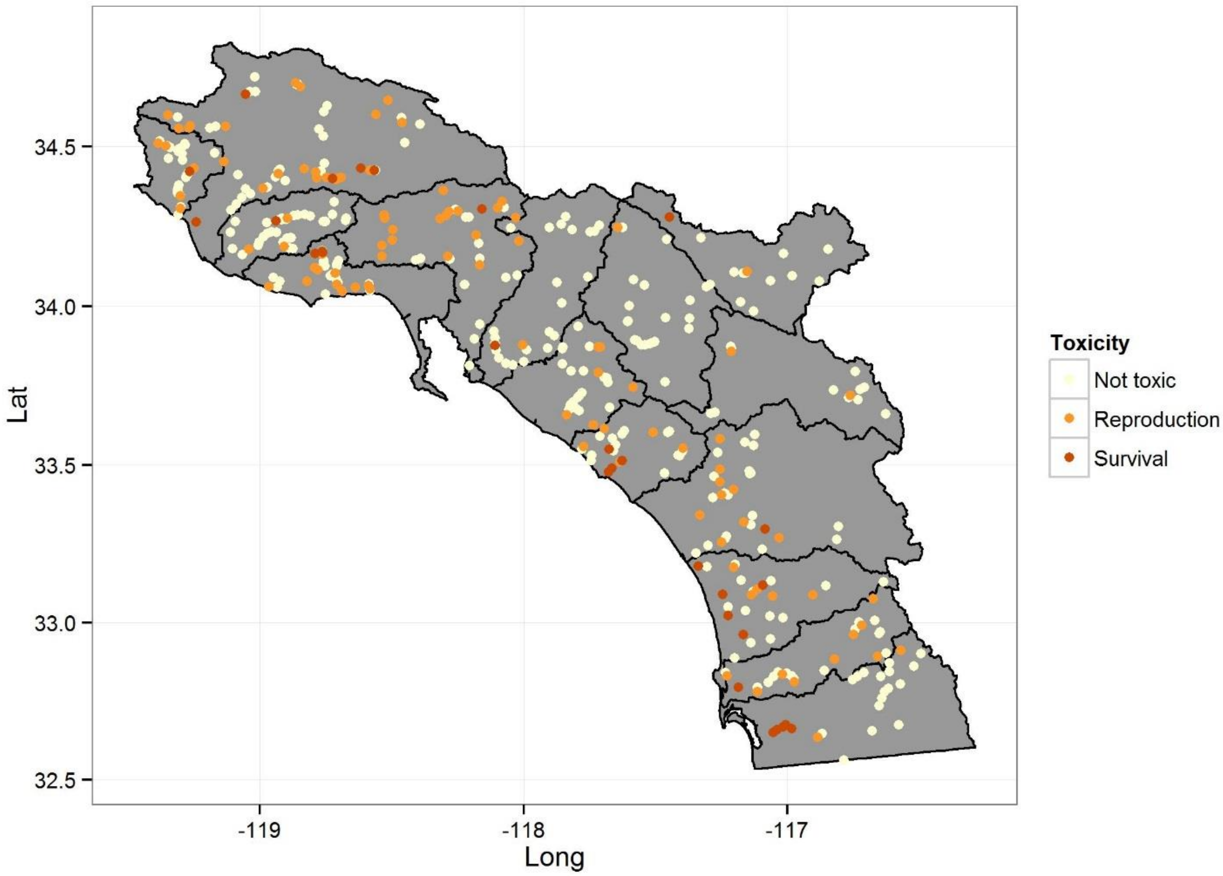


Figure 2-3. Map of toxicity.

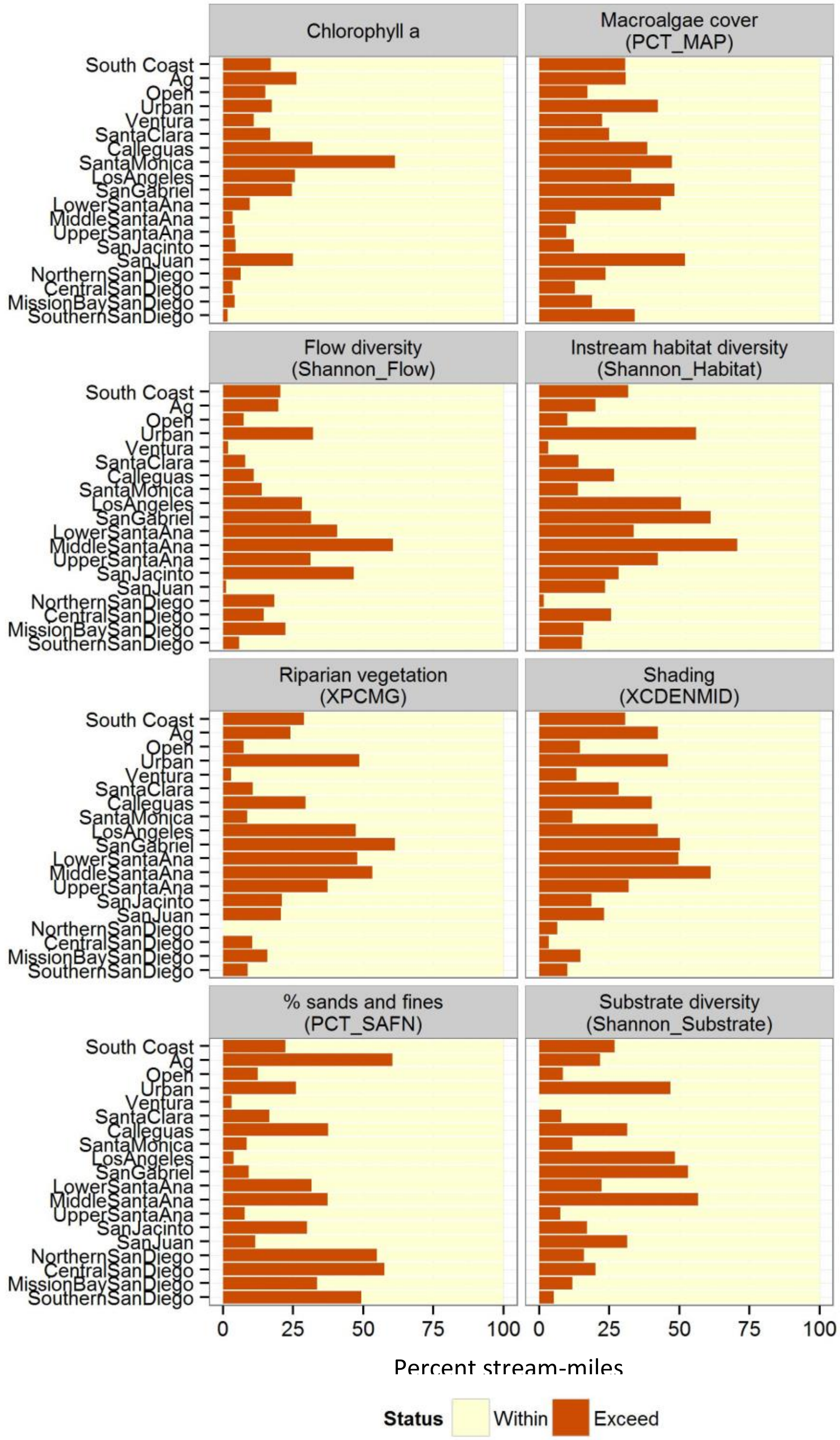


Figure 2-4. Extents of selected physical habitat variables.

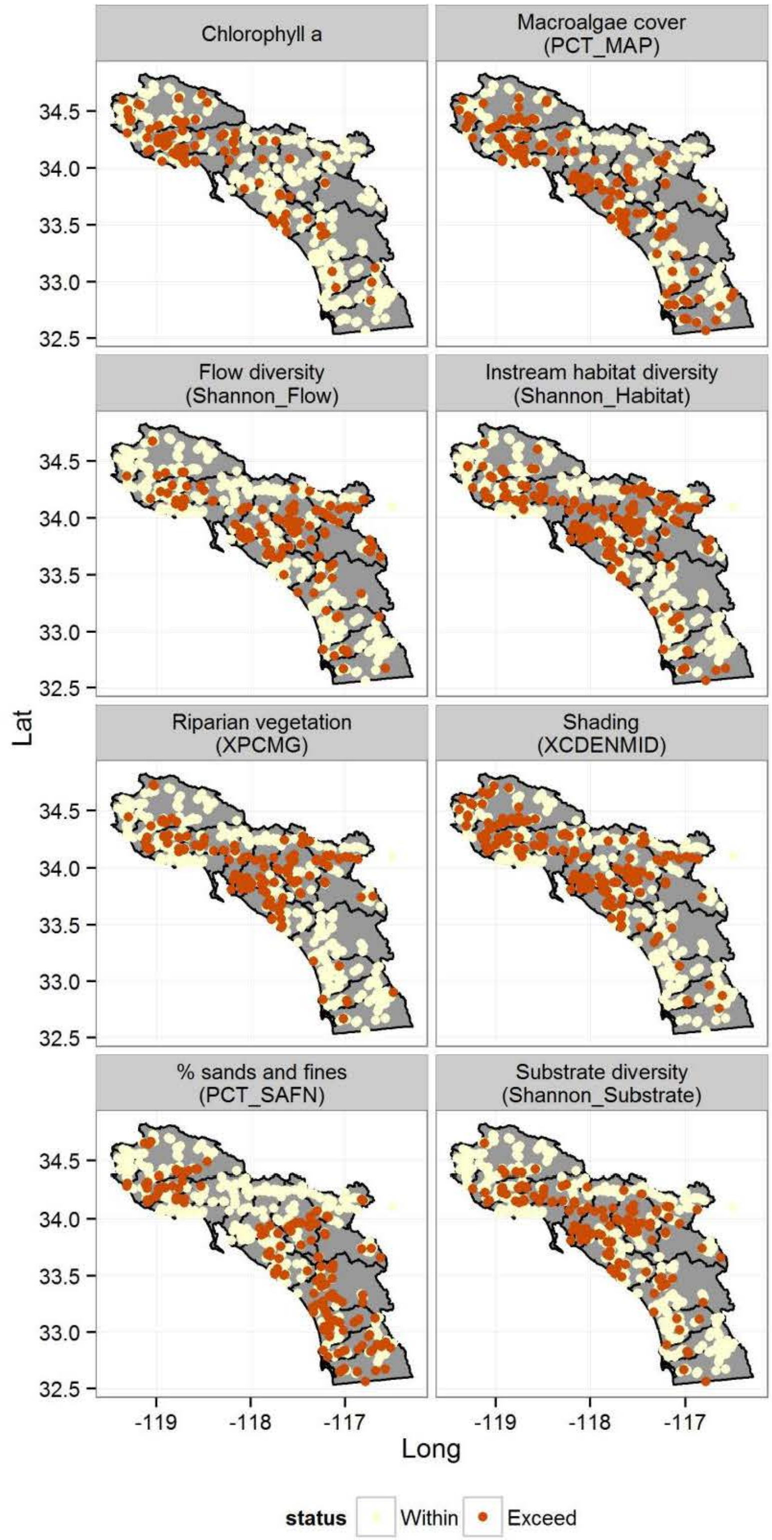


Figure 2-5. Map of selected physical habitat variables.

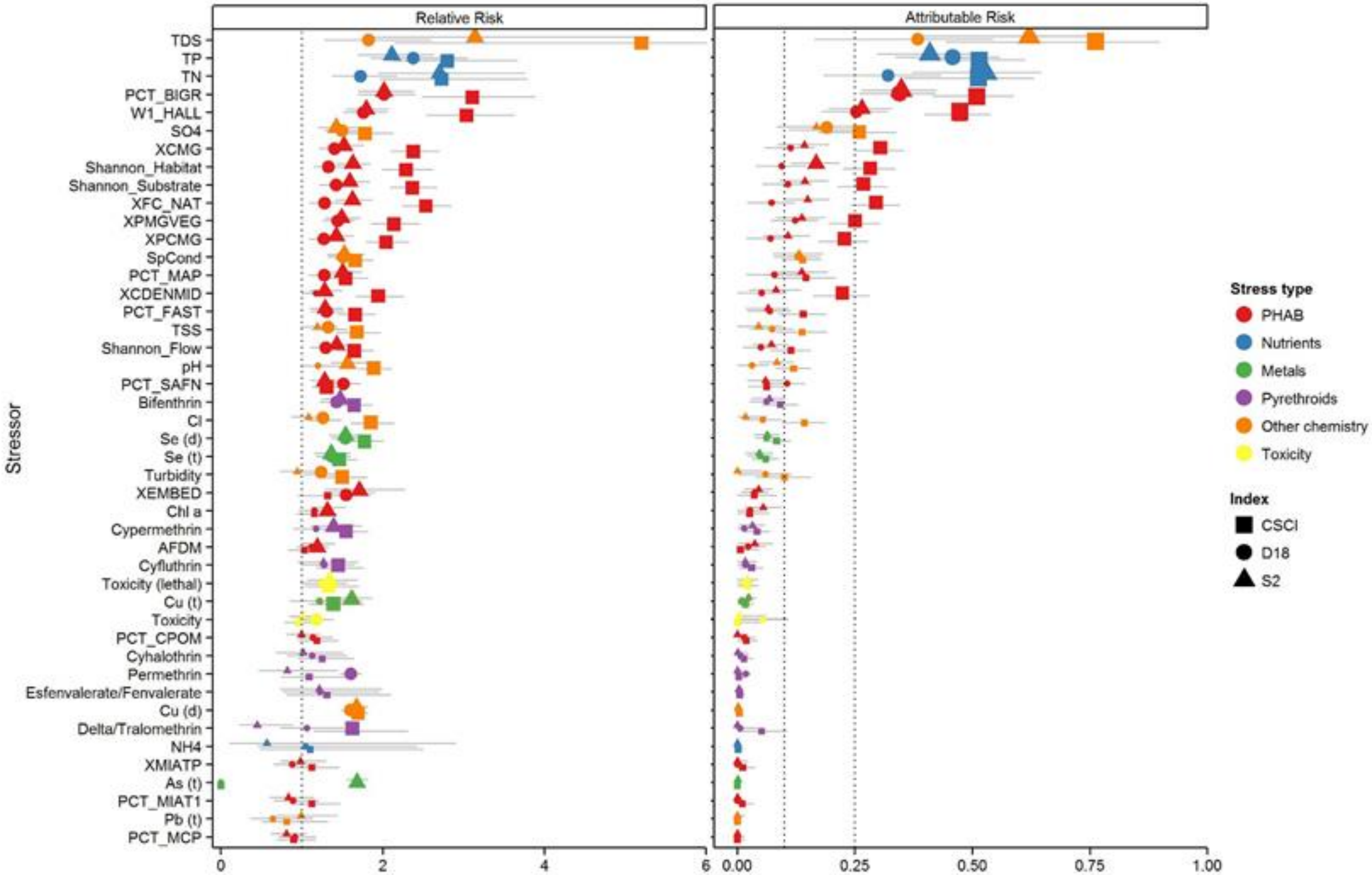


Figure 2.6. Relative and attributable risks. The horizontal lines represent the 95% confidence interval around each estimate. The dotted vertical lines represent the thresholds used to prioritize stressors.

QUESTION 3: HOW ARE BIOLOGICAL CONDITIONS CHANGING OVER TIME?

Murrieta Creek, Fall 2003

Murrieta Creek, Spring 2004

Changes in land use, such as the installation of a sand mining operation, can profoundly alter the habitat and degrade biological condition.
Photos by Scott Johnson.

Introduction

Analysis of trends allows managers to assess the effects of policies that have been implemented during the study period, the influence of disturbances like wildfire, or other activities that might change the biological condition of streams in the region. Changes observed in the region provide context to understanding site specific changes. For example, if conditions deteriorate in less disturbed areas (such as open streams), then degradation observed at an urban site might be attributable to regional stressors, such as climate change or atmospheric deposition of nutrients, rather than to management activities.

Methods

Data Collection

Data were collected as described in the Survey Overview.

Data Aggregation

Where multiple samples were collected at a single site within a year, data were aggregated as the maximum value within a site. Missing values were ignored for all relevant analyses, where appropriate.

Thresholds

Thresholds were applied as described in the section on Question 1.

Weighted Magnitudes and Extent Estimates

Weighted estimates were calculated as described in the section on Question 1, using each year (or year within land use class) as a stratum. Extents of streams in each condition class were estimated for the CSCI, S2, D18, and CRAM. In addition, the extent of streams intact for all indicators was estimated as well.

Results

All data used in this report can be downloaded from ftp.sccwrp.org/pub/download/SMCReport/SMCDataFor5yearReport.zip.

Since 2009, no obvious trends were evident for any indicator, although all indicators showed a slight depression in scores in the year 2010 (Tables 3-1 and 3-2; Figure 3-1). The median score for the CSCI, S2, and CRAM fluctuated between Class 2 and 3, while D18 fluctuated between Class 3 and 4. The percent of streams that were intact for all four indicators was highest (at 36%) in 2012, but was only 14% in 2010 (Figure 3-2). Most of the fluctuations in score affected the open streams, while the extent of healthy agricultural and urban streams remained low throughout the survey (Table 3-1, 3-2). Extent estimates were particularly imprecise for agricultural streams, as in some years very few of these sites were sampled (e.g., 5 agricultural sites were sampled for all indicators in 2011 and 2012), leading to erratic confidence intervals

(Figure 3-1). Although CSCI scores were generally high in the earlier years of the survey, these estimates were based on very small sample sizes (<25 sites in any year), and should be interpreted with caution.

Discussion

We were unable to detect trends in condition. Our inability to detect trends stems from the relatively short time frame of the survey (i.e., 5 years), as well as a study design that did not include site revisits over multiple years. These two characteristics of the survey make it difficult to distinguish trends from natural variation driven by climate or other factors. Given that a different set of sites was examined each year, the regional focus of the program, and that only five years of data are presented, it is not surprising that no distinct trends were observed. For a trend at this regional scale to be evident, a longer time period would be required and/or site revisits. It is possible that site-specific management activities affecting stream health were within the sample frame, but may have been obscured by the overall regional focus. Revisiting sites sampled in early years of this survey would provide site-specific trend estimates, which could then provide a better estimate of trends across the region. Additionally, we would be able to explore potential drivers of any observed trends.

Table 3-1. Medians for key indicators by year.

Subpopulation	2009	2010	2011	2012	2013
South Coast					
CSCI	0.71	0.70	0.81	0.80	0.65
D18	55	50	54	59	57
S2	37	34	39	43	50
CRAM	71	62	72	69	67
Agricultural					
CSCI	0.70	0.74	0.79	0.79	0.71
D18	49	49	67	61	37
S2	25	17	17	41	38
CRAM	64	66	66	74	72
Open					
CSCI	0.95	0.77	0.93	0.95	0.96
D18	75	67	68	71	75
S2	83	75	52	68	61
CRAM	82	78	83	82	84
Urban					
CSCI	0.65	0.52	0.61	0.67	0.53
D18	52	41	41	39	35
S2	33	26	27	33	48
CRAM	56	45	40	37	52

Table 3-2. Percent of stream-miles within the 10th percentile of scores at reference sites for each year

Subpopulation	2009	2010	2011	2012	2013
South Coast					
CSCI	41	28	56	52	36
D18	41	35	38	45	43
S2	34	41	36	44	59
CRAM	46	34	50	48	39
Multiple indicators	23	14	24	36	31
Agricultural					
CSCI	42	39	47	35	39
D18	28	19	61	33	42
S2	15	4	19	28	17
CRAM	25	36	35	77	51
Multiple indicators	2	8	0	40	22
Open					
CSCI	84	46	88	87	82
D18	70	62	60	71	79
S2	70	86	54	84	72
CRAM	87	70	91	85	89
Multiple indicators	57	34	51	83	79
Urban					
CSCI	8	12	19	17	7
D18	20	24	17	26	20
S2	11	23	19	12	58
CRAM	23	13	12	15	11
Multiple indicators	1	4	0	1	3

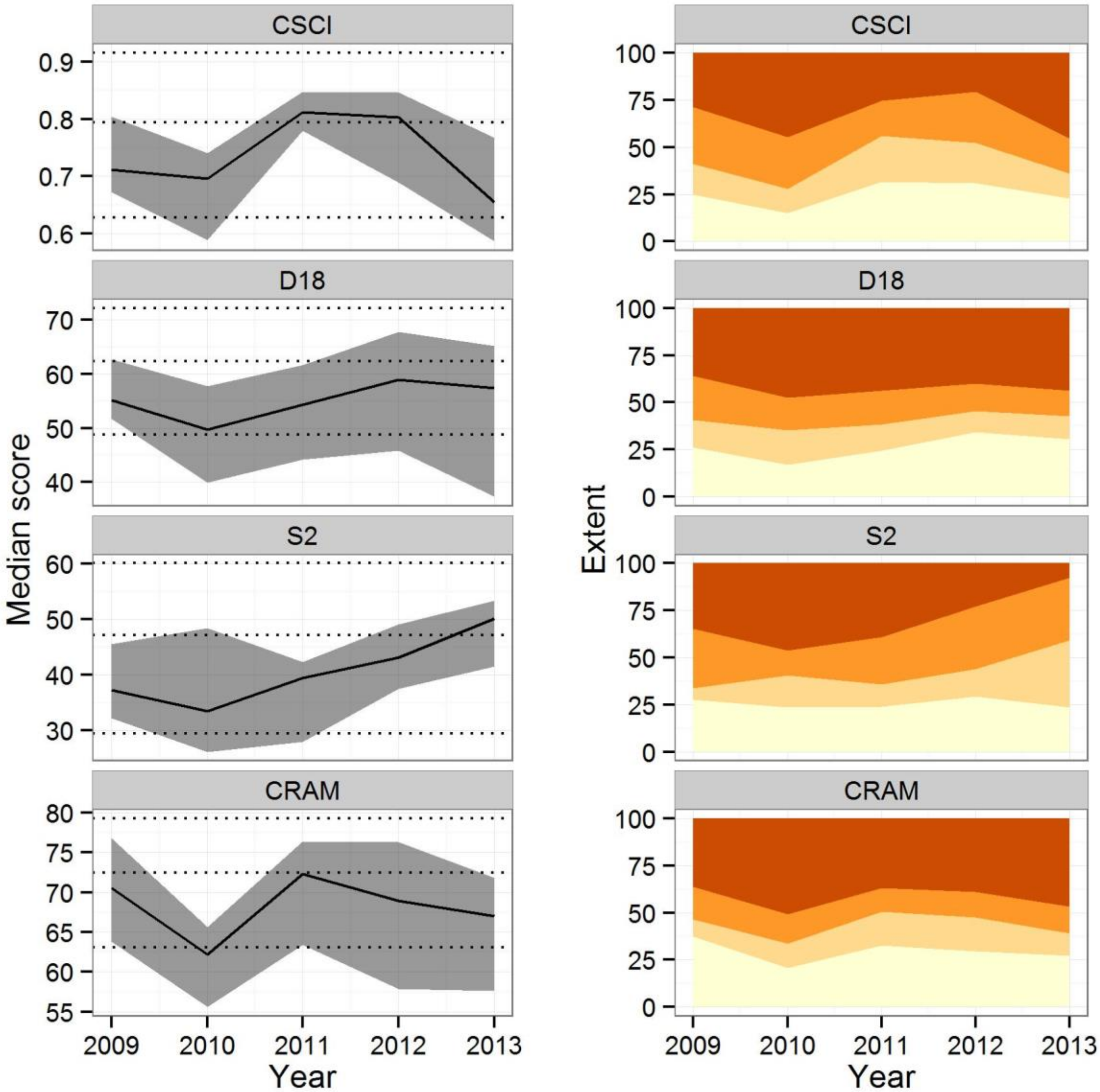


Figure 3-1. Median score and extent of condition classes by year for each indicator. The gray band in the left panel indicates the 95% confidence interval. Color in the right panel indicates condition class; lighter colors indicate better condition.

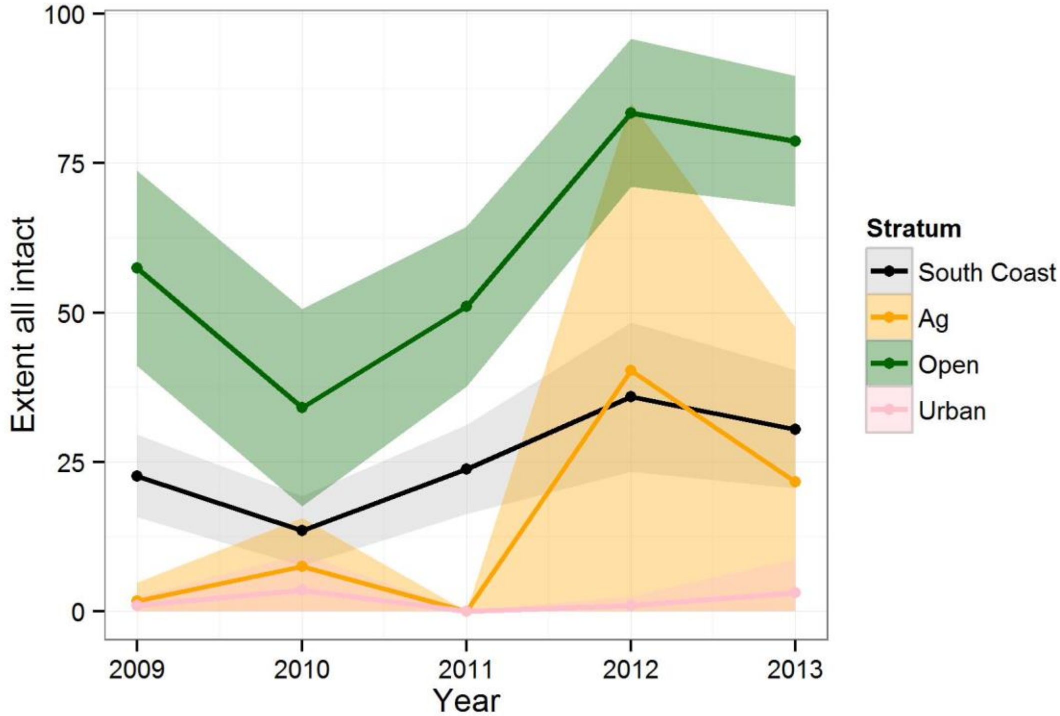


Figure 3-2. Percent of stream-miles that were intact for all four indicators

RECOMMENDATIONS

- Continue the survey for another five years, focusing on key biological indicators of stream condition, as well as high-priority stressors.
- Expand the survey to include nonperennial streams.
- Improve trend estimates by revisiting previously sampled probabilistic sites.
- Continue to investigate high priority stressors, such as habitat degradation and nutrient enrichment.
- Support studies that identify constraints on biological condition imposed by natural factors, channel engineering, water chemistry, and habitat degradation.

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Appendix 2

Appendix 7-B

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A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams

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ABSTRACT / We developed a benthic macroinvertebrate index of biological integrity (B-IBI) for the semiarid and populous southern California coastal region. Potential reference sites were screened from a pool of 275 sites, first with quantitative GIS landscape analysis at several spatial scales and then with local condition assessments (in-stream and riparian) that quantified stressors acting on study reaches. We screened 61 candidate metrics for inclusion in the B-IBI based on three criteria: sufficient range for scoring, responsiveness to watershed and reach-scale disturbance gradients, and minimal correlation with other responsive metrics. Final metrics included: percent collector-gatherer + collector-filterer individuals, percent noninsect taxa, percent tolerant taxa, Coleoptera richness, predator richness, percent intolerant individuals, and EPT richness. Three metrics had lower scores in chaparral reference sites than in mountain reference sites and were scored on separate scales in the B-IBI. Metrics were scored and assembled into a composite B-IBI, which was then divided into five roughly equal condition categories. PCA analysis was used to demonstrate that the B-IBI was sensitive to composite stressor gradients; we also confirmed that the B-IBI scores were not correlated with elevation, season, or watershed area. Application of the B-IBI to an independent validation dataset (69 sites) produced results congruent with the development dataset and a separate repeatability study at four sites in the region confirmed that the B-IBI scoring is precise. The SoCal B-IBI is an effective tool with strong performance characteristics and provides a practical means of evaluating biotic condition of streams in southern coastal California.

Assemblages of freshwater organisms (e.g., fish, macroinvertebrates, and periphyton) are commonly used to assess the biotic condition of streams, lakes, and wetlands because the integrity of these assemblages provides a direct measure of ecological condition of these water bodies (Karr and Chu 1999). Both multimetric (Karr and others 1986; Kerans and Karr 1994; McCormick and others 2001; Klemm and others 2003) and multivariate (Wright and others 1983; Hawkins and others 2000; Reynoldson and others 2001) methods have been developed to characterize biotic condition and to establish thresholds of ecological impairment. In both approaches, the ability to recognize degradation at study sites relies on an understanding of the organismal assemblages expected in the absence of disturbance. Thus, the adoption of a consistent and quantifiable method for defining reference condition is fundamental to any biomonitoring program (Hughes 1995).

KEY WORDS: Benthic macroinvertebrates; B-IBI; Biomonitoring; Mediterranean climate

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Southern California faces daunting challenges in the conservation of its freshwater resources due to its aridity, its rapidly increasing human population, and its role as one of the world's top agricultural producers. In recent years, several state and federal agencies have become increasingly involved in developing analytical tools that can be used to assess the biological and physical condition of California's streams and rivers. For example, the US Environmental Protection Agency (EPA), the US Forest Service (USFS), and California's state and regional Water Quality Control Boards (WQCBs) have collected fish, periphyton and benthic macroinvertebrates (BMIs) from California streams and rivers as a critical component of regional water quality assessment and management programs. Together, these agencies have sampled BMIs from thousands of sites in California, but no analysis of BMI assemblage datasets based on comprehensively defined regional reference conditions has yet been undertaken. In the only other large-scale study within the state, Hawkins and others (2000) developed a predictive model of biotic integrity for third- to fourth-order streams on USFS lands in three montane regions in northern California. This ongoing effort (Hawkins unpublished) is an important contribution to bioassessment in the state, but the emphasis of this work has been concentrated on logging impacts within USFS lands. The lack of a broadly defined context for interpretation of BMI-based bioassessment remains the single largest impediment to the development of biocriteria for the majority of California streams and rivers. This article presents a benthic index of biotic integrity (B-IBI) for wadeable streams in southern coastal California assembled from BMI data collected in the region by the USFS, EPA, and state and regional WQCBs between 2000 and 2003.

Methods

Study Area

The Southern Coastal California B-IBI (SoCal B-IBI) was developed for the region bounded by Monterey County in the north, the Mexican border in the south, and inland by the eastern extent of the southern Coast Ranges (Figure 1). This Mediterranean climate region comprises two Level III ecoregions (Figure 1; Omernik 1987) and shares a common geology (dominated by recently uplifted and poorly consolidated marine sediments) and hydrology (precipitation averages 10–20 in./year in the lower elevations and 20–30 in./year in upper elevations, reaching 30–40 in./year in the highest elevations and in some isolated coastal watersheds (Spatial Climate Analysis Service, Oregon State University, www.climatesource.com). The human population in the region was approximately 20 million in 2000 and is projected to exceed 28 million by 2025 (California Department of Finance, Demographic Research Unit, www.dof.ca.gov).

Field Protocols and Combining Datasets

The SoCal B-IBI is based on BMI and physical habitat data collected from 275 sites (Figure 1) using the 3 protocols described in the following subsections. Sites were sampled during base flow periods between April and October of 2000–2003.

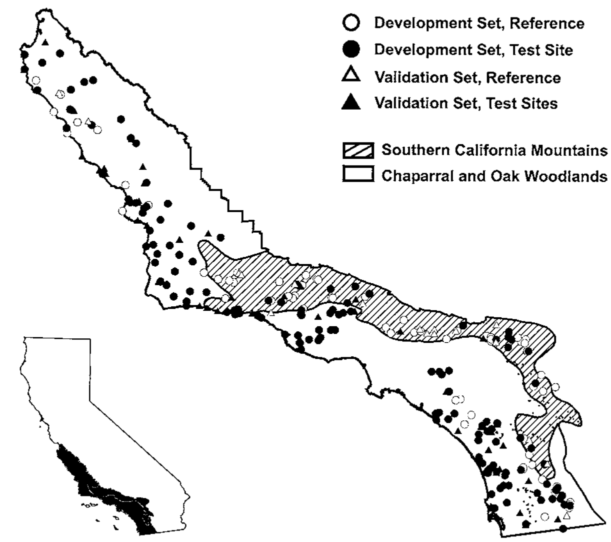

Figure 1. Map of study area showing the location of the study area within California, the distribution of test and reference sites and development and validation sites, and the boundaries of the two main ecoregions in the study area.

California Stream Bioassessment Protocol (CSBP, 144 sites). Several of the regional WQCBs in southern coastal California have implemented biomonitoring programs in their respective jurisdictions and have collected BMIs according to the CSBP (Harrington 1999). At CSBP sites, three riffles within a 100-m reach were randomly selected for sampling. At each riffle, a transect was established perpendicular to the flow, from which three separate areas of 0.18 m^2 each were sampled upstream of a 0.3-m-wide D-frame net and composited by transect. A total of 1.82 m^2 of substrate was sampled per reach and 900 organisms were subsampled from this material (300 organisms were processed separately from each of 3 transects). Water chemistry data were collected in accordance with the protocols of the different regional WQCBs (Puckett 2002) and qualitative physical habitat characteristics were measured according to Barbour and others (1999) and Harrington (1999).

USFS (56 sites). The USFS sampled streams on national forest lands in southern California in 2000 and 2001 using the targeted riffle protocol of Hawkins and others (2001). All study reaches were selected nonrandomly as part of a program to develop an interpretive (reference) framework for the results of stream biomonitoring studies on national forests in California. BMIs were sampled at study reaches (containing at least four fast-water habitat units) by disturbing two separate 0.09-m^2 areas of substrate upstream of a 0.3-m-wide D-frame net in each of four separate fast-water units; a total of 0.72 m^2 was disturbed and all sample material from a reach was composited. Field crews used a combination of qualitative and quantitative measures to collect physical habitat and water chemistry data (Hawkins and others 2001). A 500-organism subsample was processed from the composite sample and identified following methods described by Vinson and Hawkins (1996).

Environmental Monitoring and Assessment Program (EMAP, 75 sites). The EPA sampled study reaches in southern coastal California from 2000 through 2003 as part of its Western EMAP pilot project. A sampling reach was defined as 40 times the average stream width at the center of the reach, with a minimum reach length of 150-m and maximum length of 500-m. A BMI sample was collected at each site using the USFS methodology described earlier (Hawkins and others 2001) in addition to a standard EMAP BMI sample (not used in this analysis). A 500-organism subsample was processed in the laboratory according to EMAP standard taxonomic effort levels (Klemm and others 1990). Water chemistry samples were collected from the midpoint of each reach and analyzed using EMAP protocols (Klemm and Lazorchak 1994). Field crews recorded physical habitat data using EPA qualitative methods (Barbour and others 1999) and quantitative methods (Kaufmann and others 1999).

As part of a methods comparison study, 77 sites were sampled between 2000 and 2001 with both the CSBP and USFS protocols. The two main differences between the methods are the area sampled and the number of organisms subsampled (discussed earlier). To determine the effect of sampling methodology on assessment of biotic condition, we compared the average difference in a biotic index score between the two methods at each site. Biotic index scores were computed with seven commonly used biotic metrics (taxonomic richness, Ephemoptera, Plecoptera, and Trichoptera (EPT) richness, percent dominant taxon, sensitive EPT individuals, Shannon diversity, percent intolerant taxa, and percent scraper individuals) according to the following equation:

$$Score = \sum (x_i - \bar{x})/sem_i$$

where x_i is the site value for the ith metric, x is the overall mean for the ith metric, and SEM_i is the standard error of the mean for the ith metric. A score of zero is the mean value.

Because USFS-style riffle samples were collected at all EMAP sites, only two field methods were combined in this study. All EMAP and CSBP samples were collected and processed by the California Department of Fish and Game's Aquatic Bioassessment Laboratory (ABL) and all USFS samples were processed by the US Bureau of Land Management's Bug Lab in Logan, Utah. Taxonomic data from both labs were combined in an MS Access© database application that standardized BMI taxonomic effort levels and metric calculations, allowing us to minimize any differences between the two labs that processed samples. Taxonomic effort followed standards defined by the California Aquatic Macroinvertebrate Laboratory Network (CAMLnet 2002; www.dfg.ca.gov/cabw/camlnetste.pdf). Sites with fewer than 450 organisms sampled were omitted from the analyses.

Screening Reference Sites

We followed an objective and quantitative reference site selection procedure in which potential reference sites were first screened with quantitative Geographical Information System (GIS) land-use analysis at several spatial scales and then local condition assessments (instream and riparian) were used to quantify stressors acting within study reaches. We calculated the proportions of different land-cover classes and other measures of human activity upstream of each site at four spatial scales that give unique information about potential stressors acting on each site: (1) within polygons delimiting the entire watershed upstream of each sampling site, (2) within polygons representing local regions (defined as the intersection of a 5-km-radius circle around each site and the primary watershed polygon), (3) within a 120-m riparian zone on each side of all streams within each watershed, and (4) within a 120-m riparian zone in the local region. We used the ArcView® (ESRI 1999) extension ATtILA (Ebert and Wade 2002) to calculate the percentage of various land-cover classes (urban, agriculture, natural, etc.) and other measures of human activity (population density, road density, etc.) in each of the four spatial areas defined for each site. Two satellite imagery datasets from the mid-1990s were combined for the land-cover analyses: California Land Cover Mapping & Monitoring Program (LCMMP) vegetation data (CalVEG) and a recent dataset produced by the Central Coast Watershed Group (Newman and Watson 2003). Population data were derived from the 2000 migrated TIGER dataset (California Department of Forestry and Fire Protection, www.cdf.ca.gov). Stream layers were obtained from the US Geological Survey (USGS) National Hydrography Dataset (NHD). The road network was obtained from the California Spatial Information Library (CaSIL, gis.ca.gov) and elevation was based on the USGS National Elevation Dataset (NED). Frequency histograms of land-use percentages for all sites were used to establish subjective thresholds for elim-

Table 1. List of minimum or maximum landuse thresholds used for rejecting potential reference sites

Stressor metric	Definition	Threshold
N_index_L	Percentage of natural land use at the local scale	≤ 95%
Purb_L	Percental of urban land use at the local scale	> 3%
Pagt_L	Percentage of total agriculture at the local scale	> 5%
Rddens_L	Road density at the local scale	> 2.0 km/km^2
PopDens_L	Population density (2000 census) at the local scale	> 150 indiv./km^2
N_index_W	Percentage of natural landuse at the watershed scale	≤ 95%
Purb_W	Percentage of urban landuse at the watershed scale	> 5%
Pagt_W	Percentage of total agriculture at the watershed scale	> 3%
Rddens_W	Road density at the watershed scale	> 2.0 km/km^2
PopDens_W	Population density (2000 census) at the watershed scale	> 150 indiv./km^2

inating sites from the potential reference pool (Table 1). Sites were further screened from the reference pool on the basis of reach-scale conditions (obvious bank instability or erosion/ sedimentation problems, evidence of mining, dams, grazing, recent fire, recent logging).

Eighty-eight sites passed all the land-use and local condition screens and were selected as reference sites, leaving 187 sites in the test group. We randomly divided the full set of sites into a development set (206 sites total: 66 reference/140 test) and a validation set (69 sites total: 22 reference/47 test). The development set was used to screen metrics and develop scoring ranges for component B-IBI metrics; the validation set was used for an independent evaluation of B-IBI performance.

Screening Metrics and Assembling the B-IBI

Sixty-one metrics were evaluated for possible use in the SoCal B-IBI (Table 2). A multistep screening process was used to evaluate each metric for (1) sufficient range to be used in scoring, (2) responsiveness to watershed-scale and reach-scale disturbance variables, and (3) lack of correlation with other responsive metrics.

Pearson correlations between all watershed-scale and reach-scale disturbance gradients were used to define the smallest suite of independent (nonredundant) disturbance variables against which to test biological metric response. Disturbance variables with correlation coefficients $|r| \geq 0.7$ were considered redundant. Responsiveness was assessed using visual inspection of biotic metric versus disturbance gradient scatterplots and linear regression coefficients. Metrics were selected as responsive if they showed either a linear or a "wedge-shaped" relationship with disturbance gradients. Biological metrics often show a "wedge-shaped" response rather than a linear response to single disturbance gradients because the single gradient only defines the upper boundary of the biological response; other independent disturbance gradients and natural limitations on species distributions might result in lower metric values than expected from response to the single gradient. Biotic metrics and disturbance gradients were log-transformed when necessary to improve normality and equalize variances. Metrics that passed the range and responsiveness tests were tested for redundancy. Pairs of metrics with product–moment correlation coefficients $|r| \geq 0.7$ were considered redundant and the least responsive metric of the pair was eliminated.

Scoring ranges were defined for each metric using techniques described in Hughes and others (1998), McCormick and others (2001), and Klemm and others (2003). Metrics were scored on a 0–10 scale using statistical properties of the raw metric values from both reference and nonreference sites to define upper and lower thresholds. For positive metrics (those that increase as disturbance decreases), any site with a metric value equal to or greater than the 80th percentile of reference sites received a score of 10; any site with a metric value equal to or less than the 10th percentile of the nonreference sites received a score of 0; these thresholds were reversed for negative metrics (20th percentile of reference and 90th percentile of nonreference). In both cases, the remaining range of intermediate metric values was divided equally and assigned scores of 1 through 9. Before assembling the B-IBI, we tested whether any of the final metrics were significantly different between chaparral and mountain reference sites in the southern California coastal region, in which case they would require separate scoring ranges in the B-IBI. Finally, an overall B-IBI score was calculated for each site by summing the constituent metric scores and adjusting the B-IBI to a 100-point scale.

Table 2. The 61 BMI metrics screened for use in the SoCal IBI

Candidate metrics	Disturbance variables: U_index_W	Pagt_W	Purb_L	RdDens_L	Channel Alteration	Bank Stability	Percent Fines	Total Dissolved Solids	Total Phosphorus	Total Nitrogen	Range Test
Taxonomic group metrics											
Coleoptera richness*	M	w	M	S	S	—	—	—	—	—	P
Crustacea + Mollusca richness	—	—	—	—	—	—	—	—	—	—	F
Diptera richness	—	—	—	—	—	—	—	—	—	—	P
Elmidae richness	w	—	w	M	S	M	S	M	—	—	F
Ephemerellidae richness					S	M	M	S	—	M	F
Ephemeroptera richness	S	S	M	S	w	M	S	S	—	S	P
EPT richness*	S	S	S	S	S	S	S	S	—	S	P
Hydropsychidae richness	—	—	w	—	S	—	—	—	—	—	F
Percent Amphipoda individuals	—	—	—	—	—	—	—	—	—	—	P
Percent Baetidae individuals	—	—	—	—	w	—	—	—	—	—	P
Percent Chironomidae individuals	—	—	—	—	—	—	—	—	M	—	P
Percent Corbicula individuals	—	—	—	—	—	—	—	—	—	—	P
Percent Crustacea individuals	—	—	—	—	—	—	—	—	—	—	P
Percent Diptera individuals	—	w	—	—	—	—	—	—	—	—	P
Percent Elmidae individuals	—	—	—	w	M	S	S	w	—	M	P
Percent Ephemeroptera individuals	—	w	w	—	M	w	—	—	—	—	P
Percent EPT individuals	—	—	M	M	M	M	—	—	—	—	P
Percent Gatropoda individuals	—	—	—	w	—	—	—	—	—	—	P
Percent Glossosomatidae individuals	—	—	—	—	w	—	—	—	—	M	F
Percent Hydropsychidae individuals	—	—	—	M	w	M	—	—	—	—	P
Percent Hydroptilidae individuals	—	—	—	M	—	w	—	—	—	—	F
Percent Mollusca individuals	—	—	—	w	w	—	—	—	—	—	P
Percent non-*Baetis/Fallceon* Ephemeroptera individuals	w	w	—	M	w	M	—	—	w	—	P
Percent non-*Hydropsyche* Hydropsychidae individuals	—	—	—	M	w	w	—	—	—	—	F
Percent non-*Hydropsyche/Cheumatopsyche* Trichoptera individuals	w	w	—	M	w	M	M	w	—	—	P
Percent non-insect Taxa*	M	w	M	M	w	—	—	—	w	M	F
Percent Oligochaeta individuals	—	—	—	—	w	—	—	—	—	—	P
Percent Perlodidae individuals	—	—	—	w	w	—	—	—	—	—	F
Percent Plecoptera individuals	—	—	—	M	M	M	M	M	w	S	P
Percent Rhyacophilidae individuals	—	—	—	w	S	S	w	—	—	M	F
Percent Simuliidae individuals	—	w	—	w	S	w	—	—		—	P
Percent Trichoptera	w	—	—	M	M	M	M	w	w	—	P
Plecoptera richness	M	S	w	M	w	w	M	S	—	S	F
Total taxa richness	M	M	w	S	w	w	w	w	w	M	P
Trichoptera richness	S	S	S	S	S	M	S	w	—	w	P

Table 2. Continued.

Candidate metrics	U_index_W	Pagt_W	Purb_L	RdDens_L	Channel Alteration	Bank Stability	Percent Fines	Total Dissolved Solids	Total Phosphorus	Total Nitrogen	Range Test
	Disturbance variables										
Functional feeding metrics											
Collector (filterers) richness	w	—	M	S	S	M	w	—	—	—	F
Collector (gatherers) richness	—	—	—	—	—	—	—	—	—	w	P
Percent collector (filterer) + collector (gatherer) individuals*	M	—	—	S	—	w	—	M	w	M	P
Percent collector (filterer) individuals	—	—	—	w	M	M	w	—	—	—	P
Percent collector (gatherer) individuals	—	—	—	w	M	—	—	w	M	w	P
Percent predator individuals	—	—	—	w	M	—	—	—	—	—	P
Percent scraper individuals	w	w	—	M	M	w	w	—	—	—	P
Percent scraper minus snails individuals	—	—	—	w	—	w	—	—	—	—	P
Percent shredder individuals	—	—	—	w	w	—	—	—	—	—	P
Predator richness*	S	S	w	M	w	—	—	S	—	M	P
Scraper richness	S	M	M	S	S	S	S	S	—	S	P
Shredder richness	M	M	—	M	S	—	—	—	—	M	F
Tolerance metrics											
Average tolerance value	M	w	w	S	w	—	M	—	—	w	P
Intolerant EPT richness	M	w	w	M	S	—	S	S	—	S	P
Intolerant taxa richness	M	w	w	M	S	M	S	S	—	S	P
Percent intolerant Diptera individuals	—	—	—	—	—	—	—	—	—	—	F
Percent intolerant individuals*	M	w	—	M	S	M	M	S	—	M	P
Percent intolerant scraper individuals	—	—	—	w	M	w	w	w	—	—	P
Percent of intolerant Ephemeroptera individuals	—	—	—	w	w	—	w	w	—	—	P
Percent of intolerant Trichoptera individuals	—	w	—	—	w	w	w	w	—	—	P
Percent sensitive EPT individuals	w	w	—	M	M	M	M	M	w	M	P
Percent tolerant individuals	—	—	—	—	—	—	w	w	—	—	P
Percent tolerant taxa*	w	—	w	M	—	—	—	w	—	M	P
Tolerant taxa richness	—	—	—	—	—	M	—	—	—	—	P
Others											
Percent dominant taxon	—	—	—	—	—	—	—	—	—	—	P
Shannon Diversity Index	w	w	w	M	M	w	—	w	w	w	P

Note: Each metric is indicated as having either no response (—), weak response (w), moderate response (M), or strong response (S) to each of eleven minimally correlated disturbance variables and whether each metric passed (P) or failed (F) the range test. The final seven minimally correlated metrics are indicated with an asterisk (*).

Table 3. Scoring ranges for seven component metrics in the SoCal B-IBI

Metric score	Coleoptera taxa (all sites)	EPT taxa 6	EPT taxa 8	Predator taxa (all sites)	% Collector individuals 6	% Collector individuals 8	% Intolerant individuals 6	% Intolerant individuals 8	% Noninsect taxa (all sites)	% Tolerant taxa (all sites)
10	>5	>17	>18	>12	0–59	0–39	25–100	42–100	0–8	0–4
9		16–17	17–18	12	60–63	40–46	23–24	37–41	9–12	5–8
8	5	15	16	11	64–67	47–52	21–22	32–36	13–17	9–12
7	4	13–14	14–15	10	68–71	53–58	19–20	27–31	18–21	13–16
6		11–12	13	9	72–75	59–64	16–18	23–26	22–25	17–19
5	3	9–10	11–12	8	76–80	65–70	13–15	19–22	26–29	20–22
4	2	7–8	10	7	81–84	71–76	10–12	14–18	30–34	23–25
3		5–6	8–9	6	85–88	77–82	7–9	10–13	35–38	26–29
2	1	4	7	5	89–92	83–88	4–6	6–9	39–42	30–33
1		2–3	5–6	4	93–96	89–94	1–3	2–5	43–46	34–37
0	0	0–1	0–4	0–3	97–100	95–100	0	0–1	47–100	38–100

Note: Three metrics have separate scoring ranges for the two Omernik Level III ecoregions in southern coastal California region (6 = chaparral and oak woodlands, 8 = Southern California mountains).

Validation of B-IBI and Measurement of Performance Characteristics

To test whether the distribution of B-IBI scores in reference and test sites might have resulted from chance, we compared score distributions in the development set to those in the validation set. We also investigated a separate performance issue that ambient bioassessment studies often neglect: spatial variation at the reach scale. Although our use of a validation dataset tests whether the B-IBI scoring range is repeatable (Fore and others 1996; McCormick and others 2001), we designed a separate experiment to explicitly measure index precision. Four sites were resampled in May 2003. At each site, nine riffles were sampled following the CSBP, and material from randomly selected riffles was combined into three replicates of three riffles each. B-IBI scores were then calculated for each replicate. Variance among these replicates was used to calculate the minimum detectable difference (MDD) between two B-IBI scores based on a two-sample *t*-test model (Zar 1999). The index range can be divided by the MDD to estimate the number of stream condition categories detectable by the B-IBI (Doberstein and others 2000; Fore and others 2001).

Results

Combining Datasets

Unmodified CSBP samples (900 count) had significantly higher biotic condition scores ($t = -6.974$, $P < 0.0001$) than did USFS samples (500 count). However, there was no difference in biotic condition scores between USFS samples and CSBP samples that were randomly subsampled to reduce the 900 count to 500 ($t = -0.817$, $P = 0.416$). Thus, data from both targeted-riffle protocols were combined in B-IBI development.

Selected Metrics

Ten nonredundant stressor gradients were selected for metric screening: percent watershed unnatural, percent watershed in agriculture, percent local watershed in urban, road density in local watershed, qualitative channel alteration score, qualitative bank stability score, percent fine substrates, total dissolved solids, total nitrogen, and total phosphorous. Twenty-three biotic metrics that passed the first two screens (range and dose response) were analyzed for redundancy with Pearson product–moment correlation, and a set of seven minimally correlated metrics was selected for the B-IBI: percent collector-gatherer + collector-filterer individuals (% collectors), percent noninsect taxa, percent tolerant taxa, Coleoptera richness, predator richness, percent intolerant individuals, and EPT richness (Table 3). All metrics rejected as redundant were derived from taxa similar to those of selected metrics, but they had weaker relationships with stressor gradients. Dose–response relationships of the selected metrics to the 10 minimally correlated stressor variables are shown in Figure 2 and reasons for rejection or acceptance of all metrics are listed in Table 2. Regression coefficients were significant at the $P \leq 0.0001$ level among all seven selected metrics and at least two stressor gradients: percent watershed unnatural and road density in local watershed (Table 4). The final seven metrics included several metric types: richness, composition, tolerance measures, and func-

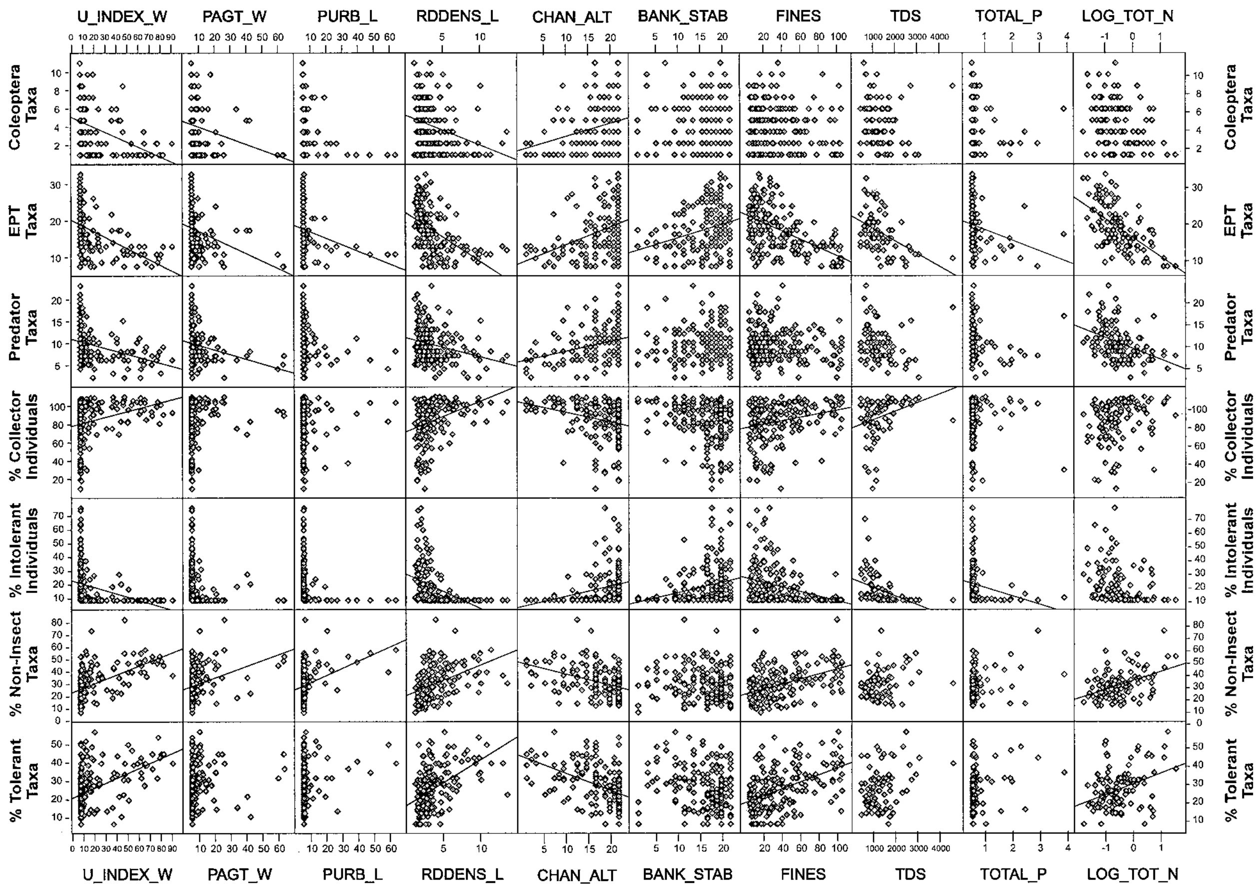

Figure 2. Scatterplots of dose–response relationships among 10 stressor gradients and 7 macroinvertebrate metrics (lines represent linear "best-fit" relationships; see text for abbreviations).

Table 4. Significance levels of linear regression relationships among 10 stressor metrics and 7 biological metrics

Metric	Coleoptera taxa	EPT taxa	Predator taxa	% Collector individuals	% Intolerant individuals	% Noninsect taxa	% Tolerant taxa
Bank Stability	0.813	**<0.0001**	0.3132	0.0009	0.0001	0.1473	0.0013
Fines	0.0017	**<0.0001**	0.0171	**0.0003**	**<0.0001**	**<0.0001**	**<0.0001**
Chan_Alt	**<0.0001**	**<0.0001**	**<0.0001**	**0.0003**	**<0.0001**	**<0.0001**	**<0.0001**
Log_U_Index_W	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Log_PAgT_W	**0.0007**	**<0.0001**	**0.0004**	0.0054	0.0014	**<0.0001**	0.0012
Log_PUrb_L	0.0367	**0.0007**	0.0344	0.6899	0.0045	**0.0002**	0.0215
Log RdDens_L	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Log_TDS	0.0094	**<0.0001**	0.0035	**0.0005**	**<0.0001**	0.0271	0.004
Log_Tot_N	0.0019	**<0.0001**	**<0.0001**	0.0078	0.0019	**<0.0001**	**<0.0001**
Log_Tot_P	0.062	**<0.0001**	0.0085	0.0162	**0.0001**	0.0018	0.0059

Note: Significant *P*-values corrected for 70 simultaneous comparisons ($P < 0.0007$) are highlighted in bold. Abbreviations are defined in Table 1 and in the text.

tional feeding groups. Because there are only seven metrics in the B-IBI, final scores calculated using this IBI are multiplied by 1.43 to adjust the scoring range to a 100-point scale.

The B-IBI scores were lower in chaparral reference sites than in mountain reference sites when calculated using unadjusted metric scores (Mann–Whitney *U*-test; $P = 0.02$). Although none of the final seven metrics

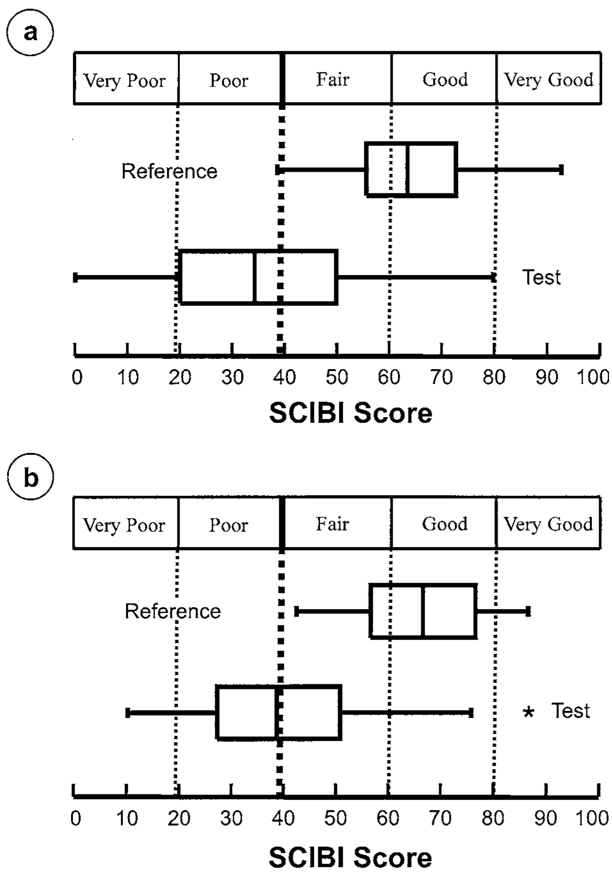

Figure 3. Box plots of B-IBI site scores for reference and test groups showing B-IBI scoring categories: (a) development sites and (b) validation sites. Dotted lines indicate condition category boundaries and heavy dotted lines indicate impairment thresholds.

were significantly different between chaparral reference sites and mountain reference sites at the $P = 0.05$ level ($P < 0.007$ after Bonferroni correction), scores for three metrics (EPT richness, percent collector-gatherer + collector-filterer individuals, and percent intolerant individuals) were substantially lower in chaparral reference sites than in mountain reference sites. We adjusted for this difference by creating separate scoring scales for the three metrics in the two ecoregions (Table 3). There was no difference in B-IBI scores between reference sites in the two ecoregions after the adjustment (Mann–Whitney *U*-test, $P = 0.364$).

Validation of B-IBI and Measurement of Performance Characteristics

The distribution of B-IBI scores at reference and nonreference sites was nearly identical between the development and validation data sets (Figure 3), indicating that our characterization of reference conditions and subsequent B-IBI scoring was repeatable and not likely due to chance. Based on a two-sample *t*-test model (setting $\alpha = 0.05$ and $\beta = 0.20$), the MDD for the SoCal IBI is 13.1. Thus, we have an 80% chance of detecting a 13.1-point difference between sites at the $P = 0.05$ level. Dividing the 100-point B-IBI scoring range by the MDD indicates that the SoCal B-IBI can detect a maximum of seven biological condition categories, a result similar to or more precise than other recent estimates of B-IBI precision (Barbour and others 1999; Fore and others 2001). We used a statistical criterion (two standard deviations below the mean reference site score) to define the boundary between "fair" and "poor" conditions, thereby setting B-IBI = 39 as an impairment threshold. The scoring range below 39 was divided into two equal condition categories, and the range above 39 was divided into three equal condition categories: 0–19 = "very poor", 20–39 = "poor", 40–59 = "fair", 60-79 = "good", and 80–100 = "very good" (Figure 3).

We ran two principle components analyses (PCAs) on the environmental stressor values used for testing metric responsiveness: 1 that included all 275 sites for which we calculated 4 watershed scale stressor values and another based on 124 sites for which we had measurements of 9 of the 10 minimally correlated stressor variables. We plotted B-IBI scores as a function of the first multivariate stressor axis from each PCA. We log-transformed percent watershed unnatural, percent watershed in agriculture, percent local watershed in urban, road density in local watershed, total nitrogen, and total phosphorous. Only PCA Axis 1 was significant in either analysis, having eigenvalues larger than those predicted from the broken-stick model (McCune and Grace 2002). In both PCAs, the B-IBI score decreased with increasing human disturbance (Figure 4) and was correlated (Spearman ρ) with PCA Axis 1 ($r = -0.652$, $P < 0.0001$ for all 275 sites; $r = -0.558$, $P \leq 0.0001$ for 124 sites). In the analysis of all 275 sites, all 4 watershed-scale stressors had high negative loadings, with percent watershed unnatural and local road density being the highest (Figure 5a). In the analysis of 124 sites, percent watershed unnatural, percent watershed in agriculture, and local road density had the highest negative loadings on the first axis, and channel alteration had the highest positive loading (Figure 4b).

Finally, we found no relationship between B-IBI scores and ecoregion (Mann–Whitney U, $P = 0.364$), Julian date ($R^2 = 0.01$, $P = 0.349$), watershed area ($R^2 = 0.002$, $P = 0.711$), or elevation ($R^2 = 0.01$, $P = 0.349$), indicating that the B-IBI scoring is robust with respect to these variables (Figure 5). Our ecoregion scoring adjustment probably corrects for the

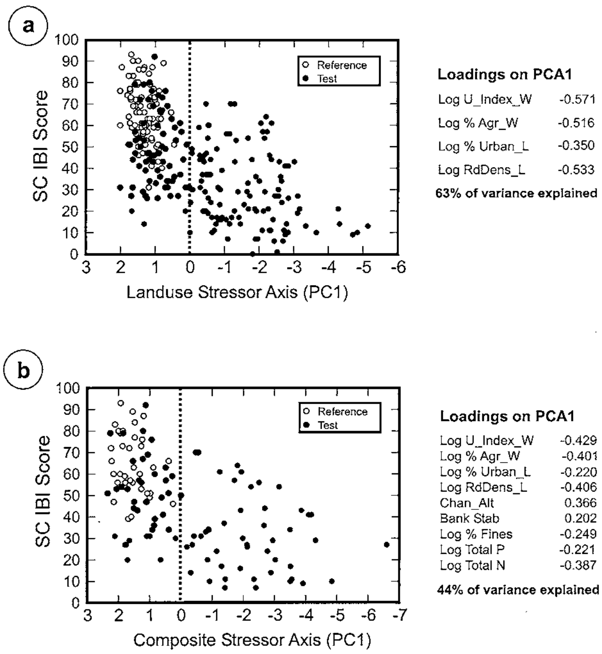

Figure 4. Scatterplots of SoCal B-IBI scores against two composite stressor axes from PCA: (a) values for all 275 sites; composite axis includes 4 land-use gradients; (b) values for 124 sites; composite axis includes 9 local and watershed scale stressor gradients.

strongest elevation effects, but there is no evidence that B-IBI scores are related to elevation differences within each ecoregion.

Discussion

The SoCal B-IBI is the most comprehensive assessment to date of freshwater biological integrity in California. As in other Mediterranean climate regions, the combination of aridity, geology, and high-amplitude cycles of seasonal flooding and drying in southern coastal California makes its streams and rivers particularly sensitive to disturbance (Gasith and Resh 1999). This sensitivity, coupled with the burgeoning human population and vast conversion of natural landscapes to agriculture and urban areas, has made it the focus of both state and federal attempts to maintain the ecological integrity of these strained aquatic resources.

Unfortunately, growing interest in biomonitoring is unmatched by financial resources available for this monitoring. Thus, combination of data among programs is very desirable, although this goal is rarely achieved in practice. We demonstrated that macroinvertebrate bioassessment data from multiple agencies could be successfully combined to produce a regional index that is useful to all agencies involved. This index is easy to apply, its fundamental assumptions are transparent, it provides precise condition assessments, and it is demonstrated to be responsive to a wide range of anthropogenic stressors. The index can also be applied throughout a long index period (mid-spring to mid-fall): Just as biotic factors tend to have more influence on assemblage structure during the summer dry period of Mediterranean climates than during the wet season when abiotic factors dominate (Cooper and others 1986; Gasith and Resh 1999), it is likely that our biotic index is more sensitive to anthropogenic stressors during the summer dry period. Because of these qualities, we expect the SoCal B-IBI to be a practical management tool for a wide range of water quality applications in the region.

This B-IBI is a regional adaptation of an approach to biotic assessment developed by Karr (1981) and subsequently extended and refined by many others (Kerans and Karr 1994; Barbour and others 1996; Fore and others 1996; Hughes and others 1998). We drew heavily upon recent refinements in multimetric index methodology that improve the objectivity and defensibility of these indices (McCormick and others 2001; Klemm and others 2003). A central goal of bioassessment is to select metrics that maximize the detection of anthropogenic stress while minimizing the noise of natural variation. One of the most important recent advances in B-IBI methods is the emphasis on quantitative screening tools for selecting appropriate metrics. We also minimized sources of redundancy in the analysis: (1) between watershed and local-scale stressor gradients for dose–response screening of biotic metrics and (2) in the final selection of metrics. The former guards against a B-IBI that is biased toward a set of highly correlated stressors and is, therefore, of limited sensitivity; the latter assures a compact B-IBI with component metrics that contribute independent information about stream condition. Combined with an assessment of responsiveness to specific regional disturbance gradients, these screening tools minimize the variability of B-IBI scores and improve its sensitivity.

The seven component metrics used in this B-IBI are similar to those selected for other B-IBIs (DeShon 1995; Barbour and others 1995, 1996; Fore and others 1996; Klemm and others 2003), but some of the metrics are either unique or are variations on other commonly used metrics. Like Klemm and others (2003), we found noninsect taxa to be responsive to human stressors, but richness was more responsive than percent of individuals. Some authors have separated the EPT metric into two or three metrics based on its component orders because the orders provided unique signals (Clements 1994; Fore and others 1996; Klemm

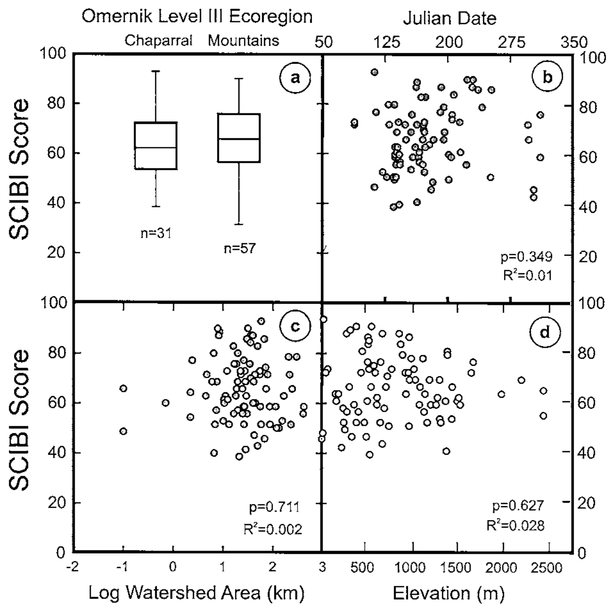

Figure 5. Relationship between B-IBI scores at 88 reference sites and (a) Omernik Level III ecoregion, (b) Julian date, (c) log watershed area, and (d) elevation.

and others 2003), but we found very similar patterns in these orders' response to various stressors we measured. To our knowledge, Coleoptera richness has not previously been included in a B-IBI, but beetle taxa might be a good indicator of the effects of fine sediments at impaired sites in this region (Brown 1973). A recent study of benthic assemblages in North Africa noted a high correspondence between EPT and EPTC (EPT + Coleoptera) (Beauchard and others 2003), but these orders were not highly correlated in our dataset. Feeding groups appear less often in B-IBIs than other metric types (Klemm and others 2003), but they were represented by two metrics in this B-IBI: predator richness and percent collectors (gatherers and filterers combined). Scraper richness was also responsive, but was rejected here because it was highly correlated with EPT richness.

The SoCal IBI should prove useful as a foundation for state and regional ambient water quality monitoring programs. Because the 75 EMAP sites were selected using a probabilistic statistical design, it will also be possible to use those samples to estimate the percentage of stream miles that are in "good", "fair", and "poor" condition in the southern California coastal region. These condition estimates, combined with stressor association techniques, have great potential to serve as a scientifically defensible basis for allocating precious monitoring resources in this region.

Acknowledgments

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Appendix 3

Bioassessment in complex environments: designing an index for consistent meaning in different settings

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Abstract: Regions with great natural environmental complexity present a challenge for attaining 2 key properties of an ideal bioassessment index: 1) index scores anchored to a benchmark of biological expectation that is appropriate for the range of natural environmental conditions at each assessment site, and 2) deviation from the reference benchmark measured equivalently in all settings so that a given index score has the same ecological meaning across the entire region of interest. These properties are particularly important for regulatory applications like biological criteria where errors or inconsistency in estimating site-specific reference condition or deviation from it can lead to management actions with significant financial and resource-protection consequences. We developed an index based on benthic macroinvertebrates for California, USA, a region with great environmental heterogeneity. We evaluated index performance (accuracy, precision, responsiveness, and sensitivity) throughout the region to determine if scores provide equivalent ecological meaning in different settings. Consistent performance across environmental settings was improved by 3 key elements of our approach: 1) use of a large reference data set that represents virtually all of the range of natural gradients in the region, 2) development of predictive models that account for the effects of natural gradients on biological assemblages, and 3) combination of 2 indices of biological condition (a ratio of observed-to-expected taxa [O/E] and a predictive multimetric index [pMMI]) into a single index (the California Stream Condition Index [CSCI]). Evaluation of index performance across broad environmental gradients provides essential information when assessing the suitability of the index for regulatory applications in diverse regions.
Key words: bioassessment, predictive modelling, predictive multimetric index, reference condition

A major challenge for conducting bioassessment in environmentally diverse regions is ensuring that an index provides consistent meaning in different environmental settings. A given score from a robust index should indicate the same biological condition, regardless of location or stream type. However, the performance (e.g., accuracy, precision, responsiveness, and sensitivity) of an index may vary in different settings, complicating its interpretation (Hughes et al. 1986, Yuan et al. 2008, Pont et al. 2009). Effective bioassessment indices should account for naturally occurring variation in aquatic assemblages so that deviations from reference conditions resulting from anthropogenic disturbance are minimally confounded by natural variability (Hughes et al. 1986, Reynoldson et al. 1997). When bioassessment indices are used in regulatory applications, such as measuring compliance with biocriteria (Davis and Simon 1995, Council of European Communities 2000, USEPA 2002, Yoder and Barbour 2009), variable meaning of an index score may lead to poor stream management, particularly if the environmental factors affecting index performance are unrecognized. Those who develop bioassessment indices or the policies that rely on them should evaluate index performance carefully across the different environmental gradients where an index will be applied.

A reference data set that represents the full range of environmental gradients where an index will be used is key for index development in environmentally diverse regions. In addition, reference criteria should be consistently defined so that benchmarks of biological condition are equivalent across environmental settings. Indices based on

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benthic macroinvertebrates (BMI) for use in California were developed with reference data sets that used different criteria in different regions (e.g., Hawkins et al. 2000, Herbst and Silldorff 2009, Rehn 2009). For example, several reference sites used to calibrate an index for the highly urbanized South Coast region had more nonnatural land use than any reference site used to develop an index for the rural North Coast region (Ode et al. 2005, Rehn et al. 2005). Furthermore, lower-elevation settings were poorly represented in these reference data sets. In preparation for establishing statewide biocriteria, regulatory agencies and regulated parties desired a new index based on a larger, more consistently defined reference data set that better represented all environmental settings. Considerable effort was invested to expand the statewide pool of reference sites to support development of a new index (Ode et al. 2016). The diversity of stream environments represented in the reference pool necessitated scoring tools that could handle high levels of complexity.

Predictive modeling of the reference condition is an increasingly common way to obtain site-specific expectations for diverse environmental settings (Hawkins et al. 2010b). Predictive models can be used to set biological expectations at test sites based on the relationship between biological assemblages and environmental factors at reference sites. Thus far, predictive modeling has been applied almost exclusively to multivariate indices focused on taxonomic completeness of a sample, such as measured by the ratio of observed-to-expected taxa (O/E) (Moss et al. 1987, Hawkins et al. 2000, Wright et al. 2000), or location of sites in ordination space (e.g., **BE**nthic **A**ssessment of **S**edimen**T** [BEAST]; Reynoldson et al. 1995). Applications of predictive models to multimetric indices (i.e., predictive multimetric indices [pMMIs]) are relatively new (e.g., Cao et al. 2007, Pont et al. 2009, Vander Laan and Hawkins 2014). MMIs include information on the life-history traits observed within an assemblage (e.g., trophic groups, habitat preferences, pollution tolerances), so they may provide useful information about biological condition that is not incorporated in an index based only on loss of taxa (Gerritsen 1995). Predictive models that set site-specific expectations for biological metric values may improve the accuracy, precision, and sensitivity of MMIs when applied across diverse environmental settings (e.g., Hawkins et al. 2010a).

A combination of multiple indices (specifically, a pMMI and an O/E index) into a single index might provide more consistent measures of biological condition than just one index by itself. Variation in performance of an index would be damped by averaging it with a 2^{nd} index, and poor performance in particular settings might be improved. For example, an O/E index may be particularly sensitive in mountain streams that are expected to be taxonomically rich, whereas a pMMI might be more sensitive in lowland areas, where stressed sites may be well represented in calibration data. Moreover, pMMIs and O/E indices characterize assemblage data in fundamentally different ways. Thus, they provide complementary measures of stream ecological condition and may contribute different types of diagnostic information. Taxonomic completeness, as measured by an O/E index, and ecological structure, as measured by a pMMI, are both important aspects of stream communities, and certain stressors may affect these aspects differently. For example, replacement of native taxa with invasive species may reduce taxonomic completeness, even if the invaders have ecological attributes similar to those of the taxa they displaced (Collier 2009). Therefore, measuring both taxonomic completeness and ecological structure may provide a more complete picture of stream health.

Our goal was to construct a scoring tool for perennial wadeable streams that provides consistent interpretations of biological condition across environmental settings in California, USA. Our approach was to design the tool to maximize the consistency of performance across settings, as indicated by evaluations of accuracy, precision, responsiveness, and sensitivity. We first constructed predictive models for both a taxon loss index (O/E) and a pMMI. Second, we compared the accuracy, precision, responsiveness, and sensitivity of the O/E, pMMI, and combined O/E + pMMI index across a variety of environmental settings. Our primary motivation was to develop biological indices to support regulatory applications in the State of California. However, our broader goal was to produce a robust assessment tool that would support a wide variety of bioassessment applications, such as prioritization of restoration projects or identification of areas with high conservation value.

METHODS

Study region

California contains continental-scale environmental diversity within 424,000 km^2 that encompass some of the most extreme gradients in elevation and climate found in the USA. It has temperate rainforests in the North Coast, deserts in the east, and chaparral, oak woodlands, and grasslands with a Mediterranean climate in coastal regions (Omernik 1987). Large areas of the state are publicly owned, but vast regions have been converted to agricultural (e.g., the Central Valley) or urban (e.g., the South Coast and the San Francisco Bay Area) land uses (Sleeter et al. 2011). Forestry, grazing, mining, other resource extraction activities, and intensive recreation occur throughout rural regions of the state, and the fringes of urban areas are undergoing increasing development. For convenience, we divided the state into 6 regions and 10 subregions based on ecoregional (Omernik 1987) and hydrologic boundaries (California State Water Resources Control Board 2013) (Fig. 1).

Compilation of data

We compiled data from >20 federal, state, and regional monitoring programs. Altogether, we aggregated data from

Figure 1. Regions and subregions of California. Thick gray lines indicate regional boundaries, and thin white lines indicate subregional boundaries. NC = North Coast, CHco = Coastal Chaparral, Chin = Interior Chaparral, SCm = South Coast mountains, SCx = South Coast xeric, CV = Central Valley, SNws = Sierra Nevada-western slope, SNcl = Sierra Nevada-central Lahontan, DMmo: Desert/Modoc-Modoc plateau, DMde =Desert/Modoc-deserts.

4457 samples collected from 2352 unique sites between 1999 and 2010 into a single database. We excluded BMI samples with insufficient numbers of organisms or taxonomic resolution (described below) from analyses. We treated observations at sites in close proximity to each other (within 300 m) as repeat samples from a single site. For sites with multiple samples meeting minimum requirements, we randomly selected a single sample for use in all analyses described below, and we withheld repeat samples from all analyses, except where indicated below. We used 1318 sites sampled during probabilistic surveys (e.g., Peck et al. 2006) to estimate the ambient condition of streams (described below).

Biological data

Fifty-five percent of the BMI samples were collected following a reach-wide protocol (Peck et al. 2006), and the other samples were collected with targeted riffle protocols, which produce comparable data (Gerth and Herlihy 2006, Herbst and Silldorff 2006, Rehn et al. 2007). For most samples, taxa were identified to genus, but this level of effort and the total number of organisms/sample varied among samples, necessitating standardization of BMI data. We used different data standardization approaches for the pMMI and the O/E. For the pMMI, we aggregated identifications to 'Level 1' standard taxonomic effort (most insect taxa identified to genus, Chironomidae identified to family) as defined by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT; Richards and Rogers 2011) and used computer subsampling to generate 500-count subsamples. We excluded samples with <450 individuals (i.e., not within 10% of target). For the O/E index, we used operational taxonomic units (OTUs) similar to SAFIT Level 1 except that we aggregated Chironomidae to subfamily. We excluded ambiguous taxa (i.e., those identified to a higher level than specified by the OTU). We also excluded samples with >50% ambiguous individuals from O/E development, no matter how many unambiguous individuals remained. We used computer subsampling to generate 400-count subsamples, and we excluded samples with <360 individuals. A smaller subsample size was used for the O/E index than for the pMMI because exclusion of ambiguous taxa often reduced sample size to <500 individuals. A final data set of 3518 samples from 1985 sites met all requirements and was used for development and evaluation of both the O/E and pMMI indices.

Environmental data

We collected environmental data from multiple sources to characterize natural and anthropogenic factors known to affect benthic communities, such as climate, elevation, geology, land cover, road density, hydrologic alteration, and mining (Tables 1, 2). We used geographic information system (GIS) variables that characterized natural, unalterable environmental factors (e.g., topography, geology, climate) as predictors for O/E and pMMI models and variables related to human activity (e.g., land use) to classify sites as reference and to evaluate responsiveness of O/E and pMMI indices to human activity gradients. We calculated most variables related to human activity at 3 spatial scales (within the entire upstream drainage area [watershed], within the contributing area 5 km upstream of a site [5 km], and within the contributing area 1 km upstream of a site [1 km]) so that we could screen sites for local and catchment-scale impacts. We created polygons defining these spatial analysis units using ArcGIS tools (version 9.0; Environmental Systems Research Institute, Redlands, California).

Classification of sites along a human activity gradient

We were unable to measure stress directly with this data set, so instead, we used a human activity gradient under the assumption that it was correlated with stress (Yates and Bailey 2010). We divided sites into 3 sets for development and evaluation of indices: reference (i.e., low activity), moderate-, and high-activity sites. We defined reference

Table 1. Natural gradients and their importance (Gini = mean decrease in Gini index), MSE = % increase in mean squared error) for random-forest models for the observed (O)/expected (E) taxa index and each metric used in the predictive multimetric index (pMMI). Predictors that were evaluated but not selected for any model include % sedimentary geology, nitrogenous geology, soil hydraulic conductivity, soil permeability, S-bearing geology, calcite-bearing geology, and magnesium oxide-bearing geology. Sources: A = National Elevation Dataset (http://ned.usgs.gov/), B = PRISM climate mapping system (http://www.prism.oregonstate.edu), C = generalized geology, mineralogy, and climate data derived for a conductivity prediction model (Olson and Hawkins 2012). Dashes indicate that the predictors were not used to model the metric.

Variable	Description	O/E		Taxonomic richness MSE	% intolerant MSE	# Shredder taxa MSE	Clinger % taxa MSE	Coleoptera % taxa MSE	EPT % taxa MSE	Data source
		Gini	MSE							
Location										
New lat	Latitude	90.5	0.09	18.8	0.0063	1.26	0.0054	0.00079	0.0027	
New long	Longitude	–	–	25.3	0.0058	0.99	0.0030	–	0.0024	
SITE_ELEV	Elevation	89.5	0.11	11.8	–	–	–	0.00231	–	A
Catchment morphology										
LogWSA	Log watershed area	86.6	0.06	–	0.0020	1.23	–	–	–	A
ELEV_RANGE	Elevation range	–	–	2.4	–	–	0.0026	–	–	A
Climate										
PPT	10-y (2000–2009) average precipitation at the sampling point	74.8	0.07	8.4	0.0063	0.92	–	–	0.0016	B
TEMP	10-y (2000–2009) average air temperature at the sampling point	81.9	0.09	9.3	0.0052	–	0.0023	–	0.0019	B
SumAve_P	Mean June to September 1971–2000 monthly precipitation, averaged across the catchment	–	–	5.5	–	–	–	–	0.0033	B
Geology										
BDH_AVE	Average bulk soil density	–	–	5.7	–	–	0.0021	–	–	C
KFCT_AVE	Average soil erodibility factor (k)	–	–	6.2	–	–	0.0027	–	0.0025	C
Log_P_MEAN	Log % P geology	–	–	3.7	–	–	–	–	–	C

Table 2. Stressor and human-activity gradients used to identify reference sites and evaluate index performance. Sites that did not exceed the listed thresholds were used as reference sites. Sources A = National Landcover Data Set (http://www.epa.gov/mrlc/nlcd-2006.html), B = custom roads layer, C = National Hydrography Dataset Plus (http://www.horizon-systems.com/nhdplus), D = National Inventory of Dams (http://geo.usace.army.mil), E = Mineral Resource Data System (http://tin.er.usgs.gov/mrds), F = predicted specific conductance (Olson and Hawkins 2012), G = field-measured variables. WS = watershed, 5 km = watershed clipped to a 5-km buffer of the sampling point, 1 km = watershed clipped to a 1-km buffer of the sampling point, W1_HALL = proximity-weighted human activity index (Kaufmann et al. 1999), Code 21 = landuse category that corresponds to managed vegetation, such as roadsides, lawns, cemeteries, and golf courses. * indicates variable used in the random-forest evaluation of index responsiveness.

	Variable	Scale	Threshold	Unit	Data source
*	% agricultural	1 km, 5 km, WS	<3	%	A
*	% urban	1 km, 5 km, WS	<3	%	A
*	% agricultural + % urban	1 km, 5 km, WS	<5	%	A
*	% Code 21	1 km and 5 km	<7	%	A
*		WS	<10	%	A
*	Road density	1 km, 5 km, WS	<2	km/km^2	B
*	Road crossings	1 km	<5	crossings	B, C
*		5 km	<10	crossings	B, C
*		WS	<50	crossings	B, C
*	Dam distance	WS	<10	km	D
*	% canals and pipelines	WS	<10	%	C
*	Instream gravel mines	5 km	<0.1	mines/km	C, E
*	Producer mines	5 km	0	mines	E
	Specific conductance	Site	99/1[a]	prediction interval	F
	W1_HALL	Reach	<1.5	NA	G
	% sands and fines	Reach		%	G
	Slope	Reach		%	G

[a] The 99th and 1st percentiles of predictions were used to generate site-specific thresholds for specific conductance. The model underpredicted at higher levels of specific conductance (data not shown), so a threshold of 2000 µS/cm was used as an upper bound if the prediction interval included 1000 µS/cm.

sites as 'minimally disturbed' sensu Stoddard et al. (2006) and selected them by applying screening criteria based primarily on landuse variables calculated at multiple spatial scales (i.e., 1 km, 5 km, watershed; Table 2). We calculated some screening criteria at only 1 spatial scale (e.g., in-stream gravel mine density at the 5-km scale and W1_HALL, a proximity-weighted index of human activity based on field observations made within 50 m of a sampling reach; Kaufmann et al. 1999). We excluded sites thought to be affected by grazing or recreation from the reference data set, even if they passed all reference criteria. Identification of high-activity sites was necessary for pMMI calibration (described below) and for performance evaluation of both pMMI and O/E. We defined high-activity sites as meeting any of the following criteria: ≥50% developed land (i.e., % agricultural + % urban) at all spatial scales, ≥5 km/km^2 road density, or W1_HALL ≥ 5. We defined sites not identified as either reference or high-activity as moderate-activity sites. We further divided sites in each set into calibration (80%) and validation (20%) subsets and stratified assignment to calibration and validation sets by subregion to ensure representation of all environmental settings in both sets (Fig. 1). Only 1 reference site was found in the Central Valley, so that region was combined with the Interior Chaparral (whose boundary was within 500 m of the site) for stratification purposes.

Development of the O/E index

Development of an O/E index or pMMI follows the same basic steps: biological characterization, modeling of reference expectations from environmental factors, selection of metrics or taxa, and combining of metrics or taxa into an index. pMMI development has an additional intermediate step to set biological expectations for sites with high levels of activity (Fig. 2). Taxonomic completeness, as measured by O/E, quantifies degraded biological condition as loss of expected native taxa (Hawkins 2006). E represents the number of taxa expected in a specific sample, based on its environmental setting, and O represents the number of those expected taxa that were actually observed. We developed models to calculate the O/E index following the general approach of Moss et al. (1987). First, we defined groups of reference calibration sites based on their

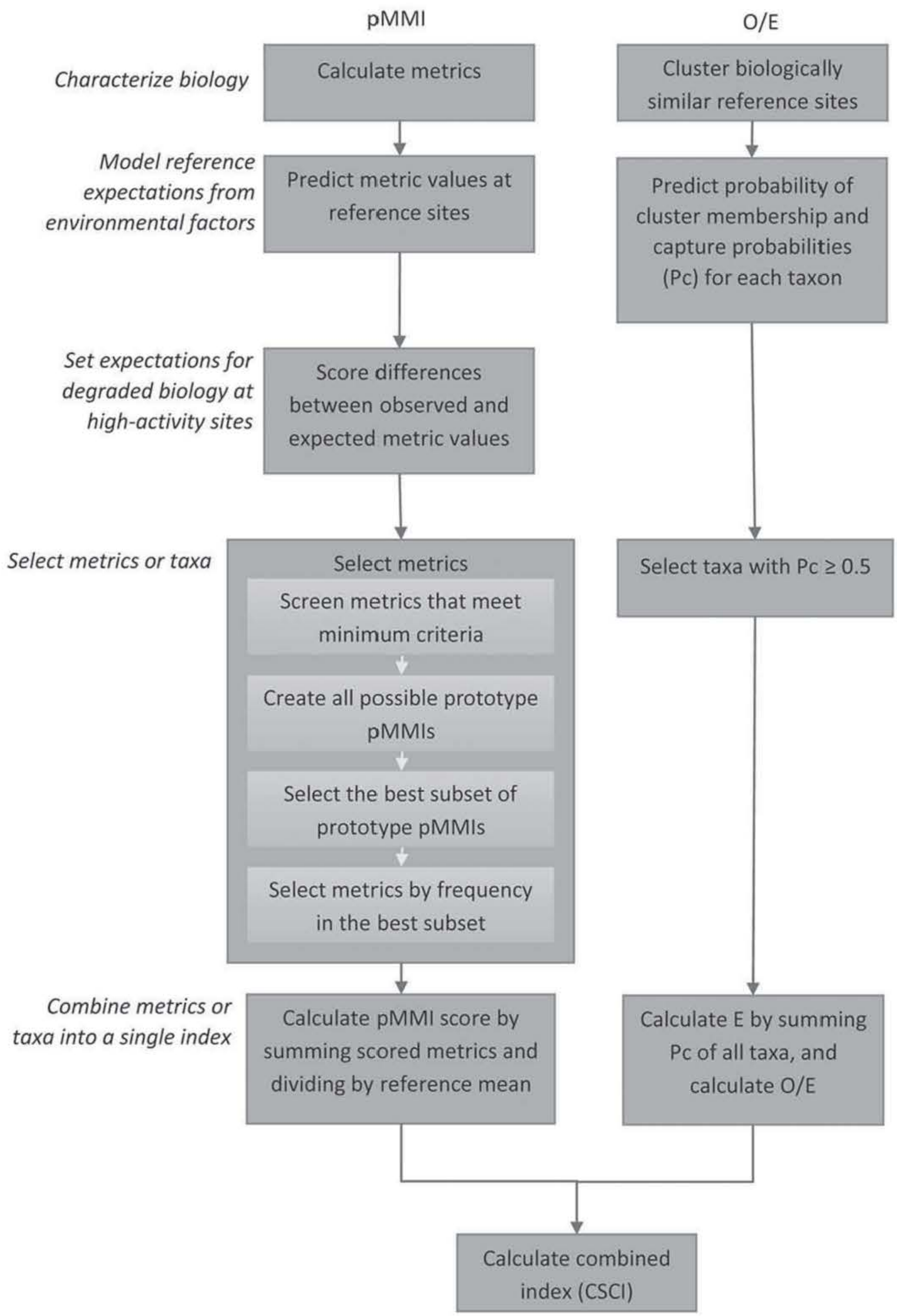

Figure 2. Summary of steps in developing the predictive multimetric index (pMMI) and observed (O)/expected (E) taxa index. Pc = probability of observing a taxon at a site, CSCI = California State Condition Index.

taxonomic similarity. Second, we developed a random-forest model (Cutler et al. 2007) to predict group membership based on naturally occurring environmental factors minimally affected by human activities. We used this model to predict cluster membership for test sites based on their natural environmental setting. The probability of observing a taxon at a test site (i.e., the capture probability) was calculated as the cluster-membership-probability-weighted frequencies of occurrence summed across clusters:

$$Pc_j = \sum_{i=1}^{k}(G_i F_i), \qquad \text{(Eq. 1)}$$

where Pc_j is the probability of observing taxon j at a site, G_i is the probability that a site is a member of group i, F_i is the relative frequency of the taxon in group i, and k is the number of groups used in modeling. The sum of the capture probabilities is the expected number of taxa (E) in a sample from a site:

$$E = \sum_{j=1}^{m} Pc_j, \qquad \text{(Eq. 2)}$$

where m is the number of taxa observed across all reference sites. We used Pc values ≥ 0.5 when calculating O/E because excluding locally rare taxa generally improves precision of O/E indices (Hawkins et al. 2000, Van Sickle et al. 2007). This model was used to predict E at reference and nonreference sites based on their natural environmental setting.

We used presence/absence-transformed BMI data from reference calibration sites to identify biologically similar groups of sites. We excluded taxa occurring in <5% of reference calibration samples from the cluster analysis because inclusion of regionally rare taxa can obscure patterns associated with more common taxa (e.g., Gauch 1982, Clarke and Green 1988, Ostermiller and Hawkins 2004). We created a dendrogram with Sørensen's distance measure and flexible β (β = −0.25) unweighted pair group method with arithmetic mean (UPGMA) as the linkage algorithm in R (version 2.15.2; R Project for Statistical Computing, Vienna, Austria) with the *cluster* package (Maechler et al. 2012) and scripts written by J. Van Sickle (US Environmental Protection Agency, personal communication). We identified groups containing ≥10 sites and subtended by relatively long branches (to maximize differences in taxonomic composition among clusters) by visual inspection of the dendrogram. We retained rare taxa that were excluded from the cluster analysis for other steps in index development.

We constructed a 10,000-tree random-forest model with the *randomForest* package in R (Liaw and Wiener 2002) to predict cluster membership for new test sites. We excluded predictors that were moderately to strongly correlated with one another (|Pearson's r| ≥ 0.7). When we observed correlation among predictors, we selected the predictor that was simplest to calculate (e.g., calculated from point data rather than delineated catchments) as a candidate predictor. We used an initial random-forest model based on all possible candidate predictors to identify those predictors that were most important for predicting new test sites into biological groups as measured by the Gini index (Liaw and Wiener 2002). We evaluated different combinations of the most important variables to identify a final, parsimonious model that minimized the standard deviation (SD) of reference site O/E scores at calibration reference sites with the fewest predictors.

We evaluated O/E index performance in 2 ways. First, we compared index precision with the lowest and highest precision possible given the sampling and sample-processing methods used (Van Sickle et al. 2005). SD of O/E index scores produced by a null model (i.e., all sites are in a single group, and capture probabilities for each taxon are the same for all sites) estimates the lowest precision possible for an O/E index. SD of O/E values based on estimates of variability among replicate samples (SDRS) estimates the highest attainable precision possible for the index. Second, we evaluated the index for consistency by regressing O against E for reference sites. Slopes close to 1 and intercepts close to 0 indicate better performance.

Development of the pMMI

We followed the approach of Vander Laan and Hawkins (2014) to develop a pMMI. In contrast to traditional MMIs, which typically attempt to control for the effects of natural factors on biological metrics via landscape classifications or stream typologies, a pMMI accounts for these effects by predicting the expected (i.e., naturally occurring) metric values at reference sites given their specific environmental setting. A pMMI uses the difference between the observed and predicted metric values when scoring biological condition, whereas a traditional MMI uses the raw metric for scoring. Traditional approaches to MMI development may reduce the effects of natural gradients on metric values through classification (e.g., regionalization or typological approaches; see Ode et al. 2005 for a California example), but they seldom produce site-specific expectations for different environmental settings (Hawkins et al. 2010b).

We developed the pMMI in 5 steps (Fig. 2): 1) metric calculation, 2) prediction of metric values at reference sites, 3) metric scoring, 4) metric selection, and 5) assembly of the pMMI. Apart from step 2, the process for developing a pMMI is comparable to that used for a traditional MMI (e.g., Stoddard et al. 2008). We developed a null MMI based on raw values of the selected metrics to allow us to estimate how much predictive modeling improved pMMI performance. The process was intended to produce a pMMI that was unbiased, precise, responsive, and able to characterize a large breadth of ecological attributes of the BMI assemblage.

Metric calculation We calculated biological metrics that characterized the ecological structure of BMI assemblages for each sample in the data set. We used custom scripts in R and the *vegan* package (Oksanen et al. 2013) to calculate a suite of 48 widely used bioassessment metrics, chosen because they quantify important ecological attributes, such as taxonomic richness or trophic diversity (a subset of which is presented in Table 3). Many of these metrics are widely used in other bioassessment indices (e.g., Royer et al. 2001, Stribling et al. 2008). Different formulations of metrics based on taxonomic composition (e.g., Diptera metrics) or traits (e.g., predator metrics) were assigned to thematic metric groups representing different ecological attributes (Table 3). These thematic groups were used to help ensure that the metrics included in the pMMI were ecologically diverse.

Prediction of metric values at reference sites We used random-forest models to predict values for all 48 metrics at reference calibration sites based on the same GIS-derived candidate variables that were used for O/E devel-

Table 3. Metrics evaluated for inclusion in the predictive multimetric index (pMMI). Only metrics that met all evaluation criteria are shown. EPT = Ephemeroptera, Plecoptera, and Trichoptera; Resp = direction of response; I = metric increases with human-activity gradients; D = metric decreases with human-activity gradients; Var Exp = % variance explained by the random-forest model; r^2 (cal) = squared Pearson correlation coefficient between predicted and observed values at reference calibration sites; r^2 (val) = squared Pearson correlation coefficient between predicted and observed values at reference validation sites; t (null) = t-statistic for the comparison of the raw metric between the reference and high-activity samples within the calibration data set; t (mod) = t-statistic for the comparison of the residual metric between the reference and high-activity samples within the calibration data set; F = F-statistic for an analysis of variance of metric residual values from reference calibration sites among regions shown in Fig. 1; S:N = signal-to-noise ratio; Freq = frequency of the metric among the best-performing combinations of metrics. Tolerance, functional feeding group, and habit data were from CAMLnet (2003). * indicates metric selected for inclusion in the pMMI.

Metric	Resp	Var Exp	r^2 (cal)	r^2 (val)	t (null)	t (mod)	F	S:N	Freq
Taxonomic diversity									
*Taxonomic richness	D	0.27	0.27	0.15	21.6	23.7	1.0	6.7	0.83
Functional feeding group									
Scrapers									
No. Scraper taxa	D	0.40	0.40	0.29	15.3	19.1	1.2	7.6	0.17
Shredders									
% Shredder taxa	D	0.27	0.27	0.46	17.6	10.6	1.0	4.1	0.33
* No. Shredder taxa	D	0.39	0.39	0.35	19.2	15.2	1.9	5.4	0.50
Habit									
Clingers									
* % Clinger taxa	D	0.34	0.34	0.42	21.7	14.6	0.2	4.8	1.00
No. Clinger taxa	D	0.39	0.40	0.32	26.0	25.3	0.5	11.1	0
Taxonomy									
Coleoptera									
* % Coleoptera taxa	D	0.30	0.31	0.22	10.3	15.8	1.0	5.0	0.83
No. Coleoptera taxa	D	0.34	0.34	0.29	13.6	20.9	0.6	6.2	0.17
EPT									
* % EPT taxa	D	0.31	0.32	0.46	30.0	23.1	0.4	6.0	0.67
No. EPT taxa	D	0.40	0.40	0.31	27.8	25.3	1.4	10.0	0.17
Tolerance									
* % Intolerant taxa	D	0.23	0.23	0.15	21.7	15.6	0.5	5.1	0.67
% Intolerant taxa	D	0.51	0.51	0.58	32.7	25.3	1.5	6.9	0.17
No. Intolerant taxa	D	0.52	0.52	0.53	28.4	21.8	1.5	9.6	0
Tolerance value	I	0.22	0.25	0.20	−21.5	−17.0	0.4	5.0	0
% Tolerant taxa	I	0.22	0.24	0.38	−26.1	−22.3	1.4	4.9	0.17

opment (Table 1). Manual refinement was impractical because of the large number of models that were developed, so we used an automated approach (recursive feature elimination [RFE]) to select the simplest model (the model with the fewest predictors) whose root mean square error (RMSE) was ≤2% greater than the RMSE of the optimal model (the model with the lowest RMSE). We considered only models with ≤10 predictors. Limiting the complexity of the model typically reduces overfitting and improves model validation (Strobl et al. 2007). We implemented RFE with the *caret* package in R using the default settings for random-forest models (Kuhn et al. 2012). We used the *randomForest* package (Liaw and Wiener 2002) to create a final 500-tree model for each metric based on the predictors used in the model selected by RFE. We then used these models to predict metric values for all sites. We used out-of-bag predictions for the reference calibration set (an out-of-bag prediction is based only on the subset of trees in which a calibration site was excluded during model training). To evaluate how well each model predicted metric values, we regressed raw observed values against predicted values for reference sites. Slopes close to 1 and intercepts close to 0 indicate better model performance. If the pseudo-R^2 of the model (calculated as 1 – mean squared error [MSE]/variance) was >0.2, we used the model to adjust metric values (i.e., observed – predicted), otherwise we used the observed metric values. Hereafter, 'metric' is used to refer to both raw and adjusted metric values.

Metric scoring Scoring is required for MMIs because metrics have different scales and different responses to stress (Blocksom 2003). Scoring transforms metrics to a standard scale ranging from 0 (i.e., most stressed) to 1 (i.e., identical to reference sites). We scored metrics following Cao et al. (2007). We scored metrics that decrease with human activity as

$$(\text{Observed}-\text{Min})/(\text{Max}-\text{Min}), \qquad \text{(Eq. 3)}$$

where Min is the 5th percentile of high-activity calibration sites and Max is the 95th percentile of reference calibration sites. We scored metrics that increase with human activity as

$$(\text{Observed}-\text{Max})/(\text{Min}-\text{Max}), \qquad \text{(Eq. 4)}$$

where Min is the 5th percentile of reference calibration sites, and Max is the 95th percentile of high-activity sites. We trimmed scores outside the range of 0 to 1 to 0 or 1. We used 5th and 95th percentiles instead of minimum or maximum values because they are more robust estimates of metric range than minima and maxima (Blocksom 2003, Stoddard et al. 2008).

Metric selection We selected metrics in a 2-phase process: 1) based on their individual performance, and 2) based on their frequency in high-performing prototype pMMIs. Evaluating the performance of many prototype pMMIs avoids selection of metrics with spuriously good performance and is preferable to selecting metrics or pMMIs based on performance evaluations conducted 1 metric at a time (Hughes et al. 1998, Roth et al. 1998, Angradi et al. 2009, Van Sickle 2010). Initial elimination of metrics based on their individual performance alleviates the computational challenge of evaluating large numbers of prototype pMMIs.

We used several performance criteria to eliminate metrics from further analysis. We assessed responsiveness to human activity by computing t-statistics based on comparisons of mean metric values at reference sites and sites with high levels of activity and eliminated metrics with a t-statistic < 10. We assessed bias by determining whether metric values varied among predefined geographic regions (Fig. 1). We considered metrics with an F-statistic > 2 derived from analysis of variance (ANOVA) by geographic region to have high regional bias and eliminated them. Other screening criteria were modified from Stoddard et al. (2008). We excluded metrics with >⅔ zero values across samples and richness metrics with range < 5. We also eliminated metrics with a signal-to-noise ratio (ratio of between-site to within-site variance estimated from data collected at sites with multiple samples) < 3.

We further screened metrics by evaluating the performance of all possible combinations as prototype pMMIs and selecting metrics that were frequent among prototypes with the best performance. First, we assembled all nonredundant combinations of metrics that met minimum performance criteria into prototype pMMIs. Limiting the redundancy of metrics increases the number of thematic groups included in prototypes, thereby improving the ecological breadth of the pMMI. Redundant combinations of metrics included those with multiple metrics from a single metric group (e.g., tolerance metrics; Table 3) or correlated metrics (|Pearson's r ≥ |0.7|). Prototype pMMIs ranged in size from a minimum of 5 to a maximum of 10 metrics, a range that is typical of MMIs used for stream bioassessment (e.g., Royer et al. 2001, Fore and Grafe 2002, Ode et al. 2005, Stoddard et al. 2008, Van Sickle 2010). We calculated scores for these prototype pMMIs by averaging metric scores and rescaling by the mean of reference calibration sites, which allows comparisons among prototype pMMIs.

Subsequently, we ranked prototype pMMIs to identify those with the best responsiveness and precision. Biased metrics already had been eliminated from consideration, and none of the prototypes exhibited geographic bias (results not shown), so we did not use accuracy to rank prototype pMMIs. We estimated responsiveness as the t-statistic based on mean scores at reference and high-activity calibration sites and precision as the SD of scores from reference calibration sites. We identified the best subset of prototype pMMIs as those appearing in the top quartile for both criteria. Therefore, prototype pMMIs in the best subset possessed several desirable characteristics: ecological breadth, high responsiveness, and high precision.

We assembled the final pMMI by selecting metrics in order of their frequency in the best subset of prototype pMMIs. We added metrics in order of decreasing frequency and avoided adding metrics from the same thematic group or correlated (Pearson's $r \geq 0.7$) metrics. We excluded metrics that appeared in <⅓ of the best prototype pMMIs from the final pMMI.

Aggregation of the pMMI We calculated scores for the final pMMI by averaging metric scores and rescaling by the mean of reference calibration sites (as for prototype pMMIs). Rescaling of pMMI scores ensures that pMMI and O/E are expressed in similar scales (i.e., as a ratio of observed to reference expectations) and improves comparability of the 2 indices.

We calculated scores for a combined index (the California Stream Condition Index [CSCI]) by averaging pMMI and O/E scores. We calculated a null combined index by averaging null MMI and null O/E scores.

Performance evaluation Evaluation of index performance focused on accuracy, precision, responsiveness, and sensitivity (Table 4). We compared the performance of each index to that of its null counterpart. Many of our approaches to measuring performance also have been used widely in index development (e.g., Hawkins et al. 2000, 2010a, Clarke et al. 2003, Ode et al. 2008, Cao and Hawkins 2011). We scored all indices on similar scales (i.e., a minimum of 0, with a reference expectation of 1), so no adjustments were required to make comparisons (Herbst and Silldorff 2006, Cao and Hawkins 2011). We conducted all performance evaluations separately on calibration and validation data sets.

We regarded indices as accurate if scores at reference sites were not influenced by environmental setting or time of sampling. Precise indices were those with low variability among reference sites and among samples from repeated visits within sites. Responsive indices were those that showed large decreases in response to human activity. Sensitive indices were those that frequently found nonreference sites to be below an impairment threshold (e.g., 10th percentile of scores at reference sites).

Performance of the indices along a gradient of expected numbers of common taxa (E) The performance of an ideal index should not vary with E. For example, index accuracy should not be influenced by the expected richness of a site. We evaluated the accuracy, precision, and sensitivity of the indices against E by grouping sites into bins that ranged in the number of expected taxa (bin size = 4 taxa). We chose this bin size because it was the smallest number that allowed analysis of a wide range of values of E with large numbers of sites in each bin (i.e., ≥37 sites for accuracy and precision estimates and 15 sites for sensitivity estimates). We measured accuracy as the proportion of reference sites in each bin with scores ≥10th percentile of reference calibration sites. We measured precision as the SD of reference sites in each bin and sensitivity as the

Table 4. Summary of performance evaluations. SD = standard deviation.

Aspect	Description	Indication of good performance
Accuracy and bias	Scores are minimally influenced by natural gradients	• Approximately 90% of validation reference sites have scores >10th percentile of calibration reference sites • Landscape-scale natural gradients explain little variability in scores at reference sites, as indicated by a low pseudo-R^2 for a 500-tree random-forest model • No visual relationship evident in plots of scores at reference sites against field measurements of natural gradients
Precision	Scores are similar when measured under similar settings	• Low SD of scores among reference sites (1 sample/site) • Low pooled SD of scores among samples at reference sites with multiple sampling events
Responsiveness	Scores change in response to human activity gradients	• Large t-statistic in comparison of mean scores at reference and high-activity sites • Landscape-scale human activity gradients explain variability in scores, as indicated by a high pseudo-R^2 for a 500-tree random-forest model
Sensitivity	Scores indicate poor condition at high-activity sites	• High percentage of high-activity sites have scores <10th percentile of calibration reference sites

proportion of high-activity sites within each bin with scores <10th percentile of reference calibration sites. We repeated all analyses with scores from indices based on null models.

Unlike accuracy and precision, the sensitivity of an ideal index (if measured as described above) may vary with E, but only to the extent that stress levels vary with E. However, how stress levels truly varied with E is unknown because human activity gradients were used to approximate stressor gradients, and direct, quantitative measures of stress levels are not possible. Even direct measures of water chemistry or habitat-related variables are at best incomplete estimates of the stress experienced by stream communities, and these data were not available for many sites in our data set. Therefore, we supplemented analyses of sensitivity against E by evaluating the difference in sensitivity between the pMMI and O/E against E. We calculated the difference as the adjusted Wald interval for a difference in proportions with matched pairs (Agresti and Min 2005) with the *PropCIs* package in R (Scherer 2013). The difference between the indices should be constant if E has no influence on sensitivity, or if E affects both indices in the same way. In the absence of direct measures of stress levels, these analyses provide a good measure of the influence of E on index sensitivity.

Establishment of biological condition classes, and application to a statewide assessment

We created 4 condition classes based on the distribution of scores at reference calibration sites, with a recommended interpretation for each condition class: likely to be intact (>30th percentile of reference calibration site CSCI scores), possibly altered (10th–30th percentiles), likely to be altered (1st–10th percentile), and very likely to be altered (<1st percentile). We used the *qnorm*() function in R to estimate thresholds from the observed mean and SD of reference calibration site CSCI scores. We explored other approaches to setting thresholds, such as varying thresholds by ecoregion or setting thresholds from environmentally similar reference sites, but rejected these approaches because of their added complexity and minimal benefits (Appendix S1).

We applied thresholds to a subset of sites from probabilistic surveys (n = 1318 sites) to provide weighted estimates of stream condition in California and for each major region. We also used the thresholds to make unweighted estimates of reference, moderate-activity, and high-activity sites for each region of the state. We used unweighted estimates because few reference probabilistic samples were available in certain regions. For weighted estimates, we calculated site weights by dividing total stream length in each stratum by the number of sampled sites in that stratum (these strata were defined as the intersections of strata from each contributing survey). All weight calculations were conducted using the *spsurvey* package (Kincaid and Olsen 2013) in R (version 2.15.2). We used site weights to estimate regional distributions for environmental variables using the Horvitz–Thompson estimator (Horvitz and Thomson 1952). Confidence intervals for estimates of the proportion of California's stream length meeting reference criteria were based on local neighborhood variance estimators (Stevens and Olsen 2004).

RESULTS

Biological and environmental diversity of California

Biological assemblages varied markedly across natural gradients in California, as indicated by cluster analysis. We identified 11 groups that contained 13 to 61 sites (Fig. 3). A few of these groups were geographically restricted, but most were distributed across many regions of the state. For example, sites in group 10 were concentrated in the Transverse Ranges of southern California, and sites in group 7 were entirely within the Sierra Nevada. In contrast, sites in groups 1 and 4 were broadly distributed across the northern ⅔ of California.

Environmental factors differed among several groups. Groups 8 through 11, all in the southern portions of the state, were generally drier and hotter than other groups, whereas groups 1 through 5, predominantly in mountainous and northern regions, were relatively wet and cold. Expected number of taxa also varied across groups. For example, the highest median E (i.e., sum of capture probabilities > 0.5) (17.2) was observed in group 3, whereas the lowest (7) was observed in group 8. The median E was <10 for 3 of the 11 groups (groups 8, 10, and 11). Sites in low-E groups were preponderantly (but not exclusively) in the southern portions of the state.

Development of predictive models

Predicting the number of locally common taxa for the O/E index The random-forest model selected to predict assemblage composition used 5 predictors: latitude, elevation, watershed area, mean annual precipitation, and mean annual air temperature (Table 1). The model explained 74 and 64% of the variation in O at calibration and validation sites, respectively. Regression slopes (1.05 and 0.99 at calibration and validation sites, respectively) and intercepts (−0.36 and 0.52) were similar to those expected from unbiased predictions (i.e., slope = 1 and intercept = 0, p > 0.05). The random-forest model was modestly more precise (SD = 0.19) than the null model (SD = 0.21) but substantially less precise than the best model possible (SD = 0.13).

Predicting metric values and developing the pMMI Predictive models explained >20% of variance in 17 of the 48 metrics evaluated for inclusion in the pMMI (a subset of which are shown in Table 3). For 10 metrics, ≥30% of

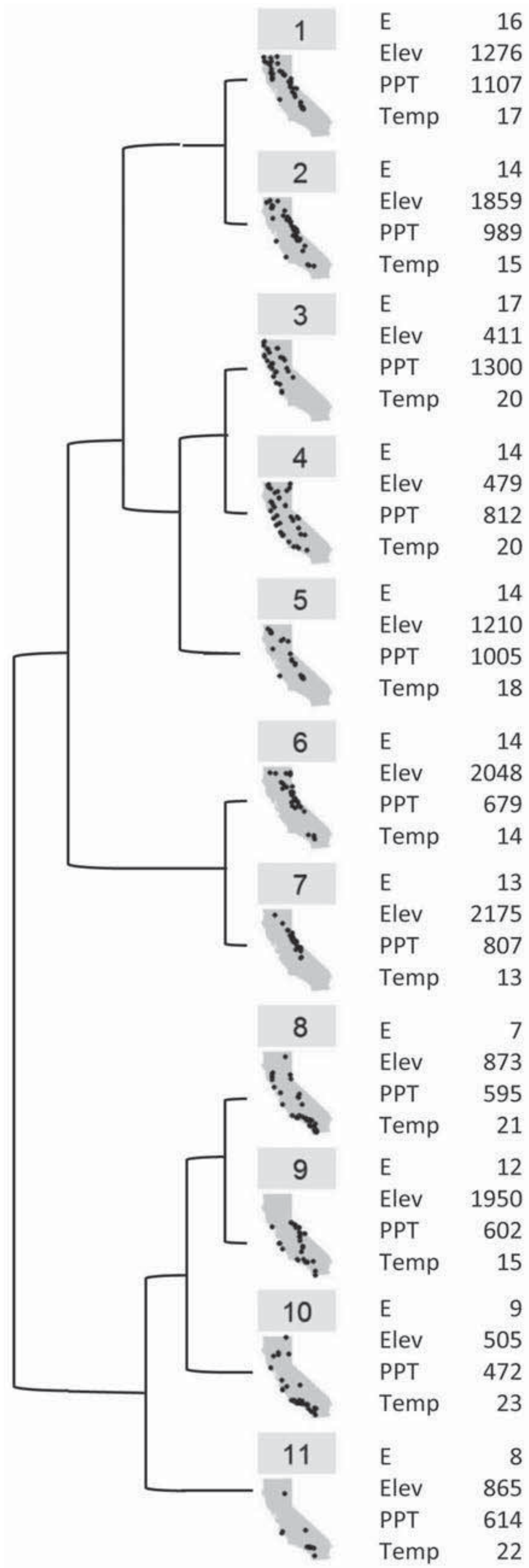

Figure 3. Dendrogram and geographic distribution of each group identified during cluster analysis. Numbers next to leaves are median values for expected number of taxa (E), elevation (Elev, m), precipitation (PPT, mm), and air temperature (Temp, °C).

the variance was explained, and for 2 metrics (no. intolerant taxa and % intolerant taxa), >50% of the variance was explained. Squared correlation coefficients (r^2) between predicted and observed metric values ranged from near 0 (e.g., Simpson diversity) to >0.5 (no. and % intolerant taxa metrics). Results for validation reference sites were consistent with results for calibration sites, but r^2 values differed markedly between calibration and validation data sets for some metrics (Table 3). In general, models explained the most variance for %-taxa metrics, and the least for %-abundance metrics, but this pattern was not consistent for all groups of metrics.

Metrics selected for the pMMI Of the 48 metrics evaluated, 15 met all acceptability criteria (Table 3). The bias criterion was the most restrictive and eliminated 21 metrics, including all raw metrics and 2 modeled metrics (% climber taxa and % predators). The discrimination criterion eliminated 15 metrics, most of which were already eliminated by the bias criterion. Other criteria eliminated few metrics, all of which were already rejected by other criteria. The 15 acceptable metrics yielded 28,886 possible prototype pMMIs ranging in size from 5 to 10 metrics, but only 234 prototype pMMIs contained uncorrelated metrics or metrics belonging to unique metric groups (data not shown). All of these prototype pMMIs contained ≤7 metrics. Of these 234 prototypes, only 6 were in the top quartile for both discrimination between reference and high-activity calibration samples and for lowest SDs among reference calibration samples.

The final pMMI included 1 metric from each of 6 metric groups (Table 3). Some of the selected metrics (e.g., Coleoptera % taxa) were similar to those used in regional indices previously developed in California (e.g., Ode et al. 2005). However, other widely used metrics (e.g., noninsect metrics) were not selected because they were highly correlated with other metrics that had better performance (pairwise correlations not shown).

The random-forest models varied in how much of the variation in the 6 individual metrics they explained (Pseudo-R^2 range: 0.23–0.39). Regressions of observed on predicted values for reference calibration data showed that several intercepts were significantly different from 0 and slopes were significantly different from 1 (i.e., $p < 0.05$), but these differences were small. The number of predictors used in each of the 6 models ranged from 2 (for no. Coleoptera taxa) to 10 (for taxonomic richness) (Table 1). Predictors related to location (e.g., latitude, elevation) were widely used, with latitude appearing in every model. In contrast, predictors related to geology (e.g., soil erodibility) or catchment morphology (e.g., watershed area) were used less often. In general, the most frequently used predictors also had the highest importance in the predictive models, as measured by % increase in mean square error. The least frequently used predictor (i.e., % P geology) was used in 1 model (taxonomic richness).

Performance of predictive models

Effects of predictive modeling on metrics For most metrics, reducing the influence of natural gradients through predictive modeling reduced the calculated difference between high-activity and reference sites, a result suggesting that stressor and natural gradients can have similar and confounded effects on many metric values (Table 3). For example, for 27 of the 48 metrics evaluated, the absolute t-statistic was much higher (difference in $|t| > 1$) for the raw metric than for the residuals. In contrast, the absolute t-statistic for residuals was higher for only 12 metrics.

Performance evaluation of the O/E, pMMI, and combined indices By all measures, predictive indices (whether used alone or combined) performed better than their null counterparts, particularly with respect to accuracy/bias (Table 5). For example, mean regional differences in null index scores at reference sites were large and significant (Fig. 4A, C, E), and responses to natural gradients were strong (Fig. 5A–O). In contrast, all measures of biases were greatly reduced for predictive indices (Fig. 4B, D, F).

Predictive modeling improved several aspects of precision. Variability of scores among reference sites was lower for all predictive indices than for their null counterparts, particularly for the pMMI (Table 5). Regional differences in precision were larger for the pMMI than O/E (both predictive and null models), and combining these 2 indices into the CSCI improved regional consistency in precision (Fig. 4B, D, F). Predictive modeling had a negligible effect on within-site variability (Table 5).

In contrast to precision and accuracy, responsiveness was more affected by index type than whether predictive or null models were used. Both predictive and null MMIs appeared to be slightly more responsive than the combined indices, which in turn were more responsive than O/E indices. This pattern was evident in all measures of responsiveness, such as magnitude of t-statistics, variance explained by multiple human-activity gradients in a random-forest model, and steepness of slopes against individual gradients (Table 5, Fig. 6A–I).

Analysis of sensitivity indicated stronger sensitivity of the pMMI than the O/E, and the combined index had intermediate sensitivity. Overall, 47% of nonreference sites had scores <10th percentile of reference calibration sites for the CSCI, in contrast with 52% of the pMMI and 35% of the O/E. Despite the overall difference between the pMMI and the O/E, agreement was relatively high (76%) when the 10th percentile was used as an impairment threshold (i.e., O/E $\geq$ 0.76 and pMMI $\geq$ 0.77). When the 1st percentile was used to set thresholds (i.e., O/E $\geq$ 0.56 and pMMI $\geq$ 0.58), the agreement rate was 90%.

Table 5. Performance measures to evaluate California State Condition Index (CSCI), MMI = multimetric index, and observed (O)/expected (E) taxa index at calibration (Cal) and validation (Val) sites. For accuracy tests, only reference sites were used. Ref mean = mean score of reference sites (* indicates value is mathematically fixed at 1), F = F-statistic for differences in scores at calibration sites among 5 regions (shown in Fig. 1, Central Valley excluded; residual df = 467), Var = variance in index scores explained by natural gradients at reference sites, among sites = standard deviation of scores at reference sites, within sites = standard deviation of within-site residuals for reference Cal (n = 220 sites) and Val (n = 60) sites with multiple samples, t = t-statistic for difference between mean scores at reference and high-activity sites, var = variance in index scores explained by human-activity gradients at all sites.

		Accuracy						Precision				Responsiveness			
		Ref mean		*F*		Var		Among sites		Within sites		*t*		Var	
Index	Type	Cal	Val	Cal	Val	Cal	Val	Cal	Val	Cal	Val	Cal	Val	Cal	Val
CSCI	Predictive	1.01	1.01	1.3	1.4	−0.08	−0.13	0.16	0.17	0.11	0.1	28.5	13	0.49	0.42
	Null	1*	1	52.9	4.7	0.41	0.12	0.21	0.2	0.11	0.11	28.6	14.8	0.64	0.58
MMI	Predictive	1*	0.98	0.8	1.3	−0.15	−0.09	0.18	0.19	0.12	0.12	30.9	14.4	0.54	0.48
	Null	1*	1	62.2	8.7	0.46	0.2	0.24	0.24	0.12	0.12	29.2	15.3	0.67	0.61
O/E	Predictive	1.02	1.03	1.2	1	0.01	−0.12	0.19	0.2	0.16	0.13	21.0	9.3	0.31	0.25
	Null	1*	1	23.5	0.9	0.23	−0.03	0.21	0.22	0.15	0.13	24.1	11.8	0.48	0.41

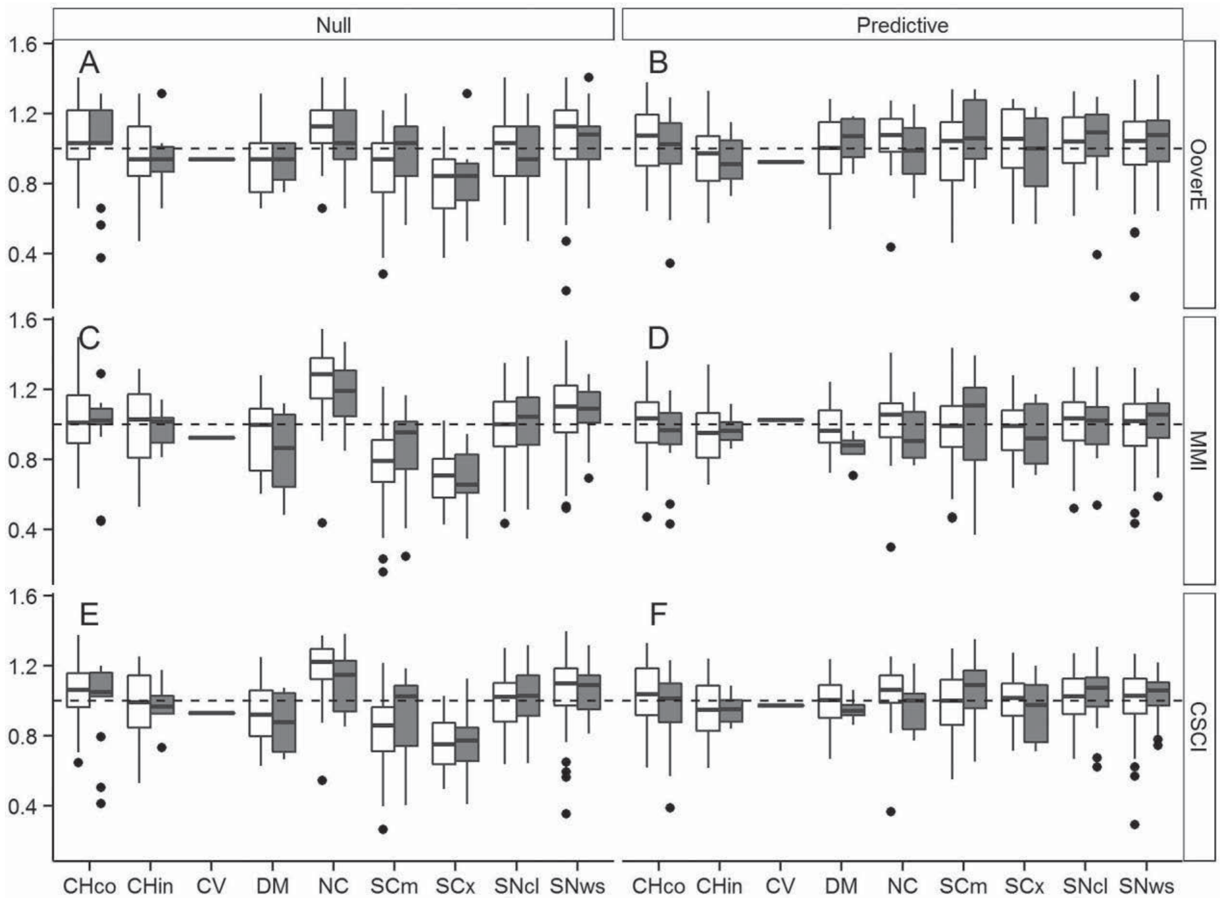

Figure 4. Box-and-whisker plots for distribution of scores for null (A, C, E) and predictive (B, D, F) models for the observed (O)/expected (E) taxon index (A, B), multimetric index (MMI) (C, D), and the combined index (CSCI) (E, F) scores by geographic region (see Fig. 1 for codes). White boxes indicate scores at calibration sites, and gray boxes indicate scores at validation sites. The horizontal dashed lines indicate the expected value at reference sites (= 1). Lines in boxes are medians, box ends are quartiles, whiskers are 1.5× the interquartile range, and dots are outliers (i.e., values >1.5× the interquartile range).

Effect of E on performance By most measures, performance was better at high-E than at low-E sites, but predictive indices were much more consistent than their null equivalents. For example, the accuracy of null indices was very poor at low-E sites (0.46–0.54 at E = 5; Fig. 7A), whereas predictive indices were much more accurate (0.73–0.86 at E = 5; Fig. 7E. At high-E sites, accuracy was >0.90 for both predictive and null indices. Precision was better at high-E sites for the pMMI and O/E index, but the CSCI had better and more consistent precision than the other indices at all values of E (Fig. 7B, F). For example, precision ranged from 0.22 to 0.15 (range = 0.07) for both the pMMI and the O/E, whereas it ranged from 0.18 to 0.14 (range = 0.04) for the CSCI.

In contrast to the weak associations between E and accuracy and precision, E was very strongly associated with sensitivity, as measured by the percentage of high-activity sites with scores <10^{th} percentile threshold (Fig. 7C, G). The pMMI classified a larger proportion of sites as in nonreference condition across nearly all values of E than the O/E index did, but the difference was largest at low-E sites (Fig. 7D, H). For example, at the lowest values of E analyzed (5), the pMMI identified 87% of high-activity sites as biologically different from reference, whereas O/E identified only 47% of sites as in nonreference condition. As E increased, the difference between the 2 indices in proportion of sites classified as nonreference decreased. Wald's interval test indicated significant differences between the indices for values of E up to 13. At low-E sites, the sensitivity of the CSCI was between the 2 indices, but at high-E sites, CSCI was more similar to pMMI. All 3 indices showed that low-E sites were more pervasively in nonreference condition than high-E sites, and the proportion of sites with scores <10^{th} percentile of reference calibration sites decreased as E increased. In contrast to precision and accuracy, sensitivity was more consistent across settings for

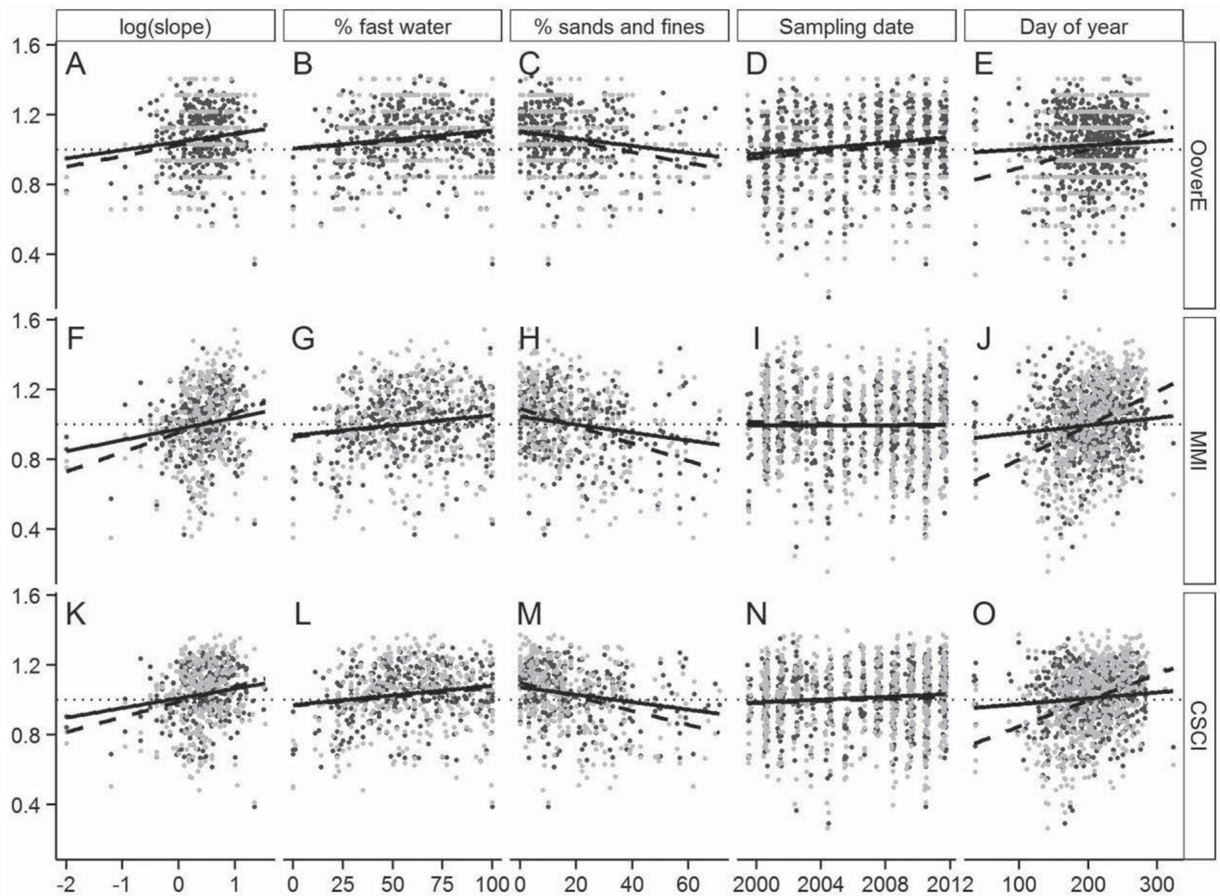

Figure 5. Relationships between observed (O)/expected (E) taxon index (A–E), multimetric index (MMI) (F–J), and the combined index (CSCI) (K–O) scores and slope (A, F, K), % fast water (area of reach with riffle, run, cascade, or rapid microhabitats) (B, G, L), % sand and fines (C, H, M), sampling date (D, I, N), and day of the year (E, J, O) at reference sites for predictive (black symbols, solid lines) and null (gray symbols, dashed lines) indices. The dotted line indicates a perfect relationship without bias.

null than predictive indices. For all analyses of performance relative to E, validation data yielded similar results (not shown).

Establishment of biological condition classes and application to a statewide assessment

We established 4 biological condition classes based on the distribution of CSCI scores at reference calibration sites. Statewide, 52% of streams were likely to be intact (i.e., CSCI ≥ 0.92 [30th percentile of reference calibration sites]). Another 18% were possibly altered (i.e., CSCI ≥ 0.79 [10th percentile]), 11% were likely to be altered (i.e., CSCI ≥ 0.63 [1st percentile]), and 19% were very likely to be altered (i.e., CSCI < 1st percentile) (Table 6). Although many (i.e., 49%) high-activity sites were very likely to be altered, this number varied considerably by region. Few high-activity sites were in this condition class in the more forested regions (e.g., 24% in the North Coast, 15% in the Sierra Nevada), whereas higher numbers were observed in relatively arid regions (e.g., 100% in the Desert/Modoc region and 68% in the Central Valley). In contrast, the percentage of reference sites in the top 2 classes varied much less across regions, from a low of ~85% in the South Coast and Desert/Modoc regions to a high of 98% in the North Coast (Table 6).

DISCUSSION

Our evaluation of index performance across different environmental settings demonstrates that, to the greatest extent possible with existing data, we have designed an index with scores that have comparable meanings for different stream types in an environmentally heterogeneous region of the USA. Each site is benchmarked against appropriate biological expectations anchored by a large and consistently defined reference data set, and deviations from these expectations reflect site condition in a consistent way across environmental settings. Thus, the index can be used to evaluate the condition of nearly all perennial streams in California, despite the region's considerable environmental and biological complexity. Three ele-

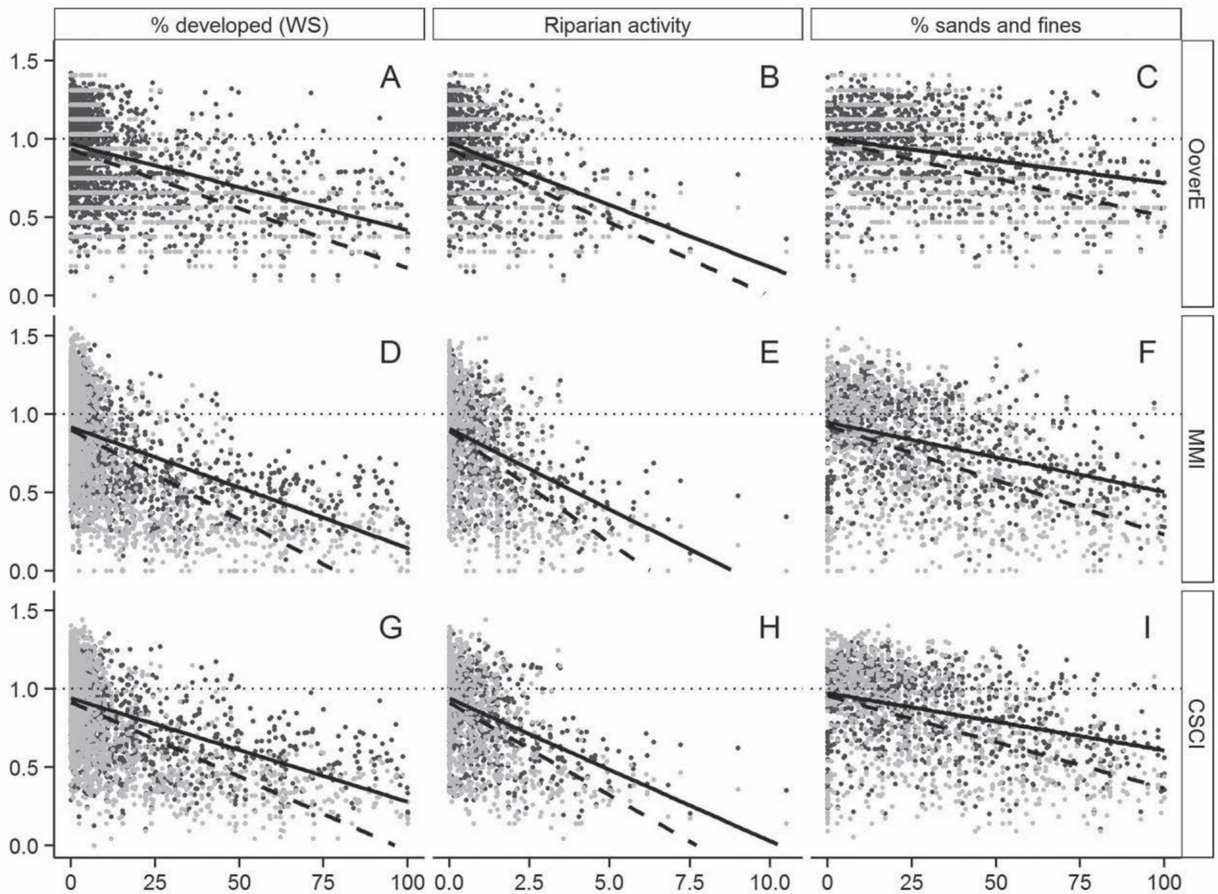

Figure 6. Relationships between observed (O)/expected (E) taxon index (A–C), multimetric index (MMI) (D–F), and the combined index (CSCI) (G–I) scores and % developed area of the watershed (WS) (A, D, G), riparian activity (B, E, H), and % sand and fines (C, F, I) for predictive (black symbols, solid lines) and null indices (gray symbols, dashed lines). The dotted line indicates the reference expectation of 1.

ments of the design process contributed to the utility of this index in an environmentally complex region: a robust reference data set, predictive modeling, and the combination of multiple endpoints into a single index.

Large, representative reference data sets

The 1st element was the large, representative, and rigorously evaluated reference data set (Ode et al. 2016). Natural factors that influence biological assemblages must be adequately accounted for to create an assessment tool that performs well across environmental settings (Cao et al. 2007, Schoolmaster et al. 2013). The strength of relationship between natural factors and biology varies with geographic scale (Mykrä et al. 2008, Ode et al. 2008), and representing locally important factors (such as unusual geology types with limited geographic extent, e.g., Campbell et al. 2009) contributes to the ability of the index to distinguish natural from anthropogenic biological variability in these environmental settings. Our reference data set was spatially representative and encompassed >10 y of sampling. Long-term temporal coverage improves the representation of climatic variability, including El Niño-related storms and droughts. The spatial and temporal breadth of sampling at reference sites provides confidence in the applicability of the CSCI for the vast majority of wadeable perennial streams in California.

Predictive modeling

The 2nd element of the CSCI's design, predictive modeling, enabled the creation of site-specific expectations for 2 indices, and these models created indices superior to those created by null models in nearly every aspect, particularly with respect to bias in certain settings. These results are consistent with a large body of literature showing similar results for indices that measure changes in taxonomic composition (e.g., Reynoldson et al. 1997, Hawkins et al. 2000, Van Sickle et al. 2005, Hawkins 2006, Mazor et al. 2006). However, few studies to date showed that the benefits extend to MMIs (e.g., Bates Prins and Smith 2007, Pont et al. 2009, Hawkins et al. 2010b, Schoolmaster et al. 2013, Vander Laan and Hawkins 2014).

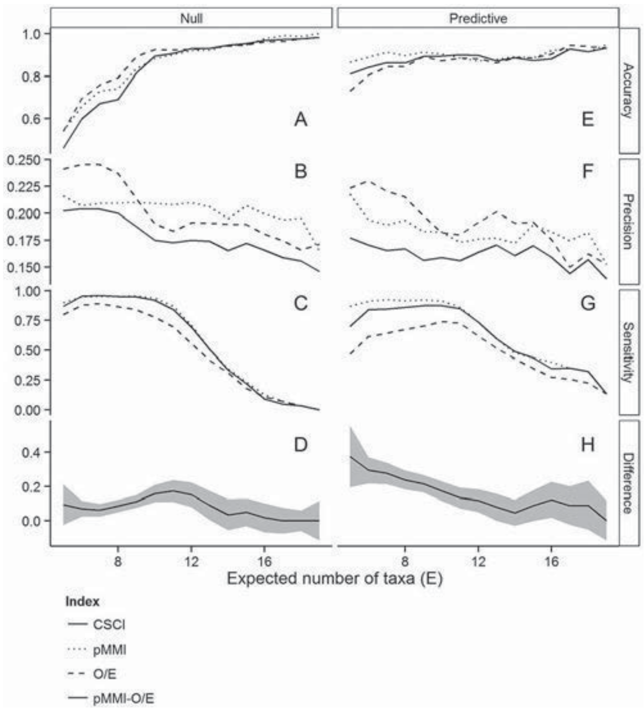

Figure 7. Effect of expected number of taxa (E) on accuracy (A, E), precision (B, F), sensitivity (C, G), and difference in sensitivity between the predictive multimetric index (pMMI) and the observed (O)/expected (E) taxa indices (D, H) for null (A–D) and predictive (E–H) index performance. The gray bands in the bottom panels C and G indicate the 95% confidence interval around the difference. Accuracy = proportion of reference calibration sites in reference condition (i.e., score >10th percentile of reference calibration sites) for each index. Precision = standard deviation of reference calibration sites for each index. Sensitivity = proportion of high-activity sites not in reference condition.

Our preference for predictive over traditional MMIs is not based only on the superior performance the pMMI relative to its null counterpart. The null MMI evaluated in our study was simplistic and did not reflect typical typological approaches to MMI development, which include regionalization in metric selection (e.g., Stoddard et al. 2008), regionalization in scoring (e.g., Ode et al. 2005), or normalization to watershed area (e.g., Klemm et al. 2003) to account for variability across reference sites. However, traditional MMIs based on regionalization usually lack metric and scoring standardization, which complicates interregional comparisons. Even if typological approaches provided equivalent performance to predictive indices, the latter would be preferred because of their ability to set site-specific management goals because predictive indices can better match the true potential of individual sites (Hawkins et al. 2010b). Thus, a watershed manager could take action to maintain a level of diversity a stream can truly support, rather than a level typical of potentially dissimilar reference sites.

Combining multiple indices

The 3rd element of the CSCI's design that contributed to its utility in different stream types was inclusion of both the pMMI and the O/E index. Regulatory agencies expressed a strong preference for a single index to support biocriteria implementation, and we thought that the CSCI was preferable to either the pMMI or O/E index. The different sensitivities of the 2 components should enhance the utility of the CSCI across a broad range of disturbances and settings. Together, they provide multiple lines of evidence about the condition of a stream and provide greater confidence in the results than a single index that might be biased in certain settings. Use of both metric and multivariate indices is widespread in assessments of coastal condition (e.g., the M-AMBI index; Muxika et al. 2007) specifically because the combination takes advantage of the unique sensitivities of each index in different habitat types (Sigovini et al. 2013). Applications of a multiple-index approach in stream assessment programs are uncommon, but the need has been suggested (e.g., Reynoldson et al. 1997, Mykrä et al. 2008, Collier 2009).

The decision to use both the pMMI and O/E index was based, at least partly, on observations that they had different sensitivities in different settings, particularly at low-E sites. The difference between the 2 indices might mean that the O/E index correctly indicates a greater resilience to stress at certain stream types or that the pMMI is more finely tuned to lower levels of stress simply because it was specifically calibrated against high-activity sites in similar settings. Mechanistically, the difference probably occurred because O/E index scores are mainly affected by the loss of common taxa. For example, in low-E sites (which were common in dry, low-elevation environments in southern and central coastal California), the O/E index predicted occurrence of only a small number of highly tolerant taxa (e.g., baetid mayflies) because only these tolerant taxa occur with high probability in these naturally stressful environments. Sensitive taxa also occur at reference sites in drier, low-elevation settings, but they were typically too rare to affect the O/E index (Appendix S2).

The interpretive value of rare, sensitive taxa in estimation of biological integrity of an individual site is unclear, but the ability of a site to support these taxa may be important to the health of a dynamic metacommunity, where rare taxa occupy only a small subset of suitable sites at any one time. Although several investigators have shown that exclusion of rare taxa usually enhances precision of O/E indices (e.g., Ostermiller and Hawkins 2004, Van Sickle et al. 2007), our results suggest that in certain settings, this exclusion may obscure an important response to

Table 6. Percentage of sites in different condition classes by region and site status. Percentiles refer to the distribution of scores at reference calibration (Cal) sites. Overall estimates are based on sites from probabilistic surveys and are not split into Cal or validation (Val) sets. For reference, moderate-, and high-activity sites, numbers in the last 6 columns are percentage of sites. For overall assessments, these numbers are percentage of stream miles. Dashes indicate that no sites were analyzed.

	Total sites		Likely to be intact ≥30th percentile (CSCI ≥ 0.92)		Possibly altered 30th–10th percentile (CSCI ≥ 0.79)		Likely to be altered 1st–10th percentile (CSCI ≥ 0.63)		Very likely to be altered <1st percentile (CSCI < 0.63)	
Region	Cal	Val	Cal	Val	Cal	Val	Cal	Val	Cal	Val
Statewide										
Reference	473	117	75	74	15	16	8	8	1	3
Moderate activity	626	156	53	56	20	20	18	17	8	7
High activity	497	122	13	18	13	14	25	22	49	46
Overall	919		52		18		11		19	
North Coast										
Reference	60	16	85	63	13	31	0	6	2	0
Moderate activity	88	26	58	50	26	15	9	27	7	8
High activity	45	9	29	67	33	33	13	0	24	0
Overall	162		58		23		10		9	
Chaparral										
Reference	74	19	68	63	20	26	9	0	3	11
Moderate activity	146	34	47	65	18	15	29	15	6	6
High activity	126	28	18	21	13	7	18	11	50	61
Overall	147		34		16		17		33	
South Coast										
Reference	96	23	70	70	16	9	14	22	1	0
Moderate activity	202	52	49	52	22	23	19	17	9	8
High activity	241	60	5	10	12	13	32	27	52	50
Overall	387		44		16		16		24	
Sierra Nevada										
Reference	221	55	77	82	14	11	7	5	1	2
Moderate activity	148	35	68	60	20	29	8	9	5	3
High activity	27	8	56	25	11	38	19	13	15	25
Overall	106		70		19		6		5	
Central Valley										
Reference	1	0	100	–	0	–	0	–	0	–
Moderate activity	8	1	0	0	0	0	38	100	63	0
High activity	47	13	0	0	4	8	28	38	68	54
Overall	60		2		8		18		71	
Desert/Modoc										
Reference	21	4	71	75	14	25	14	0	0	0
Moderate activity	34	8	44	63	9	0	29	13	18	25
High activity	5	4	0	50	0	0	0	50	100	0
Overall	57		48		14		9		30	

stress. Including rare taxa in certain environmental settings while excluding them in others may improve the consistency of an O/E index in complex regions, but we did not explore this option. The observation that sensitivity of all indices was lowest where E was highest was unexpected, and may be attributed to several potential causes. Most probably, anthropogenic stress was less severe at high-E than at low-E sites. High-activity sites were identified via indirect measures based on stressor sources (e.g., development in the watershed) rather than direct measures of water or habitat quality, so we could not ensure homogenous levels of disturbance among this set of sites. Alternatively, high-E settings might be more resilient to stress, perhaps because of their greater diversity (Lake 2000). Thus, the indices may have different responses to the same level of stress in different settings, depending on E.

Despite the lower sensitivity of the O/E index at low-E sites, we think that including it in a combined index was preferable to using the more sensitive pMMI by itself. Combining the 2 indices was a simple way to retain high sensitivity at low-E sites, while retaining the advantages of the O/E as a measure of biodiversity (Moss et al. 1987, Hawkins et al. 2000). The ability of the O/E index to measure taxonomic completeness has direct applications to conservation of biodiversity and makes it particularly sensitive to replacement of native fauna by invasive species. Furthermore, because it is calibrated with only reference sites, the O/E index is not influenced by the distribution or quality of high-activity sites. In contrast, we used the pMMI under the assumption that the set of high-activity sites adequately represented the types of stressors that might be encountered in the future. Inclusion of the O/E index in the CSCI provides a degree of insurance against faulty assumptions about the suitability of the high-activity site set for pMMI calibration.

We combined the 2 indices as an unweighted mean for several technical reasons, but primarily because this was the simplest approach to take without stronger support for more complicated methods. As we demonstrated, the CSCI has less variable performance across stream types than its 2 components. Approaches that let the lowest (or highest) score prevail are more appropriate when the components have similar sensitivity, but in our case would be tantamount to using the pMMI alone and muting the influence of the O/E index. Approaches that weight the 2 components based on site-specific factors (e.g., weighting the pMMI more heavily than the O/E index at low-E sites) are worthy of future exploration. Evaluating the pMMI and O/E indices independently to assess biological condition at a site might be useful, particularly at low-E sites, but the combined index is preferred for applications where statewide consistency is important, such as designation of impaired waterbodies.

Unexplained variability

In our study, predictive models were able to explain only a portion of the variability observed at reference sites—sometimes a fairly small portion. For example, the SD of the predictive O/E was only slightly lower than the SD of the null O/E (0.19 vs 0.21) and much larger than that associated with replicate samples (0.13). None of the selected random-forest models explained >39% (for the no. shredder taxa metric) of the variability at reference calibration sites. The unexplained variability may be related to the additional effects of environmental factors that are unsuitable for predicting reference condition (e.g., alterable factors, like substrate composition or canopy cover), environmental factors unrelated to those used for modeling (e.g., temporal gradients, weather antecedent to sampling), field and laboratory sampling error, metacommunity dynamics (Leibold et al. 2004, Heino 2013), or neutral processes in community assembly that are inherently unpredictable (Hubbell 2001, Rader et al. 2012). The relative contribution of these factors is likely to be a fruitful area of bioassessment research. Given the number and breadth of environmental gradients evaluated for modeling, we think it unlikely that additional data or advanced statistical methods will change the performance of these indices.

Setting thresholds

Some investigators have suggested that thresholds for identifying impairment in environmentally complex regions may require different thresholds in different settings based on the variability of reference streams in each setting. For example, Yuan et al. (2008) proposed ecoregional thresholds for an O/E index for the USA based on the observation that index scores at reference sites were twice as variable in some ecoregions as in others. Alternatively, site-specific thresholds could be established based on the variability of a subset of environmentally similar reference sites. We rejected both of these approaches in favor of uniform thresholds based on the variability of all reference calibration sites. We rejected ecoregional thresholds or other typological approaches because the validity of ecoregional classifications may be questionable for sites near boundaries. We rejected site-specific thresholds based on environmentally similar reference sites because they did not improve accuracy or sensitivity relative to a single statewide threshold when predictive indices are used (Appendix S1). These results are consistent with those of Linke et al. (2005), who showed that indices calibrated with environmentally similar reference sites had similar performance to indices based on predictive models that were calibrated with all available reference sites. Other approaches, such as direct modeling of the SD of index scores as a function of natural factors, also might improve comparability of scores across settings (R. Bailey, Cape Breton University, personal communication).

Conclusions and recommended applications

Many recent technical advances in bioassessment have centered on improving the performance of tools used to score the ecological condition of water bodies. Much of the progress in this area has come from regional, national, and international efforts to produce overall condition assessments of streams in particular regions (e.g., Simpson and Norris 2000, Van Sickle et al. 2005, Hawkins 2006, Hering et al. 2006, Stoddard et al. 2006, Paulsen et al. 2008). A key challenge in completing these projects has been incompatibility among scoring tools designed to assess streams in multiple regions, each calibrated for unique and locally important environmental gradients (Cao and Hawkins 2011). This issue has been well documented for large-scale programs in which investigators have attempted to integrate scores from a patchwork of assessment tools built for smaller subregions (Heinz Center 2002, Hawkins 2006, Meador et al. 2008, Pont et al. 2009), but far less attention has been paid to the meaning of index scores at individual stream reaches (Herlihy et al. 2008, Ode et al. 2008). Assessment of CSCI performance across the range of environmental settings in California was essential because the CSCI is intended for use in regulatory applications that affect the management of individual reaches, and consistent meaning of a score was a key requirement of regulatory agencies and stakeholders. We attempted to maximize consistency of the CSCI by using a large and representative reference set and by integrating multiple indices based on predictive models. Consistent accuracy was attained through the use of predictive models, whereas the consistency of precision and sensitivity was improved through the use of multiple endpoints.

The CSCI was designed for condition assessments, but we think it has broad application to many aspects of stream management. For example, it could be used to select comparator sites with similar biological expectations to test sites for use in causal assessments (e.g., CADDIS; USEPA 2010) or to prioritize streams that can support rare or threatened assemblages for restoration or conservation (Linke et al. 2011). The predictions generated by the index can inform management decisions about streams for which no biological data are available. Predictive indices, such as the CSCI, are powerful additions to the stream manager's tool kit, especially in environmentally complex areas. We recognize the challenges in enabling the general public to calculate an index as complex as the one presented here. Fortunately, online automation of many of the steps is possible. For example, much of the GIS analysis can be simplified by using publicly available resources like StreamStats (US Geological Survey 2012). An automated tool is in development, but people who are interested in using the CSCI or examining its component models are encouraged to contact the authors.

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Appendix S1. Nearest-neighbor thresholds do not improve performance of predictive indices.

Variable impairment thresholds may be useful when the precision of an index varies greatly across settings (Death and Winterbourn 1994). For example, Yuan et al. (2008) observed 2-fold differences in variability at reference sites across ecoregions in an observed (O)/expected (E) taxa index for the USA, results that justified different thresholds for each region. In such circumstances, a uniform threshold may increase the frequency of errors in the more variable settings. Reference sites with scores below a uniform threshold may be disproportionately common in settings where the index is less precise. A variable threshold that is lower in more variable settings may reduce this error rate (i.e., the reference error rate).

To determine if variable impairment thresholds based on site-specific characteristics could lead to an unbiased distribution of errors across regions, we evaluated 2 approaches to establishing thresholds: 1) a traditional approach, where a single number (based on variability in scores at all reference calibration sites) was used as a threshold, and 2) a site-specific approach, where thresholds were based on only a subset of the most environmentally similar reference calibration sites. In both cases, we considered sites to be in reference condition if their index score was >10th percentile of the relevant set of reference calibration site values. We measured environmental similarity as standard Euclidean distances along all environmental gradients used in predictive models (Table 1). We evaluated several different sizes of reference-site subsets (25, 50, 75, 100, and 200, and the full set of 473). We calculated the error rate for all regions (except for the Central Valley, which had only 1 reference site) as the proportion of sites with scores below the threshold. We plotted these regional error rates against the number of reference sites used to calculate the threshold (Fig. S1) and transformed scores at test sites into percentiles relative to each of these distributions. We used the predictive California Stream Condition Index

(CSCI) and its null equivalent in this analysis.

Variable thresholds greatly reduced the regional bias of the error rate of the null index, but had a negligible effect on the predictive index. For example, the null index had a very high error rate (0.30) in the South Coast when a uniform threshold was used, but this error rate dropped to 0.10 when variable thresholds based on 25 or 50 reference sites were used. In contrast, the regional error rate of the predictive index was always <0.15 and was not highly influenced by the number of reference sites used to establish thresholds.

We recommend a uniform threshold used in conjunction with a predictive index because of the added complexity and minimal benefits provided by the variable, site-specific thresholds.

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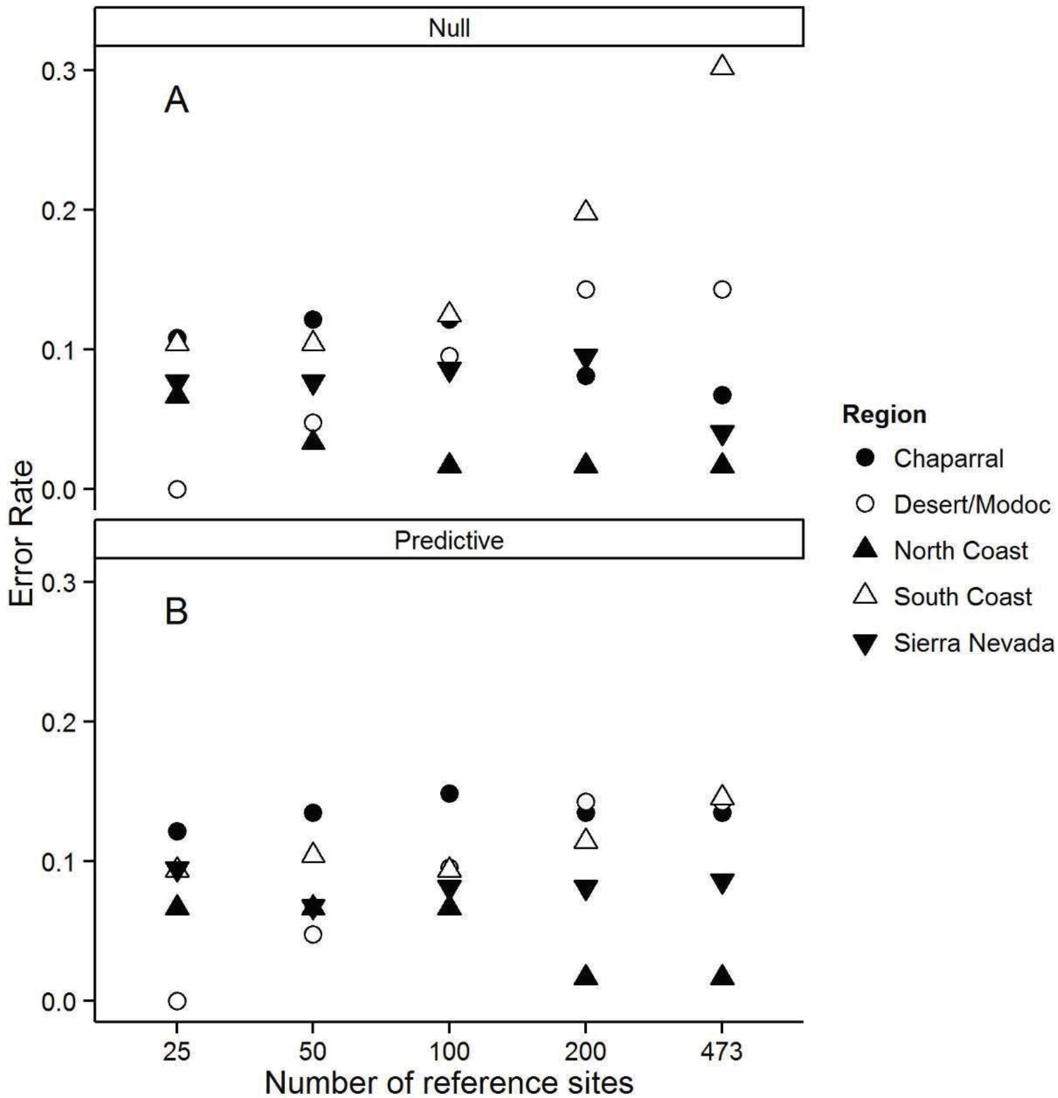

Fig. S1. Effects of nearest neighbor thresholds on error rates, calculated as the proportion of reference calibration sites below the threshold for null (A) and predictive (B) indices. Each point represents a different region. The highest number of reference sites is equivalent to the uniform threshold used in the main study.

Appendix S2. Index responsiveness as a function of predicted % sensitive taxa: a comparison of a predictive metric approach and the observed (O)/expected (E) taxa index.

The responsiveness of a bioassessment index depends on its ability to change in response to stress, and the loss of sensitive taxa is typically one of the strongest responses to stress (Rosenberg and Resh 1993, Statzner et al. 2004). To see if the ability to detect the loss of sensitive taxa depends on number of common taxa (E), we compared the proportion of sensitive taxa expected by an O/E index and a predictive multimetric index (pMMI) under different values of E. For the pMMI, this proportion was calculated as the predicted % intolerant taxa metric, as described in the accompanying manuscript. For the O/E, this proportion was calculated as the % of expected operational taxonomic units (OTUs) that are sensitive (OTUs with tolerance value < 3. For OTUs consisting of multiple taxa with different tolerance values, we used the median tolerance value). CAMLnet (2003) was the source of tolerance values. Estimates from both the O/E and pMMI were plotted against E to see whether the 2 indices allowed consistent ranges of response across values of E. These predictions were compared with the observed % intolerant taxa at reference sites to confirm the validity of these estimates.

At high-E sites (E > 14), both the pMMI and O/E had a consistent capacity to detect loss of sensitive taxa (Fig. S2A, C). Furthermore, both indices estimated similar proportions of sensitive taxa (~40%), suggesting that the 2 indices have similar sensitivity in these settings. Both indices also predicted a decline in the proportion of sensitive taxa at low-E sites, indicating that E affects the sensitivity of the pMMI and O/E. However, at the lowest levels of E, the O/E had no capacity to detect loss of sensitive taxa, whereas the pMMI predicted ~20% sensitive taxa at these sites, preserving a limited capacity to respond to loss of sensitive taxa. This capacity explains why the pMMI was more sensitive than the O/E at low-E sites.

Inspection of the data at reference sites indicates that sensitive taxa were truly present at these low-E sites (Fig. S2B, D) and that modeling the metric directly sets more accurate expectations for sensitive taxa in these settings (metric prediction vs observed $R^2 = 0.80$; O/E prediction vs observed $R^2 = 0.55$). However, these taxa were excluded from the index because of the minimum capture probability (i.e., 50%). Therefore, the predictive metric and not the O/E will be able respond to the loss of sensitive taxa at low-E sites.

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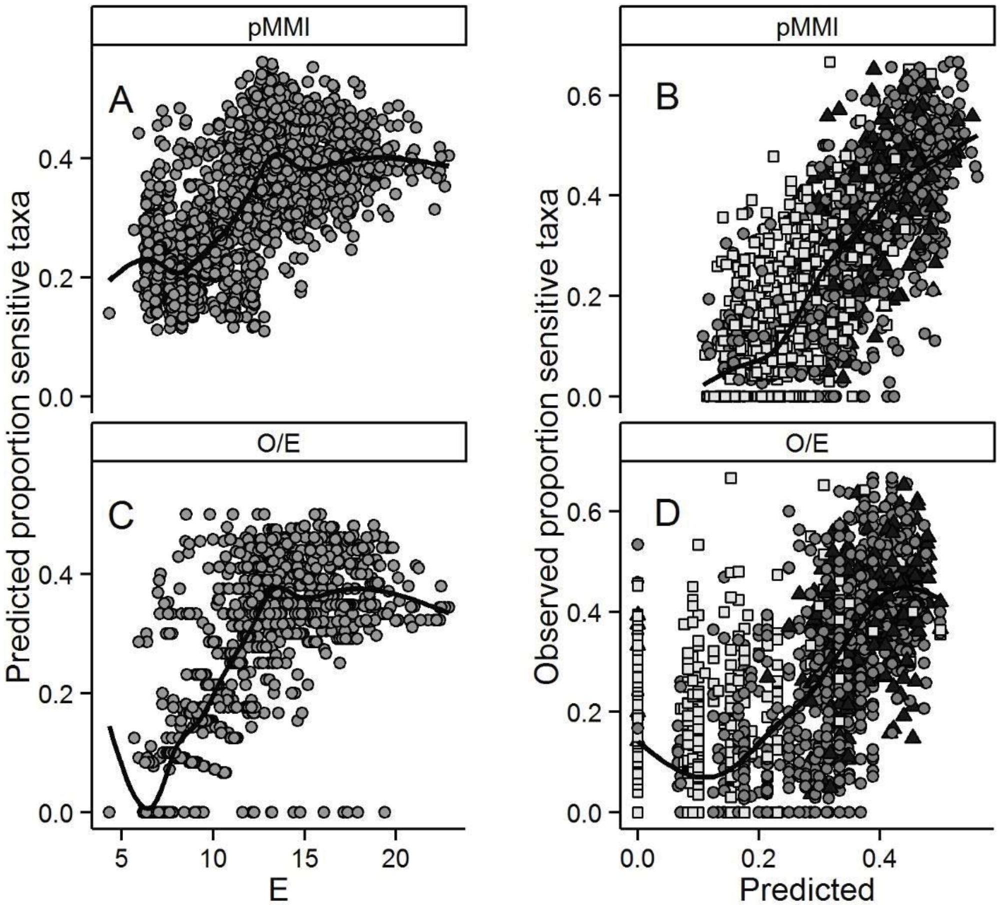

Fig. S2. Proportion of sensitive taxa predicted by a predictive multimetric index (pMMI) (A, B) and an observed (O)/expected (E) taxa index (C, D) at all sites (A, C), or observed at reference calibration (B, D) sites. Dark triangles represent sites with high (>15) numbers of expected taxa, gray circles represent sites with moderate (10–15) numbers of expected taxa, and white squares represent sites with low (<10) numbers of expected taxa. The solid line represents a smoothed fit from a generalized additive model.

Appendix 4

Comparability of biological assessments derived from predictive models and multimetric indices of increasing geographic scope

Peter R. Ode[1], Charles P. Hawkins[2] and Raphael D. Mazor

Abstract

As the use of bioassessment techniques expands, the demand for tools that can score biological condition from aquatic community data has spurred the creation of a large number of predictive models (e.g., observed over expected (O/E) indices) and multimetric indices (MMIs). The geographic and environmental scopes of these indices vary widely and coverages often overlap. If indices developed for large, environmentally heterogeneous regions provide results that are equivalent to those developed for smaller regions, then regulatory entities could adopt indices developed for larger regions rather than fund the development of multiple local indices. This potential was evaluated by comparing the performance (precision, bias, responsiveness, and sensitivity) of benthic macroinvertebrate O/E and MMIs developed for California (CA) with indices developed for two large-scale condition assessments of United States (US) streams: the US Environmental Protection Agency's Western Environmental Monitoring and Assessment Program's (WEMAP) stream project and the western portion of the national Wadeable Streams Assessment (WSA-West). Both WSA-West and WEMAP O/E scores were weakly correlated with CA O/E index scores, had lower precision than the CA index, were influenced by two related natural gradients (percent slope and percent fast water habitat) for which the CA index was not, and disagreed with 21 - 22% of impairment decisions derived from the CA index. The WSA-West O/E index produced many fewer impairment decisions than the CA index. In the MMI comparisons, both WEMAP and WSA-West MMI scores were much more strongly associated with CA MMI scores than those found in the O/E comparisons. However, the WSA-West and WEMAP MMIs produced many fewer impairment determinations than the CA MMI. Because the WEMAP and WSA-West indices were biased and differed in responsiveness compared with CA indices, they could produce different estimates of regional condition compared with indices that are calibrated to local conditions. Furthermore, the lower precision of the WEMAP and WSA-West indices compromises their use in site-specific assessments where both precision and accuracy are important. However, because the magnitude of differences in impairment decisions was very sensitive to the thresholds used to define impaired conditions, it may be possible to adjust for some of the systematic differences among the models, thus rendering the larger models more suitable for local application. Future work should focus on identifying the geographic and environmental scale that optimizes index performance, determining the factors that most strongly influence index performance, and identifying ways of more accurately specifying reference condition from geographically extensive sets of reference site data.

Introduction

The widespread adoption of bioassessment techniques for assessing the ecological condition of waterbodies has generated an abundance of indices available to water resource managers (Reynoldson *et al*. 1997, Hughes *et al*. 1998, Barbour and Yoder

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2000, Hawkins *et al* 2000a, Van Sickle *et al*. 2005, Bonada *et al*. 2006). Because these tools were generated to meet different needs, their geographic scopes differ widely and often overlap.

As the proliferation of new indices continues, end-users (e.g., regulatory entities developing numeric biocriteria, Yoder and Rankin 1995) will need guidance for selecting among these different indices and evaluating how many different indices a region needs for effective bioassessment. If local and regional assessments based on indices developed for broad geographical areas are equivalent to assessments based on indices developed for smaller areas, then regulatory entities could profit by adopting the large-scale indices and abandoning the development and maintenance of multiple, smaller-scale indices. This potential is attractive because indices that apply to large geographic areas have already been developed for many regions of the world, including: Great Britain (Moss *et al*. 1987), Australia (Simpson and Norris 2000), Europe (Statzner *et al*. 2001), and the United States (Stoddard *et al*. 2006, 2008; Yuan *et al*. 2008). Widespread use of common indices would facilitate consistency in data interpretation among the variety of users of ecological condition indices (Bonada *et al*. 2006, Hawkins 2006).

However, indices developed for large geographic regions may have limitations that could restrict their value for both site and regional assessments. Most notably, such indices must account for natural variation that occurs within large regions. Performance characteristics of both multimetric and predictive model indices are limited by their capacity to account for variability among the reference sites used to develop indices (Moss *et al*. 1987, Hughes 1995, Reynoldson *et al*. 1997, Karr and Chu 1999, Hawkins *et al*. 2000a, Bailey *et al*. 2004, Bonada *et al*. 2006).

It is a central principle of ecology that biological assemblages naturally vary along many environmental gradients (Andrewartha and Birch 1954, Hutchinson 1959, Hynes 1970). The precision and accuracy of any index will therefore depend on how well the mechanics of index calculation account for the effects of these natural gradients on assemblage structure (Johnson *et al*. 2004, Johnson *et al*. 2007, Van Sickle *et al*. 2005, Hawkins 2006, Heino *et al*. 2007, Mykrä *et al*. 2007, 2008). If biological variation associated with local environmental gradients (e.g., reach slope or substrate size) is masked by environmental factors that vary over large spatial scales (e.g., climatic factors and geology), then indices developed from more spatially restricted datasets may be required for site-specific assessments.

Recently derived biological indices developed for the EPA's national WSA and the WEMAP project (Stoddard *et al*. 2005, 2006; EPA 2006) presented an opportunity to evaluate this idea by comparing performance metrics (precision, bias, responsiveness, and sensitivity) of these indices with those of indices developed specifically for California (Ode *et al*. 2005, Rehn *et al*. 2005). The comparability of both site-specific and regionally aggregated biological assessments, where CA indices <WEMAP indices <WSA-West indices in geographic extent and geoclimatic heterogeneity, were evaluated. For these comparisons, assessments of an independent set of evaluation (test) sites that had not been used in developing any of the indices were conducted. To the extent that the test dataset permitted, parallel analyses for both MMI and O/E indices of benthic macroinvertebrate (BMI) assemblage condition were performed.

Methods

O/E Development

Three sets of predictive models were used to produce the O/E index values for comparison. All the O/E models were developed following a standardized process (Clarke *et al*. 2003, Hawkins *et al*. 2000a, Moss *et al*. 1987) described in the EMAP Western Streams and Rivers Statistical Summary (Stoddard *et al*. 2006). The process included: 1) sampling a set of environmentally diverse sites for BMIs, 2) specifying which of these sites would be used as reference sites, 3) applying a standard taxonomy (operational taxonomic units; OTUs) to all samples, 4) clustering of reference sites according to their similarity in BMI assemblage composition, 5) calculating and screening candidate predictor variables, and 6) calibrating linear discriminant functions models for predicting assemblage composition at new sites. All models were developed with map-level predictor variables (with the exception that field measured reach slope was used in one model) to allow more universal applicability of models (Table 1). Aside from the specific combination of predictor variables used in the models, the major difference among models was the range of environmental heterogeneity or geographic extent encompassed by the reference sites used in each model. Models were based on data from either targeted-riffle benthic samples (CA models) or a combination of targeted-

Table 1. Predictor variables used for all predictive models.

	California Models	WEMAP Models	WSA Model (no sub-models)
Sub-model 1	Watershed area Longitude Latitude Temperature	No predictors (null models)	Watershed area Longitude Day of year Minimum temperature Elevation Precipitation Slope
Sub-model 2	Longitude Preipitation Day of year Watershed area	Watershed area Longitude Elevation Precipitation	
Sub-model 3	Watershed area Temperature	No predictors (null models)	

riffle and reach-wide, multiple-habitat samples (WEMAP and WSA-West models). These two types of samples appear to be generally comparable for CA streams (Rehn *et al*. 2007). Other aspects of model development were similar (Table 2).

WSA-West model

A single western US model (WSA-West) developed during the national wadeable streams assessment (Yuan *et al*. 2008) encompassed the most heterogeneous environmental conditions and the largest geographic scope (~2,500,000 km^2; Figure 1). The WSA-West model was developed for all mountainous and xeric regions of the western United States and excluded only plains ecoregions (Figure 1; see Environmental Protection Agency 2006). To produce the WSA-West O/E index, 519 reference sites were clustered into 31 groups, and 7 predictor variables were selected to predict group membership (Table 1).

WEMAP models

The same data used to construct the WSA-West model had been previously used to develop five separate ecotype-specific submodels (Stoddard *et al*. 2006, 2008). All sampled sites (reference and non-reference) were assigned to one out of five broad ecotypes based on a k-means classification (MacQueen 1967) of long-term climatic (temperature and precipitation), geographic variables (latitude, longitude and elevation), and topographic variables (watershed area and channel slope). This pre-classification of sites was mainly designed to reduce the range of environmental heterogeneity encompassed by each model. The geographic scope of the resulting submodels ranged from ~200,000 km^2 to ~1,800,000 km^2 (Figure 2). Of the five submodels developed for the WEMAP study area (Stoddard *et al*. 2005, 2006), four submodels applied to geoclimatic conditions found in California. One model used predictor variables, whereas the other three were null models that predicted the same biota at all

Table 2. Comparison of BMI collection method, taxonomic effort levels and organism counts used both to build models and score test sites. See methods for definitions.

Indicator	Model	Field Method	Taxonomic Effort	Organism Count
O/E	WEMAP	RWB	Some species, but mostly genus (including Chironomidae)	300 (after removal of ambiguous individuals)
	WSA	RWB		
	2 CA sub-models	TRB		
MMI	WEMAP	RWB	Some species, but mostly genus (including Chironomidae)	300
	WSA	RWB	Some species, but mostly genus (including Chironomidae)	300
	CA model (NCIBI / SCIBI)	TRB	Genus, Chironomidae to family	500

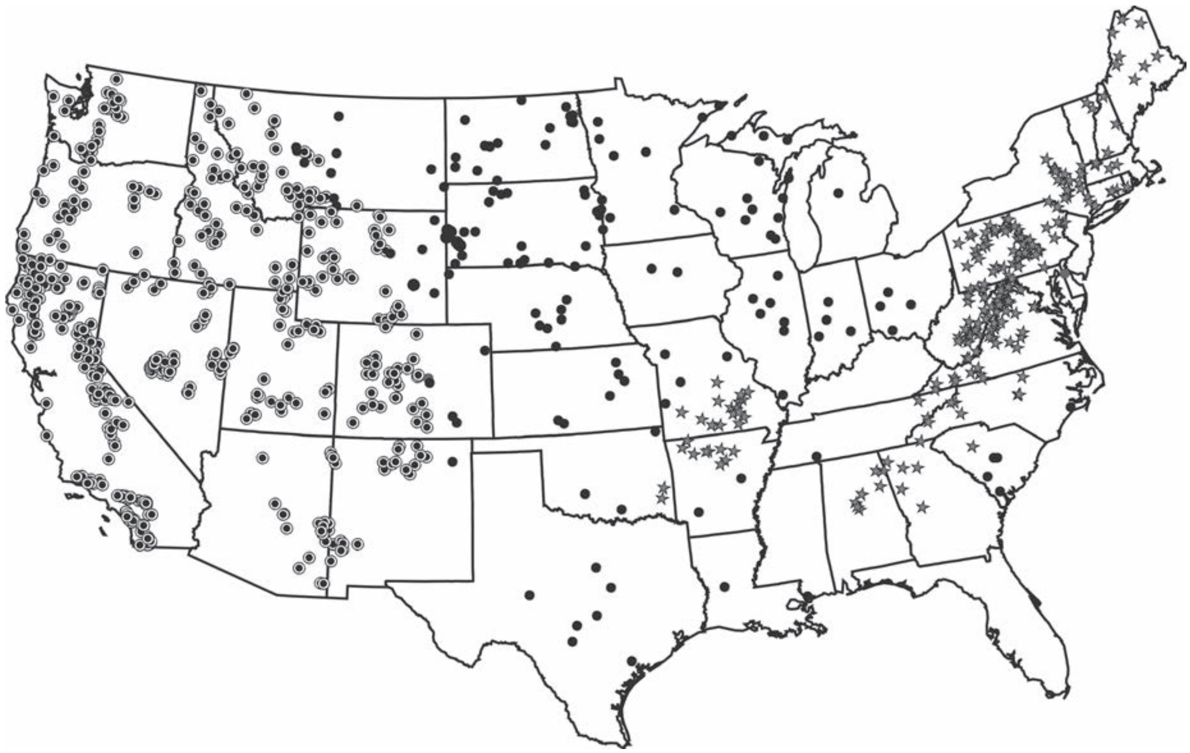

Figure 1. Location of reference sites used to create the three WSA predictive sub-models. Only the western sub-model applies to California sites. Each symbol represents a different sub-model.

sites within a geoclimatic region (Van Sickle *et al*. 2005; Table 1).

CA models

The third model set included three submodels that were developed for three types of climatic conditions in CA: cool-wet sites (mean monthly temperature (MMT) >9.9ºC and mean monthly precipitation (MMP) >895 mm), warm-dry sites (MMT >9.9ºC and MMP <895 mm), and cold-mesic sites (MMT <9.9ºC; Figure 3). The three CA submodels were calibrated from data collected at 209 reference sites, 179 of which were also used in calibrating WEMAP and WSA-West models (the other 30 sites were used as validation samples in the WEMAP and WSA projects). The spatial extent of the reference sites for these submodels was ~150,000 km^2 each (Figure 3). These three submodels also used unique combinations of predictor variables (Table 1).

MMI Development

The WSA, WEMAP, and CA MMIs were developed following similar methods as first developed by Karr (1981) and extended by others (Kerans and Karr 1994, Hughes *et al*. 1998, McCormick *et al*. 2001, Klemm *et al*. 2003): 1) assignment of a large pool of sites to either reference or test sets based on their degree of anthropogenic stress, 2) division of the site pool into calibration and validation sets, 3) using the calibration set to screen biological response metrics based on their responsiveness to important stressor gradients, their signal-to-noise ratios, and their non-redundancy with other metrics,

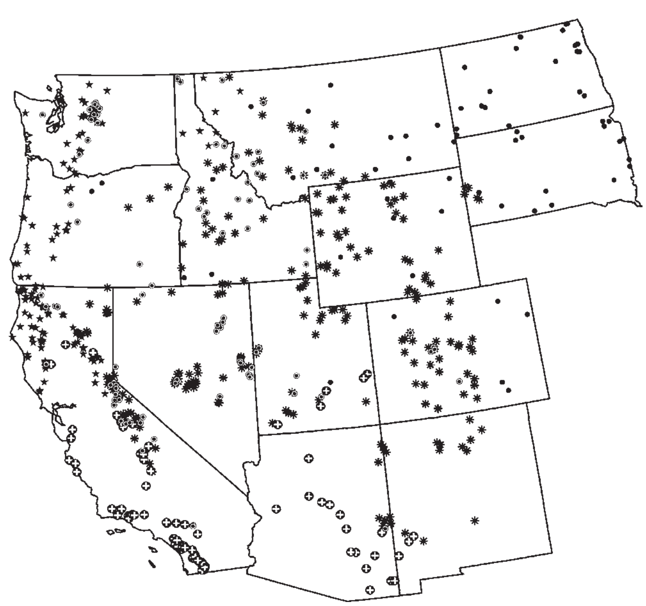

Figure 2. Location of reference sites used to create the five WEMAP predictive sub-models. Note that four of the five sub-models apply to California.

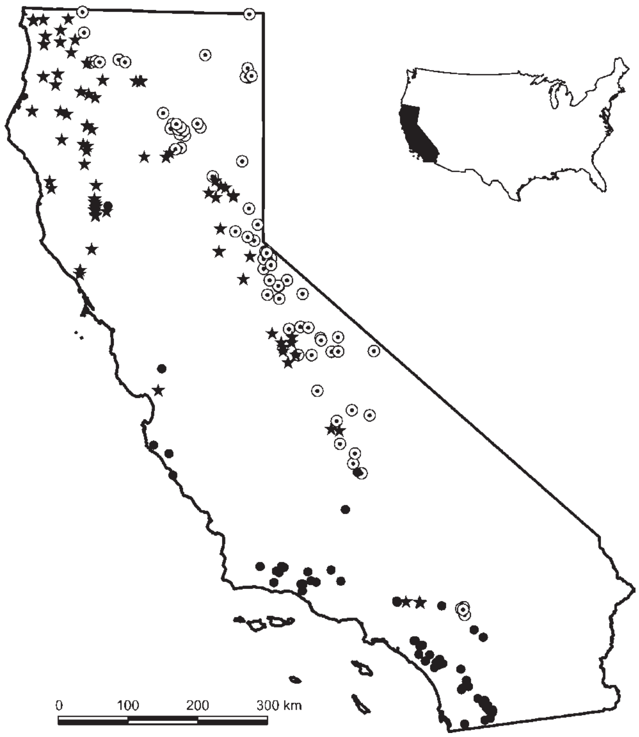

Figure 3. Location of reference sites used to create the three CA predictive sub-models. Each symbol represents a different sub-model.

4) establishing scoring ranges for selected metrics, 5) assembling a composite MMI from the component metrics, 6) establishing impairment thresholds for the index, and 7) evaluating index performance against the validation dataset (Herlihy *et al*. 2008, Stoddard *et al*. 2008).

These MMIs differed in a few important respects (Tables 2 and 3). The CA indices were based on subsamples of 500 organisms collected from targeted-riffle habitats (TRB) and identified primarily to genus level, but the WSA-West and WEMAP indices were based on subsamples of 300 organisms collected from multiple reach-wide composite habitats (RWB) with some individuals identified to species level (see text below for details on field and lab methods).

WSA-West MMIs

The EPA's WSA program developed two MMIs (xeric and western mountain ecoregions; Omernik 1987) to support its assessments of western streams using a calibration dataset of 775 sites (235 xeric and 540 mountain; Stoddard *et al*. 2008, EPA 2006). Both indices used six metrics, five of which were in common (Table 3). Scoring ranges for both WSA-West MMIs were scaled from 0 to 100 (Van Sickle and Paulsen 2008).

WEMAP MMIs

WEMAP developed three MMIs (xeric, plains and mountain ecoregions) for its analyses (Stoddard *et al*. 2005, 2006), two of which (xeric and mountain) applied to CA sites. The calibration dataset was comprised of 244 xeric and 565 mountain sites, nearly all of which (754 of 809) were used in WSA-West MMI development. As in the WSA-West index, the xeric and mountain versions of the WEMAP MMI consisted of six metrics, but shared fewer metrics in common (Table 3). Index values for both WEMAP MMIs were scaled from 0 to 100 (Stoddard *et al*. 2005).

CA MMIs

Two MMIs were developed for use in coastal California: the Southern Coastal California Index of Biotic Integrity or SCIBI (Ode *et al*. 2005) and the Northern Coastal California Index of Biotic Integrity or NCIBI (Rehn *et al*. 2005). The two CA MMIs included both the mountain and xeric aggregate ecoregions used for the WSA and WEMAP MMIs, and separate metric scoring ranges were established for the Omernik Level III (1987) ecoregions within each CA MMI development area (Figure 4). Of the 502 sites used to develop the CA MMIs, 119 were also used in WEMAP and WSA-West MMI development. The NCIBI consisted of eight metrics, whereas the SCIBI consisted of seven metrics, with four metrics in common (Table 3). The CA MMIs were also scaled from 0 to 100 (Ode *et al*. 2005, Rehn *et al*. 2005).

Test Site Data

These analyses incorporate BMI data collected for two large-scale probability surveys of CA streams. For clarity, use of the term "test sites" was restricted to refer only to these probabilistic samples of evaluation sites and not to non-reference sites used to calibrate MMIs, which are sometimes referred to as "test sites" in MMI development. For the O/E comparisons, data collected from 127 sites during the WEMAP 2000-2003 survey were used. For the MMI comparisons, data from 68 sites sampled by the California State Monitoring and Assessment Program (CMAP) between 2004 and 2006 were used. It was necessary to use different test sets for the O/E and MMI analyses because: 1) the restricted geographic boundaries of the CA MMI models limited the number of sites shared between O/E and MMI data sets, and 2) the MMI calibration datasets were

Table 3. BMI metrics comprising the multimetric indices. EPT = Ephemeroptera, Plecoptera, and Trichoptera.

Metric	California		WEMAP		WSA	
	NCIBI	SCIBI	Mountain	Xeric	Mountain	Xeric
EPT Richness	X	X	X	X	X	X
% Individuals in Top 5 Taxa			X		X	X
% Non-Insect Taxa	X	X		X		
Clinger % Taxa				X	X	X
% Intolerant Individuals	X	X				
% Non-Insect Individuals			X			X
% Tolerant Taxa		X	X			
Coleoptera Richness	X	X				
Scraper Richness					X	X
Tolerant % Taxa					X	X
% Burrower Individuals			X			
% Collector Individuals		X				
% EPT Taxa					X	
% Intolerant Taxa				X		
% Non-Gastropod Scraper Individuals	X					
% Omnivore Taxa			X			
% Predator Individuals	X					
% Shredder Taxa	X					
Diptera Richness	X					
Predator Richness		X				
Shannon Diversity				X		
Shredder Richness				X		

partially comprised of sites used for the O/E test set. The 127 sites used to evaluate predictive models were distributed throughout California (Figure 4a), whereas the 68 sites used to evaluate MMI models were restricted to coastal watersheds (Figure 4b). Most MMI test sites were concentrated in the northern half of the state (61 sites north of Monterey Bay), and the majority of these sites (40) were located within the boundaries of the NCIBI calibration sites (Figure 4b). The remaining 21 northern California sites were concentrated in the San Francisco Bay and Santa Cruz Mountains regions, which lie between the development regions of the two CA MMIs (Figure 4b). We used the NCIBI to score sites located between the NCIBI and SCIBI regions for the cross-index comparisons because this region is ecologically more similar to the North Coast than the South Coast and because reference conditions for this area were better represented in the NCIBI (Rehn *et al*. 2005). SCIBI scores were used for another 14 sites located within the region defined by the SCIBI calibration sites. Although the different geographic distributions in test sites may affect comparisons between MMIs and O/E indices, they do not affect comparisons of the performance of each type of index among the three geoclimatic scales.

Test site, field, and laboratory methods

All test sites were sampled in accordance with standard WEMAP field methods (Peck *et al*. 2006). A sampling reach was defined as 40 times the average stream width at the center of the reach, with a minimum reach length of 150 m. Two BMI samples were collected from each reach with standard 500-µm D-frame nets: 1) a RWB sample consisting of eleven 0.09-m^2 samples taken from equally spaced locations throughout the reach and 2) a TRB sample consisting of eight 0.09-m^2 samples taken from fast water habitat units within the reach (Hawkins *et al*. 2003).

All BMI samples used for the test datasets were processed at the California Department of Fish and Game's Aquatic Bioassessment Laboratory in Chico, CA. At least 500 individuals were identified to the standard taxonomic resolution targets described in Richards and Rogers (2006), i.e., those levels of taxonomic resolution that can be consistently achieved. A true, fixed 500-count random subsample was then

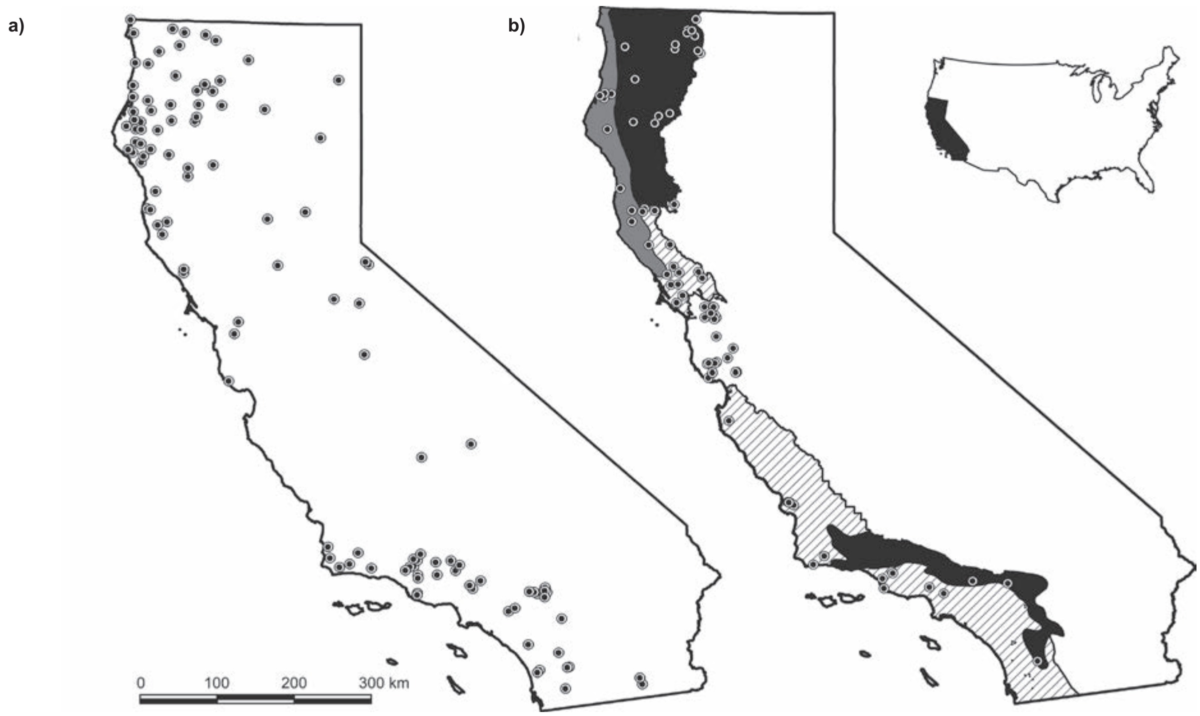

Figure 4. Location of test sites used for comparative analyses: 127 test sites used in O/E comparisons (a) and 68 test sites used in IBI comparisons (b). The three solid shaded regions correspond to mountain ecoregions used in the western and national models, whereas the three hatched regions correspond to the xeric ecoregions used in the western and national models. The two solid shaded regions in the northwest part of the state circumscribe the region for which the North Coast IBI was developed. The hatched regions and the continuously shaded region in southwestern part of the state circumscribe the region for which the South Coast IBI was developed. The inset shows the location of California in the United States.

obtained by computer resampling the sample data. Samples with between 450 and 500 individuals were retained in analyses. These raw data were then used to produce the standardized taxa lists and metrics needed for the various indices (Table 3). All analyses were based on the field methods, sample sizes and taxonomic levels used to develop each index (as indicated in Table 2).

Scoring Sites: Predictive Models

BMI taxonomic data

The raw subsample count data were further processed for use with the predictive models by:
1) converting the original identifications to the taxonomic levels used in the models (e.g., OTUs),
2) eliminating individuals that could not be assigned to an OTU (i.e., ambiguous individuals), and
3) resampling the remaining non-ambiguous individuals to 300-count samples. Samples with <300 individuals were retained in analyses.

Predictor variables

Geographic coordinates (latitude and longitude) were obtained via GPS measurements taken during sample collection. Watershed area were calculated after delineating upstream watershed boundaries for each site with automated GIS scripts or manual delineation where necessary. Long-term MMP, MMT, and MMA values for each site were estimated from GIS grids of (1961-1990) obtained from the Oregon Climate Center (http://www.ocs.orst.edu/prism). Site elevations were derived from 30-meter digital elevation models (http://ned.usgs.gov). Channel (reach) slope was measured in the field (as it was in model development).

Geographic and environmental attributes were used to assign each site to the appropriate WEMAP and CA models. Assignment of sites to the five WEMAP models was based on latitude, longitude, elevation, MMP, MMT, watershed area, and channel slope. These assignments were made prior to model building during the k-means analysis (MacQueen 1967). Assignment of test sites to the appropriate CA model was conducted after model development. This study used a simple classification and regression tree model based on long-term precipitation and air temperature to assign sites to the CA submodels.

O/E values were calculated based on just those taxa with site probabilities of capture ≥0.5 because these values result in more precise O/E values that are also usually more sensitive to stress (Hawkins *et al*. 2000a, Ostermiller and Hawkins 2004, Van Sickle *et al*. 2007) than O/E values based on all taxa in the reference calibration data set. When reporting impairment decisions for the test sites, impairment thresholds were set at two standard deviations below the mean value of reference sites for all O/E models (Table 4).

Scoring Sites: MMIs

BMI taxonomic data

Because the MMIs differed with respect to organism count and taxonomic resolution, MMI scores were calculated based on the sample counts and taxonomy used when developing each index (Table 2). MMI values were then calculated for test samples that had been collected in a standard manner to avoid confounding comparisons with inter-method variability. All sites were assigned to either the xeric or mountain aggregate ecoregions, with mountain ecoregions being further divided into Southern California Mountains, Klamath Mountains, Coast Ranges, and Southern and Central California Chaparral and Oak Woodlands for the CA MMIs (Omernik 1987). MMI values were then calculated based on the specific scoring ranges developed for each individual metric and region and rescaled these MMI values from 0 to 100. As for O/E models, impairment thresholds for all MMIs were set at two standard deviations below the mean value at reference sites (Table 4).

TRB was used as the default sample type, although RWB samples were used at six sites where TRB samples were unavailable or had low sample counts (<450 organisms). Because it was found elsewhere that RWB samples on average scored 7.8 points lower on the CA IBIs than TRB samples (Rehn *et al*. 2007), 7.8 points were added to CA IBI scores for these RWB samples. To evaluate the potential effect of using TRB samples instead of RWB samples (the method used in national and western model development; Table 2) in comparisons, an additional analysis was performed in which both the TRB and RWB data from 21 sites with all three MMIs were scored. If paired t-tests indicated significant differences between methods, RWB scores were adjusted by a correction factor corresponding to the difference between mean site scores.

Comparison of Index Scores

The CA index values were used as a benchmark for comparing the performance of the WSA-West and WEMAP indices. Comparisons were based on index precision, bias, responsiveness, and sensitivity.

O/E comparisons

Precision was measured as the standard deviation (sd) of reference site O/E values. Bias was measured as the tendency for reference site O/E values to vary systematically with one or more of four

Table 4. Standard deviation (sd) values and impairment thresholds (IT) for each predictive model (O/E) and coefficients of variation (CV) and impairment thresholds (IT) for MMIs. Note that only WEMAP sub-models 2 through 5 apply to California.

California O/E			WEMAP O/E			WSA O/E		
Sub-model	sd	IT	Sub-model	sd	IT	Model	sd	IT
1	0.13	0.74	1	0.24	0.52	West	0.20	0.59
2	0.17	0.66	2	0.15	0.70			
3	0.16	0.68	3	0.20	0.60			
			4	0.20	0.60			
			5	0.17	0.66			
California MMI			**WEMAP MMI**			**WSA MMI**		
Sub-model	CV	IT	Sub-model	CV	IT	Sub-model	CV	IT
NCIBI	0.14	52	Mountain	0.13	55	Mountain	0.26	28
SCIBI	0.19	39	Xeric	0.23	36	Xeric	0.25	34

natural gradients (reach slope, elevation, watershed area, and percent of reach with fast water habitats). The study also assessed relative bias between pairs of O/E indices using linear regression; slopes were tested for significant differences from 1, and intercepts were were tested for significant differences from 0. The consequences of these types of biases were illustrated by plotting the pair-wise differences in index scores against these natural gradients. Responsiveness was measured as the mean difference between reference and test sites in O/E values. Sensitivity was measured as the proportion of test sites assessed as impaired by the models. This measure of sensitivity is a joint function of precision, bias, and responsiveness. For these assessments, the threshold values for inferring impairment were defined as 2 sds below the reference (calibration) means (Table 4). Binomial tests (Zar 1999) were used on sites with disagreeing impairment decisions to determine if the indices were equally likely to detect impairment. This test was performed within each of the three CA submodels, as well as on all sites combined. In addition to comparison of impairment determinations based on 2 sds thresholds, two different threshold corrections for ecoregional differences were also evaluated. In the WSA, impairment thresholds were established separately for xeric and mountain ecoregions at the 5th percentile of the calibration reference population (estimated as 1.64 standard deviations below the reference mean; Herlihy *et al*. 2008). We also estimated separate thresholds for mountain and xeric regions at 2 sd below the mean for each ecoregion, an approach consistent with previous comparisons. For all relevant analyses, Bonferroni adjustments were applied for multiple comparisons when the correction was conservative. That is, the correction was not applied when we were screening natural gradients as potential drivers of bias, but was applied for hypothesis tests of index agreement (e.g., impairment decisions, responsiveness tests).

Multimetric index comparisons

MMI analyses paralleled the O/E comparisons. However, raw MMI scores were not directly comparable because the scores at calibration reference sites differed among the MMIs. Therefore, MMI scores were rescaled by dividing the raw score by the index's reference mean. These adjusted scores were then used as a "common currency" in all analyses in which scores were compared directly. Thus, the MMI scaling in these analyses was similar to the ~1.0 reference mean in O/Es. Only the comparisons of impairment decisions were based directly on the raw MMI scores.

Results

O/E Comparisons

Precision

The predictions of the WSA-West and WEMAP models were less precise (reference site O/E sd = 0.17 to 0.20) than those of the CA models (sd = 0.13 to 0.17; Table 4). Imprecision in model predictions contributed, in part, to weak relationships between the CA O/E indices and the WSA-West and WEMAP O/E indices (CA vs. WSA-West $r^2 = 0.32$, CA vs. WEMAP $r^2 = 0.35$; Figure 5). However, the stronger agreement between the less precise WSA-West and WEMAP O/E indices (WSA-West vs. WEMAP $r^2 = 0.58$) indicates that factors other than precision (e.g., bias) must also be affecting differences in agreement (Figure 5).

Bias

The WSA-West and WEMAP O/E values were biased predictors of the CA O/E values and each other, with slopes and y-intercepts significantly different ($p < 0.001$) than 1 and 0, respectively, for all comparisons (Figure 5). Differences were large, with slopes as low as 0.58 and intercepts as high as 0.36. These results showed that the nature of the bias was not constant across all sites. Instead, differences in index scores depended on the site-specific differences among models in how they either over- or under-estimated E (the expected number of predicted taxa) relative to one another. The reason that the O/E indices were biased predictors of one another occurred, at least in part, because the WSA-West and WEMAP models failed to adjust predictions of E for the effects of at least one natural gradient. This failure is illustrated by systematic variation in reference site O/E values produced by the WSA-West and WEMAP models across percent slope (WSA-West score = 0.025% slope + 0.80, p = 0.001; WEMAP score = 0.023% slope + 0.67, p = 0.002) and percent fast water habitat gradients (WSA-West score = 0.0051% fast water + 0.747, p <0.001; WEMAP score = 0.0045% fast water + 0.63, p <0.001). No such relationships were evident for CA O/E values (CA score = 0.0086% slope + 0.78, p = 0.259; CA score = 0.0016% fast water + 0.77, p = 0.205). The reason the CA O/E indices were unrelated to reach slope is probably related to the fact that, within CA, channel

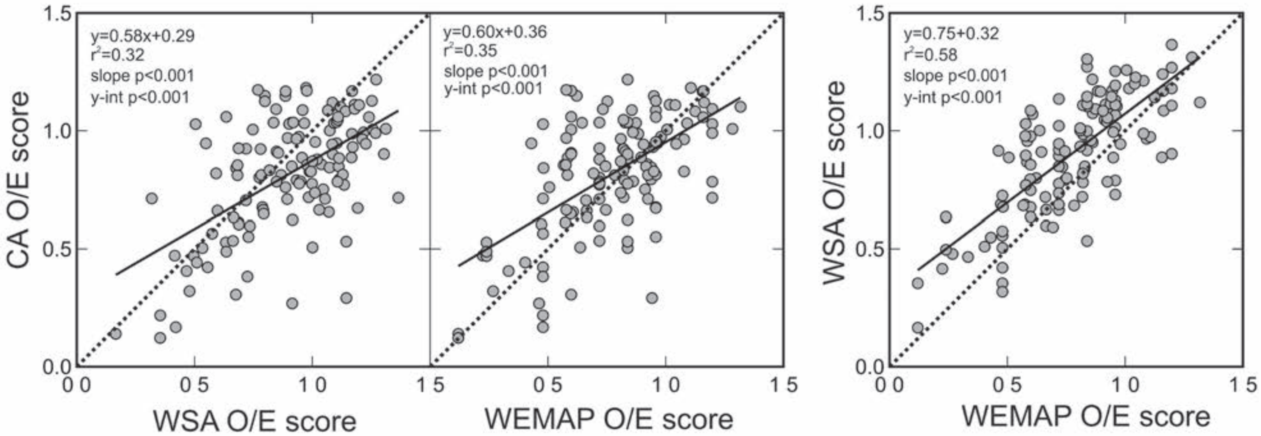

Figure 5. Regressions between O/E scores at CA test sites for all combinations of models. The dotted diagonal lines represent perfect 1:1 relationship between the models, and the thick solid lines indicate linear best-fit relationships. Significance tests are for y-intercept (y-int) = 0 and slope = 1.

slope was associated with watershed area (Area), a predictor in all three CA models (square root slope = 4.11 -0.531*log Area – 0.040*latitude across all reference sites, n = 209, $r^2 = 0.14$, model p <0.001). It is therefore possible that watershed area was a surrogate predictor of reach slope within CA. Percent fast water was measured at too few sites to determine its relationship with watershed area within CA. As a consequence of the bias between the WSA-West and WEMAP model predictions, pair-wise differences between O/E values for both the WSA-West and WEMAP indices and the CA indices were significantly related to channel slope and percent fast-water habitat (Figure 6). Similar biased predictions associated with either elevation or watershed area were not observed, nor were any of these relationships observed for pair-wise differences in values between WSA-West and WEMAP (Figure 6; Table 5). Furthermore, correlation coefficients were low for all of these relationships (Table 5), indicating that very little variance in differences between the indices was explained by these natural gradients. Although not related to the four natural gradients we examined, there was a tendency for the WSA-West model to produce higher O/E scores than the WEMAP submodels, especially at lower O/E values (p <0.005; Table 5; Figures 5 and 6).

Responsiveness

The WEMAP models tended to produce the lowest O/E values and the WSA-West models the highest O/E values at the test sites (Table 6). O/E values based on the CA models tended to be intermediate in magnitude. This pattern generally occurred for both mountain and xeric ecoregions, although differences were not always statistically significant. However, the magnitude of difference in mean test site O/E values between mountain and xeric test sites varied with the models used. The CA models resulted in lower average O/E values for xeric than for mountain sites (Table 6), whereas both the WEMAP and WSA-West models produced statistically similar mean O/E values at xeric and mountain test sites.

Index sensitivity and concordance among assessments

The WSA-West O/E was much less likely to lead to inferences of impairment (16 of 127 sites; Table 7) than either the WEMAP O/E (43 of 127 sites) or the CA O/E (35 of 127 sites, binomial tests, p <0.001). When an ecoregion correction based on 2 sds (consistent with primary analyses) was applied, there was no effect on any impairment decision (16 out of 127 sites impaired) because the separate xeric and mountain thresholds were within 2 points on a 100 point scale of their combined threshold. However, when an ecoregion correction based on the 5th percentile threshold used for the national wadeable streams assessment (Herlihy *et al*. 2008) was applied, the number of sites determined to be impaired by the WSA-West index (27 of 127 sites) was not significantly different from the 35 impairment decisions produced by the CA O/E index (binomial test, p = 0.081; Table 7).

Multimetric Index Comparisons: Comparison of TRB vs. RWB for WSA and WEMAP MMIs

MMI scores derived from the TRB and RWB sampling methods were highly correlated for both

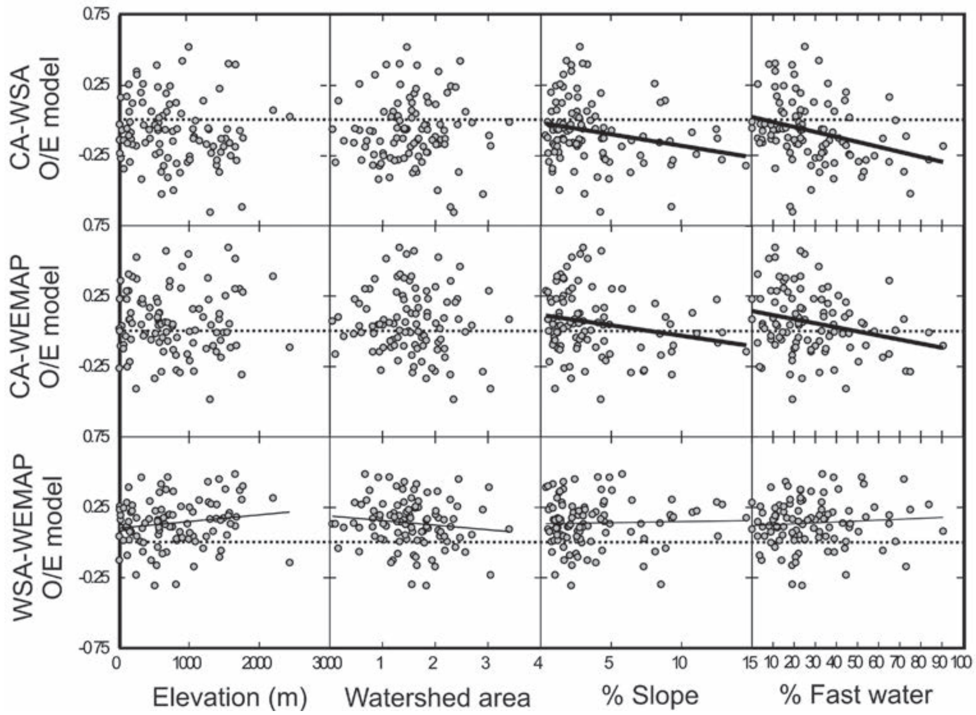

Figure 6. Scatterplots and regressions between the pair-wise differences in O/E values for three different O/E indices and four environmental gradients at CA test sites. The dashed horizontal lines represent zero difference. Thick solid lines denote regressions with r^2 and slopes significantly different from 0; thin solid lines denote those with intercepts significantly different from 0 but non-significant slope.

WSA and WEMAP indices (WSA $r^2 = 0.75$, WEMAP $r^2 = 0.73$), as has been shown elsewhere for CA MMIs (Rehn *et al*. 2007). For WEMAP MMIs, RWB samples collected in the mountain ecoregion scored on average 7.2 points lower than TRB samples (paired t test, $p < 0.001$), but samples based on the two methods collected in the xeric ecoregion produced statistically indistinguishable scores ($p = 0.65$). Mountain WSA MMI values were also lower for RWB samples (4 points, $p = 0.02$), but RWB MMI values from the xeric region were higher than TRB samples by 6 points ($p = 0.002$). For the purpose of inter-index comparisons, these scoring biases were corrected by adding 7.2 points to the MMI values for those mountain WEMAP RWB samples used in comparisons (three sites), adding 4 points to values for the mountain WSA RWB samples, and subtracting 6 points from values for xeric WSA RWB samples (three sites). However, only TRB samples were used in remaining MMI analyses.

Precision

The northern and southern CA MMIs were more precise (reference site CVs = 0.14 and 0.19) than the WSA-West mountain and xeric MMIs (CVs = 0.26, 0.25), but comparable to those of the WEMAP mountain and xeric MMIs (CVs = 0.13, 0.23; Table 4). Associations among the rescaled MMI indices (CA vs. WSA-West $r^2 = 0.70$, CA vs. WEMAP $r^2 = 0.76$, and WSA-West vs. WEMAP $r^2 = 0.75$; Figure 7) were much stronger than we observed for the O/E indices (Figure 5).

Bias

The rescaled WSA-West MMI was a biased predictor of both the CA and WEMAP MMIs, with slopes significantly different ($p < 0.001$) from 1 (Figure 7). In addition, the WEMAP MMI on average produced higher scores at test sites than the CA MMI (Table 6). The WEMAP MMI rated low-scoring sites higher than the WSA-West MMI and high-scoring sites lower than the WSA-West MMI (Figure 7). However, most of these differences in MMI values were not associated with the natural gradients we considered, except for the significant relationships between CA and WEMAP pairwise differences and both elevation and watershed area (Figure 8).

Responsiveness

On average, the rescaled CA MMIs scored test sites lower than the rescaled WEMAP MMIs, which

Table 5. Regressions (y = a + bx) for relationships shown in Figures 6 and 10 where y is the difference between the index scores of two models and x is a natural gradient variable. Asterisks indicate significant slopes, y-intercepts, or r^2 values at p = 0.05 level (significance threshold not adjusted for multiple comparisons).

Index	Natural Gradient	Model Difference	b	p-value for b	a	p-value for a	r^2
O/E (n = 101)	Elevation	CA-WSA	-0.000043	0.283	-0.043	0.259	0.01
		CA-WEMAP	0.0000042	0.918	0.059	0.132	0
		WSA-WEMAP	0.000048	0.112	0.1	<0.001*	0.03
	log Watershed Area	CA-WSA	0.0029	0.928	-0.081	0.125	0
		CA-WEMAP	-0.025	0.424	0.1	0.06	0.01
		WSA-WEMAP	-0.028	0.23	0.18	<0.001*	0.01
	Percent Slope	CA-WSA	-0.016	0.019*	-0.017	0.606	0.05*
		CA-WEMAP	-0.015	0.035*	0.12	<0.001*	0.04*
		WSA-WEMAP	0.0015	0.77	0.13	<0.001*	0
	Percent Fastwater	CA-WSA	-0.0035	0.002*	0.023	0.543	0.09*
		CA-WEMAP	-0.0029	0.012*	0.14	0.001*	0.06*
		WSA-WEMAP	0.00064	0.458	0.12	<0.001*	0.01
MMI-rescaled (n = 68)	Elevation	CA-WSA	0.000047	0.586	-0.24	<0.001*	0
		CA-WEMAP	0.00012	0.041	-0.15	<0.001*	0.06
		WSA-WEMAP	0.000073	0.415	0.086	0.028*	0.01
	log Watershed Area	CA-WSA	-0.043	0.19	-0.13	0.105	0.03
		CA-WEMAP	-0.057	0.01	0.011	0.832	0.1
		WSA-WEMAP	-0.014	0.674	0.14	0.095	0
	Percent Slope	CA-WSA	0.0024	0.832	-0.23	<0.001*	0
		CA-WEMAP	0.011	0.151	-0.14	<0.001*	0.03
		WSA-WEMAP	0.0085	0.46	0.09	0.020*	0.01
	Percent Fastwater	CA-WSA	0.0021	0.182	-0.28	<0.001*	0.03
		CA-WEMAP	-0.00071	0.518	-0.1	0.004*	0.01
		WSA-WEMAP	-0.0028	0.086	0.18	<0.001*	0.04

in turn scored test sites lower than rescaled WSA-West MMIs (Table 6). This trend generally held for both mountain and xeric ecoregions, although the WSA-West vs. WEMAP mountain contrast was not significantly different. All MMIs tended to score test sites in the xeric ecoregion lower than test sites in the mountain ecoregion, although the difference in mean values based on the WSA-West MMI was not significant (Table 6).

Index sensitivity and concordance among assessments

As with the O/E indices, impairment decisions differed considerably among the rescaled MMI indices (Table 8). The number of sites assessed as impaired was far fewer for the WSA-West and WEMAP MMIs (21 and 17 sites of 68 total sites, respectively) than the CA MMI (39 of 68 sites, binomial tests, p <0.001). This pattern occurred in both xeric and mountain ecoregions but was only significant in the xeric ecoregions (binomial tests: mountain p = 0.219, xeric p <0.001).

Summary of WEMAP and WSA-WEST indices performance relative to CA indices

Differences in index precision, bias, and responsiveness can each contribute to differences in index performance as measured by index sensitivity, the likelihood that an assessment will identify impairment. In this study, assessment differences between WEMAP or WSA-West indices and CA indices depended on the type of index examined and specific differences in index precision, bias, and responsiveness (Table 9). Although the large-scale indices tended to lead to different inferences regarding biological condition than the CA indices, the specific differences

Table 6. Results of t-test comparisons for differences in index responsiveness between sets of mountainous and xeric test sites, or between model pairs. Mean 1 and Mean 2 indicate the mean scores of the first and second members of each tested pair. All MMI scores were rescaled by dividing scores by the appropriate reference mean.

Test Dataset	Comparison Type	Test group	Indices in Test	Mean 1	Mean 2	Difference	p (*significant α =0.0167)	Test (2-tailed)
O/E	***Index Comparison***	*Both Ecoregions (n = 127)*	CA vs. WSA	0.82	0.90	0.09	<0.001*	paired t-test
			CA vs. WEMAP	0.82	0.77	0.04	0.032	
			WSA vs. WEMAP	0.90	0.77	0.13	<0.001*	
		MTN only (n = 74)	CA vs. WSA	0.87	0.93	0.06	0.023	paired t-test
			CA vs. WEMAP	0.87	0.80	0.07	0.002*	
			WSA vs. WEMAP	0.93	0.80	0.13	<0.001*	
		XER only (n = 53)	CA vs. WSA	0.75	0.87	0.12	0.005*	paired t-test
			CA vs. WEMAP	0.75	0.74	0.00	0.938	
			WSA vs. WEMAP	0.87	0.74	0.12	<0.001*	
	Ecoregion Comparison	*MTN vs. XER*	CA	0.87	0.75	0.12	0.006*	2 sample t-test
			WSA	0.93	0.87	0.06	0.156	
			WEMAP	0.80	0.74	0.05	0.248	
MMI	***Index Comparison***	*Both Ecoregions (n = 68)*	CA vs. WSA	0.65	0.88	0.23	<0.001*	paired t-test
			CA vs. WEMAP	0.65	0.77	0.12	<0.001*	
			WSA vs. WEMAP	0.88	0.77	0.11	<0.001*	
		MTN only (n = 30)	CA vs. WSA	0.80	1.00	0.20	<0.001*	paired t-test
			CA vs. WEMAP	0.80	0.88	0.07	0.009*	
			WSA vs. WEMAP	1.00	0.88	0.13	0.018	
		XER only (n = 38)	CA vs. WSA	0.53	0.78	0.24	<0.001*	paired t-test
			CA vs. WEMAP	0.53	0.69	0.15	<0.001*	
			WSA vs. WEMAP	0.78	0.69	0.09	0.006*	
	Ecoregion Comparison	*MTN vs. XER*	CA	0.80	0.53	0.27	<0.001*	2 sample t-test
			WSA	1.00	0.78	0.23	0.0219	
			WEMAP	0.88	0.69	0.19	0.001*	

Table 7. Counts of CA sites declared impaired (I) and not impaired (NI) by CA O/E estimates and corresponding WEMAP and WSA O/E estimates. WSA-Adjusted: Impairment thresholds set at 5th percentile for each ecoregion.

		CA Sub-model 1 (n = 58)		CA Sub-model 2 (n = 44)		CA Sub-model 3 (n = 25)		Total (n = 127)		All Sites
		I	NI	I	NI	I	NI	I	NI	
CA	I	13	-	16	-	6	-	35	-	35
	NI	-	45	-	28	-	19	-	92	92
WEMAP	I	10	7	11	8	4	3	25	18	43
	NI	3	38	5	20	2	16	10	74	84
WSA	I	5	1	7	2	0	1	12	4	16
	NI	8	44	9	26	6	18	23	88	111
WSA-Adjusted	I	9	4	9	4	0	1	18	9	27
	N	4	41	7	24	6	18	17	83	100

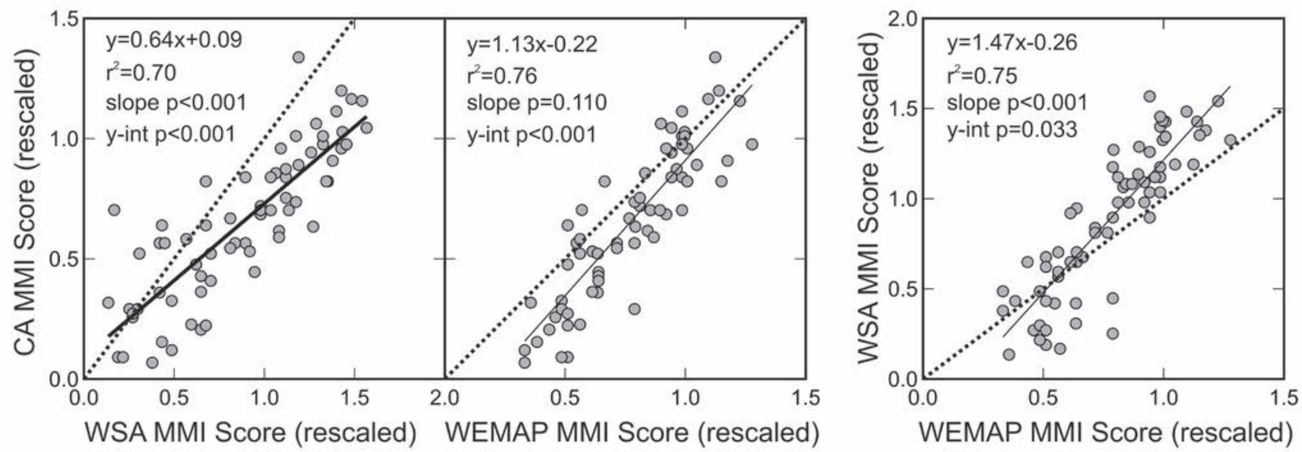

Figure 7. Regressions between rescaled scores at CA test sites between rescaled index scores for different combinations of the MMIs. The dashed diagonal lines represent perfect 1:1 relationship between the models, and the thick and thin solid lines indicate linear best-fit relationships. Significance tests are for y-intercept (y-int) = 0 and slope = 1.

among indices were variable. These differences lead to the WEMAP O/E index having similar sensitivity to the CA O/E indices, whereas the WSA-West O/E index was less sensitive. The difference between these two large-scale indices appeared to be largely associated with differences in their responsiveness. The MMI comparisons showed the opposite response in that the WEMAP MMI was slightly more sensitive than the CA MMI in mountain regions while the WSA-West MMI was less sensitive than the CA MMI in xeric regions. As we saw for the O/E comparisons, the differences between the WEMAP and WSA-West MMI sensitivities were also most clearly associated with differences in their responsiveness.

Discussion

The multiple spatial scales over which environmental gradients influence the taxonomic and functional composition of freshwater assemblages has been the focus of considerable interest in recent

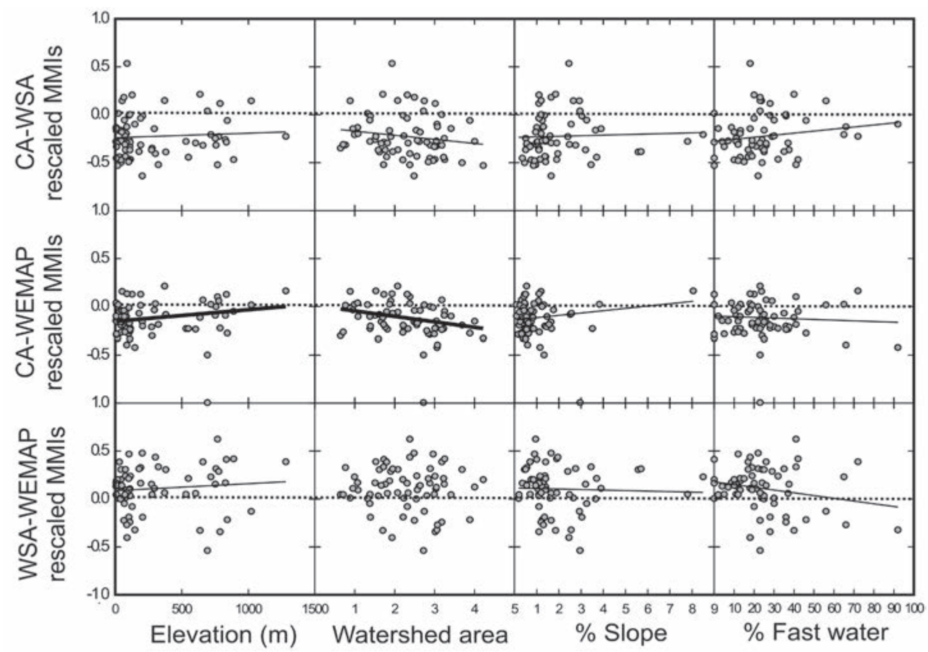

Figure 8. Scatterplots and regressions between the pair-wise differences in rescaled MMI values for the three different MMIs and four environmental gradients at CA test sites. The dashed horizontal lines represent zero difference. Thick solid lines denote regressions with r^2 and slopes significantly different from 0; thin solid lines denote those with intercepts significantly different from 0 but non-significant slope.

Table 8. Counts of CA sites declared impaired (I) and not impaired (NI) by CA MMI estimates and corresponding WEMAP and WSA MMI estimates.

		CA Mountain (n = 30)		CA Xeric (n = 38)		Total (n = 68)		All Sites
		I	NI	I	NI	I	NI	
CA	I	10	-	29	-	39	-	39
	NI	-	20	-	9	-	29	29
WEMAP	I	5	1	15	0	20	1	21
	NI	5	19	14	9	19	28	47
WSA	I	5	1	11	0	16	1	17
	NI	5	19	18	9	23	28	51

years (Poff 1997, Johnson *et al*. 2004, Johnson *et al*. 2007, Heino *et al*. 2007, Hoeinghaus *et al*. 2007, Mykrä *et al*. 2007, Mykrä *et al*. 2008). At the heart of all of these studies is a desire to clarify understanding of the factors that determine species distribution limits, one of the central goals of ecological theory (Levins 1966, Wiens 1989, Peters 1991, Brown *et al*. 1996, Guisan and Zimmermann 2000). This issue has significant implications for the utility of biotic indices because their effectiveness depends understanding how distribution patterns of individual taxa are influenced by landscape and waterway environmental heterogeneity, and how those effects are expressed at different scales of observation.

Index Comparability

O/E indices

Matching test sites with appropriate reference condition is a critical element of all bioassessments (Moss *et al*. 1987, Hughes *et al*. 1995, Stoddard *et al*. 2007). Errors in specifying the correct reference condition can lead to either under- or over-estimates of the true biological condition at individual sites. Our results show that the failure of the large-scale predictive models to account for the effects of some naturally occurring environmental factors caused substantial systematic differences among the O/E values derived from these models relative and those derived from the CA models. The fact that the most spatially extensive models (WEMAP and WSA-West models) did not adjust for the effects of local environmental heterogeneity (i.e., slope, percent fast-water habitats) on E, and hence O/E, shows that such spatially extensive models may have limited applicability for site-specific assessments and use of these assessments to generate regional assessments. There are several reasons the more spatially extensive models may have failed to account for the effects of reach slope and percent fast water on assemblage composition. First, available map-derived variables may not have been good surrogates for these variables when used at large scales. For example, watershed area is likely related to one or more factors that influence taxa presence at a site, including channel slope and amount of fast-water habits (Hynes 1970, Allan and Castillo 2007). However, watershed area might not be consistently associated with channel slope across a region the size of the western United States. In the three sets of models we examined, watershed area appeared to account for differences among sites in channel reach for only the spatially less extensive CA models. Even in those models that used direct measures of channel slope as a predictor variable (e.g., the WSA-West model), the relationship between invertebrate taxa and slope may be obscured by strong relationships between invertebrate composition and predictors that vary markedly across regions, such as temperature and precipitation. Furthermore, a predictive model based on linear relationships between biotic composition and predictor variables will fail to accurately describe any non-linear relationships and hence inaccurately predict the taxa that should occur under specific states of that variable. In contrast, over a smaller range of environmental conditions, surrogate predictors such as watershed area, temperature, or precipitation may adequately capture differences between sites in local habitat features such as channel slope and type of habitat. In general, these problems of prediction bias might be reduced in the future by both improving how well reference site networks represent all

Table 9. Summary of differences in precision, bias, responsiveness, and sensitivity of the WEMAP and WSA indices relative to CA indices. M = mountain ecoregion, X = xeric ecoregion. The term "similar" indicates no statistical difference; the terms "lower" and "higher" indicate the direction of a significant difference.

Performance Measure	O/E		MMI	
	WEMAP	WSA	WEMAP	WSA
Precision	Lower	Lower	Similar	Lower
Bias	Yes	Yes	Yes	Yes
Responsiveness	Lower	Lower	Lower	Lower
Sensitivity	Similar	Lower	Lower	Lower

streams of interest (in terms of both sample size and types of streams) and by using robust predictors such as Random Forests (Cutler *et al*. 2007) that do not assume linear relationships.

The fact that the WSA-West model strongly underestimated impairment relative to the CA model has at least two possible explanations: 1) poorer precision in the WSA-West model resulted in lower impairment thresholds and thus fewer impairment decisions, and 2) WSA underestimated the probabilities of capture of some of the taxa that contribute to the O/E calculations. The second result could have arisen if the reference sites used to predict the fauna in California streams were less rich on average than the otherwise similar California sites assessed. Vinson and Hawkins (1996) reported that invertebrate taxa richness in streams draining mountainous regions of California (Coast Range Mountains and Sierra Nevada) was higher than streams draining other mountainous regions in the western USA. Models based on a mix of reference sites from across the western United States might therefore be expected to under-predict richness at CA mountain sites. This explanation seems plausible for the WSA-West model, because average WSA-West O/E values for CA mountainous reference sites were greater than 1 on average (Sierra Nevada = 1.04, Southern Coastal Mountains = 1.11, and Klamath Mountains = 1.04). However, WEMAP reference site O/E values did not exhibit this trend. It seems prudent that we should refine models to explicitly account for the effects of biogeographic history on taxa richness. Such modeling might be accomplished through the use of categorical predictive variables that classify sites by their relevant zoogeographic region rather than general purpose ecoregions (Hawkins and Vinson 2000, Hawkins *et al*. 2000b). The contrasting result for the WEMAP model (i.e., that WEMAP model did not underestimate impairment relative to the CA model despite precision values intermediate between the CA and WSA models) is likely the consequence of the tendency of the WEMAP model to score sites lower than the WSA model.

Multimetric indices

Although, agreement among the MMI scores was considerably stronger than for the O/E indices, the relationships between scores were not consistent across the scoring range, indicating differences in responsiveness of the indices at low vs. high biotic condition sites. Also, although the WEMAP and WSA-West MMIs were derived from nearly identical datasets, there were numerous differences in the performance of the two larger MMIs, including precision, responsiveness and sensitivity. These differences reflect the different approaches used to develop the MMIs (Ode *et al*. 2005; Rehn *et al*. 2005; Stoddard *et al*. 2005, 2008).

Differences in MMI responsiveness were likely caused by one or more of the following: 1) differences in how metrics were scaled in the separate indices, 2) differences in the quality of sites used to calibrate the indices, or 3) differences in how individual metrics in each MMI respond to stress. Because there was considerable overlap in metrics among the indices, much of the difference among the MMIs in their assessments probably lies in differences in the scoring ranges of specific metrics. For example, although the number of EPT taxa is a nearly ubiquitous metric in MMIs (Karr and Chu 1999), the scoring range for this metric varies among regions. An EPT scoring range established from reference site data combined across a large spatial extent will not necessarily reflect local reference conditions. In some regions, test sites will be underscored; in others they will be overscored. We found evidence of this effect in the number of disagreements in impairment decisions made under the different MMIs. Furthermore, the WSA-West MMI did not indicate a difference in biotic condition between mountain and xeric test sites, whereas the CA and WEMAP MMI did. This finding was echoed in the way impairment decisions differed between WEMAP and WSA-West indices in xeric and mountain regions. Both WEMAP and WSA-West MMIs tended to overestimate impairment at mountain sites relative to the CA MMI, whereas the WSA-West MMI underestimated impairment at xeric sites relative to the CA MMI.

A final potential explanation is that differences in MMI performance were related to differences in the calibration sets used to derive the metric scoring ranges. Because MMIs are calibrated with both reference and test data, any difference in the biological quality of either set of calibration sites can affect a site's scoring, just as they can in O/E models (Hawkins 2006). Because of incomplete information regarding the quality of reference and test sites used to calibrate the different indices, how seriously such differences affected index performance could not be addressed at this time.

Effects of spatial scale on index performance

It has been long known that taxonomic composition is influenced by natural environmental gradients. How these relationships are expressed at different spatial scales, and hence affect biological indices, is much less clear, but is of increasing interest (Finn and Poff 2005, Heino *et al*. 2007, Cao *et al*. 2007, Mykrä *et al*. 2008). MMIs and predictive models use different methods for accounting or adjusting for natural gradients. Predictive models are explicitly designed to describe how natural environmental gradients affect the distribution of individual taxa (Wright *et al*. 1989, 2000). However, some natural gradients may be important at certain geographic scales, but cease to matter at other scales, as shown in this study and elsewhere (Mykrä *et al*. 2008).

In contrast to O/E indices, MMIs attempt to minimize the effects of natural gradients by a priori classification of reference sites into environmentally homogeneous sets of sites. In addition, metrics are selected to be insensitive to natural gradients, or by adding correction factors that adjust for scoring differences along gradients (Karr and Chu 1999). In this study, for example, scoring ranges for the EPT richness metric varied little across spatial scales within ecoregions (Ode *et al*. 2005; Rehn *et al*. 2005; Stoddard *et al*. 2005, 2008), and the CA MMI for the North Coast explicitly corrects for watershed area in affected metrics (Rehn *et al*. 2005).

In this study, the large-scale predictive models were not completely successful in adjusting for two of the gradients (percent slope and percent fastwater habitats) we examined. Likewise, the CA and WSA-West MMIs were not completely effective at controlling for an elevation gradient.

Index performance and model traits

All the biological indices in our evaluations produce scores by comparing biological expectations to observed biology. Although E in O/E is explicitly modeled (i.e., predicted), MMI expectations are derived from a set of reference sites that are grouped (by ecoregion, stream size, etc.) to maximize similarity of the biological assemblages at reference sites. Thus, both O/E and MMI are indices based on modeled expectations. Levins (1966) postulated that there is an inherent tradeoff among three desirable model traits: reality (i.e., accuracy, or lack of bias), precision, and generality (see also Guisan and Zimmermann 2000). Although these model traits are not necessarily mutually exclusive, we cannot expect the models used to predict biotic conditions to optimize each trait. In creating standardized indices applicable across a large range of geoclimatic conditions, generality was improved at the expense of both reality and precision. This tradeoff points to the need to develop more localized models for bioassessment programs, especially those that use biocriteria to infer if streams are supporting their designated aquatic life uses. However, the fact that impairment decisions can be very sensitive to the thresholds used to define impaired conditions (as seen when an ecoregion-based correction was applied to the WSA-West model for O/E comparisons), suggests that it may be possible to adjust for some of the systematic differences among the models. Larger models could be rendered more suitable for local application by calibrating impairment thresholds to local reference conditions. In practice, a local regulatory entity could recalculate the standard deviations for O/E or MMI models based only on local reference sites and use these to set locally relevant thresholds.

Concluding Remarks

The answer to the central question of whether indices developed from geoclimatically extensive data can substitute for more locally produced indices depends both on their intended use and the type of indicator. In regional condition assessments, accuracy (lack of bias) is more important than precision. That is, for low precision can be compensated by looking at large numbers of samples with the expectation that the estimated average condition will still be accurate. For the purpose of regional assessments, use of the WEMAP O/E index produced results that were generally comparable to the CA indices. In contrast, because of its strong bias, the WSA-West O/E index would probably underestimate regional impairment. Likewise, lower precision and differences in responsiveness across the scoring range make the WSA-West MMIs less desirable for regional condition assessments.

For site-specific assessments, where both accuracy and precision are important, it seems clear that locally derived indices should outperform large-scale indices for both types of index (see also Mykrä *et al*. 2008). Because most applications of bioassessment tools are site-specific, there is a clear need to continue to develop regional models that explicitly take locally important gradients into account (Heino *et al*. 2007). However, because the WEMAP MMI had similar precision and WEMAP MMI scores were highly correlated with CA MMI scores, the WEMAP MMI might provide an acceptable substitute in California (and potentially other regions in the western US) until local MMIs are developed, assuming care is taken to adjust impairment thresholds to reflect local reference conditions.

Finally, these results suggest three related applied research needs: 1) identifying the geographic or geoclimatic scale that optimizes index performance, 2) determining the factors that most strongly influence index performance and identifying the geographic scales at which they vary, and 3) identifying ways of more accurately specifying the reference condition from geoclimatically extensive sets of reference site data. It is not known much about which factors influence the optimal geographic scale for producing either predictive models or multimetric indices, but the rapidly expanding field of bioassessment would benefit greatly from the ability to predict these factors.

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Appendix 5

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SWAMP
Surface Water Ambient Monitoring Program

Final Technical Report | **2009**

Recommendations for the Development and Maintenance of a Reference Condition Management Program (RCMP) to Support Biological Assessment of California's Wadeable Streams

March 2009

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Recommendations for the development and maintenance of a reference condition management program (RCMP) to support biological assessment of California's wadeable streams

Report to the State Water Resources Control Board's
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EXECUTIVE SUMMARY

Direct measures of the ecological condition of waterbodies have received a recent surge in interest within California's water quality management and regulatory programs because biology-based assessments have several advantages over chemistry- or toxicity-based assessments. Biological assessments are more closely linked to the beneficial uses to be protected and chemistry- or toxicity-based criteria usually lack the predictive ability to infer biological condition. Ultimately, California needs to develop biology-based standards, or biocriteria, as a regulatory tool for monitoring and protecting aquatic life use.

Biological assessment tools, including biocriteria, attempt to objectively "score" the biological integrity at a given site. A crucial component to the development of assessment tools is understanding biological expectations at reference sites that consist of natural, undisturbed systems. These reference systems set the biological condition benchmarks for comparisons to the site(s) being evaluated. Two recent external reviews of the State Water Board's Surface Water Ambient Monitoring Program (SWAMP) affirmed the importance of a sound statewide reference condition program (i.e., TetraTech 2002, SPARC 2006).

In October 2007, the SWAMP bioassessment committee assembled a technical panel of statewide and national experts in bioassessment. The panel met for three days to develop a set of recommendations that the SWAMP program could use to establish and maintain a comprehensive reference condition management program (RCMP). The program accounts for biological variation caused by natural environmental gradients and balances statewide consistency with the flexibility needed to adapt to California's diverse regional settings. Furthermore, the plan allows for adaptive refinement over time.

The panel defined a general strategy for establishing the RCMP that has four components:

1. California will be divided into different geographic regions based on coarse biogeographic similarities in order to partition some of the natural variability among regions (these boundaries should be consistent with those used for the SWAMP Perennial Streams Assessment)
2. A pool of reference sites will be assembled within each region through a sequential process of identification and screening of candidate sites
3. The sites within each reference pool will be managed through iterative review of data to refine regional boundaries, ensure continued suitability of sites and ensure adequate representation of natural gradients
4. A monitoring design will be created for sampling this pool of reference sites to document the range of biological and physical condition at reference sites, and monitor for changes to this condition over time

The panel recommended identifying and screening candidate locations to create a pool of verified reference sites using either a "standard model" or an "alternative model". The standard model will cover the vast majority of the state where high quality sites are available. The alternate model will apply in those regions where an insufficient quantity of high quality sites exist and another strategy is required for selecting candidates for the reference pool. This may include regions such as the agriculturally dominated Central Valley or the intensely urbanized southern California coastal plain.

The standard model is a synthesis of widely used techniques for selection and screening candidate sites using a toolbox consisting of existing site data, GIS techniques, expert knowledge and site visits. The alternative approach consists of two general strategies: 1) modification of standard tools (e.g., lowering the GIS screening thresholds, collecting more intensive site data) and 2) use of non-standard approaches. The non-standard approaches include:

- Select best sites using existing biological indices
- Species pool approach
- Factor-ceiling approach
- Model taxon preferences for limiting environmental gradients

These different approaches are not mutually exclusive and several panel members recommended they be used in combination to provide weight-of-evidence that candidate sites are acceptable for the reference pool in these difficult locations.

The panel outlined a monitoring strategy for the RCMP, which included recommendations for sampling methods, sampling density and frequency, and the set of biological, chemical and physical attributes that should be collected at each reference site. The panel strongly recommended that the RCMP should be compatible with ongoing statewide monitoring programs such as the newly developed SWAMP Perennial Streams Assessment. For the monitoring design, the panel recommended both random and targeted sites. A probabilistic rotating panel was suggested for the random design because it provides an unbiased method for defining natural variability while still optimizing large-scale trend detection. Targeted repeated sampling designs are useful for detecting trends at specific locations; some of these sites have been sampled for years and provide a rich history that should not be lost.

To guide the SWAMP program as it implements the RCMP, the panel made a series of recommendations for prioritizing the elements of the plan. The panel recommended that the implementation begin by screening existing datasets for reference sites, followed by a combination of GIS screens and site visits to fill in gaps in regions with few reference sites.

FOREWORD

The recommendations in this document were developed by a technical panel composed of experts in bioassessment. The panel reflected a broad range of local, statewide, and national experiences with freshwater bioassessment, specifically with defining reference conditions for bioassessment and biocriteria. The panel met for three days on October 17-19, 2007 to outline the content of this document. The meeting followed a four-step process:

1) Defining the background of the problem
2) Establishing a set of guiding philosophies for the development of a reference site management plan
3) Providing general guidance by outlining an overall approach
4) Providing detailed guidance for specific technical issues

This document follows a similar format. This document captures all of the items agreed to by consensus of the group and attempts to point out diverging opinions or unresolved issues. On occasion, we expand on key concepts that were implicit to our discussions, but may not have been discussed directly. Where appropriate, we use sidebars, tables, and figures to illustrate key concepts or provide additional information. Thank you to Dr. Robert Hughes (Oregon State University) for additional document review.

Panel Members (from left to right): David Herbst (University of California at Santa Barbara, Sierra Nevada Aquatic Research Laboratory), Peter Ode (California Department of Fish and Game, Aquatic Bioassessment Laboratory), Raphael Mazor (Southern California Coastal Water Research Project), D. Phil Larsen (US EPA retired, Western Ecology Division), Andrew Rehn (California Department of Fish and Game, Aquatic Bioassessment Laboratory), Lenwood Hall (University of Maryland, Wye Research and Education Center), Terrence Fleming (US EPA Region IX, Office of Water), Charles Hawkins (Utah State University, Western Center for Monitoring and Assessment of Freshwater Ecosystems), Alan Herlihy (Oregon State University, Department of Fisheries and Wildlife), Kenneth Schiff (facilitator, Southern Coastal California Water Research Project).

CONTEXT: LINKING BIOASSESSMENT TO BIOCRITERIA[1]

Aquatic bioassessment is the applied science of interpreting the ecological condition of waterbodies directly from the organisms that inhabit them. Biocriteria are narrative or numeric standards that define whether the integrity of biological communities is impaired at a specific site. Water quality regulatory programs can receive many benefits from adopting biology-based standards as targets of their policies and management actions. The key to using biology-based methods effectively is the establishment of benchmarks that objectively define the biological expectations (or potential) of a given site. Reference conditions provide these objective benchmarks.

Why bioassessment?

The Clean Water Act (Section 101a) requires states to "restore and maintain the chemical, physical and biological integrity" of their waterbodies. For decades, most state water quality monitoring programs have focused on the chemical integrity (and to a lesser extent physical integrity) of waterbodies largely because these parameters are relatively simple to sample, relatively straightforward to measure and evaluate, and methods for developing chemical criteria are relatively standardized. While chemical/ toxicological and physical condition monitoring may provide indirect measures of ecological condition, exclusive focus on these measures is inadequate for protection of aquatic life uses, one of the primary beneficial uses of concern in water quality management. Because many chemical/ physical water quality thresholds are based on toxicity to aquatic organisms (USEPA WQS handbook, 2nd Edition 1994), these indirect measures are often surrogates for the beneficial use that is the target of protection efforts. Furthermore, biological integrity is frequently impaired by factors other than chemical contamination (e.g., hydrologic alteration, instream and riparian habitat alteration). Ultimately, ecological condition assessments provide the most appropriate assessment endpoint for protecting beneficial uses associated with aquatic life.

Why biocriteria?

Adoption of biology-based regulatory standards has the potential to provide significant enhancements to the protection of water resource integrity because biocriteria provide a regulatory mechanism for applying bioassessment's benefits to numerous water resource objectives.

The State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP) is supporting the biocriteria goal by developing tools for using benthic macroinvertebrates as indicators of the health of aquatic life in perennial streams. SWAMP's objective is to develop the bioassessment infrastructure (i.e., standardized methods, analytical tools, objective reference conditions, interpretive framework) that will enable water quality programs to employ biocriteria in a variety of regulatory applications.

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[1] Much of the information summarized in this section was synthesized from several key sources: Barbour *et al*. 1996a, Karr 1995, 1997, Stoddard *et al*. 2006.

Importance of reference conditions to bioassessment and biocriteria

The development of chemical criteria for aquatic life follows a relatively straightforward process in which numerical standards are based on results from lab-based toxicity testing. For most chemical contaminants, management objectives are focused on keeping concentrations below these toxicity-derived numerical thresholds. In contrast, biological objectives are based on maintaining the integrity of an assemblage (or multiple assemblages) of organisms. The challenge in developing biocriteria is translating what is currently a narrative standard into an ecologically relevant numerical standard. Development of biological criteria, however, is complicated by the fact that the composition of stream communities varies naturally even in the absence of anthropogenic stress. Thus, biocriteria will require a fundamentally different approach to establishing the expectations for unimpaired waterbodies.

A standardized lexicon of terms used to define biological expectations (adapted from Stoddard *et al.* 2006):

Reference Condition (RC(BI)) — Because this term has been used for a wide range of meanings, Stoddard *et al.* (2006) argue that the term should be restricted to meaning "reference condition for biological integrity" — in the absence of significant human disturbance or alteration"

Minimally Disturbed Condition (MDC) — stream condition in the absence of "significant" human disturbance. Assumes all streams have some anthropogenic stresses, but in most cases will approach true RC(BI)

Historical Condition (HC) — stream condition at a specific point in time (e.g., pre-Columbian, pre-industrial, pre-intensive agriculture, etc.)

Least Disturbed Condition (LDC) — the best physical, chemical and biological conditions currently available ("the best of what's left"). This definition is sufficiently flexible to establish biological expectations even in highly altered systems

Best Attainable Condition (BAC) — the expected ecological condition of least disturbed sites given use of best management practices for an extended period of time. This definition is helpful for communicating the potential for improving ecological condition above the currently best available conditions

Reference conditions (based on reference sites) provide a widely accepted mechanism for defining appropriate expectations and accounting for this natural variability (Hughes *et al*. 1986, Barbour *et al*. 1996, Karr and Chu 1999, Bailey *et al*. 2004). Reference sites are sections of streams that represent the desired state of stream condition (*sensu* Meyer 1997) for a region of interest. Once suitable reference reaches have been identified, these are used to characterize the range of biotic conditions expected for minimally disturbed sites. Deviation from this range is then used as evidence that test sites are impaired. [2]

Tiered aquatic life use (TALU) framework

The potential for biocriteria to improve aquatic life beneficial use protection can be greatly enhanced by a flexible framework for interpreting beneficial use attainment in a variety of settings. The current system of aquatic life use designations in California is outdated and does not adequately take advantage of advances in our ability to assess aquatic life use attainment. The USEPA and other states (notably, Maine and Ohio) have recognized this problem and have

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[2] Approaches to the selection of reference sites have been discussed extensively (Hughes and Larsen 1988, Hughes 1995, Rosenberg *et al.* 1999, Stoddard *et al*. 2006). Although there has been much debate about terminology used to describe expected biological conditions, the concept is flexible and can be applied either very narrowly (e.g., the condition of waterbodies before European invasions) or more broadly (e.g., the "least disturbed" or "best available" conditions currently found in a region of interest). The strategy in this document follows terminology usage recommended by Stoddard *et al*. 2006 (see text box).

developed a "tiered" system of aquatic life use designations, which utilize the power of biological information to develop graduated levels of protection.

"Tiered aquatic life uses" (TALU), supported by numeric biocriteria, can be thought of as defining different management levels for biological condition across a quality continuum that ranges between "natural" conditions to complete loss of the natural biological community (Figure 1). In the TALU system, "tiers" represent classes of waterbodies that are grouped based on similarities in anthropogenic disturbance levels, resulting biological condition, and recovery potential (USEPA 2005). Under this flexible system, designated uses to support aquatic life can cover a broad continuum of biological conditions, with some waters being closer to the ideal of "natural" or "minimal human impact" than others. Biocriteria applied in a framework of TALU designations can help shift the regulatory focus from performance-based standards (e.g., limiting the number of chemical criteria exceedences) to impact-based standards (e.g., attainment of ecological condition targets).

Reference conditions play two distinct roles in the TALU framework

The y-axis in the TALU framework (see Figure 1) is biological condition, a scale that measures ecological integrity of a site. The upper limit of the biological condition axis is anchored by an idealized target that represents the natural state of ecological conditions, or RC(BI) in the strict sense of Stoddard *et al.* (2006).

In addition, within each tier, there is some best attainable condition (BAC, *sensu* Stoddard *et al.* 2006) for waterbody classes in these tiers.

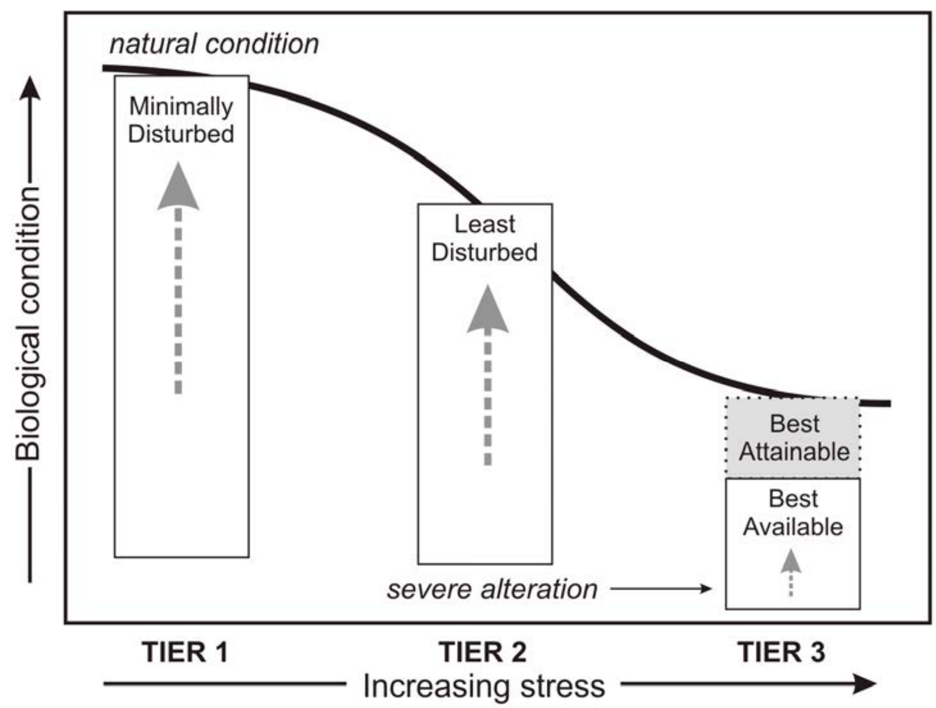

Figure 1. The biological condition gradient (BCG) used to define stream condition tiers in the TALU framework. Boxes indicate the expected range of biological condition scores at sites within each tier. Figure modified from Stoddard *et al*. 2006.

INTRODUCTION

General background

As the use of biological information in states' water quality regulatory programs has expanded across the US, these programs have followed a typical progression in which biosurveys (collection of biological samples, often as supplements to existing chemical monitoring) are followed by bioassessments (assessing ecological condition from biological data), finally progressing to full biocriteria (use of biological data to make regulatory decisions about aquatic life use condition).

As other programs proceeded along the path toward standardized interpretation of bioassessment data, they all recognized the need for grounding their programs with explicitly defined expectations for biological condition. Although criteria and procedures used to identify reference sites vary from program to program, the basic approaches used by most programs are quite similar. A partial review of water quality assessment programs in the North America (both state and federal programs), European Union (Water Framework Directive) and Australia (Water Reform Framework) revealed that many programs employed a similar GIS-based landscape-scale analysis to identify candidate watersheds, followed by site reconnaissance to evaluate reach-scale impacts (Barbour *et al*. 1996a, Whittier *et al*. 1987, Rosenberg *et al*. 1999, ANZECC and ARMCANZ 2000, Drake 2003, REFCOND 2003, Grafe 2004).

Reference sites manage natural variation

The composition of organisms at a site is a function of both natural and anthropogenic factors. These factors can be viewed as a series of "filters" that determine which taxa occur at a site (Poff and Ward 1990, Poff 1997, Statzner *et al*. 2001). For example, the pool of benthic macroinvertebrate taxa occurring within a large region like California's Sierra Nevada is a function of large scale processes (e.g., parent geology, climate and evolutionary history); the subset of taxa that occur at a given site at a given point in time is determined by a series of biotic and abiotic filters (e.g., life history traits, competition and predation, substrate composition, pH, thermal and hydrologic regimes, pollution tolerance) that further limit the occurrence of each taxon. The central challenge in bioassessment is to develop techniques that maximize the detection of signals of anthropogenic stress filters while minimizing the noise from natural filters. The identification of reference sites (that captures sources of natural variation) is a key component of most strategies for meeting this challenge (Hughes 1995, Wright and Li 2002, Bailey *et al*. 2004).

California's progress toward biocriteria implementation has followed a similar path. Since the early 1990s, bioassessment samples have been collected from more than 4000 sites by state and federal agencies alone (Figure 2). Some of these programs have been spatially extensive probability assessments of environmental condition such as the US EPA's Environmental Monitoring and Assessment Program (EMAP) and the California's Monitoring and Assessment Program (CMAP). Others are more directed studies to assess watershed-specific conditions or trends at locations of interest such as regional SWAMP monitoring, US Forest Service monitoring, and the US Geological Survey's National Water Quality Assessment Program (NAWQA). In addition, an abundance of additional sites have been sampled for National Pollutant Discharge Elimination System (NPDES) permit monitoring, and by citizen monitoring groups.

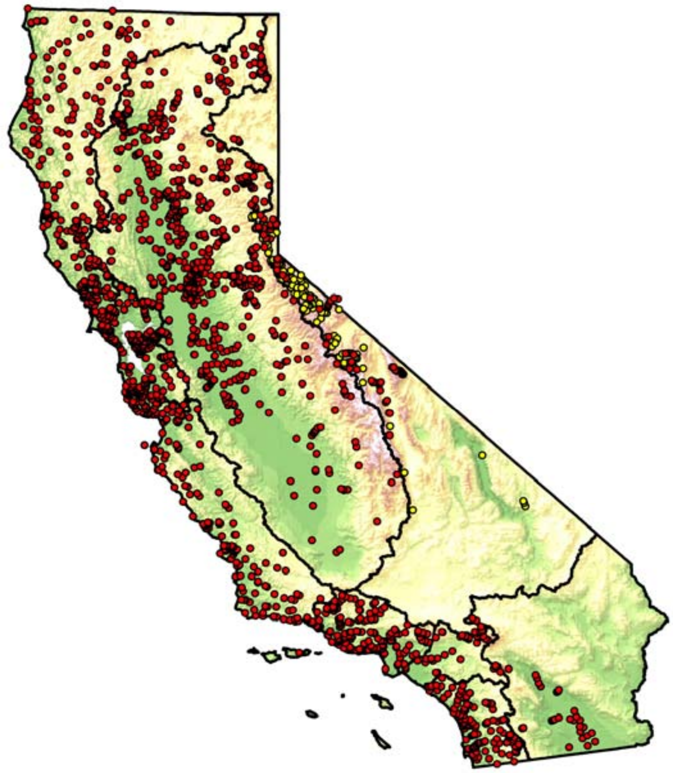

Figure 2. Approximately 3000 bioassessment sampling locations in California sampled between 1994 and 2007. Red circles represent sites processed by Aquatic Bioassessment Laboratory, yellow circles represent those processed by Sierra Nevada Aquatic Research Laboratory. More than 1000 other sites have been sampled by other state and federal agencies, permitted dischargers and citizen monitoring groups.

Because the early applications of bioassessment techniques in California were fragmented, the procedures for defining reference condition were largely *ad hoc* or project specific, with little or no attempt to apply consistent methods from project to project. Most of the reference or "control" sites used in early California bioassessment studies (e.g., point source enforcement cases, watershed specific bioassessments) were selected to define local expectations and were not selected using common criteria that would enable comparisons among projects.

Several large scale efforts to screen reference sites were undertaken in the early 2000's to support biological index development or as part of large state probability surveys: Western EMAP (2000-2003) and CMAP (2004-2007). In a concurrent effort, the USFS collaborated with scientists at Utah State University to identify over 200 reference sites on forest service lands in California between 1998 and 2000. Sites from these sampling programs were combined with other regional datasets to produce several of the main biotic indices used in California (statewide O/E models, North Coast IBI, South Coast IBI). Separate reference sites were used to develop the Eastern Sierra IBI (Herbst and Silldorf 2006).

In all of the large-scale studies between 1998 and 2007, both landscape scale and local scale factors were used for screening reference sites. Although common approaches were used to screen sites for most of these projects, little or no attempt was made to ensure consistency in screening among projects. This limits the utility of existing reference sites for statewide applications for several reasons. First, each project may use very different factors for selecting reference sites (e.g., one program may rely more on landscape scale factors while another may rely more on local scale factors). Second, some projects may use similar factors to select reference sites, but use different thresholds to screen sites (e.g., road density cutoffs or % upstream development cutoffs). Third, even when similar screening criteria are used for the same landscape or local scale factors, temporal variation in the reference site data has rarely been accounted for.

Why SWAMP needs an RCMP

The recent commitment by the SWAMP program to develop bioassessment/ biocriteria infrastructure provides us with an opportunity and impetus to standardize the reference site selection process statewide. The SWAMP program has long recognized this need, recently devoting a significant portion of its funding to developing reference condition datasets. Three recent peer reviews of SWAMP affirmed the importance of this effort:

1. In 2002, the SWAMP program funded an external review of bioassessment programs throughout California. That review was conducted by the lead author of the USEPA's bioassessment guidance document for streams and rivers.[3]

2. In 2005-06, the entire SWAMP program was peer-reviewed by an external "Scientific Planning and Review Committee" (SPARC), comprised of water quality experts from around the country.[4] The SPARC strongly recommended that SWAMP continue to develop its bioassessment program as a very high priority, specifically commenting that: a) the state board should consider revamping its entire standards program to make better use of biological endpoints (i.e., bioassessments) and b) the bioassessment program should focus particular attention on fostering consistency in its scoring indices.

3. In 2008, the USEPA (2009) conducted a Critical Elements Review of SWAMP's progress toward developing the technical elements to support biocriteria. The review stressed the fundamental importance of defining reference conditions and supported CA's reference condition strategy.

Establishing consistency in SWAMP's reference site selection process is clearly a key to effective implementation of biocriteria. However, identifying reference sites for California's perennial streams is complicated by its size (i.e., there are more than 300,000

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[3] The external review, conducted by Dr. Michael T. Barbour and Colin Hill of Tetra Tech, Inc., produced a final report in January 2003 titled *The Status and Future of Biological Assessment for California Streams*, which may be viewed on the Internet at http://www.swrcb.ca.gov/swamp/reports.html

[4] The SPARC's final report is posted at: http://www.waterboards.ca.gov/swamp/docs/reports/sparc486_swampreview.pdf

stream kilometers), diverse ecological settings (12 Level III Omernik ecoregions are present in California, Figure 3), and anthropogenic settings (vast regions of the state are entirely converted to either agricultural or urban land uses). There are many natural gradients within each ecoregion. For example, the elevation in the Southern California Coastal Ecoregion extends from sea level to 8,000 feet encompassing cold water, high gradient mountain streams, but also includes warm water, low gradient streams in the flood plain. To complicate matters further, there are extreme natural temporal cycles of dry and wet years, which may not occur in all regions of the state during the same year. This is compounded by the episodic natural disturbance of flooding and fires. Finally, human-dominated landscapes can be so pervasive in locations such as urban southern California and the agriculturally dominated Central Valley that no undisturbed reference sites may currently exist in these regions. A statewide framework for consistent selection of reference sites must account for this complexity.

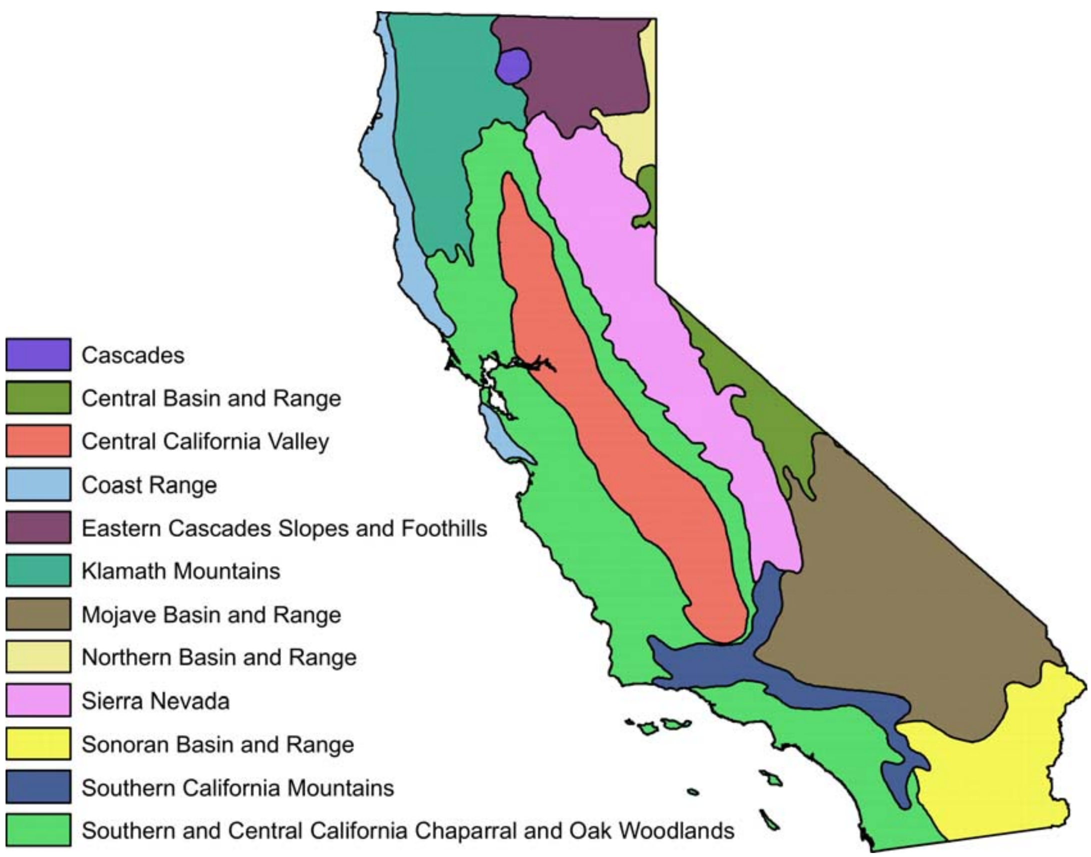

Figure 3. Boundaries of 12 Level III Omernik ecoregions present in California.

GOALS AND OBJECTIVES

This document summarizes recommendations to SWAMP for the development and maintenance of a Reference Condition Management Program (RCMP) that will support its regulatory biological assessment programs. The goal of the SWAMP RCMP is to provide an objective system for defining the expected biological and physical condition for wadeable streams and rivers in California. This system will identify pools (populations) of verified reference sites and outline procedures for sampling them to determine the range of biological expectations in these pools.

The monitoring objective

Data collected from reference sites will be used to answer a primary question: "what is the expected natural composition of lotic freshwater organisms in each of the major biogeographical regions of California"? The answer needs to be determined with sufficient rigor to serve as the basis for setting defensible numeric biocriteria. Our primary focus is on establishing expectations for benthic macroinvertebrate assemblages in perennial wadeable streams, but we expect that the approach will allow similar assessments of algal and fish assemblages as well as instream habitat condition and riparian condition.

Accounting for natural variability

An extension of the central monitoring question is: "what is the range of biotic measures (e.g., taxonomic composition, individual metrics and biological indices) in high quality sites and which natural environmental gradients (both spatial and temporal) are most strongly related to this variation." Ultimately, the goal is to identify the major sources of natural variability for all biological response measures (Figure 4). To account for these gradients, reference sites should be distributed to represent the full gradient range.

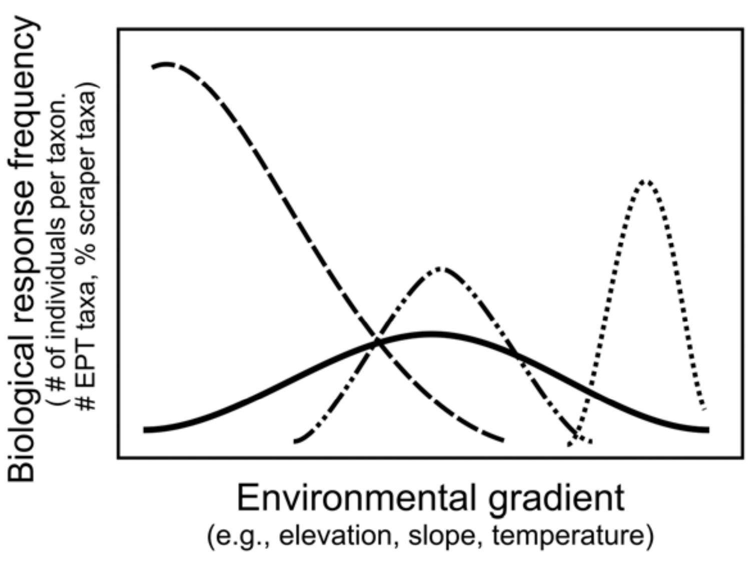

Figure 4. Hypothetical frequency distribution relationships between biological responses and environmental gradients.

GUIDING PHILOSOPHIES

In order to guide the development of the RCMP, the panel agreed upon a set of basic philosophies. These philosophical principals were used to guide their decision-making:

- **Use natural condition as the desired state whenever possible -** The panel's goal was to identify sites in natural or near-natural conditions whenever possible. However, the panel recognized that there are regions in the state where an insufficient number of sites in near-natural condition were likely to be found. The panel agreed that setting biological expectations were no less important in these regions. Therefore, the panel endeavored to identify the best attainable condition in these suboptimal regions of the state.

- **Balancing statewide consistency with regional flexibility** - The panel agreed that the reference strategy should balance a set of desirable, but sometimes naturally conflicting, traits: objectivity, consistency and flexibility. For example, a reference program that works for all of California can't be both perfectly consistent and perfectly flexible. This strategy aims to balance the competing demands of statewide consistency with the flexibility needed to adapt to unique regional conditions.

- **Reference site management is an iterative process -** The management of a reference site network is an ongoing and iterative process. The monitoring program should be responsive to new information and perspectives gained from selecting and monitoring reference sites. The general strategy should build in analysis of data to optimize selection strategies (process of selecting sites) and management design (e.g., how many sites, regional boundaries, which natural gradients to account for).

- **The RCMP should be transparent -** The technical process of determining reference conditions should be transparent to external review. As the state moves toward implementation of biocriteria, transparency and comprehension of the RCMP process will improve stakeholder confidence and provide structure for discussions about setting objective standards.

- **These recommendations are a starting point -** The panel understood that their recommendations provide a starting point for evaluating reference condition rather than an exhaustive set of operating procedures for selecting reference sites. This document is written assuming that SWAMP will develop a technical workplan that details a more refined program as the RCMP is implemented.

GENERAL GUIDANCE

The general approach for establishing the SWAMP reference site network has four components:

1. California should be divided into different geographic regions based on coarse biogeographic similarities in order to partition some of the natural variability among regions
2. A pool of reference sites should be assembled within each region through a sequential process of identification and screening of candidate sites
3. The reference pools should be managed through iterative review of data to refine regional boundaries, ensure continued suitability of sites and ensure adequate representation of natural gradients
4. A monitoring design should be created for sampling this pool of reference sites to document the range of biological and physical condition at reference sites, and monitor for changes to the condition of reference sites over time

All but the second component, site selection, apply equally to all regions of the state. The site selection process has two versions depending on the availability of high quality reference sites. We refer to the two versions in this document as: 1) the "standard model", which applies to regions with a sufficient number of reaches with relatively low levels of anthropogenic stress; and 2) the "alternate model", which applies to regions that do not have a sufficient number of high quality reaches. The vast majority of California should be able to apply the standard model.

Component I: Partitioning CA into biogeographic regions

Two general schemes are available for delineating California's ecoregions (Omernik 1995 and Bailey *et al.* 1994). We follow Omernik's divisions here because the boundary delineation decisions were generally based on a broader range of geology, climate and zoogeography than Bailey's. Omernik Level III ecoregions have been delineated for all of North America (Omernik 1995), with 12 Level III ecoregions falling in California (Figure 3).

Partitioning the state into different regions based on habitat similarities has some precedence in California bioassessment. The SWAMP Perennial Streams Assessment (PSA) has relied on a combination of Omernik ecoregions and regional board boundaries to partition the state for assessment purposes (Figure 5). Because these definitions include significant ecological gradients that contribute to natural variability in biological assemblages, and because they comprised existing assessment units, the panel agreed that these delineations were appropriate to use as initial boundaries for the reference network. However, the panel also stressed that ecoregions do not always adequately capture natural gradients that are key drivers of aquatic assemblages (insert references here, Hawkins and Norris 2000). Thus, data analyses must address the suitability of these boundaries as the program collects more data.

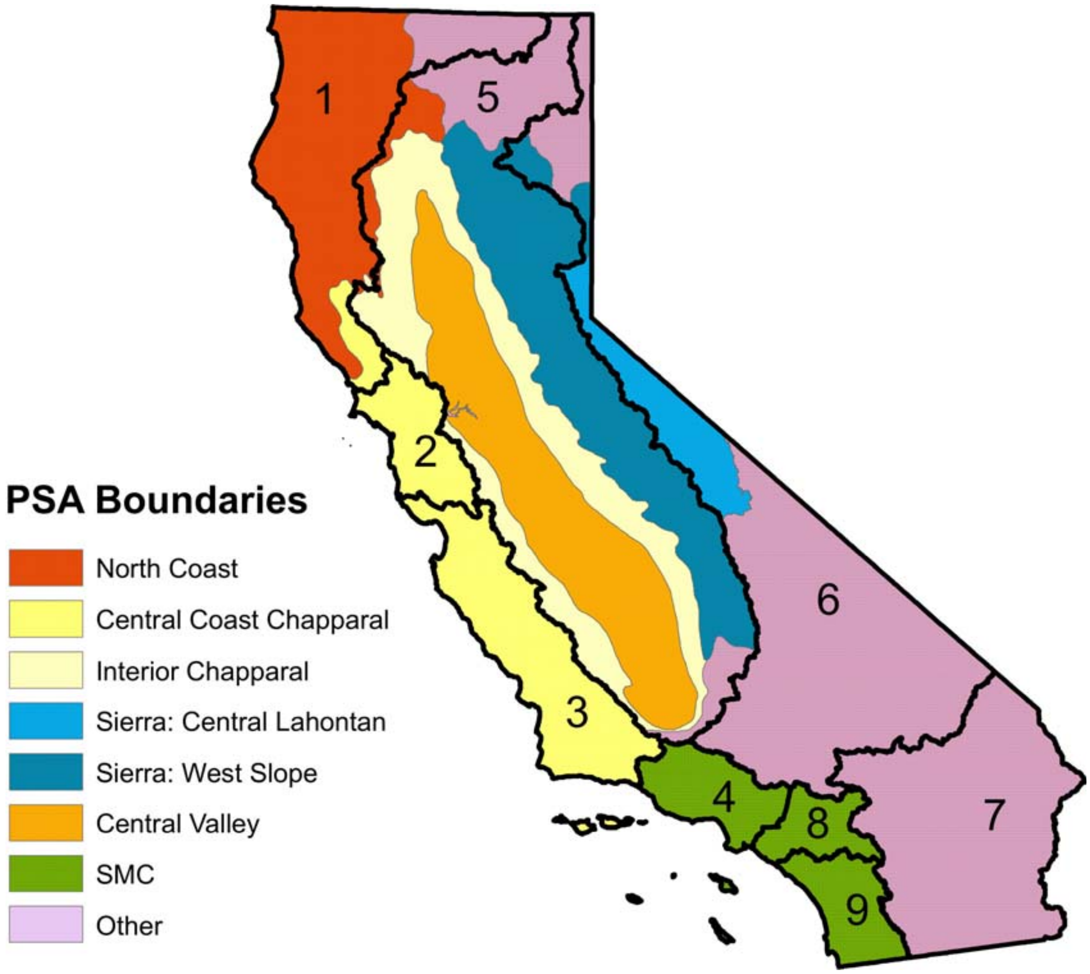

Figure 5. Boundaries used for defining the regional subunits of the SWAMP Perennial Stream Assessment (PSA) survey. SWAMP regional board boundaries one through nine are indicated by thick lines. SMC=Southern Coastal California Stormwater Monitoring Council.

Component II (a): Selecting sites: the "standard model"

The second step in the general approach is the most resource intensive and technically challenging: to develop a large pool of reference sites within each ecoregion. The ability to precisely establish biological expectations within each region is a function of the number of sites that are sampled and natural variability within each region. Therefore, the pool of reference sites should be large enough to provide a robust characterization of natural variability. Furthermore, reliance on a small number of reference sites is risky because it increases the consequences of catastrophic failure of individual sites. The size of the site pool in each region will depend on the number of major environmental gradients in each region (e.g., elevation, temperature, etc.) and the strength of influence of these gradients on biotic assemblages.

The panel recommended a sequential approach for assembling a set of candidate reference sites and screening suitable sites for the final reference pools within each region. The process includes: 1) screening data from previous site visits to identify candidate sites, 2) application of remote sensing and point-source GIS data screens of all potential stream reaches (combining landscape and local scale) to identify candidate sites, 3) use of best professional judgment/ local knowledge to add sites to the candidate pool.

Once a set of candidate sites is assembled, each candidate site should receive an on-site visit to evaluate its suitability. The exact type of data collected for evaluations during this stage will vary by region, but at a minimum should include: observations of local landuse activities, instream and channel habitat condition, riparian condition, evidence of recent natural disturbance. Some regions may require additional chemical data (water column or sediment) or toxicological data to confirm site suitability.

Sites that pass both the remote sensing and field reconnaissance screens become part of the reference pool for that region.

Component II (b): Selecting sites: the "alternate model"

The panel recognized that the standard model is not likely to work in all regions of California. The conversion of natural landscapes to agricultural and urban land uses is so extensive in some parts of the state that the entire region is devoid of waterbodies that could be used to define reference condition. Most regions of California should be able to use the standard model; the alternate model should only be used when the standard model is not feasible.

The panel defined the following criteria as triggers for acceptable use of alternate site selection strategies (both criteria must apply):

1) Insufficient high quality sites are available within one of the main regions (or a large section of one of the main regions) to adequately characterize ecological potential. Suitable stream reaches are unavailable for one or more of the following reasons:
    a) Anthropogenic landuse is a dominant factor in all watersheds within the region (or subregion)
    b) Normal flow is modified (e.g., flow diversions, dams, withdrawal or augmentation)
    c) Natural channels are altered (e.g., all or most channels converted to conveyances, irrigation supply/drains)
    d) Riparian corridors are impacted throughout the region (e.g., concretized riparian or surrounding landscape modified)

2) No comparable region exists from which to draw inference about biological expectations. That is, the areas are unique in their biological expectation so regions with few reference sites are not able to incorporate sites from another region.

This situation is not unique to California streams and many large programs have recognized the need to deal with regions with insufficient reference sites (REFCOND 2003, Stoddard *et al*. 2005, Paulsen *et al*. 2006). National guidance for developing state biocriteria programs highlighted the need for special treatment of these conditions (Barbour *et al*. 1996a,b). While the unique needs of these regions are widely recognized, the approaches for establishing ecological potential for reference-poor regions are far from standardized.

The RCMP panel outlined a general strategy for approaches to explore in reference-poor regions. The RCMP panel did not take any strong position on the relative strengths of these alternatives nor how different approaches should be combined to define expected conditions in reference-poor regions. Some of the alternative strategies included:

1. Use a modified version of the standard approach (e.g., use lower thresholds, emphasize local condition measures)
2. Alternate approaches
   a. Use existing tools to screen sites
   b. Species pool approach
   c. Factor-ceiling approach
   d. Model taxon preferences for key environmental gradients

These alternative strategies are not mutually exclusive and, when appropriate, should be used as multiple lines of evidence to reinforce an objective definition of biological expectation in regions without reference sites. In the "specific guidance" sections of this document (see Alternate Strategies for Selecting Sites) we describe these approaches and discuss strategies for applying them to California's challenging landscapes.

Component III: Managing the regional site pools

After the site pools have been assembled for each region, the RCMP requires an ongoing evaluation of data from these sites to address several key management questions. There are two major components to managing the reference pools: 1) evaluation of the regional representation of natural gradients and 2) periodic review of sites to evaluate changes to their suitability.

The ability to effectively understand natural sources of biological variation is fundamental to establishing sound biocriteria[5]. Therefore, the RCMP must directly assess the reference pools to ensure representation of regionally important natural gradients. This review should include a periodic review of the suitability of the initial regional boundaries proposed here.

The second aspect to site management is periodic review of sites in the reference pools to assess their continued suitability as reference sites. Conditions within stream reaches and in their upstream drainages can change over time (e.g., timber harvest, conversion of natural landscapes to agricultural or urban/suburban/exurban uses). Furthermore, we may discover sources of stress that were unknown when sites were initially added to the reference pools (e.g., discovery of nonpoint source discharges, mines, flow withdrawals/diversions, small-scale placer mining, etc.). Sites that fall into this category may be monitored to measure the impacts of these stressors, but they should be removed

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[5] See discussion on p. 5.

from the reference site pools. In contrast, natural disturbances (e.g., forest fires, catastrophic flooding or landslides) can also alter the biological condition at sites and they should be excluded for sampling temporarily, but should remain in the reference site pool[6].

Component IV: The monitoring strategy

The panel recommended an integrated probabilistic and targeted sampling design for the RCMP. The probabilistic approach will sample a rotating subset of randomly-selected (rotating panel design) sites from within the reference pool each year to estimate average biological condition. A subset of the randomly-selected sites should be sampled annually to measure year-to-year variability at sites and improve SWAMP's ability to detect drift in reference condition within each region over time. This design provides an unbiased assessment of natural variability with enhanced trend detection.

Targeted sampling is comprised of fixed sites near locations of special interest, but this should be supplemental to the probabilistic sampling effort. Fixed sites provide additional power to detect trends, but suffer from its inability to extrapolate to other locations. However, many agencies already monitor reference sites and, provided they meet the RCMP selection criteria, these sites have the added benefit of years of historical data. As SWAMP extends its reference monitoring program through collaboration with other state and federal programs, it should retain the ability to incorporate these sites.

The panel emphasized sampling more probabilistically selected sites over targeted sites, but did not make any recommendations about relative proportion of each type. This decision should reflect the relative importance to the SWAMP program of estimating current biological expectation versus detecting changes in the reference state. Changes in the reference state may become increasingly important due to factors such as climate change.

[6] A special study of natural disturbance recovery could be especially enlightening with regard to understanding natural variation.

SPECIFIC GUIDANCE

1.0 Site Selection: Assembling the reference candidate pool

The panel recommended a sequential approach for assembling a pool of potential reference sites using a series of tools to identify candidate sites (Figure 6). The toolbox components included: 1) use of existing data from previous site visits, 2) GIS data screens of all potential stream reaches using databases of stressor data (combining landscape and local scale), 3) expert selection of site locations based on regional experience.

1.1 Use of existing sites

Previously sampled sites are an excellent source of candidate reference sites and where available in sufficient numbers, can constitute a ready-made pool of reference sites. However, previously sampled sites vary widely in the amount of information associated with them, and they fall into two categories: 1) sites with a large amount of associated environmental data that is sufficient to evaluate without additional data collection, 2) sites that require additional data collection to produce adequate evaluations. Several programs in the state have collected sufficient data to meet the first condition (e.g., EMAP, Central Valley WEMAP, CMAP, SNARL, some regional board programs), but most sampled sites fall into the second class.

The current distribution of existing candidate sites in California is illustrated in Figure 7. Sites were pre-screened from ABL and SNARL databases and sorted into one of three tiers based on the availability of different types of screening data. Under the RCMP, Tier 1 sites would pass to the pool of verified reference sites if they passed a BPJ screen (see following section), sites in other tiers would be placed in the candidate pool and be subjected to the full site screening process (Figure 6).

1.2. GIS data screens of all potential stream reaches using databases of stressor data [7]

If regions do not have sufficient existing sites to fill the final pool of fully screened reference sites (steps 1 - 3 of the general guidance), then new candidate sites should be identified through use of geographic information systems (GIS) techniques for screening remote sensing data and GIS databases of point source stressors. GIS-based searches for candidate reaches are expected to contribute the majority of sites in many regions.

Ode (2002) described a GIS based method for identifying candidate stream reaches using a series of remote sensing data filters. Under this approach, candidate watersheds are identified for a region with GIS techniques and then stream reaches within these watersheds are targeted for reconnaissance to verify reference quality characteristics. The RCMP generally follows this approach, which consists of the following steps:

[7] GIS techniques are used at two different stages of the RCMP process: 1) searching for potential new reference streams (described in this section) and 2) quantifying impacts to existing sites (described in the following section). The techniques are very similar, but differ somewhat in their application. The search phase is a relatively coarse screen of candidate watersheds while the verification phase is site specific and allows for multiple spatial scales of GIS analysis (see Figure 8).

1.2.1 Assemble GIS layers of important landuse disturbances
The list of potential impacts to stream condition is very long and includes multiple point and non-point sources of disturbance. Quantitative measures of many human or human-influenced activities are available in digital spatial (GIS) formats from various state and federal agencies (see Tables 1 and 2), but there is a very large amount of variation in the degree to which datasets are accurate, current, and consistent across wide geographical ranges.

1.2.2 Determine appropriate reporting units (areas of analysis) and create necessary GIS layers~ Current GIS applications for locating least disturbed waterbodies in a region (see ATtILA text box) calculate summary stressor metrics (e.g., % urban landuse, road density) for each reporting unit (typically watersheds) in the region of interest. Candidate stream sites are then selected from within these watershed areas. It is recommended that the RCMP use a modified version of watershed polygons developed by the national NHD+ program.[8]

1.2.3 Use ATtILA extension to calculate stressor metrics using remote sensing and point source datasets (see ATtILA text box)~ ATtILA produces summary output in a spreadsheet containing multiple stressor metrics for each candidate watershed (i.e., % agricultural landuse, % impervious surface, # of mines, # road crossings/stream km).

1.2.4 Analyze distribution of stressor metrics and select appropriate thresholds
Screening thresholds for GIS stressor metrics can be set using a variety of approaches: 1) visual inspection of frequency histograms for natural breaks in distributions, 2) statistical criteria[9] (e.g., eliminate watersheds with road densities greater than 1.5 standard deviations above the mean for all watersheds in the region, or eliminate all but the lowest 25th percentile of all road densities), 3) established (i.e., literature based) impact thresholds. At this stage in the screening process, the RCMP panel recommended the use of fairly liberal screening thresholds since GIS data are often inexact and impacted sites can be screened during later stages of the site verification process.

1.2.5 Eliminate watersheds that fail GIS screens
Because of the large number of stressor variables that are quantified in this step, there will be a large number of metrics to evaluate. The panel discussed two options for how to combine the information from these different screens:

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[8] With funding from the SWAMP program, CSU Chico's Geographic Information Center (GIC) has developed a method for creating nested watersheds from the native polygons available from the NHD+ program. The NHD+ polygons are limited in their utility as reporting units because they are non-overlapping. Thus, 2nd order watershed boundaries in NHD+ do not include their tributary 1st order basins. The GIC's modification creates new watershed polygons that are aggregates of all upstream polygons (e.g., 4th order watersheds contain all upstream 3rd, 2nd and 1st order polygons).

[9] Effective of statistical properties of distributions to define thresholds depends on a normal distribution of scores. Some distributions (e.g. highly skewed or bimodal) may be better interpreted by looking for natural breaks or using literature based criteria.

a) Screens could be applied as a series of filters, with failure in any metric resulting in elimination of the watershed from the candidate pool.

b) Alternately, a multi-metric index of stressors could be used to create a composite score for each candidate site and low scoring watersheds would be removed from the candidate pool.

The panel recommended the use of a hybrid approach, in which the multi-metric scoring would be used to screen watersheds, but "kill-switches" would be employed to eliminate watersheds that exceeded high impact thresholds for particular stressors (e.g., eliminate watersheds with > 10% urban landuse).

As an additional consideration, the panel recommended that the RCMP explore quantitative methods for deciding which impacts to use for selection. For example, some stressors may have a greater effect than others and, thus, should be weighted more heavily than relatively benign influences. A corollary would apply to data sets with different levels of confidence. For example, information about mine locations may be available, but not about which are actively contributing contaminants to streams.

ATtILA extension for GIS Landscape Analysis

http://www.epa.gov/esd/land-sci/attila/intro.htm

To quantify landuse activities occurring upstream of sites, the Ebert and Wade (2004) developed a user friendly interface that accepts a range of GIS data layers and produces summary statistics for areas defined by the user. The extension, Analytical Tools Interface for Landscape Analysis (ATtILA), is a plugin to ESRI□s ArcView□ (version 3.x) GIS software (ESRI Products) and takes advantage of ESRI□s Spatial Analyst extension to run the spatial calculations.

- The ATtILA extension calculates the percentages of various landuse activities occurring in specified areas (urban; forested; agricultural-row crops; agricultural- orchards□vineyards; agricultural-total), other correlated measures of human activity (population density; road length; road density; road crossings□stream mile; percent impervious surface), and estimated nitrogen and phosphorus loadings.
- ATtILA can use polygons of any spatial extent as reporting units (e.g., entire upstream basin, local buffers)
- In 2007, the SWAMP program provided funds for a project to adapt the ATtILA extension to meet the GIS needs the RCMP process. Specific enhancements being developed include the ability to add custom stressor coverages, summarize point source data, and facilitate rapid adjustment of stressor thresholds for screening candidate sites. The project will be coordinated with the implementation of the RCMP
- It is expected that the capabilities of the modified ATtILA extension will expand as the RCMP process develops over time.

1.2.6 Identify candidate stream reaches within candidate watersheds[10]

After eliminating watersheds using GIS screens, the remaining watersheds represent potential candidates for the reference pool. These areas may be able to be further refined to further isolate candidate stream reaches (see Figure 8).

[10] An alternative strategy is to select candidate stream segments directly using analytical tools designed to work with the NHD+ datasets. Under this approach, confluence points would be the the reporting unit and NHD+ tools would summarize all upstream landuses. Errors in the current version of NHD+ (primarily problems with flowline connectivity) currently limit the effectiveness of this approach, but it may become more useful as NHD+ improves. The RCMP should remain open to both approaches and revisit this issue as new versions of NHD are released.

1.3 Use of local knowledge to add sites to the candidate pool

Although existing data and GIS searches will contribute the majority of sites to the candidate pool, a few sites may be added to the candidate pool on the basis of local knowledge. Local knowledge can sometimes help in identifying candidate sites because GIS datasets are imperfect and GIS screens may pass over good sites because of inaccurate or outdated disturbance information. These sites, however, should be critically evaluated because subpar sites based on local knowledge will dilute the quality of the reference pool. More rigorous evaluation of these sites should include examination of existing data.

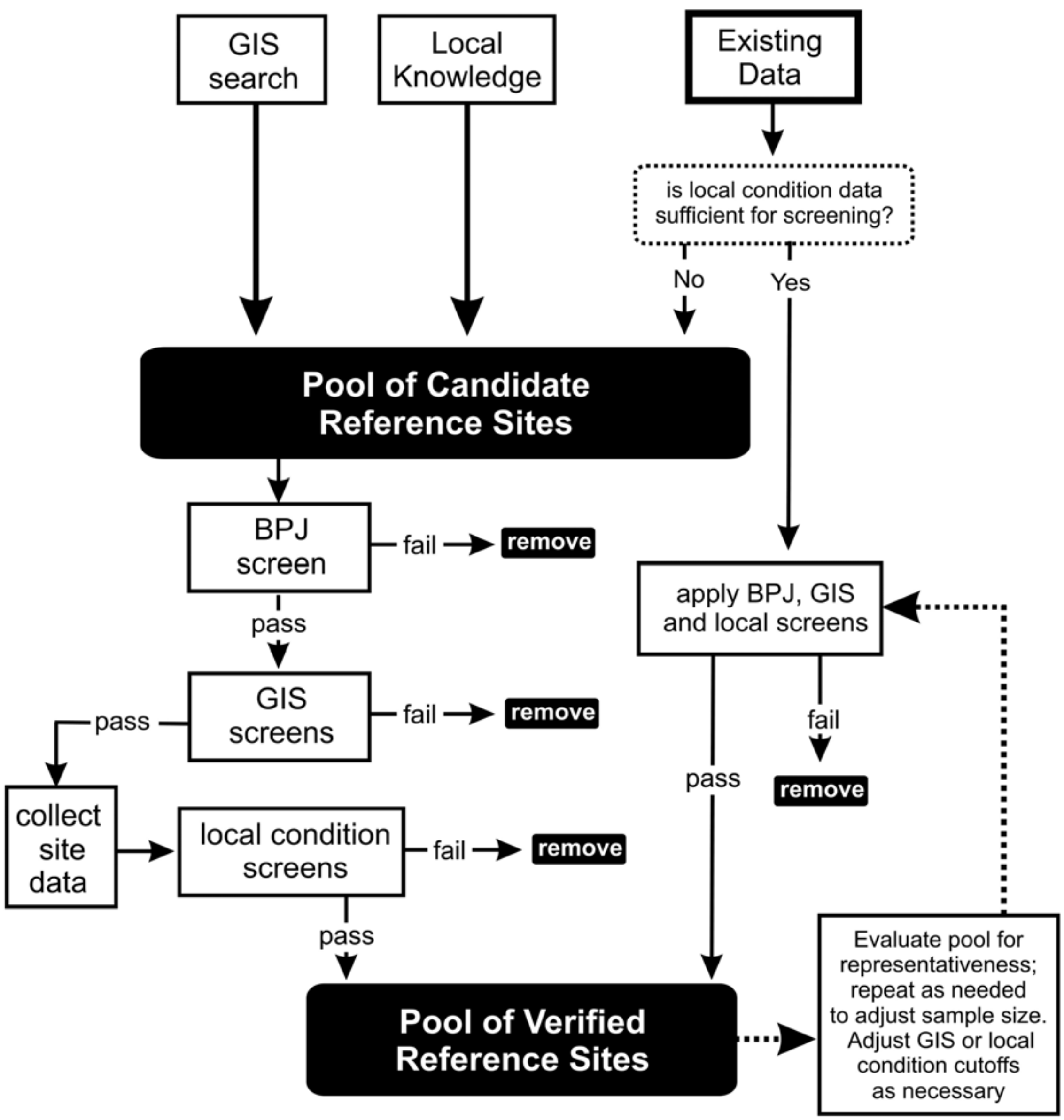

Figure 6. Schematic of the standard reference site selection and verification process.

Table 1. Potential GIS data coverages for nonpoint sources.

NON POINT-SOURCE COVERAGES			
Information Type	**Data Source(s)**	**Notes**	**Coverage**
Landuse/Landcover	National Landcover Dataset (NLCD), MRLC	1992, 2001 satellite imagery, allows for 9-yr landcover change assessments	Statewide
Impervious Surface	NLCD, Others	Quality varies regionally	NLCD statewide, others patchy
Road Density	USFS, TIGER		Statewide, but patchy
Timber Harvest	CDF, THPs		
Vegetative Change/ Vegetative Change Cause (LCMMP)	USFS/CDF		Not Statewide
Population Density	Census Blocks, CDF	Produced in conjunction with decadal population censuses; censuses can be combined to estimate population change	Statewide
Grazing	Cattlemen's Association		Not Statewide
Fire History	CDF, USFS		Best for FS lands

Table 2. Potential GIS data coverages for point sources.

POINT-SOURCE COVERAGES			
Information Type	**Data Source(s)**	**Notes**	**Coverage**
Mining	USGS	Possibly outdated	Statewide
NPDES	EPA	Prone to inaccuracies	Statewide
303(d) listed streams	SWRCB	Every three years	Statewide
Water Diversions/ Extractions	USGS, NHD□	Possibly outdated	Statewide
Dams	CalWater	Doesn't include overflow info	Statewide
Stormwater Inputs	NHD□, Counties	Uneven coverages	Patchy
POTW	EPA	Prone to inaccuracies	Statewide
Landslide Datasets	CalTrans		Statewide

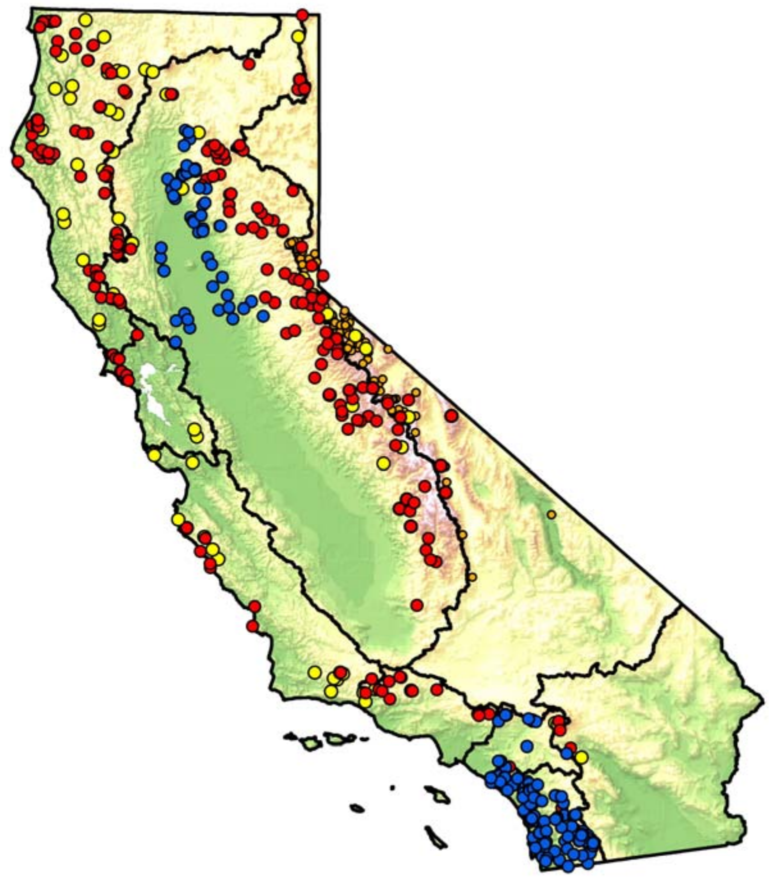

Figure 7. Partial set of bioassessment sites available for initial screens assigned to one of three tiers. Tier 1 sites (yellow circles) are EMAP and CMAP sites that passed a full suite of screens based on the most complete data for evaluation. Chemical and habitat thresholds were based on Stoddard *et al*. (2005) and landuse thresholds were based on Ode *et al*. (2005) and Rehn *et al*. (2005). Tier 2 sites (red circles) are USFS and Regional Water Board sites that have passed a less stringent screening process, but might very well be reference and need additional data before they either passed into Tier 1 or eliminated from the candidate pool. Tier 2 sites were screened based on land use, less extensive physical habitat data and limited or no chemical data. Tier 3 sites (blue circles) are cases in the Sacramento Valley, Sierra Nevada foothills and southern coastal California that probably need an alternative reference screening process (e.g., the factor ceiling approach). SNARL sites (orange circles in Eastern Sierra Nevada) used different screening thresholds, but are likely equivalent to Tier 1 sites.

2.0 Site Selection: Screening the candidate pool

Once a large set of sites is selected for the candidate pool, sites in the pool undergo a series of screening steps to either validate sites as appropriate reference sites or eliminate them from the pool. The major screening tools are: 1) expert opinion (BPJ), 2) landscape screens (GIS), and 3) local condition screens.

2.1 BPJ screens

While BPJ can play a role in identification supplementing the pool of candidate sites, it plays a bigger role in eliminating candidate sites. Sites should be eliminated on the basis of BPJ knowledge that there are known problems that aren't accounted for in GIS datasets. For example, GIS datasets may miss recent development, known pollutant spills, or nonpoint sources. This step should include coordination with local watershed groups, landowner groups and other stakeholders to eliminate inappropriate sites. The rationale for rejection should be documented.

2.2 Landscape scale screens (GIS)

Just as GIS techniques are essential for adding sites to the candidate pool (Figure 6), they also play a crucial role in reference site verification. The datasets and techniques used in this step are essentially the same as those used in searching for candidate watersheds/ stream segments, but the application of the tools differs somewhat. Whereas the GIS analyses were applied at a fairly coarse spatial scale in Section 1.2, GIS tools can be applied at multiple spatial scales during the screening stage.

The first step in the second GIS stage is to convert candidate watershed areas into specific sampling sites by selecting a common point on the stream segments in each watershed (e.g., the downstream confluence point), making them equivalent to other sites in the candidate pool (as in Figure 8a).

The chief benefit to the two-stage application of GIS techniques is that it gives us the opportunity to identify multiple sampling locations within reference watersheds.
While sites would normally be screened using stream confluence points as the candidate site locations, site locations could be moved to other points in the watersheds to identify additional reference sites within good watersheds or to avoid portions of the watershed with undesirable sources of human disturbance (Figure 8b).[11]

Using watershed delineation tools and local site buffering tools currently available for use with GIS software, polygons should be created to represent different spatial scales upstream of each site (e.g., the entire watershed draining to the site, the upstream area within a 5 km radius of the site, the area within a 200m buffer on either side of the stream within 1km upstream). Once created, these areas can be used as reporting units for

[11] Although the two stage application of GIS techniques gives us greater flexibility to identify multiple candidate stream reaches within each candidate watershed, an alternative strategy would be to eliminate the coarse search for watershed described in Section 1.2 and go straight to the more refined screening analysis indicated in Figure 8a.

ATtILA analyses. Metrics calculated for the different spatial scales can be screened as in Section 1.2.5.

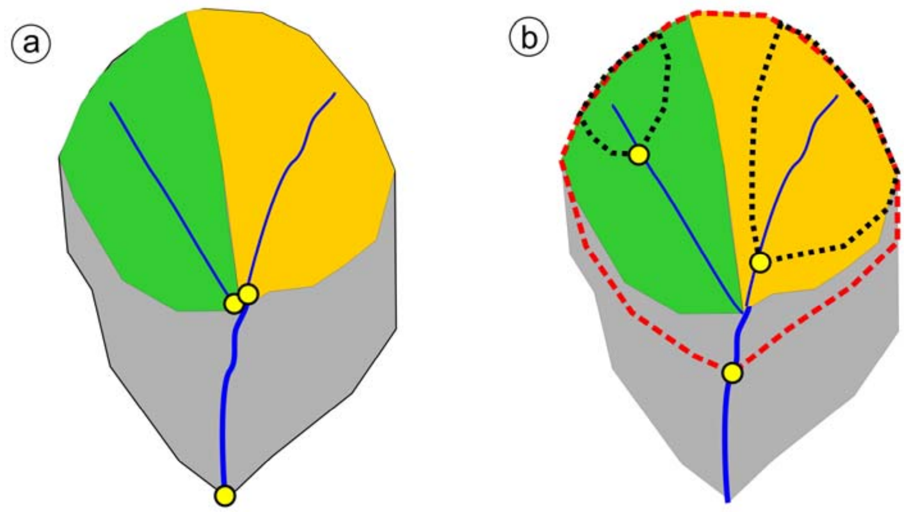

Figure 8. Illustration of alternative applications of the second stages of GIS analysis in the RCMP using a hypothetical second order watershed containing two first order watersheds: a) normal site locations represented by yellow circles, b) alternate site locations and their watershed boundaries (represented by dotted lines).

2.3 Local Condition Screens

Sites that have passed BPJ and GIS screens are then subjected to an evaluation of site scale stressors. Some of the local scale information can be obtained from aerial photography of sites, but the majority of this information will come from site visits and in some cases collection of water quality data.

2.3.1 Site scale data: Aerial photography

Aerial photography provides a unique view of potential site scale stressors. Digital orthophoto quadrangles (DOQs) are available for the entire state of California (DFG). Google Earth is another source of digital satellite imagery. DOQs and other sources of aerial photographic images can provide excellent information about local stressors not available through other sources, but are subject to the same timeframe limitations as other digital sources.

2.3.2 Site scale data: Site visits

The panel strongly recommended site visits as a crucial component of reference site verification. Once candidate list have been narrowed down to sites that meet BPJ, GIS and DOQ screens, land ownership should be determined for each site and owners contacted to obtain access permission and or sampling permits as needed. Site owners can also be contacted at this point to determine if there are any reasons for rejecting sites.

Field visits should be used to collect both qualitative (e.g., presence of obvious disturbances) and quantitative data (e.g., % intact riparian zone). Quantitative measures should focus on data that can be collected and analyzed cost-effectively.

2.3.3 Qualitative data

Visual assessments of site suitability should include a minimum set of observations:

- Upstream impoundments, or evidence of water withdrawal or diversion
- Evidence that the site is non-perennial
- Evidence of recent fire, flooding or landslides
- Local grazing impacts
- Presence of significant anthropogenic use (e.g., campgrounds, etc.)

2.3.4 Quantitative data

At a minimum, site visits should include characterization of physical habitat using the SWAMP Physical Habitat Procedures (Ode 2007) and conventional water chemistry. Physical habitat characteristics should include measures of both instream and riparian condition. SWAMP habitat procedures may be supplemented with riparian condition measures collected with the California Rapid Assessment Method (CRAM) for riverine wetlands. Water chemistry analyses should include the following analytes: chloride, turbidity, pH, total nitrogen, total phosphorus, conductivity, and alkalinity. Some chemical analytes may not be needed in all regions. For example, sulfate (a good indicator of mining activity) is not likely to be informative in xeric regions. One recommendation was to create a checklist of activities by region. Another option is to supplement with sediment and/or water column toxicity. While these tests may be expensive, they are less expensive than a screen for a long list of toxic constituents.

2.3.5 Combining site data for screening decisions

As with GIS screens (Section 1.2.5), there are many ways to combine site data to make determinations. The panel again recommended use of a hybrid approach in which site scale data is combined to calculate a multi-metric site condition score. The use of kill switches was also recommended for excessively high or low scores for individual habitat or chemistry.

3.0 Alternate strategies for selecting reference sites

While most regions of California can follow the standard approach for selecting reference sites, there are at least two large regions in California that lack sufficient high quality sites. The first is the Central Valley where natural landscapes have been almost entirely converted to agricultural and urban land uses. Most natural stream reaches in this region have been channelized or otherwise modified to support irrigation and flood control. The second is in coastal southern California (elevations below 1200 ft – upper elevations can follow standard model) where conversion to urban and suburban land uses has led to the channelization of most stream reaches. Recent studies in these regions demonstrate that at least some waterbodies in highly modified regions can support fairly rich BMI assemblages, even under considerable alteration and agricultural development (Griffith *et* *al*. 2003, deVlaming *et al*. 2004, deVlaming *et al*. 2005, Ode *et al*. 2005). Thus, there is enough range in biotic condition to differentiate degrees of impairment in these regions.

The panel recognized the unique limitations of these regions and recommended that a separate set of approaches be developed for them. Despite the differences in methodology, the goal of the alternate strategy is the same as the standard approach: to characterize the best attainable biological condition in these regions. This section outlines a set of approaches that the RCMP could follow. These fall into two general categories:

- Use a modified version of the standard approach
- Explore non-standard approaches

3.1 Modified use of standard approach

The first option is to use the set of techniques described for the standard approach, but to modify the way the techniques are applied. Modifications fall into two general types: 1) much greater emphasis on reach scale screening data, 2) use of less stringent criteria for rejecting sites.

One of the panel's philosophies is that potential reference sites in highly modified regions need a much larger amount of supporting data to verify their status than in less modified regions. In both the Central Valley and southern coastal California lowlands, streams exist in a landscape matrix with a universally high level of unnatural land uses. Furthermore, many streams have extensive flow manipulation, including water diversion, re-introduction, and inter-basin transfers that render watershed based tools irrelevant. For both these reasons, watershed based stressor analyses are less informative screening tools. Accordingly, much greater reliance should be placed on data collected from direct site visits than on remote sensing data. The panel recommended increased emphasis on riparian condition, instream habitat condition, and water column chemistry. In some cases, additional data (e.g., sediment and or water column toxicity) will be necessary to verify sites.

Selective relaxation of screening thresholds may also be an effective means of identifying the best available sites in a region. For example, acceptable road densities are likely to be much higher in southern coastal California than in other regions of the state. Likewise, acceptable local agricultural landuse percentages and acceptable levels of fine sediments are likely to be higher in the Central Valley than in less modified regions. While less stringent thresholds may help identify some of the best sites in highly modified regions, the use of kill switches is an essential safeguard against accepting unacceptably low thresholds. Specific cutoffs such as >10% local impervious surface, or toxin concentrations greater than the standards set by the California Toxic Rule may be more appropriate in these heavily modified landscapes.

A version of this modified standard approach was applied to search for reference sites in the Central Valley (Ode *et al*. 2005). Remote sensing data (e.g., landuse percentages) and other GIS datasets (e.g., pesticide application rates) was used as a coarse screening tool, but this data was de-emphasized in favor of riparian condition and instream habitat scores. This study identified approximately 20 potential reference creeks in the Sacramento Valley (see Figure 7), but these still need to be screened for water chemistry and toxicity before they are acceptable.

3.2 Non-standard approaches

Although modified use of the standard techniques can go a long way toward providing the data needed to adequately characterize biological expectations in these areas, it is unlikely to resolve the entire problem of identifying a sufficient number of candidate reference sites. The panel recommended the exploration of several different alternative, non-standard techniques:

- Select best sites using existing biological indices
- Species pool approach
- Factor-ceiling approach
- Model taxon preferences for limiting environmental gradients

All of the non-standard strategies suffer to a greater or lesser degree from circularity since the establishment of a biological reference site is being established with biological data. However, the extreme lack of reference sites in these regions requires us to consider accepting some circularity while adding additional steps to guard against the risks of circularity. The best way to guard against these risks is to use independent datasets to select the biotic response metrics.[12]

3.2.1 Use of existing indices to select sites with high quality biology

A straightforward alternate approach is to use existing biological assessment tools from the same region to identify sites that could be used to establish biological expectation in problem regions. [13] High scoring sites would be assumed to represent the "least disturbed" sites in the region. The method assumes that BMI assemblages in the target region have similar responses to anthropogenic stress as the region(s) for which the indices were created. Issues with circularity are mitigated by the fact that the scoring tools were derived objectively using independent datasets.

A variation on this approach is possible in regions where only a few reference sites can be identified (either using the standard methods or the modified standard described above). Under this variation, a model (either MMI or O/E) would be created using a small number of reference sites. Then new sites with similar BMI assemblages would be added to the reference pool and the model recalculated. This recursive approach results in more explanatory power because it is based on a larger number of reference sites, but it is inherently circular because the new sites are not chosen based on independent information.

[12] Note also that some have argued that the circularity concern is less of a problem in highly modified systems than more pristine systems because relationships between metrics and stressors are simpler (Karr and Chu 1999).

[13] Examples of existing biological assessment tools include the Southern California IBI (Ode *et al*. 2005), northern California IBI (Rehn *et al*. 2005) and the California RIVPACS models (Hawkins unpublished).

3.2.2 Species pool

Another option is the species pool approach, which uses the total faunal diversity of a region (i.e., central valley or southern California coastal urban lowlands) to establish a biological condition axis. The process involves assembling a pool of all BMI taxa ever collected from the region, then using taxonomic richness as the measure of biological integrity at test sites. The inventory could be compiled from existing data sets, historical records (i.e., museums or other voucher collections), or directed field surveys. This technique assumes that richness is a good measure of condition, that there hasn't been extensive extinction of native fauna and that the constituent species in the pool are all potential colonists of any test stream.

The utility of this approach could be enhanced in at least two ways. The number of richness metrics could be increased by breaking richness out by taxonomic groups (midges, worms, mayfies, etc.), isolating the different information content in these groups. Further, the species pool could be modeled to associate expected taxa with key environmental gradients (i.e., substrate composition, elevation, etc.) and the proportion of taxa present at reference sites could be a potential target for attainment of reference state. If this approach were taken, then the species pool concept should be tested first in a region where identifying reference sites are not problematic as proof of concept.

3.2.3 Factor-ceiling approach

Carter and Fend (2005) developed a technique for defining a range of biotic expectation that takes into account the decrease in biotic condition caused by physical modification along an axis of increasing urbanization. In their example, a simple statistical technique (partitioned least squares regression, OLS) was used to identify the highest biotic scores along an urbanization gradient. Upper values define the range of expected biotic conditions for the region. Since a full urbanization gradient was used to take into account decreasing biotic potential with increasing urbanization, the resulting range of expected conditions is a conservative estimate of biotic potential for the region. While this approach could be used in both the Central Valley and southern coastal California lowlands, the method would work especially well in the Central Valley because the agricultural impact gradient is not as strongly confounded by elevation or other longitudinal gradients as the urban ones studied by Carter and Fend (2005).

The first step is to identify key measures of physical modification (hydrologic modification, channel modification, streambed modification) and to combine these into a multifactor axis of agricultural modification (i.e., the primary axis in a PCA of these stressors). The second step would be to identify appropriate metrics for detecting biotic impairment in valley streams.

3.2.4 Modeling taxon preferences for limiting environmental gradients

The final alternate strategy involves modeling taxon preferences for key environmental gradients, or limiting environmental differences (LED) and then using these relationships to select the most appropriate sites for setting biological benchmarks. Different habitat features (e.g., climate, channel morphology, water chemistry, substrate characteristics) can be thought of as acting as "filters" that select for particular species traits (Poff 1997).

This conceptual framework provides a way of accounting for the influence of both natural and anthropogenic factors on species distributions. Chessman and others (Chessman 1995, 2006, Chessman and Royal 2004, Chessman *et al*. 2008) recently developed a technique for using the tolerance or preference of individual taxa for key environmental filters (e.g., water temperature range, substrate composition, flow regime) to predict the assemblage of taxa that could be expected to occur at any test site under minimal human stress. Deviation from that expectation is used to infer degradation just as it is in predictive models (e.g., RIVPACS).

This is a promising approach; even the primitive assignment of taxa to simple preference classes used by Chessman and Royal (2004) resulted in stronger associations between their water quality assessments and independent measures of human disturbance than did the Australian predictive models developed from reference sites. They achieved similar results when applying the technique to fish assemblages (Chessman *et al*. 2007).

To adapt this to California's heavily modified regions, there is a need to develop models of the environmental affinities of Central Valley and southern coastal California lowland BMI taxa. It will likely take several years to collect enough samples to characterize individual BMI responses across key environmental gradients, but some of this data has already been collected and could be worked with now.

3.3 Combining approaches

The alternatives described in this section are not mutually exclusive; the RCMP could use more than one in each region. It is possible that not all approaches will work equally well in all regions and, as a result, different alternatives might be used in different regions. The panel was silent on which approaches, or which combinations of approaches should be prioritized.

The panel cautioned that using these non-standard approaches would require significant effort. Since these non-standard approaches have been used sparingly elsewhere, and essentially not at all in California, pilot studies looking into their applicability was recommended. The first step in the panel's recommendation was to evaluate existing datasets to determine if historical data exists for implementing any of these approaches. As mentioned in section 3.2.2, these approaches should be tested in a location where reference sites exist. Developing any non-standard approach needs to be ground-truthed before widespread use of the tool should be applied. Once this proof-of-concept occurs, then targeted data collection in one of the reference-poor regions can be initiated.

MANAGING THE REFERENCE POOLS

Accounting for natural variation

Classification of streams according to natural gradients can help partition natural sources of variation in biological assemblages and thereby improve our ability to detect deviation from reference condition (see Hughes 1995 for a review of the history of stream classifications). The RCMP needs to ensure that the regional reference site pools are representative of the most important regional gradients. The best way to test the representation of these gradients is through ordination of BMI datasets to determine which natural gradients explain most BMI variation in each region. Assessment of natural variation should include a periodic review of the suitability of the initial regional boundaries. The initial boundaries may either expand or contract and regions may need to be subdivided or merged as we gain more detailed information about the drivers of natural biological variation in each region.

However, since most regions do not have many reference sites to begin with, these analyses will have to take place iteratively as the program builds up a sufficient number of sites in each region. As initial guide, the panel recommended that the RCMP attempt to distribute sites to represent the following natural gradients:

- Stream size (stream order, discharge volume, etc.)
- Geology (with special attention to gradients in calcareous composition)
- Climate (temperature and precipitation)
- Elevation
- Reach slope (an important driver of stream morphology and substrate composition)
- Conductivity and natural nutrient gradients (associated with alkalinity)

The second component to site management is periodic review of sites in the reference pools to assess their continued suitability as reference sites. Conditions within stream reaches and in their upstream drainages can change over time (e.g., timber harvest, conversion of natural landscapes to agricultural or urban/suburban/exurban uses). Furthermore, we may discover sources of stress that were unknown when sites were initially added to the reference pools (e.g., discovery of point source discharges, mines, flow withdrawals/diversions, small-scale placer mining, etc.). Sites that fall into this category may be monitored to measure the impacts of these stressors, but they should be removed from the reference pools.

Dealing with natural disturbance

Natural disturbances such as forest fires, catastrophic floods and landslides can have a significant impact on biological assemblages and physical habitat conditions. As such, they can contribute considerable noise to reference distributions, thereby reducing the precision of biological assessment tools based on these distributions.

There are several competing philosophies for how to handle sites with recent natural disturbances. For example, Idaho's program flagged sites affected by natural disturbance to assess in parallel with other reference sites (Grafe 2004). In contrast, Oregon explicitly included these sites with other reference sites, as a means of incorporating natural disturbance as a component of natural variability (Drake 2003). The RCMP will keep these sites in the reference pools, but will not sample them after the disturbance. The appropriate time to avoid sampling disturbed reference sites is not currently known and should be the subject of targeted research or special study.[14]

[14] The San Diego Regional Water Quality Control Board has funded a multi-year project with the ABL to track biological assemblage recovery in reference and test sites following two large scale forest fires events in 2003 and 2007.

MONITORING STRATEGY

Monitoring Design

The primary question to be answered from the monitoring of the RCMP is "what is the expected natural composition of lotic freshwater organisms in each of the major biogeographical regions of California"? In order to answer this question, the panel agreed it is most important to gather information from a large number of sites in order to capture the full range of natural variability within a region. To collect this information in a spatially balanced and unbiased fashion, the panel advocated a probabilistic sampling design. Probabilistic designs were used in the REMAP, WEMAP, CMAP and PSA surveys in order to get unbiased estimates of stream condition and the approach for this design would be similar. In this case, the regional reference pool would represent the sample frame where sites would be selected at random for sampling. As in the PSA, these randomly drawn sites could be stratified to ensure the spatial distribution across natural gradients such as stream order, elevation, slope, geology, precipitation, or other factors.

An important secondary component to answering the monitoring question is to assess how the range of natural conditions changes over time. Certainly year-to-year variability can alter the distribution and abundance of organisms based on climatic conditions (i.e., wet vs. dry year, warm vs. cold year, etc.). Revisiting sites is the most powerful way to gather this type of temporal information. Two designs lend themselves to answering this question. The first would be to revisit a subset of the probabilistic sites. The panel favored this type of design, termed "rotating panel", because it provides both temporal and spatial variance terms. Urquhart and Kincaid (1999) and Larsen *et al*. (2004) describe the rotating panel strategy in more detail. However, a large number of potential reference sites are already being monitored on a regular basis. Provided these sites can pass the large- and local-scale screening criteria, the panel recommended sampling these sites as a cost-effective method to gain trends information at specific locations of interest. The main drawback to the targeted design, however, is the lack of ability to extrapolate to other reference locations.

Indicators and methods

Once the reference site pools are established, they can be sampled to meet the needs of a variety of programs. However, the panel agreed that a base program should monitor those indicators that are currently being used for SWAMP's statewide assessments (see PSA text box). These indicators include BMIs, physical habitat quality and basic water quality measurements. In some instances, enhancement of the indicators in certain regions or at certain sites may be needed to

Indicators sampled for the SWAMP Perennial Stream Assessment (PSA)

Biological
- BMIs
- Algae (diatoms, soft algae)
- CRAM riverine wetland methods

Physical Habitat
- SWAMP instream and riparian condition (derived from EMAP field protocols)

Chemical
- Nutrients (SRP, NO_2, NO_3,TP, TN, Si)
- Major ions (Cl, $S0_4$)
- SSC, turbidity
- pH
- Hardness, alkalinity, conductance

address local concerns. Region-specific enhancements were deemed acceptable as long as the base program is not handicapped to implement the enhancements. For example, additional biological indicators such as fish have been used by others (Hughes *et al.* 2005; Brown and Moyle 2005). Field and laboratory methods and quality assurance measures should also be consistent with SWAMP.

Number of reference sites

The appropriate number of sites to sample in each region depends on the extent of variation related to natural gradients, which is currently unknown for most regions. The panel therefore could not provide specific guidance on sample size. Instead the panel made two recommendations:

1. The RCMP should sample approximately 50 sites in each region to support assessments of natural variability. Intensification of sampling in initial years was recommended to establish the reference baseline, with potentially reduced intensity in later years.

2. The RCMP should conduct power analysis to determine the optimal sample size for assessing confidence in the statistical parameters of the distribution of biological metrics (Figure 9). For example, an assessment of variance at reference sites within a region can be calculated based on existing data (although not all regions have enough sites to support this at present). The inflection point of this power curve represents an efficient sample size where additional sites provide little improvement in confidence, yet fewer sites might dramatically broaden the confidence limits.

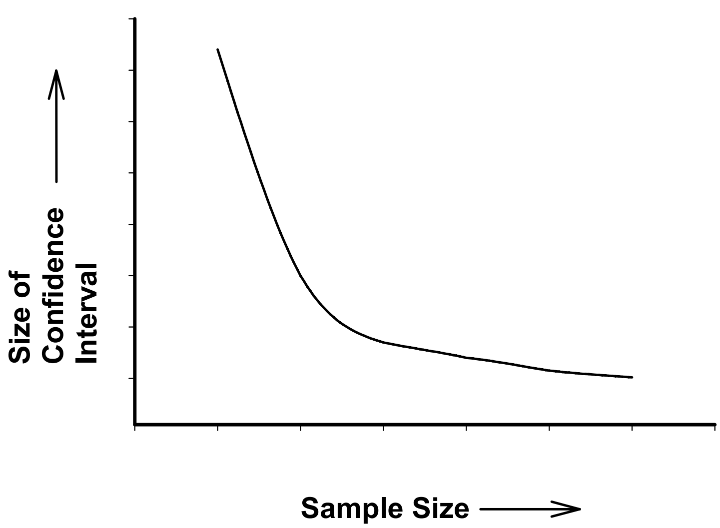

Figure 9. Example power curve defining sample sizes relative to site variability.

Sampling frequency
Sampling frequency affects trend detection. The optimal sampling frequency for trend detection is a function of sampling design. Trend detection as part of the probabilistic design is a function of number of sites (spatial variability), sampling frequency (temporal variability), amount of change to be detected, and other factors. The panel recommended a subset of probabilistic sites be sampled once within the appropriate index period for the region (should be consistent with the index period used for the SWAMP PSA). The recommended index period should capture a time frame where benthic macroinvertebrate communities are sufficiently stable to produce repeatable results, but prior to stress from late season flow reductions. Revisiting a subset of probabilistic sites each year will provide an estimate of interannual variability, thus improving large-scale trend detection. The proportion of revisited sites was not addressed specifically by the panel, but could be optimized using power analysis.

The panel agreed that targeted sites were an efficient way to assess long-term trend detection. Sampling frequency at targeted sites is a function of variability in the biological metrics, the amount of time required to detect a trend, and the amount of detectable change. The panel recommended that the RCMP use power analysis to establish the optimal sampling frequency (Figure 10). Once again, this could possibly be accomplished using data from existing sites that have been sampled for a number of years.

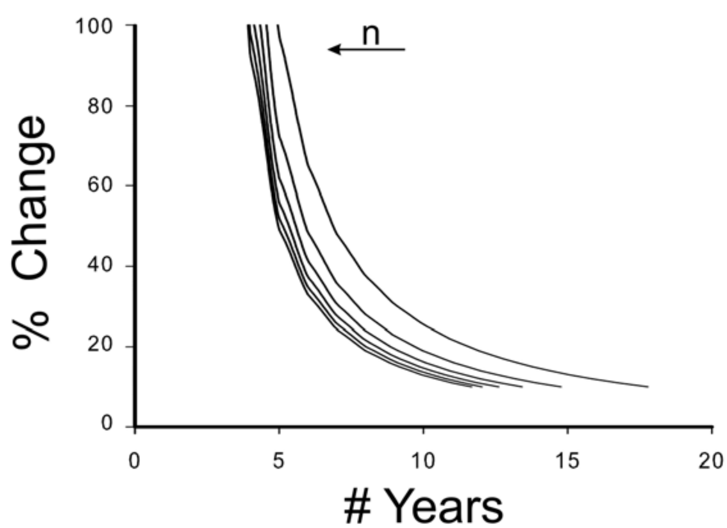

Figure 10. Theoretical power curves describing the relationship between the number of samples collected and the magnitude of detectable change at fixed sites. Individual curves represent different numbers of samples per year, with higher numbers toward the left of the figure.

ADDITIONAL RECOMMENDATIONS

Funding

Defensible bioassessment techniques and biocriteria require a reference condition program that can document both spatial and temporal variation. While the panel did not recommend a minimum level of funding, they advised that funding will need to be long term and stable. Several cost-effective strategies are available, but options discussed included trade-offs between probabilistic and targeted sites, optimizing sample size using power analysis (see previous section on sample size and frequency), and finding additional partners to help support the RCMP (see section below on collaboration). Regardless, SWAMP should prioritize some sampling effort every year to document annual variation in reference condition.

Inter-regional consistency

The RCMP should continue to focus on the issue of fostering consistency among the various regions of the state. Statewide assessments and comparisons among regions require a common currency for interpreting statewide assessments, and for inter-regional comparisons. However, this goal is complicated by the need for regional specific reference selection criteria. While the panel did not deliberate extensively on this topic, it recognized the importance of the issue and provided some initial guidance to help focus the thinking of the program. The main advice from the panel was that the objective of inter-regional consistency can probably not be resolved by the reference site selection process itself, but rather must be dealt with through data analysis and interpretation.

Development and application of assessment tools can be based on either regional reference pools or combined statewide reference pools. Regionalized assessment tools provide sensitivity to local environmental gradients and are more likely to pick up sites that deviate from the regional expectation. In contrast, statewide assessment tools would judge all of the state's sites on the same basis, but may reduce responsiveness to locally important gradients. Furthermore, we may have to accept that the performance of statewide analytical tools may vary regionally depending on the quality of the respective regional reference pools.

An example of an analytical solution is a hybrid approach in which both the regional and statewide indices are built and both tools are used to score test sites. Where both tools agree, there is relative certainty in the assessment of that site (i.e., both tools indicate reference-like or both indicate impacted). Where the tools disagree, a greater degree of relative uncertainty exists and additional information may be required to help interpret the status of that site (i.e., other indicators, additional sampling).

Collaborations/Coordination

Consistent with its policy to coordinate with other state and federal water quality monitoring efforts, SWAMP should seek opportunities to build partnerships with other state and federal agencies. Many of these entities have current reference programs (e.g., USFS, EPA, USGS), while others would benefit from joining an established reference program (e.g., Non-point Source Monitoring, State Parks, Irrigated Lands Program, Agricultural Coalitions, National Park Service, etc.). In addition SWAMP should explore ways to combine its bioassessment RCMP with other program components that would benefit from reference condition (e.g., CRAM, wetland monitoring, nutrient and sediment criteria monitoring).

The panel recommended exploration of ways to improve the types and quality of data used in GIS analyses. For example, the program could seek opportunities to coordinate with other state/federal/university efforts to enhance base layers like the NHD+ and stressor layers for quantification of grazing, timber harvest, pesticide application, etc. Further, the RCMP would should explore research efforts designed to improve prediction of specific stressor impacts and efforts to develop models that can be used to assess impact components that are not easily summarized by the ATtILA model. For example a model predicting sediment load (AnnAGNPS sedimentation model, USDA 2000) was applied by the University of Nevada, Reno. Other needs include estimating mining impacts, pesticide impacts and a means for summarizing the intensity of water manipulation within candidate areas.

Involving stakeholders in the process

It is often desirable to select sampling locations that occur on publicly owned land or land with easy access. Since it is important to sample streams from a truly representative set of sites within an area, it is often necessary to sample from reaches running through privately owned land. Reasonable efforts should be taken to obtain permission from landowners before rejecting candidate sites. This stage is very important and the quality of the final data set (and the ability to make inferences about reference conditions in the region of interest) will depend on the ability to obtain a representative set. The degree to which this stage is important varies regionally since some areas have more private ownership than others (e.g., western Sierra Nevada has many more publicly-owned lands than the interior chaparral).

Building effective relationships with local stakeholders (regional boards, watershed groups, landowner group, tribal groups, etc.) is clearly a critical part of making this reference site selection methodology work, especially in regions with a large degree of private ownership. To this end, implementation of this RCMP should include efforts to promote transparency in methods, encourage feedback and participation and explore opportunities to improve access to important privately held reference sites.

CONSIDERATIONS FOR OTHER FLOWING WATERS

The following section is not intended to be an exhaustive review of issues for defining reference conditions for these waterbodies, but a summary of the panel's preliminary guidance regarding issues that are likely to be important in these systems.

Large Rivers/ Non-wadeable streams

Large rivers are likely to require non-standard approaches to defining biological expectations because there are relatively few non-wadeable streams/rivers in the state and most receive the cumulative impacts of all human activities in their watersheds. Furthermore, several panelists suggested that standard chemical and physical habitat screening was unlikely to work in these systems. Screening criteria should include quantification of hydromodification, distance downstream from dams or other stressors.

Several of the alternative strategies could apply to these systems. Another alternative would be to target sampling at points along river just before they experience significant increases in sources of anthropogenic stress (e.g., where rivers in the western Sierra Nevada descend into the Central Valley).

Non-perennial streams

Non-perennial streams tend to have more variable biological assemblages than perennial streams. The standard approach should work for most of these systems statewide, but special attention should be given to classification of non-perennial streams by their degree of "intermittent-ness" in both space and time. The panel suggested that the RCMP should take advantage of current statewide vegetative mapping efforts to explore the potential for classifying non-perennial streams.

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Appendix 6

MEMORANDUM

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DATE: 31 July 2009
TO: Phil Markle
FROM: Jerry Diamond, Ph.D.

SUBJECT: Reference conditions and bioassessments in southern California streams

All bioassessment methods depend on having appropriate reference conditions with which to base an assessment; i.e., bioassessment data for a given site cannot be accurately interpreted by themselves—interpretation or assessment of the site data is done within the context of the biology that can be expected to occur naturally, given the type of habitat present, the type of aquatic system, and the physiographic region (i.e., ecoregion) of the country (Stoddard et al., 2006). Identifying appropriate reference conditions for certain types of aquatic systems, habitats, and ecoregions can be problematic because of wide-scale human land use changes such as hydrological modification (e.g., dams, levees, concrete channelization), urbanization (e.g., increased runoff, removal of riparian vegetation, bank protection structures), and agricultural/ livestock effects (e.g., water removal for irrigation, removal of riparian vegetation).

Southern California (Los Angeles, San Diego and surrounding counties) is an area that has experienced intense land use changes over the past 50 years, particularly in terms of urbanization and its many environmental consequences (e.g., changes in the natural hydrology, changes in stream geomorphology, etc.). In particular, low gradient as well as low elevation streams in this region have been especially prone to land use effects. This situation has resulted in high uncertainty regarding appropriate reference conditions for low gradient and low elevation streams in this region.

This observation was identified in a Technical Report I and others at Tetra Tech prepared for the Los Angeles Regional Water Quality Control Board (Tetra Tech, 2005; 2006). In that report we evaluated stream biological condition with respect to a generalized human disturbance gradient in the region, as part of an EPA-funded project to evaluate the possibility of developing tiered aquatic life uses (TALU) for southern California coastal streams. Relying on SWAMP and other data for the region, we attempted to use the recently developed southern California IBI (SoCal IBI, Ode et al., 2005) to define certain attributes of the Biological Condition Gradient for the region, which could then be used to develop TALU (Davies and Jackson, 2006). We observed that the BCG should be different (i.e., expectations lower) for low versus high elevation streams in that project and that low elevation streams lacked a clear reference condition in this region.

Working with a Technical Advisory Committee (TAC) on this project (consisting of regional experts from California Fish & Game, State Water Resources Control Board, other Regional Boards, EPA Region 9, and universities), we identified a lack of appropriate reference sites for low elevation/low gradient streams as a critical data gap in moving forward with TALU. A fairly extensive search of existing biological data in the region by Tetra Tech and the TAC indicated that suitable reference sites at lower elevations and/or for lower stream gradients were not available with which to benchmark a biological condition gradient.

Subsequent to the above project, I have been working with the Southern California Coastal Water Research Project (SCCWRP) and the LA Regional Board in facilitating two workshops on TALU for the region. In the most recent stakeholder workshop (held June 2008), there was focused discussion on the issue of appropriate reference conditions, in which there was agreement that low gradient (rather than low elevation) was perhaps the most critical factor distinguishing stream biology in the region and that reference condition for low gradient streams (many but not all of which occur at low elevation) is a critical data gap (Schiff and Diamond, 2009). In fact, in the "road map" of projects developed from this workshop, defining reference condition for streams in this region was identified as one of the top priority needs.

Given the difficulty in identifying appropriate reference conditions for low gradient coastal streams in southern California, it is perhaps premature to set regulatory requirements based on biology observed at these types of sites. The TALU framework, as well as the regional stakeholder workshops (e.g., Schiff and Diamond, 2009) recognize that different hydrologic, geomorphic, and other habitat-related factors will dictate the biological characteristics that can be expected in a given stream. The type of aquatic life uses one can reasonably expect from a low gradient or modified stream in southern California, for example, are not the same as from a high gradient or natural stream, as our previous work has demonstrated. What is the expected biological condition for low gradient or modified streams in southern California is a question that needs more attention and, as noted by all stakeholders at the June 2008 workshop, incorporation of information using other assemblages (e.g., algae) in addition to macroinvertebrates.

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Appendix 7

B233

IDENTIFYING BARRIERS TO TIERED AQUATIC LIFE USES (TALU) IN SOUTHERN CALIFORNIA

Ken Schiff
and
Jerry Diamond

Southern California Coastal Water Research Project

Technical Report 590 - June 2009

Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California

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June 2009

Technical Report 590

PREFACE

The goal of this document is to explore the use of a new environmental management tool in southern California known as Tiered Aquatic Life Use or TALU. TALU focuses on the traditionally difficult regulatory problem of maintaining balanced biological communities. The existing California State regulatory framework only lists broad, categorical biological expectations such as warmwater (WARM) or coldwater (COLD) habitat. TALU has the potential to refine the biological expectations within each of these broad categories based on a variety of factors including physical habitat, hydrology, or level of habitat alteration. More detailed expectations tailored to the specific habitat could dramatically improve environmental managers' ability to assess biological impairment and set appropriate benchmarks for improvement.

The goal of this document was to create a workplan for implementing TALU in southern California. We compiled existing information about TALU and, by working with local stakeholders, identified some of the largest technical and potential policy barriers for implementation. This was not an easy task since southern California stakeholder opinions, sensitivities, and personal agendas can dramatically differ. TALU is a powerful tool that can be utilized as a positive step towards conservation and restoration or, alternatively, abused as a means of limiting regulatory oversight. Ultimately, this report lists 13 projects that should be undertaken to help resolve these barriers and develop scientifically defensible tiered aquatic life uses, and integrate these tiered uses into the existing water quality standards program to the betterment of the environment.

This document does not focus on the many non-technical factors that will be fundamental for TALU to be a successful management tool. These factors, which can be political and procedural, are built into the State and Federal regulatory policy development process. Many times, divisive policy issues are a function of perception rather than fact. It is the aim of this document to ensure that the all of the facts are available to evaluate the viability of TALU as a meaningful regulatory tool.

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Participants TALU workshop June 19, 2008, Southern California Coastal Water Research Project, Costa Mesa, CA.

LIST OF ACRONYMS

ACOE	Army Corps of Engineers
BCG	Biological condition gradient
COLD	coldwater habitat
CSUSM	California State University San Marcos
DWR	Department of Water Resources
EMAP	Environmental monitoring and assessment program
EPA	Environmental Protection Agency
EWH	exceptional warmwater habitat
GSG	Generalized stressor gradient
IBI	Index of biological integrity
MWH	modified warmwater habitat
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PSA	Perennial Stream Assessment
SANDAG	San Diego Association of Governments
SCAG	Southern California Association of Governments
SCCWRP	Southern California Coastal Water Research Project
SFEI	San Francisco Estuary Institute
SMC	Storm water Monitoring Coalition
SNARL	Sierra Nevada Research Laboratory
SWAMP	Surface water ambient monitoring program
TALU	Tiered aquatic life use
USFS	United Sates Forest Service
WARM	warmwater habitat (California)
WWH	warmwater habitat (Ohio)

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BACKGROUND

What are Tiered Aquatic Life Uses (TALU)?

All states, including California, have designated uses (known as beneficial uses in state terminology) that protect aquatic life. California has several different beneficial uses relevant to protecting aquatic life including warmwater and coldwater habitat, and protection of different life stages such as fish migration and spawning.[1] Most ecosystem managers recognize that the more specific the designated use definition, the clearer it is to describe attainment goals and ensure maintenance and protection of the designated use. EPA also acknowledged this fact and, in response, developed a framework for states to develop Tiered Aquatic Life Uses (TALU).

TALU recognizes different management goals for waterbodies within a given waterbody class and these goals are defined based on detailed information on biological condition and stressor intensity. An example of TALU would be the three tiers of warmwater use defined by the Ohio EPA (OEPA, 2008): exceptional warmwater habitat (EWH), warmwater habitat (WWH), and modified warmwater habitat (MWH). All of these tiers are part of a designated use for warmwater habitat, but each of these tiers is associated with different biological expectations based on detailed knowledge of these systems. EWH has a higher expectation of biological condition (i.e., the types of flora and fauna that should be present represent higher water quality and higher habitat quality) than WWH, which in turn, has a higher biological expectation than MWH.

It is important to recognize that tiered uses are defined based on fundamental differences in structural or hydrological condition, not the current biological or water quality condition. Instead, biological expectations for each tiered use are based on knowledge of what biota is capable of occurring in a waterbody given the fundamental structural or hydrological template that exists. In this way, environmental managers utilize TALU to achieve effective stewardship of beneficial uses by: (1) identifying high quality waterbodies and preventing the gradual degradation of these waterbodies; and (2) identifying restoration benchmarks for degraded biological condition in waterbodies given their structural and hydrologic condition.

Southern California is a tremendously valuable location for examining the application of TALU because of its wide array of biological habitats, extensive structural and hydrologic modification, and regulatory agencies' desire to regulate on biological as well as chemical condition. Streams, coastal lagoons, and bays support sensitive aquatic species, diverse wildlife, and unique habitats. As a result, southern California needs a more refined way of defining Aquatic Life Uses. For example, coastal perennial streams in southern California can range widely in terms of the degree of urbanization, hydrologic regime, and habitat alteration. The TALU framework could be a powerful tool to refine the WARM designated beneficial use and to better reflect attainable aquatic life goals for different stream conditions.

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[1] Categorical aquatic life beneficial uses that are designated for waterbodies in California include: Warm Freshwater Habitat; Cold Freshwater Habitat; Inland Saline Water Habitat; Estuarine Habitat; Wetland Habitat; Marine Habitat; Rare, Threatened, or Endangered Species; Migration of Aquatic Organisms; and Spawning, Reproduction, and/or Early Development.

Initial Steps of the TALU Process in Southern California

There has been some exploration of TALU concepts in southern California. These initial steps have included a pilot study (Tetra Tech, 2005; 2006) and a subsequent public workshop. Between 2005 and 2007, the pilot study gathered a group of experts to discuss the technical underpinnings of a TALU framework for southern California coastal streams. No new data were collected as part of this effort, but relevant available biological data were compiled to conceptualize the two primary components of TALU: (1) the biological condition gradient (BCG); and (2) the generalized stressor gradient (GSG).

The BCG describes how ten general ecological attributes of aquatic ecosystems change in response to increasing levels of stressors. These attributes include several common aspects of community structure (e.g., pollution sensitive species, endemic long-lived species) organism condition, ecosystem function, and biological attributes related to stream connectivity and the larger watershed scale. The gradient can be considered analogous to a field-based dose-response curve where dose (x-axis) = increasing levels of stressors and response (y-axis) = biological condition (Figure 1). The BCG is divided into six levels of biological condition along the stressor-response curve, ranging from observable biological conditions found at no or low levels of stressors (Level 1) to those found at high levels of stressors (Level 6).

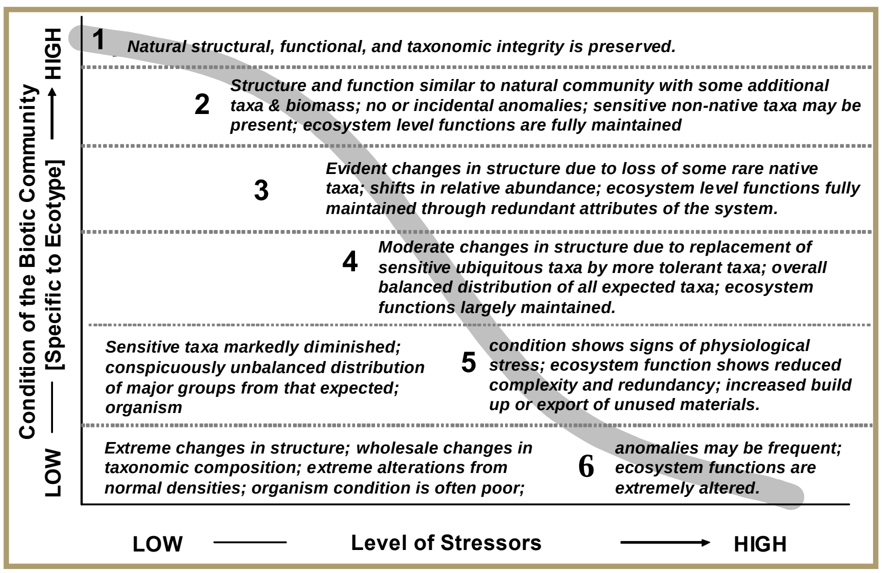

Figure 1. Conceptual model of the Biological Condition Gradient.

The GSG describes the stressor gradient present in the region of interest. Stressors are physical, chemical, or biological factors that adversely affect aquatic biota. Stressors can occur at different scales including instream, within the riparian area and floodplain, or within the watershed. Understanding the linkages between stressors and the response of aquatic biota will help determine existing and potential biological conditions of the aquatic biota. Multiple stressors are usually present and the GSG on the x-axis seeks to represent the cumulative influence of stressors, much as the y-axis generalizes biological condition.

The primary outcome of the pilot study was that TALU could be created in the unique stream environments of southern California. Although much work was left to be accomplished, a BCG and GSG were conceptualized, as well as potential tiered use definitions for perennial streams in the region. The BCG was based largely on the existing Southern California Index of Biological Integrity (IBI; Ode *et al.* 2005) and its associated biological metrics, while the GSG was based primarily on physical habitat measurements and watershed scale disturbance metrics. Relationships were identified between types of coastal perennial streams in southern California, observed aquatic life condition, and preliminary tiered aquatic life uses, along with their corresponding biological expectations.

Several uncertainties were also identified during the pilot study regarding the BCG, GSG, and biological expectations for different tiers. Examples of key uncertainties included defining truly natural conditions in areas where little natural condition remains. Identifying unimpaired sites is vitally important for setting the upper range (i.e. Level 1) of the BCG. Another key uncertainty was the efficacy of additional indicators such as fish or amphibians. One additional uncertainty was optimizing metrics for quantitatively expressing the GSG.

In November, 2007, the Los Angeles Regional Water Quality Control Board sponsored a stakeholder workshop on TALU. The goal of the workshop was two-fold: (1) communicate the findings of the pilot study; and (2) garner input from stakeholders on the viability of TALU as a management tool. Presentations by the US EPA Office of Water and Region IX, the Los Angeles Regional Water Board, and Tetra Tech (US EPA's technical contractor) laid out the rationale, approach, and goals of TALU. The participants were educated about the TALU framework with insight provided by the results of the Southern California pilot study.

The primary outcome of the stakeholder workshop was an earnest interest in TALU. Break-out discussions identified a multitude of issues that were classified into four general areas: (1) determining reference conditions, best attainable conditions, and levels within the BCG; (2) defining stressor gradient metrics; (3) protecting high quality sites and encouraging restoration of degraded sites; and (4) clarifying the regulatory process for developing TALUs.

Identifying Barriers

In June 2008, a second workshop was held to further investigate the specific barriers to implementing TALU in southern California. The workshop was comprised of 12 invited participants representing a cross-section of stakeholders including regulatory, regulated, scientific, and non-governmental sectors (please see Acknowledgements). The group focused on a single goal: design a workplan to overcome the barriers associated with TALU development. Ultimately, the workplan will provide guidance to regulatory and regulated stakeholders that outline the steps necessary to develop TALU in a way that is scientifically defensible and feasible for management. There were three chief considerations asked of participants:

- What are the primary data gaps or information needs?
- How do we combine data gaps into unique project designs?
- What are the factors for prioritizing projects to fill data gaps?

In an effort to constrain the scope of the workplan, the workshop participants immediately decided to limit the scope to perennial wadeable streams in the southern California region.

The workshop ideas and concerns fell into one of three areas including biological, stressor, and implementation related data gaps. The biological-related data gaps included identifying appropriate indicators, adequate representation of reference conditions and range of impact (for defining the BCG scale), capturing natural temporal variation (seasonal/interannual), and specific biological responses to changes in flow (hydromodification).

The stressor related data gaps included improving the understanding and quantification of the human disturbance gradient (to build the GSG), improving the information for quantifying and defining stressor gradients at both the local and watershed scales (e.g., physical habitat and GIS/land use, respectively), and identifying site specific factors that influence stressor impact on aquatic life (e.g., best management practices).

The implementation related issues included identifying appropriate habitat breaks for TALU application, development of appropriate criteria, setting tiers, determining values for nonbiological indicators (i.e. water quality objectives) for the tiers, and integrating TALU with other state or federal regulatory programs.

There were several factors the workshop participants utilized for prioritizing project concepts. These included availability of data/information for compilation as opposed to new data collection, estimated cost, time for completion, and perceived importance in providing defensibility of TALU structure. Ultimately, 14 projects were derived for the workplan based on these criteria.

Table 1. Summary of data gaps or information needs identified at the June 19, 2008 technical meeting regarding the advancement of Tiered Aquatic Life Uses (TALU) in southern California coastal perennial streams and proposed projects that address these gaps.

DATA GAP	PROPOSED PROJECTS
Biology-related	
• The BCG needs to include more than one type of indicator, so that expected responses to human development are accurately evaluated	• Project □1: Develop algal indicators of biological condition for perennial coastal California streams; • Project □2: Develop riparian vegetation and habitat indicators suitable for BCG development
• Natural condition needs to be defined for each stream classifications to determine Level 1 for the BCG	• Project □3: Define minimally impacted (natural) biological condition for coastal perennial streams and determine appropriate stream classification factors
• Temporal variability needs to be captured in the BCG	• Project □4: Determine seasonal and interannual variability for relevant biological indicators and identify appropriate ranges of indicators for BCG development
• Representation of biological sites needs to be broad and complete enough to ensure accurate BCG development	• Project □5: Characterize range of available biological indicator information and identify gaps in BCG
• Biological expectations for hydrologically modified streams need to be defined	• Project □6: Determine appropriate BCG for different degrees of hydrologic modification
Stressor-related	
• Need to evaluate if recent changes in physical habitat sampling methods provide useful information for quantifying the GSG	• Project □7: Evaluate and develop a refined set of physical habitat measures that help develop the GSG
• Better base maps are needed for quantifying stressor information	• Project □8: Develop refined base maps of stressor information
• Need to better define and integrate landscape and reach scale stressors to quantify the human disturbance gradient	• Project □9: Research and evaluate different indices of human disturbance as GSG surrogates
• Need to understand why individual outlier sites have unpredictably good or bad biological condition	• Project □10: Examine BMP effects on biological condition
Implementation-related	
• Need to translate science to policy when setting stream classifications and tiered uses	• Project □11: Determine appropriate implementation criteria for identifying stream classes and tiered uses
• Consider biocriteria as a means to evaluate whether tiered uses are being achieved	• Project □12: Integrate BCG development and TALU with potential biocriteria
• Examine how other water quality objectives should be tiered along with biological uses (e.g., DO, temperature)?	• Project □13: Determine potential tiered water quality objectives
• Need to link TALU with other regulatory programs (TMDL, 401□404, stormwater) • State-wide implementation vs. region-specific approaches need to be evaluated	• Project □14: Link TALU with other regulatory programs

SPECIFIC PROJECTS

Project 1:	**Develop algal indicators of biological condition for perennial coastal California streams**
Issue:	Previous BCG development efforts were based primarily on macroinvertebrate data and assessment tools. However, macroinvertebrate data and assessment tools alone may not be sufficiently sensitive and robust to characterize perennial coastal California streams. Several examples exist including low gradient streams. Therefore, BCG development should include more than one type of indicator so that expected responses to human disturbance are accurately evaluated. Algae often respond differently to stressors, particularly nutrients, than macroinvertebrates. Therefore, inclusion of algal indicators will provide a more comprehensive BCG.
Tasks:	1. Compile existing algal data for southern California. 2. Segregate algal data and related assessment tools into various habitat types, including consideration of elevation, stream gradient, and degree of channelization. 3. Identify whether sufficient algal data is available for reference sites in southern California to develop an algal indicator. If not, identify sites and collect data as needed. 4. Correlate algal data and related assessment tools with physical or chemical stressors, land use, etc. Other stream systems can provide insight into these relationships. 5. Determine if algal data show sufficient sensitivity to stressors in southern California to serve as useful indicators of human impacts. 6. If algal indicators are sufficiently sensitive to act as useful indicators of biological condition in perennial southern California streams, select an indicator, or suite of indicators, to develop the BCG for algae. This process should be reviewed using an expert panel to verify BCG attributes for algae. 7. Set detection, precision, and accuracy estimates for the algal index developed.
Product:	Identification of algal indicators and expected changes with increasing stress. Detailed description of BCG for algal indicators.
Information Available:	Algal bioassessment methods and data collection are currently underway as part of SWAMP program. Some data is available through Western EMAP. A South Coast periphyton IBI is currently under development at SCCWRP. Additional sampling could be conducted to fill in gaps or verify correlations, as needed.
Estimated Cost:	□100,000 to 500,000, depending upon whether sufficient data are available
Schedule:	Two to three years, depending on availability of data
Potential Collaborators:	SCCWRP, EMAP, SWAMP, SNARL, CSUSM

Project 2:	**Develop riparian vegetation and habitat indicators suitable for BCG development**
Issue:	During the BCG Pilot Study for southern California coastal streams, the Technical Advisory Committee clearly recognized that riparian vegetation/habitat is a useful indicator of biological condition. However, use of riparian vegetation/habitat as an indicator of biological condition must be approached cautiously, as lack of vegetation/habitat can also be considered part of the stressor gradient. Preliminary work using the California Rapid Assessment Method (CRAM) was used as a placeholder absent any other standardized riparian quantification method. However, more work is needed to refine the usefulness of riparian vegetation and habitat indicators in TALU development, including identifying reference conditions and determining whether quantifiable metrics can be developed that characterize the condition gradient in response to stressor intensity.
Tasks:	1. Examine current status of CRAM to see if quantitative metrics of disturbance have been assessed. 2. If not, collate existing CRAM information along with metrics of stress or disturbance level. 3. Determine appropriate riparian/waterbody classifications (habitats) for which individual natural conditions will be defined. These could include high elevations streams, low elevation/high gradient streams, and low elevation/low gradient streams. 4. Identify specific changes in riparian indicators with stressor intensity, characterizing natural conditions as well as conditions under various levels of stress. During this process, develop a means to consider lack of vegetation due to hydrologic modification as a stressor. Identify BCG thresholds for riparian condition using CRAM. 5. Assess whether CRAM serves as an appropriate and sufficiently sensitive metric for riparian vegetation/habitat in southern California perennial coastal streams. If CRAM does not appear to be a good metric, assess whether other metrics should be used instead.
Product:	Identification of riparian indicators and expected condition gradient with increasing stress. Detailed BCG for riparian indicators.
Information Available:	Current on-going work on CRAM, including the State's Wetland Monitoring Program; 404/401 monitoring for restoration/mitigation projects. SWAMP/Perennial Stream Assessment monitoring.
Estimated Cost:	$100,000 to 500,000, depending upon whether sufficient data are available
Schedule:	Two to three years, depending upon availability of data
Potential Collaborators:	SCCWRP, SFEI, CA Coastal Conservancy, US ACOE, Southern CA Wetland Recovery Project

Project 3:	**Define minimally impacted (natural) biological condition for coastal perennial streams and determine appropriate stream classification factors.**
Issue:	BCG development depends on having Level 1 (natural condition) defined, even if it is not represented in the region at present. The Pilot Study suggested that high elevation streams were a different class from low elevation streams, but this may not be the case and the exact elevation cutoff is unknown. The separation of stream classifications is driven largely by ecotonal gradients of physical factors and biological assemblages in the absence of stressors, i.e. a comparison of reference conditions. Identifying different classes of streams is critical because this is what determines ultimate biological expectations (i.e., low elevation or low gradient stream biological assemblages may never look like those of a high elevation or high gradient stream, even with outstanding habitat and water quality).
Tasks:	1. Compile biological indicator data, water quality data, pertinent classification metadata (elevation, gradient, geology, etc.), and stressor data. 2. Identify sites and data that are believed to represent natural conditions (Level 1) using the stressor data. If unstressed sites are unavailable, then alternative approaches can be evaluated including using sites outside of the Southern California Bight, historical information, museum archives, etc. 3. Evaluate the degree to which biological expectations differ between different coastal streams in southern California and determine classes. This is typically accomplished using multivariate statistical techniques. 4. Verify stream class determination and Level 1 attribute conditions using expert opinion.
Product:	Database of macrobenthos, other biological indicators, and pertinent physical and stressor information. Statistical analysis of biological assemblages sufficient to delineate stream classes. List and range of data for biological metrics, physical, and stressor information that characterizes Level 1 of the BCG for different classes of streams in the region.
Information Available:	Macroinvertebrate data are available from a wide range of sources including SWAMP, EMAP, SMC, NPDES monitoring, amongst others. Sufficient data may also be available for other indicators such as algae, riparian condition, and fish. (See projects 1 and 2.) SWAMP is also creating a Reference Condition Management Plan that will directly address this issue in future years.
Estimated Cost:	□150,000 - □250,000
Schedule:	One to two years.
Potential Collaborators:	SWAMP, SMC, USFS, EMAP

Project 4:	**Determine Seasonal and Interannual Variability for Relevant Biological Indicators and Identify Appropriate Ranges of Indicators for BCG Development**
Issue:	A comprehensive and accurate BCG depends, in part, on understanding and incorporating natural variability in the biological condition of the indicators. All biological indicators have some variability between seasons and between years resulting from differences in hydrological or climate regime, or innate differences in population recruitment or mortality rates. To a large extent, this type of variability has not been evaluated, creating an information gap in terms of uncertainty in biological indicator thresholds for different levels of the BCG.
Tasks:	1. Compile biological indicator data for individual sites over time. Preferably, each site will have multiple seasons and/or multiple years of record. 2. Characterize and quantify the variability of biological data, including individual metrics and composite metrics for various indicators. 3. Identify multi-year variability for given index periods and evaluate the need for a single index period in BCG development for a given indicator. Quantify appropriate ranges for individual indicators under natural conditions (Level 1 of the BCG) as well as for various stress levels.
Product:	Time-series data for specific biological indicators and sites, and statistics for seasonal and inter-annual variability based on different classes of streams. Identification of appropriate ranges of indicators to be used in setting Level 1 of the BCG.
Information Available:	Multi-year site data for macrobenthic assemblages are collected largely by NPDES permittees, although the data for reference sites may be limited. EMAP has revisited a subset of sites. The USFS has revisited some sites, but many are not in the southern California region.
Estimated Cost:	$100,000-$200,000 if data are available
Schedule:	One year
Potential Collaborators:	SWAMP, EMAP, USFS, NPDES permittees

Project 5:	**Characterize range of available biological indicator information and identify gaps in biological condition gradient**
Issue:	BCG development depends on having a complete understanding of how various biological indicators change with increasing stressor intensity. While the character of natural conditions and extremely stressed conditions is often known with some precision, changes in biological condition with intermediate levels of stress are not often as well characterized, yet this information is crucial to having a useful BCG for TALU development. Without sufficiently represented gradients of biological condition, inappropriate thresholds for BCG levels may be established. Therefore, it is critical that datasets of appropriate indicators cover the entire range of biological conditions in response to stressors. If gaps are present in the data (i.e., not enough intermediate-stressed sites), additional sampling will be needed.
Tasks:	1. Compile data sets for biological indicators, physical habitat, and stressor data. This may coordinate well with Projects 1-3. 2. Characterize the distribution of data for biological indicators and determine potential breaks or groups that may define thresholds for BCG levels, based on response of the data to stressors. Identify areas of the distribution in which there are relatively few sites represented or parts of the distribution in which there are sharp changes in indicator condition. 3. Determine if locations of missing data represent areas where thresholds will be placed. These areas of the gradient would be the prioritized data gaps for additional sampling.
Product:	Compiled data set of biological, physical habitat, and stressor information. Graphs and tables describing the distributions of each indicator. Prioritized list of data gaps requiring additional sampling.
Information Available:	For a focus on macroinvertebrates, spatially distributed data sets are preferred such as SWAMP, EMAP, PSA, SMC, USFS and others.
Estimated Cost:	□50,000 to □150,000; perhaps □□500,000 if additional sampling is included.
Schedule:	One year for data compilation and analysis
Potential Collaborators:	SWAMP, EMAP, PSA, SMC, USFS and others

Project 6:	**Determine appropriate BCG for different degrees of hydrologic modification**
Issue:	Hydromodification is one of many potential stressors. However, the pervasiveness of hydrologic modification in southern California and the significant degree to which it can impact biota makes it a particularly important stressor. Since hydrologic modification represents a stressor condition that is difficult to reverse in the short- to medium-term, this may be one basis upon which TALU is considered for southern California coastal streams (i.e., for low gradient□low elevation streams, assign tiers based on degree of hydromodification such as full channelization, concrete sides with soft botton, and unchannelized). Therefore, understanding how biological expectations change with hydrologic modification is an essential step towards refining the BCG and developing TALU in the region.
Tasks:	1. Compile biological, physical habitat, stressor condition, and water quality data as well as hydromodification attributes from existing data. This can include various biological indicators (benthic macroinvertebrates, algae, riparian vegetation, fish, amphibians, etc.) and could be done in coordination with Projects 7, 8, and 9. Develop metrics of hydrologic modification that can be scaled from natural (no modification) to extreme modification. 2. Develop a relationship between biological metrics or IBI and hydromodification metrics. 3. Verify relationships and identify a refined and comprehensive BCG that takes these relationships into account, using an expert review panel. The expert panel should help derive decision rules for weighting different data and determining BCG level based on various biological datasets (i.e., macroinvertebrates, algae, riparian vegetation, fish, amphibian, etc.).
Product:	A refined BCG based on level of hydrologic modification. Proposed tiered aquatic life uses based on varying levels of hydrologic modification.
Information Available:	SCCWRP, Counties of Ventura and Los Angeles, and the SMC are currently working on hydrologic modification projects related to erosion. For a focus on macroinvertebrates, spatially distributed data sets are preferred such as SWAMP, EMAP, PSA, SMC, USFS and others
Estimated Cost:	□50,000 to □150,000; perhaps □□500,000 if additional sampling is included.
Schedule:	Two to three years. One and one half years for data compilation and the remainder for developing the BCG
Potential Collaborators:	SWAMP, EMAP, PSA, SMC, USFS and others

Project 7:	**Evaluate and develop a refined set of physical habitat measures that help develop the GSG.**
Issue:	Physical habitat quality should be an important factor in determining biological condition expectations. Until recently, most physical habitat sampling followed protocols that were semi-quantitative and subject to large sampler-to-sampler variance. The Pilot Study showed that these highly variable, semi-quantitative physical habitat measurements were insufficiently robust for developing a predictable GSG. More quantitative, less variable, physical habitat protocols have recently been developed and are now being implemented throughout the region. These new protocols may be more useful in developing the GSG since they are more quantitative, but no one has examined their results critically for this type of TALU application.
Tasks:	1. Compile physical habitat data for sites using the new protocols along with biological data, as available. 2. Characterize the statistical distribution of various physical habitat measures. It may be useful to examine multi-metric indices of physical habitat condition. It may also be useful to differentiate the data by stream classification and degree of hydromodification. 3. Determine relationships between physical habitat metrics and biological measures. Recommend the physical habitat metrics that best predict biological responses. 4. Pilot test recommended metrics at a range of sites to evaluate the utility of the proposed physical habitat metrics.
Product:	Series of correlation plots or matrices of physical habitat metrics and biological responses. Recommend validated physical habitat metrics for use in developing the GSG.
Information Available:	EMAP has the most quantitative physical habitat measurements. SWAMP and the Perennial Stream Assessment have developed new methods for physical habitat that are derived from the EMAP protocols. The SMC will be using the SWAMP protocols in the upcoming years and the data generated could serve as the validation data set.
Estimated Cost:	□200,000 - □500,000, not including additional data collection
Schedule:	Two to three years
Potential Collaborators:	EMAP, SWAMP, PSA, SMC

Project 8:	**Develop refined base maps of stressor information**
Issue:	Development of a reliable GSG is dependent upon having accurate stressor information. Moreover, this information will help define the tiers for TALU implementation. Currently, insufficient stressor information exists with which to draw relationships with existing biological indicators. For example, macroinvertebrate data are available for many sites in the region, but associated stressor information is not complete. This stressor information comes in many varieties, but can be broken into two types: watershed scale and reach scale. Watershed stressors focus on large-scale cumulative impacts such as upstream land use. Reach stressors focus on local impacts such as physical habitat, flow, or water quality.
Tasks:	1. Compile data on watershed scale stressors. This may include, but is not limited to, land use, imperviousness, flow augmentation or diversions as well as associated structures (i.e., dams, reservoirs, etc.), and point source discharges. 2. Compile data on reach scale stressors. This may include, but is not limited to, stream bed material (i.e., fully channelized, concrete-lined with soft bottom, unchannelized), nonpoint source inputs, road crossings and associated structures (i.e., bridges, culverts, Arizona crossings). 3. Place all of this information into a GIS platform for use in future projects. Use the GIS to create maps of the stressor distributions. 4. Evaluate maps to ensure they are using the most up-to-date information and identify sites needing follow-up reconnaissance to ensure desired accuracy.
Product:	GIS layers and base maps of watershed and reach scale stressors.
Information Available:	Much of the watershed scale stressor information is currently available and compiled. Less information has been compiled for reach scale stressors.
Estimated Cost:	□250,000 to □500,000
Schedule:	One to three years, depending on number of stressors and scale.
Potential Collaborators:	DWR, SCAG□SANDAG, most public works and flood control agencies, NOAA.

Project 9:	**Research and evaluate different indices of human disturbance as GSG surrogates**
Issue:	There are myriad of biological stressors, which often have cumulative impacts on southern California streams. Successful TALU delineations depend on having a clear understanding of these stressors and their gradations (i.e., the GSG). Through the process of defining GSG attributes, stakeholders can determine which stressors are controllable (and therefore, not an appropriate aspect of tiered uses) and which are not readily controllable (and might make for good attributes to use in defining tiers). Previously, only landscape scale stressors were evaluated. However, these large-scale stressor evaluations were incomplete and virtually no reach-scale stressors appeared adequate for describing biological response in the biological indices examined to date (i.e., macroinvertebrates). The goal of this project is to improve the GSG for developing TALU.
Tasks:	1. Compile the existing knowledge of stressor indices from the literature, particularly those used in other water programs. 2. Use the existing knowledge from task 1 to create metrics to characterize stressors. This may include multi-metric approaches. 3. Evaluate the biological responses along each stressor metric gradient to identify the best (most predictive) approach. Conduct this process with several types of biological responses to determine the most sensitive biological response to stress. 4. Verify the pros and cons of potential stressor metrics and select preferred approach using an expert review panel. 5. Create a GIS map of stressor metrics for perennial streams region wide.
Information Available:	There are a number of stressor metrics recently developed and published in the literature. Land cover data are readily available, but should be checked for currency and accuracy (see Project 8). Hydrologic as well as physiochemical data are available from several sites and time periods. Where data do not exist, a targeted sampling program may be required.
Product:	Literature review of existing approaches to stressor identification. Series of correlation plots or matrices of stressor metrics and biological responses. Recommended GSG options for use in developing TALU.
Estimated Cost:	□200,000 - □400,000
Schedule:	Two to three years
Potential Collaborators:	SWAMP, NPDES permittees, USGS, DWR

Project 10:	**Examine BMP effects on biological condition**
Issue:	Condition assessments from the Pilot Study indicated that some sites had relatively "good" biological condition considering the level of stressors such as surrounding land use. Similarly, some sites had relatively "poor" biological condition despite an apparent lack of significant stressor sources. The initial assumption has been that unique, site-specific circumstances help dictate the outlier conditions of these sites. To determine whether site-specific circumstances are the cause of the outlier conditions, sites that are uncharacteristically "good" or "bad" should be examined to determine if this is a result of specific practices, such as BMPs or the presence of industrial discharges. This analysis can help determine whether the indicators are appropriate, and potentially identify the key physical and/or hydrologic factors that can help improve degraded sites.
Tasks:	1. Using the compiled data set from Projects 6, 8, and 9, look for anomalous sites that do not fit the BCG/GSG relationship. 2. Conduct site reconnaissance to determine site-specific factors, including BMPs or specific discharges, if any. 3. Based on BMPs or other factors that yielded better than expected biological condition, recommend approaches that may help improve other lower quality sites (e.g., BCG Level 5 or 6). An alternative is to work with agencies that are preparing to install BMPs to test BMP effectiveness. 4. Recommend procedures for handling outlier or anomalous sites within a TALU framework.
Product:	Report with maps showing outlier sites and evaluation of factors causing site-specific condition. Create a list of BMPs that will improve biological condition at these sites. Guidelines for dealing with outlier sites in TALU implementation where site-specific factors need to be accounted for.
Information Available:	SWAMP and the Perennial Stream Assessment have a large number of sites that can contain outliers for investigation. SCCWRP has just completed an assessment of BMPs for habitat restoration.
Estimated Cost:	$100,000 to $200,000, more if sampling or BMP construction is required.
Schedule:	One to two years
Potential Collaborators:	SWAMP, EMAP, PSA

Project 11:	**Determine appropriate implementation criteria for identifying stream classes and tiered uses**
Issue:	BCG and GSG-related projects will determine appropriate classes of perennial streams in Southern California, within which more specific aquatic life uses can be defined. To implement this classification, there needs to be objective science-based criteria for distinguishing classes so that water quality standards can clearly identify to which class a given segment belongs. However, there are policy implications for how stream classifications are attributed. It is this intersection of science and policy that requires thoughtful implementation to ensure equity, effectiveness, and cost efficiency. Several questions need to be answered such as, if classification is based on elevation (or gradient), what is the specific cutoff for high vs. low elevation streams (or high vs. low gradient); are there exceptions to this classification; and how is this classification scheme best applied to ensure efficient implementation of TALU? Similarly, TALU tier thresholds are derived from application of scientific information, but these thresholds need to be re-evaluated once they are applied to actual stream reaches to ensure the biological expectations are appropriate.
Tasks:	1. Compile, summarize, and analyze statistically the database from Projects 3, 4, 6, 8, and 9 will be to identify stream classes that should be considered for separate TALU □regions□. This will be done in a pilot watershed. 2. Conduct GIS analysis and create a map of stream classification assignments and proposed tiered uses in the pilot watershed. 3. Evaluate the stream assignments to confirm appropriate classes and tiered uses within each class using a task force of scientists, regulatory and regulated agency staff, as well as nongovernmental organizations. While the goal is not to agree on every stream reach assignment, this project will help to define a framework for conducting the public process in the remainder of the region.
Product:	Framework document detailing the criteria and process for assigning stream classifications and tiered uses.
Information Available:	Results of Projects 3, 4, 6, 8, and 9
Estimated Cost:	□75,000 □150,000
Schedule:	One year
Potential Collaborators:	Regulatory agencies and regulated stakeholders

Project 12:	**Integrate BCG and TALU development with potential biocriteria**
Issue:	Formulation of tiered aquatic life uses will be most useful if there are appropriate criteria available to ensure protection of waterbodies within each tier. Currently, no biocriteria have been established as regulatory water quality standards for southern California streams although the Southern California IBI for macroinvertebrates has been suggested. On-going algae work, including that proposed in Project 1, could provide information with which to develop biocriteria for algae, if algae criteria can be developed that serve as good indicators of biological condition. If appropriate biocriteria can be formulated, they could be used as measurement benchmarks with which to evaluate impairments and restoration progress as well as document protection of different aquatic life uses.
Tasks:	1. Establish a task force consisting of regulatory, regulated, and nongovernmental agencies to provide a context for biocriteria interpretation. This group may best be served by using a regulatory agency as the lead. 2. Create a framework that maps the relationship between beneficial uses in basin plans, biocriteria, use attainability analysis, and antidegradation policies. Data compiled and used as part of this workplan should help immensely. 3. Write a consensus-based white paper outlining the regulatory model that can be used as the basis for integrated policy development.
Product:	White paper outlining the regulatory model that can be used as the basis for integrated policy development
Estimated Cost:	□75,000-□150,000
Schedule:	One to two years
Potential Collaborators:	Regulatory agencies and regulated stakeholders

Project 13:	**Determine potential tiered water quality objectives**
Issue:	In developing tiered aquatic life uses, it may be appropriate to modify water quality objectives to reflect what is necessary to obtain and maintain aquatic life uses for that tier. For example, if a high quality tiered aquatic life use is identified (and supported by both BCG and available biological condition data), it may be critical to have more stringent water quality objectives for certain parameters, such as oxygen, temperature, sediment, and possibly certain chemical pollutants, than are necessary for more standard aquatic life uses. Likewise, if a tiered use is identified for highly modified waterbodies, it may be desirable to modify objectives in cases where a less stringent objective may be adequately protective. Tiered or modified water quality objectives may not be appropriate for certain types of parameters. While there have been some evaluations of this issue at the national level, no guidance has been developed. If and how objectives are modified in concert with TALU will have a direct bearing on how TALU is implemented.
Tasks:	1. Convene a workshop consisting of regulatory agencies, resource agencies, and invited scientists to discuss appropriate actions in tasks 2-3 below. 2. Evaluate what EPA and others have considered, and list the pros and cons of different strategies for dealing with tiered water quality objectives. 3. Identify a preliminary list of parameters for possible tiering, as well as a list of parameters for which tiered objectives would be inappropriate. 4. Identify a pilot study to test the feasibility of tiered water quality objectives. Where possible, actual data for parameters should be examined from segments representing all tiers.
Product:	Topical Workshop. Position paper recommending results of evaluation and parameters potentially subject to tiering, if any. Design for Pilot Study.
Estimated Cost:	□50,000 to □75,000
Schedule:	Six months to one year
Potential Collaborators:	Regulatory and regulated entities.

Project 14:	**Link TALU with other regulatory programs**
Issue:	Local, State, and Federal regulatory programs do not operate in isolation from one another. Water quality standards, biocriteria, total maximum daily loads (TMDLs), NPDES permitting, 401/404 certification for streambed alteration are just a few examples. Optimizing the interplay between regulatory programs and regulatory agencies will help reduce redundancy and increase effectiveness of the regulatory framework. This will be particularly important in determining if TALU should be initiated at the local, regional, or statewide level.
Tasks:	This project will require two tasks. First, a policy committee should be gathered to help evaluate optimal implementation strategies. This policy committee should contain representatives from regulatory, regulated, and environmental advocacy organizations. Regulatory program representation should include RWQCB, SWRCB, and EPA. Second, the committee should draft an implementation workplan to coordinate efforts.
Product:	Implementation strategy workplan.
Information Available:	There are other examples that can serve as a model for this Committee including the State's Sediment Quality Objectives.
Estimated Cost:	$100,000 to $200,000
Schedule:	Two years
Potential Collaborators:	Regulatory and regulated entities

PROJECT INTEGRATION AND SYNTHESIS

The projects outlined in the previous section are designed to address major data gaps in our understanding of biological responses to stressors in southern California perennial streams and how the stressor axis of the BCG should be constructed and applied. These projects are necessary to formulate a scientifically defensible framework upon which tiered aquatic life uses can be developed and implemented. To make the most efficient use of available resources, certain projects should be completed or at least largely completed prior to others. Ideally, regulators and stakeholders would cooperatively lay out the TALU development framework in order to make the process efficient, effective, and transparent. To that end, we see projects being conducted in four phases, understanding that there will be (and should be) some overlap in the timing of different phases so that the process is as efficient as possible.

In the first phase, basic information is needed regarding biological responses to stressors, characterizing the stressor gradient, and the types of data available for BCG analyses. Therefore, Project #3 (natural condition definition and appropriate classification) and Project #5 (characterize range of biological condition data available) should be initial priorities. Unless these projects are addressed, subsequent BCG or GSG-related projects may be flawed or incomplete. Simultaneously, Project #7 (improve physical habitat measures to develop the GSG), Project #8 (improved base maps for stressors), and Project #9 (evaluate indices of human disturbance) should also be first phase projects of high priority. Results of Projects 7, 8, and 9 will be instrumental in developing a sound GSG axis with which subsequent BCG development can occur. The outcome of the first phase of projects will be:

- A better understanding of how natural condition should be described biologically
- Available data or information to characterize Level 1 of the BCG (at least for macroinvertebrates)
- Degree to which the full range of biological condition is represented using available site data for the southern California
- Preferred ways to characterize the stressor gradient and data refinements needed to define and quantify the GSG
- Refinements to physical habitat metrics and results that will feed into the GSG characterization and provide useful information for other programs and applications
- More informative base maps to allow better characterization of the range of stressor intensity represented using current biological sites

A second phase of projects would build on the ones noted above, refining the BCG further using other assemblage data (algae, Project #1, and riparian vegetation, Project #2). The inclusion of algae and riparian vegetation condition attributes is considered key to making the BCG more robust and scientifically defensible. The inclusion of these assemblages, as well as macroinvertebrates (and fish or other vertebrates to the extent possible), will ensure that a broader range of effects of stressors are included in the BCG and properly interpreted. The timing of these projects would also allow completion of current algal and CRAM data collection efforts, which will be instrumental in completing Projects 1 and 2. Results of Phase 2 would be a more comprehensive BCG that can now be refined in Phase 3 using expert consensus and site-specific information.

The third phase of projects would further refine and ultimately complete previous work in the form of more complete, robust BCG characterization (Project #6), and consideration of ways that may be effective in restoring certain tiers of aquatic life uses in some cases (Project #10, evaluate effects of BMPs and other site-specific factors on biological condition). The analysis of more site-specific biological-stressor relationships (Project #10) is neither necessary, nor desirable when formulating the BCG for a region (Phases 1 and 2) but is useful once a regional BCG is developed and the beginnings of implementation are being considered. Site-specific relationships can also be helpful in validating the BCG and determining the types of stream conditions that may be highest priority for restoration efforts.

The fourth and final phase of projects addresses TALU implementation issues (Projects 11, 12, and 13). In order to develop appropriate implementation criteria for stream classification, tiered uses, biocriteria, and appropriateness of tiered water quality objectives, a well-characterized and accepted BCG (including a robust GSG) is critical. The science provided in the first 3 phases will help guide appropriate implementation strategies. While biocriteria can be developed without TALU, implementation of biocriteria in the context of TALU is likely to have greater environmental benefits, be easier for regulatory agencies to implement in the long run, and be more defensible to stakeholders. Phase 4 projects could start as Phase 2 projects are being completed, once better information becomes available to characterize the BCG and GSG. However, Phase 4 implementation projects are not likely to be completed until after BCG development is complete (Phase 3).

While approximate costs are provided in the project descriptions, the estimates are by no means rigorous and there are many opportunities for cost savings by leveraging among projects and outside studies. For example, there are at least eight projects that rely on compiled databases of biological condition, hydrology, physical habitat, and stressor information. Obviously, this needs only to be done once and, even then, portions will be done in individual project development (i.e., stressor specific information, Project 8). Another example would be the formation of expert panels and task force committees. Virtually every project would benefit from the use of independent, multi-sector review as a means for oversight, validation, and transparency. These committees are crucial to success, but a new committee is not needed for every study. One committee could take on the challenge of several projects, especially if the projects are similar in nature such as those described within each of the implementation phases. Finally, the potential collaborators for these projects were repeated over and over again. An integrated approach with multiple agencies attacking these data gaps will increase the cost leveraging necessary to overcome the hurdles to achieving TALU.

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Appendix 8

Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams

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December 8, 2006

Data Report: Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams

Introduction

Under a previous work assignment with EPA Region 9 and the Los Angeles Regional Water Quality Control Board, Tetra Tech used available biological and habitat quality data (provided primarily by EMAP), as well as information provided by local and regional experts, to develop a preliminary Biological Condition Gradient (BCG), which is a framework that characterizes changes in biological condition going from undisturbed (reference) to very impaired conditions (Davies and Jackson, 2006). The range of potential impaired conditions encountered in the region constitutes the Generalized Stressor Gradient (GSG), which is a framework that characterizes changes in stressor attributes going from undisturbed to very impaired conditions (Davies and Jackson, 2006). In order to develop a defensible framework for tiered aquatic life uses (TALU), streams in the region need to be categorized with respect to their biological expectations considering the types of classes that either occur naturally or that are distinguishable based on what are major habitat alterations due to anthropogenic factors.

Since the initial work was completed by Tetra Tech, several other sources of macroinvertebrate and habitat data became available, primarily through California's Statewide Assessment and Monitoring Program (SWAMP) as well as other sources. These data provided substantially more information on the low elevation, urbanized streams in the region (e.g., in and around Los Angeles and San Diego), a major data gap identified by Tetra Tech in the previous work. As a result, we were able to more confidently identify the range of biological conditions currently observed in streams affected to varying degrees by anthropogenic alterations. Through these analyses, the revised results presented in this report should provide more confidence in terms of how streams might be classified in the region, and ultimately, potential tiered aquatic life use definitions.

Tetra Tech previously incorporated several suggestions from Technical Advisory Committee (TAC) members in the region regarding the types of attributes that should be considered in developing the BCG and the GSG for the region. As noted previously, certain attributes identified in EPA's national BCG framework were either modified or removed for the southern California region because they are either not relevant to this region or were better incorporated as part of the generalized stressor gradient (GSG). Key biological characteristics that were included in the BCG are: (1) Southern California IBI and component metrics developed by Department of Fish and Game (DFG) for macroinvertebrates; (2) fish assemblage information obtained from Drs. Jonathan Baskin, Thomas Haglund, and Camm Swift; (3) and algae diatom information obtained from EPA's Rapid Bioassessment Protocols and Western EMAP sources.

This revised report updates the macroinvertebrate attribute information for the BCG based on the new data evaluated. Presented here is a conceptual BCG that is intended to serve as a precursor to a final, fully calibrated BCG that could be used in the TALU framework or in Use Attainability Analyses (UAA). Other biological information was not updated in this exercise. We would note that new periphyton information being collected in the region by the Southern California Coastal Water Research Project (SCCWRP) and by Tetra Tech could be very useful in further refining the BCG in the future. We would also note that the TAC felt that the BCG attribute long-lived or regionally endemic species may be especially useful in terms of discriminating biological condition over the stressor gradient in this region. This attribute is characterized mostly in terms of vertebrate species information (number or types of fish, amphibian and reptile species) since these species are relatively long-lived and/or endemic to a particular drainage or watershed in this region. The TAC agreed that better information concerning these types of species would be very beneficial in refining the BCG and perhaps aquatic life uses as well.

Data Sources

Additional macroinvertebrate data used in these analyses were obtained from California Department of Fish and Game (Pete Ode) and from EPA Region 9 (Terry Fleming). Data for approximately 1700 benthic macroinvertebrate samples and physical habitat assessments were compiled, along with geographical coordinates at over 300 sites in southern California between 1998 and 2005. Biological data included data for the seven different metrics, which comprise the Southern California IBI (SoCal IBI), as well as the IBI score for each sample (Table 1). Habitat assessments were based on the Rapid Bioassessment Protocols (Barbour et al. 1999) and included data scores for the 10 different parameters on a 0-20 scale (0 poor, 20 optimal) as well as the total habitat score for each site (Table 1).

Table 1. Biological metrics and physical habitat parameters used in analyses.

Biological Metrics	**Physical Habitat Parameters**
EPT taxa	Epifaunal substrate
Intolerant taxa percent	Sediment deposition
Predator taxa	Embeddedness
Coleoptera taxa	Riffle frequency
Non-insect percent	Channel alteration
Tolerant taxa percent	Channel flow
Collector percent	Bank vegetative protection
	Bank stability
	Velocity/ depth regime
	Riparian zone width
Southern California IBI	**Total Habitat Score**

In addition to instream physical habitat measures, the stressor gradient was characterized by landscape influences on sampling locations. For each location, 5 km radius circles were delineated and land use/land cover (LULC) percentages (MRLC 1992) were calculated within these circles to represent general landscape activities in the vicinity of the sample sites. These LULC percentages were used to calculate a Landscape Development Intensity (LDI) index (Brown and Vivas 2006) that weights each land use type base on the energy that each uses. Potential LDI index scores range from 1 to 10 with 1 representing natural systems and 10 representing the most intense urban land uses. Agricultural land uses have LDI coefficients between 2 (low intensity pasture) and 7 (high intensity feed lots, dairy farms, etc.). Urban land uses have LDI coefficients that range between 7 (low density residential) and 10 (central business district). This LDI index is used as another indicator of the stressor gradient as it serves as a surrogate for chemical and hydrologic impacts, which may not be included in instream physical habitat measures. LDI has been used by Florida in its biological assessment program (Fore 2004) and is particularly useful for distinguishing an urbanized gradient.

Preliminary Stream Classification

Natural variations in streams of this region can be attributed generally to differences in elevation. Through basic knowledge of the study area, as well as inspection of aerial photographs, it was determined that an elevation of 1200 feet appeared to be a relatively reliable threshold for distinguishing between higher and lower gradient stream systems. Using this elevation threshold, four types of site classes were identified with which BCG attributes were evaluated:

1) natural high elevation foothills (>1200 ft),
2) natural low elevation (<1200 ft),
3) low elevation partially altered channel or riparian zone,
4) low elevation concrete-lined channel.

Sites were grouped into one of these categories based on visual inspection of aerial photographs of each site and its surrounding area. These four stream classes cover the range of stressor and biological conditions observed in the Southern California Bight region. In addition, these four classes were clearly distinguishable from each other visually and were thought to be distinct ecologically as well.

Stressor Measures in Relation to Stream Classes

Median habitat scores were related to natural and anthropogenic influences as represented by the four site classes (Figure 1). Habitat scores were also related to LDI index scores, demonstrating a relationship between habitat quality and overall landscape stress (Figure 2).

Macroinvertebrate Data

BCG attributes that were refined based on the updated macroinvertebrate data included attributes 3, 4, and 5. Other BCG attributes remained unchanged from the previous version developed by Tetra Tech because there were no new data or other information that would help further refine other BCG attributes. In conducting these analyses, we compiled relevant macroinvertebrate metric data for each attribute by stream class as defined in previous work and as noted above. One of the key questions examined in this exercise is whether the initial classifications used previously continue to be scientifically defensible given the more extensive biological data made available.

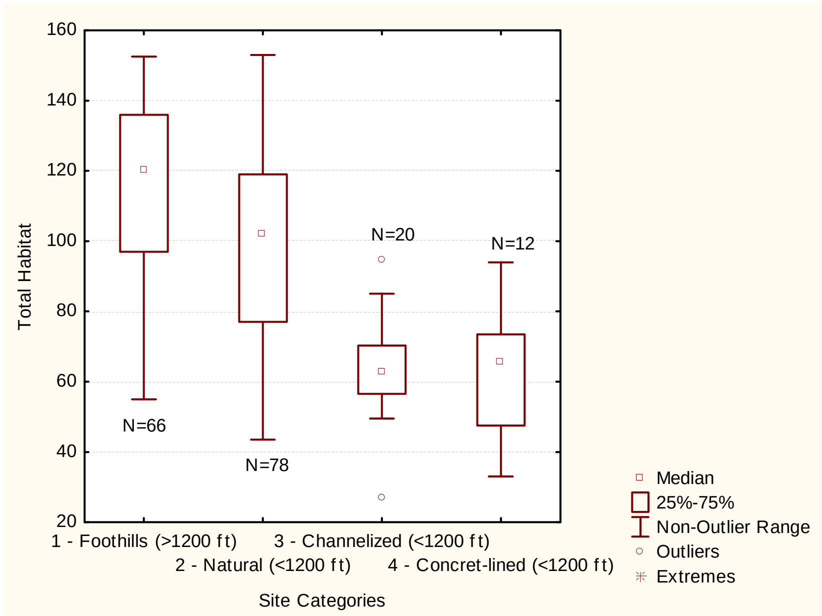

Figure 1. Total habitat scores organized among four site categories

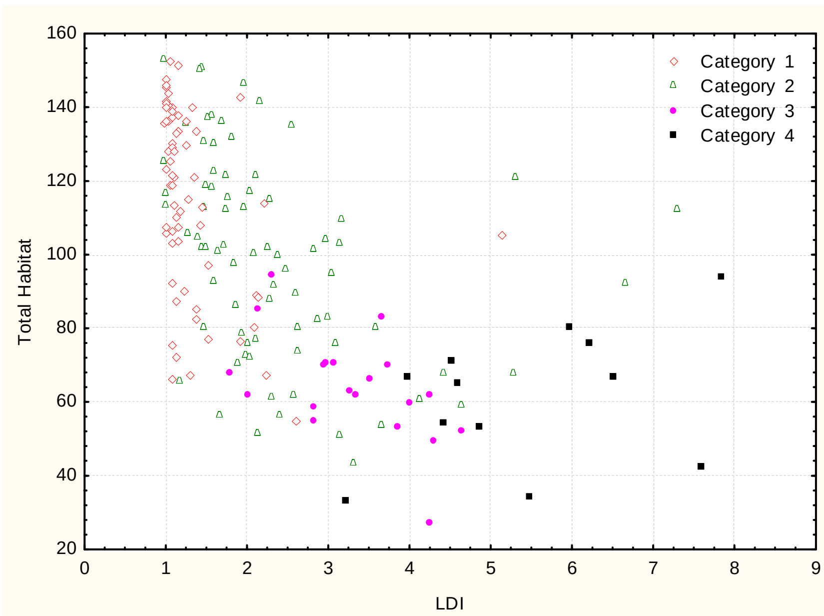

Figure 2. Total habitat scores versus LDI index scores organized among four site categories.

Scatterplots of the SoCal IBI and biological metrics versus habitat assessment score and LDI index score were used to examine relationships between habitat condition and overall landscape stress on macroinvertebrate assemblages. In addition, biological data were categorized according to the four site classes to illustrate variability within site classes in terms of response to stress. Non-parametric Kruskal-Wallis tests (at an alpha = 0.05) were used to statistically evaluate differences in results among the four site categories.

Results

Southern California IBI scores ranged from 0 to approximately 90 and about 60 percent of the sites were impaired according to the classifications developed by Ode et al. (2005) (i.e., IBI scores less than 40) (Figure 3). For the two selected metric distributions (Figure 3), about 8 percent of the sites had no EPT taxa and approximately 40 percent of the sites had percent non-insect less than 10%. Sites located above 1200 ft elevation generally had higher IBI and sensitive metric scores than those found below 1200 ft (Figures 4 and 5). Approximately 30 percent of the sites above 1200 ft were impaired, while 80 percent of the sites below 1200 ft were impaired and half of these were rated as very poor. For the non-insect percent metric, about 50 percent of the sites above 1200 ft had non-insect percents less than 20%, while about 70 percent of the sites below this elevation had values less than 20%. EPT taxa values had relatively similar distributions among the two elevation categories.

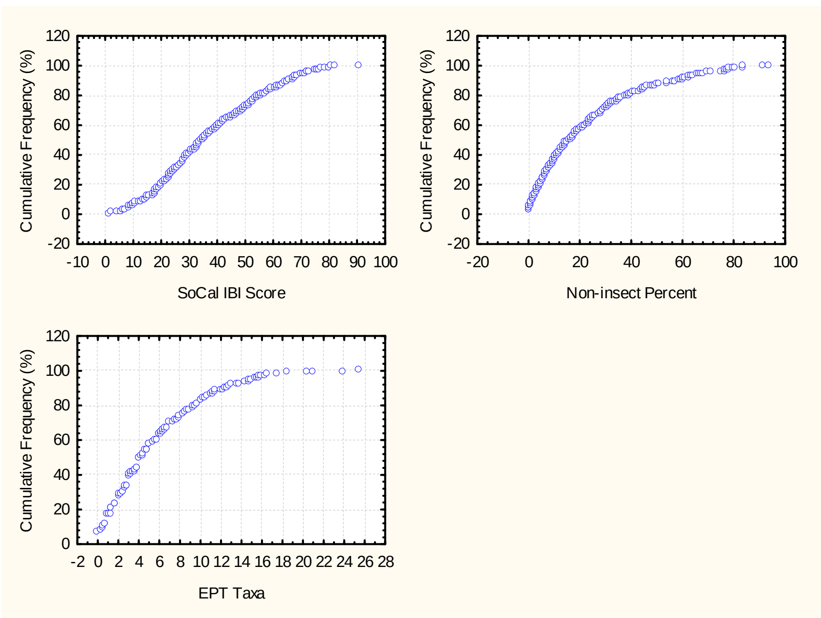

Figure 3. Cumulative frequency distribution plots for the SoCal IBI and two example metrics, intolerant percent and EPT taxa.

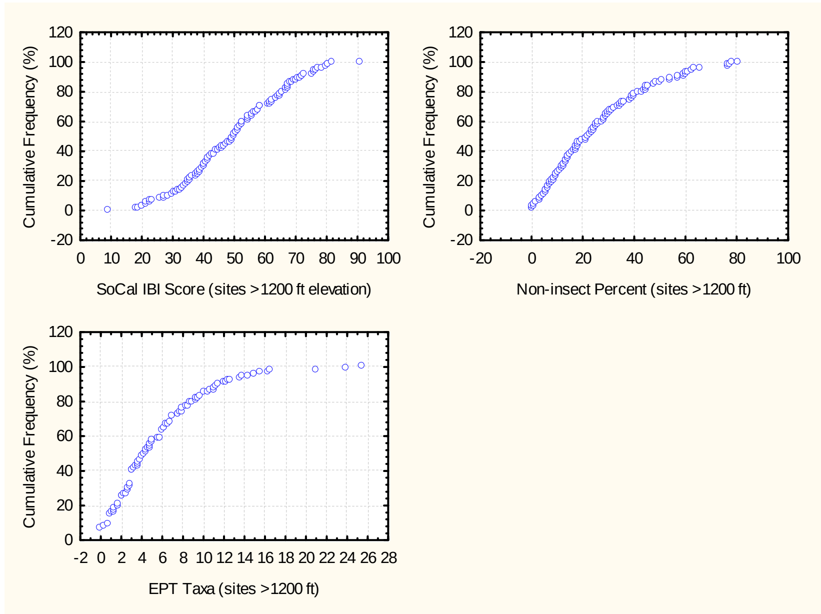

Figure 4. Cumulative frequency distribution plots for the SoCal IBI and two example metrics for sites located at elevations greater than 1200 feet.

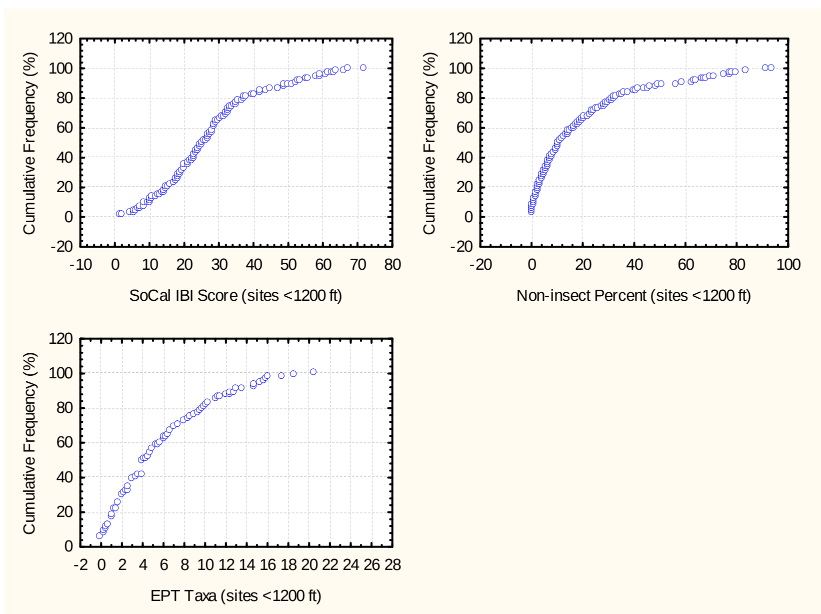

Figure 5. Cumulative frequency distribution plots for the SoCal IBI and two example metrics for sites located at elevations lower than 1200 feet.

Southern California IBI

As shown in Figure 6 the SoCal IBI scores were higher in natural channel sites (both >1200 ft and <1200 ft) than at human-altered sites (both partially altered and concrete lined categories). A non-parametric Kruskal-Wallis test confirmed that the two natural categories (1 and 2) were significantly different (p<0.05) from one another and each was significantly different from both of the human-altered site classes (3 and 4). SoCal IBI scores, however, were not significantly different between the two altered site classes. The following summarizes relationships regarding three of the BCG attributes that were subject to change based on the additional data in this analysis, and site classification. The three BCG attributes examined were: (1) sensitive ubiquitous taxa, (2) taxa of intermediate tolerance, and (3) tolerant taxa.

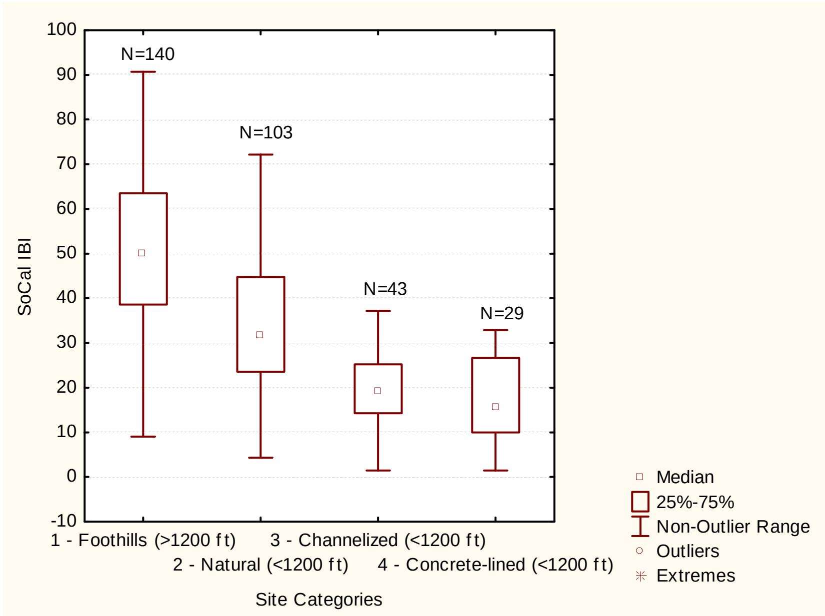

Figure 6. Southern California IBI scores in relation to the four site class categories used in this evaluation.

Attribute 3: Sensitive Ubiquitous Taxa

The Southern California IBI developed by DFG and others (Ode et al. 2005) includes four metrics that represent sensitive ubiquitous macroinvertebrate taxa: intolerant percent, number of EPT taxa, Coleoptera taxa, and number of predator species. All four sensitive ubiquitous taxa metrics showed similar patterns in response to the four site class categories (Figure 7). For intolerant percent, EPT taxa, and Coleoptera taxa, the two impacted classes of sites did not appear to be different from one another. For all four metrics, values for the two classes of natural sites were noticeably different from the two impacted classes. Additionally, the foothills class (i.e., category 1) was substantially different than the other natural site class (<1200 ft). A Kruskal-Wallis test on all the four metrics showed that all groups were significantly different (p<0.05) from one another, except the two altered classes which were statistically the same. Although predator taxa values among the two impacted classes (3 and 4) appeared different (Figure 4), the Kruskal-Wallis test indicated that this difference was not significant at an alpha level = 0.05.

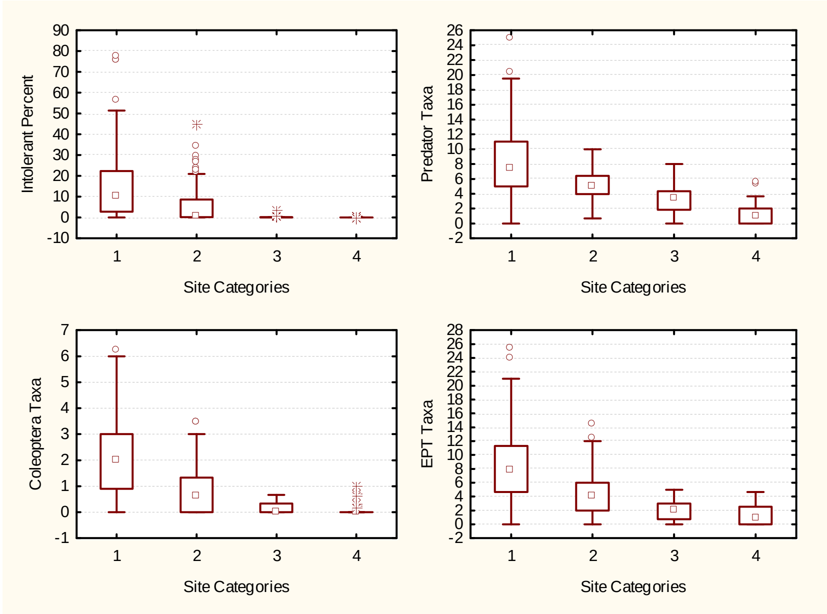

Figure 7. Intolerant percent, predator taxa, Coleoptera taxa, and EPT taxa reported in benthic samples as a function of four site class categories (see text for description of site categories).

Attribute 4: Taxa of Intermediate Tolerance

The SoCal IBI does not have a metric that includes only intermediate tolerant taxa. However the TAC recognized certain taxa that they considered to be representative of this attribute. These taxa included the caddisfly *Hydropsyche*, the mayfly *Baetis*, and elmid beetles. Dominance of these taxa is thought to signify fair – poor biological condition in this region. However, Figures 8 and 9 suggest otherwise – *Baetis* and *Hydropsyche* percent were lowest in site categories 3 and 4 (altered channels) and declined in response to increasing landscape disturbance as represented by LDI scores. Kruskal-Wallis tests confirmed these differences. Percent *Baetis* was significantly different ($p<0.05$) between category 1 and the two altered classes and category 2 was significantly different from category 4. The two natural stream class categories, as well as categories 2 and 3, and 3 and 4, were statistically the same. For percent *Hydropsyche*, the two natural categories were statistically the same, as were the two altered categories; otherwise, all categories were significantly different from one another.

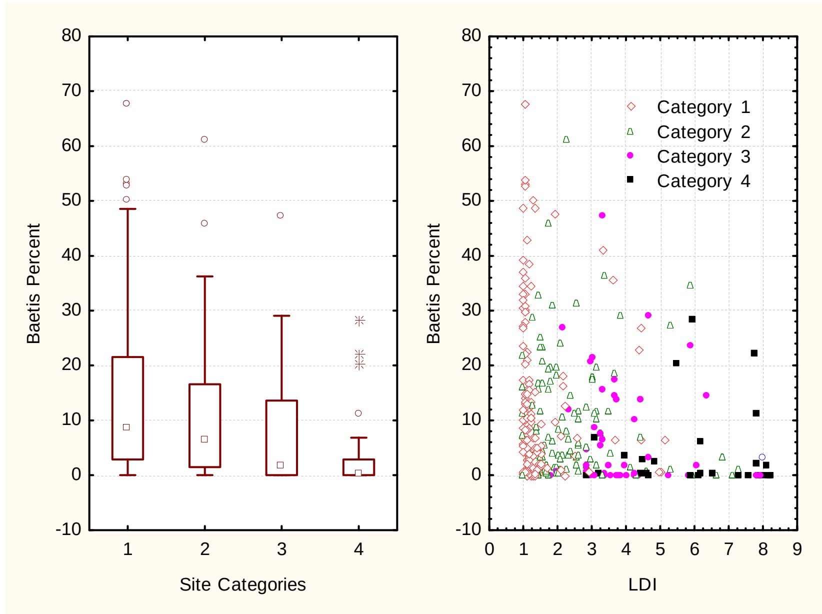

Figure 8. Baetis percent among four site categories and plotted versus LDI scores

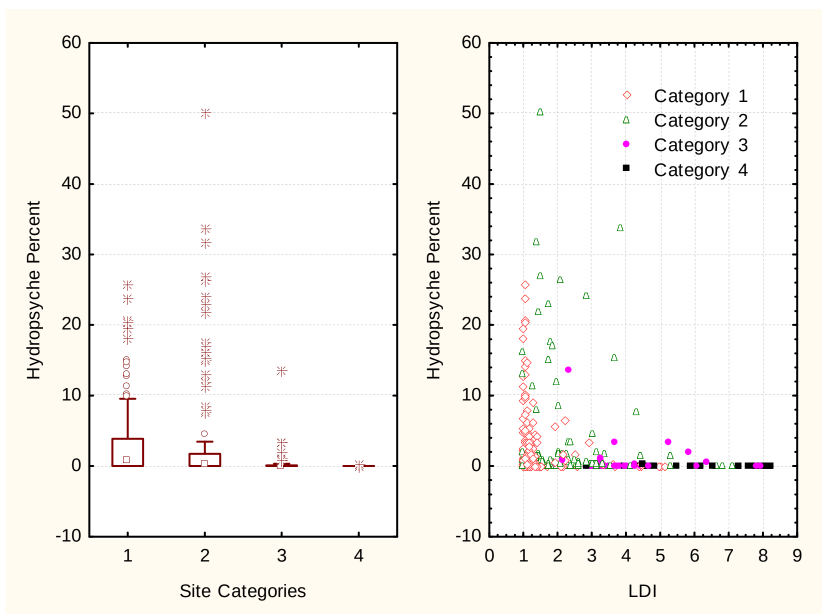

Figure 9. Hydropsyche percent among four site categories and plotted versus LDI scores

Attribute 5: Tolerant Taxa

The SoCal IBI includes three metrics that are indicative of tolerant taxa: percent collectors, number of non-insect taxa, and percent tolerant taxa. The percent collector metric showed a gradual increase from natural foothill (>1200 ft) streams (Category 1) to the concrete lined channels (Category 4) (Figure 10). Non-insect and percent tolerant metric scores were actually higher at the partially-altered sites than at the concrete lined sites. In fact, for these two metrics, concrete-lined channels appeared to be similar to both types of natural stream classes (Categories 1 and 2). A Kruskal-Wallis test on the non-insect taxa metric values indicated that categories 1 and 2 (natural sites) were not significantly different ($p>0.05$) from category 4 (concrete-lined channels); all other categories were significantly different from one another. For the percent tolerant metric, categories two and three were statistically the same as category 4, while category 1 was significantly different from all the other categories. A Kruskal-Wallis test on the percent collector metric indicated that all categories were significantly different from one another except categories 2 and 3 (low elevation natural channel and channelized), which were statistically the same.

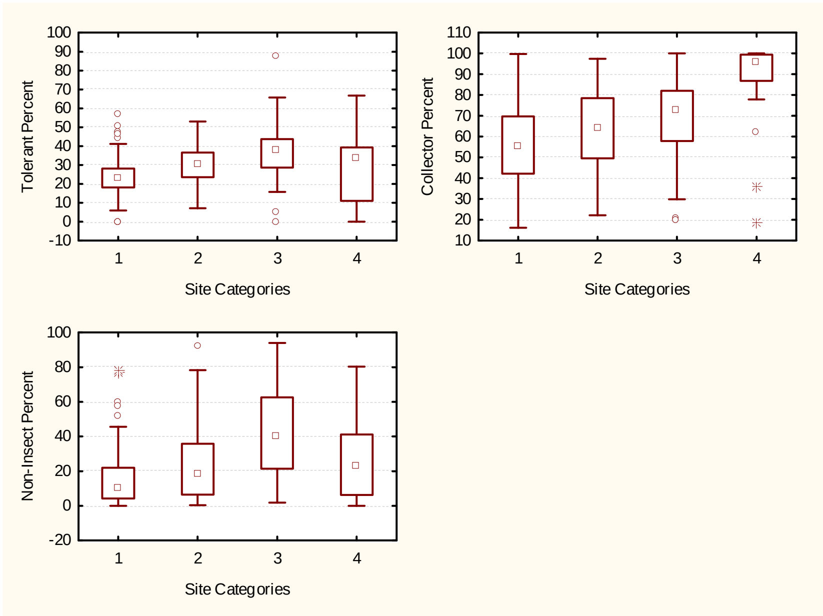

Figure 10. Percent tolerant taxa, percent collector taxa, and percent non-insect taxa reported in benthic samples as a function of four site class categories (see text for description of site categories).

Refinement of the BCG

Based on our method of site classification, we could not distinguish biologically, partially altered channels from concrete-lined channels for the majority of metrics, as well as the SoCal IBI; i.e., the concrete-lined channels can apparently achieve biological condition levels similar to those observed in partially altered low elevation streams. As we observed in the previous work, higher elevation streams have a higher biological expectation than lower elevation streams in the region, independent of the degree of channel alteration. In addition, the types of taxa often observed in the higher elevation cooler streams is different than those observed in the warmer lower elevation streams. This is borne out by the fishery information as well. While the exact elevation threshold to be used to separate low from high elevation stream classes is somewhat flexible (we used 1200 feet elevation), there are scientific data to support distinguishing higher elevation streams from lower elevation streams in terms of biological expectations. Use

Attainability Analyses might be necessary in some cases to clarify whether a borderline stream segment belongs to the lower or higher elevation stream class.

Figures 11 and 12 show relationships between the SoCal IBI, its component metrics, and increasing stress, as measured by either stream habitat quality score or the LDI index. The SoCal IBI and metrics were generally responsive to habitat degradation (Figure 11) and overall landscape alteration (Figure 12). Particular metrics that appeared most related to both habitat and LDI scores are percent tolerant taxa, predator taxa, and EPT taxa.

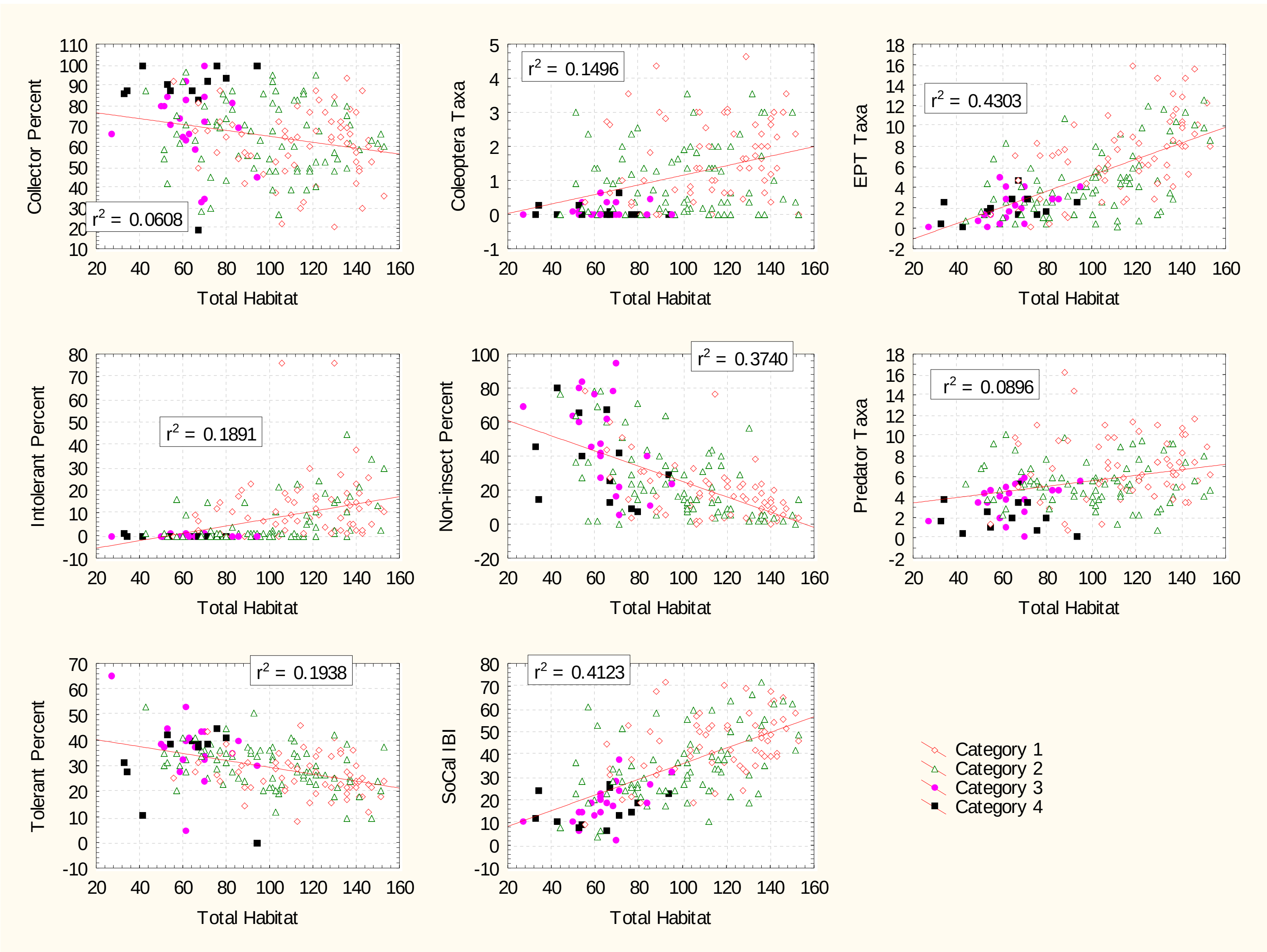

Figure 11. SoCal IBI and associated metrics versus total habitat scores organized among four site categories. All correlations were significant ($p<0.05$).

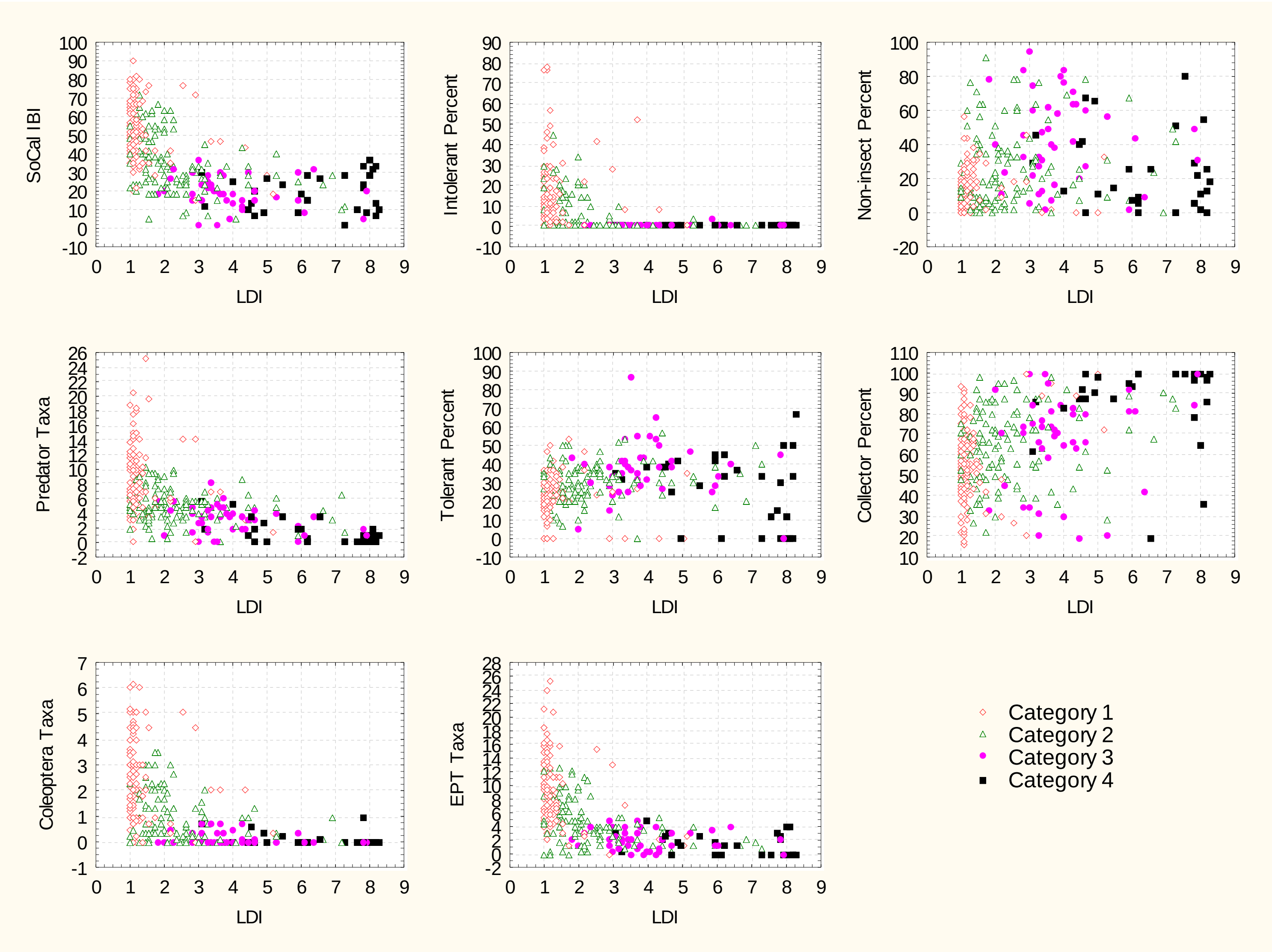

Figure 12. SoCal IBI and associated metrics versus LDI index scores organized among the four site class categories.

Tables 2 and 3 present the revised BCG incorporating the findings observed in the present analyses. In higher elevation streams, some sites appeared to be fairly pristine, as judged by a completely naturally vegetated land cover for many miles around the site. The macroinvertebrate assemblage at these sites showed all the signs of being minimally disturbed (i.e., true reference sites *sensu* Stoddard et al., 2006) and the TAC acknowledged this as well. Therefore, there is the possibility that the natural condition (i.e., BCG level 1) is known and quantifiable for Attributes III and V, and perhaps other attributes, for higher elevation streams in southern California (Table 2). Definitions for Attributes III and V in terms of macroinvertebrate indicators were updated based on the current analyses. Attribute IV (intermediate tolerant taxa) was not updated and it is not clear whether this attribute is relevant to southern California streams. Taxa that are thought to be intermediately tolerant (e.g., *Baetis*, *Hydropsyche*), did not display the expected trend with increasing stress, as measured by either habitat quality or LDI. Other studies have found that taxa of intermediate tolerance are found in roughly similar proportions across BCG tiers 2-5, representing a wide variety of conditions (Gerritsen and Leppo, 2004; Gerritsen and Jessup, 2006). Perhaps other faunal or algal indicators are more discriminating in terms of this attribute.

For lower elevation streams, it is not clear whether truly natural, unimpaired sites still exist in the southern California bight. However, at least a few low elevation sites displayed IBI and metric values approaching the highest scores found anywhere in the region. This may, of course, be a natural outcome of how the IBI was developed. As a placeholder, BCG level 1 (native condition) was defined for Attributes III and V for macroinvertebrates based on a compilation of the best metric scores observed for all low elevation sites combined (total of 175 sites; Table 3). Again, intermediately tolerant taxa (Attribute IV) may not be an informative attribute in terms of macroinvertebrates for this region. Number of Coeloptera (beetle) taxa is thought to be another indicator of sensitive ubiquitous taxa (Figure 7); however, the total number of taxa observed in the dataset (6 taxa) is few, making it difficult to discern fine differences with stressor level. Therefore, this metric was removed from the BCG table pending more information.

Among lower elevation streams, there are currently some differences in biological condition between natural and human-altered streams. However, while available habitat quality data suggests several factors that are different between the two types of streams (e.g., substrate heterogeneity and stability, channel sinuosity and complexity, riparian condition quality), it is unclear what is potentially attainable in the human-altered streams in the region (i.e., a least disturbed condition). When low elevation streams are examined with respect to increasing stress (as measured by either the habitat quality index or the LDI index), we can distinguish two separate classes corresponding to relatively natural channels and those that are altered hydrologically on the basis of certain metrics such as percent collectors. However, there appear to be more similarities than differences in terms of biological expectations between these two classes (Figure 10). Using the BCG framework, the best achievable condition (not necessarily best attainable) for altered low elevation streams in the region corresponds to a BCG level of 4, an LDI index score of approximately 4, and a SoCal IBI score of approximately 37 (Figure 12). The best achievable score for a given site, based on this dataset for the more natural channel low elevation streams appears to correspond to a BCG level of 2, an LDI index score of 2, and a SoCal IBI score of 72. No one site appeared to meet all of the indicator criteria identified under BCG level 1 for low elevation streams.

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

	Biological Condition Gradient					
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
Ecological Attributes	Native structural, functional and taxonomic integrity is preserved; ecosystem function is preserved within the range of natural variability	**Minimal** changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa but Sensitive-ubiquitous taxa are a dominant component; ecosystem functions are fully maintained through redundant attributes of the system;	**Some** changes in structure due to loss of sensitive or rare native taxa; shifts in relative abundance of taxa but Sensitive-ubiquitous taxa are common and abundant; ecosystem functions are fully maintained through redundant attributes of the system	**Major** changes in structure due to replacement of some Sensitive-ubiquitous taxa by more tolerant taxa,; overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes	Sensitive taxa are nearly absent; conspicuously unbalanced distribution of major groups from that expected; organism condition shows signs of physiological stress; system function shows reduced complexity and redundancy; increased build-up or export of unused materials	Extreme changes in structure; wholesale changes in taxonomic composition; extreme alterations from normal densities and distributions; organism condition is often poor; ecosystem functions are severely altered
I Historically documented, long-lived or regionally endemic taxa Relies on fish and other vertebrates; May need to break out by basin*	As predicted for natural occurrence except for global extinctions (e.g., unarmored 3-spine stickleback, Pacific Treefrog, California newt, or garter snakes present); steelhead and lampreys in foothills.	As predicted for natural occurrence except for global extinctions; 3-spine stickleback present in lowland;	Some may be absent due to global extinction or local extirpation; 3-spine stickleback rare or extirpated	Some may be absent due to global, regional or local extirpation	Usually absent; stickleback very rare or absent.	Absent

* LA Basin may have historically more endemic fish species than either San Gabriel, Malibu, San Diego drainages. Also need to distinguish upland from lowland sites. Trout more upland; sticklebacks and sculpins lowland. Most long-lived species extinct in region; may be similarity between long-lived or endemics and sensitive-rare species.

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
II Sensitive-rare taxa (currently rare)*	As predicted for natural occurrence, with at most minor changes from natural densities Sculpin (Cottus asper) (Ventura); lamprey adults in upland streams) red-legged frogs present; 3 spine armored stickleback	Virtually all are maintained with some changes in densities	Some loss, with replacement by functionally equivalent Sensitive-ubiquitous taxa	May be markedly diminished	Absent	Absent
III Sensitive-ubiquitous taxa [% intolerant individual EPT]	As predicted for natural occurrence, with at most minor changes from natural densities Partially armored Stickleback common; speckled dace species present in upland streams. Trout present in higher elevation streams. > 40% Intolerant; > 22 EPT taxa; > 20 Predator taxa	Present and abundant; > 16 EPT taxa > 14 predator taxa; > 30% intolerants Diatoms main form of periphyton; Achnanthes oblongella, ventralis; Cymbella amphioxys, gracilis, Amphora inariensis	Common and abundant; ≥10 EPT; ≥ 11 predator; >20% intolerants	Present but some replacement by functionally equivalent taxa of greater tolerance. ≤10 EPT, ≤ 11 predator, < 20% intolerants	Frequently absent or markedly diminished; less sensitive EPT (e.g., Baetidae) may be present but not more sensitive taxa. < 7 EPT; < 6 predator; < 4% intolerants	Absent ≤4 EPT taxa; <2% intolerant; <3 predator taxa

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	
IV Taxa of intermediate tolerance	As predicted for natural occurrence, with at most minor changes from natural densities Native sucker present Western toad Common stickleback	As naturally present with slight increases in abundance	Often evident increases in abundance Diatom species include: Achnanthes biasolettiana, Cymbella sinuata, Denticula tennis, Fragilaria construens, Navicula capitata.	Common and often abundant; relative abundance may be greater than Sensitive-ubiquitous taxa	Often exhibit excessive dominance	May occur in extremely high OR extremely low densities; richness of all taxa is low
V Tolerant taxa [non-insect taxa %tolerant taxa Collectors]	As naturally occur, with at most minor changes from natural densities Arroyo chub present <10% tolerant; <5% Non Insect taxa; >40% Intolerant <30% collectors	As naturally present with slight increases in abundance; <45% collectors; >30% intolerants; <10% non-insects; coleopteran taxa present; <15% tolerant taxa Arroyo chub present	May be increases in abundance of functionally diverse tolerant taxa; <50% collectors; >20% intolerants; <15% non-insects; <25% tolerant Arroyo chub present	May be common but do not exhibit significant dominance; few coleopteran taxa; >15% non-insects; >25% tolerant taxa, >50% collectors; <20% intolerant taxa Diatom indicators include: Nitzchia palea, Navicula atomus, minima, Fragilaria capucina, Cymbella affinis, Stephanodiscus. Attached green algae more prolific – Cladophora, Stigeoclonium, Oedogonium – as well as blue-greens such as Oscillatoria, Ababena Arroyo chub present	Often occur in high densities and are dominant; high percentage of collectors and non-insect taxa; few predator or EPT taxa >60% collectors; >30% tolerant taxa; >20% non-insect taxa; <10% intolerant taxa Arroyo chub less abundant	Comprise ≥ one-third of the assemblage; often extreme departures from normal densities (high or low); no coleoptera, sensitive EPT taxa, and few predator taxa. Mostly collector taxa and often high proportion of non-insect taxa >75% collectors; >40% non-insect taxa; >40% tolerant taxa; <2% intolerant taxa Arroyo chub scarce

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	
VI Non-native or intentionally introduced taxa <u>Include riparian vegetation</u>	Non-native taxa not present	Non-native taxa may be present, but in few numbers and very few species represented	Introduced non-native taxa may be more common in some assemblages (e.g. fish, amphibians, or macrophytes).	Non-native taxa fairly numerous but may not dominate assemblage	Some assemblages (e.g., fish, amphibians, or macrophytes) are dominated by non-native taxa (e.g., brown trout, Cottus asperus in upland)	Often dominant; may be the only representative of some assemblages (e.g., plants, fish, amphibians).
VII Organism Condition (especially of long-lived organisms) More data needed*[*]	Any anomalies are consistent with naturally occurring incidence and characteristics	Any anomalies are consistent with naturally occurring incidence and characteristics	Anomalies are infrequent	Incidence of anomalies may be slightly higher than expected	Biomass may be reduced; anomalies increasingly common	Long-lived taxa may be absent; Biomass reduced; anomalies common and serious; minimal reproduction except for extremely tolerant groups

[*] Percent fish anomalies (DELTS) higher in more stressed systems in the Central Valley (USGS report); should be useful attribute for LA region but unclear whether there are sufficient data available.

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	
VIII Ecosystem Functions	All are maintained within the natural range of variability. Algal as well as plant source of energy.	All are maintained within the natural range of variability	Virtually all are maintained through functionally redundant system attributes; minimal increase in export except at high storm flows	Virtually all are maintained through functionally redundant system attributes though there is evidence of loss of efficiency (e.g., increased export or decreased import)	There is apparent loss of some ecosystem functions manifested as increased export or decreased import of some resources,. Shift to almost entirely algal production: % Collector-filterers dominate the macroinvertebrate assemblage indicative of filamentous algae and DOC as the major energy sources.	Most functions show extensive and persistent disruption
* For southern California streams, may work in opposite direction? Limited connectance naturally, at least in uplands; greater connectance is artificially derived – leads to increase in exotics and decrease in natives.						

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

	Biological Condition Gradient					
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
Ecological Attributes	Native structural, functional and taxonomic integrity is preserved; ecosystem function is preserved within the range of natural variability	**Minimal** changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa but Sensitive-ubiquitous taxa are a dominant component; ecosystem functions are fully maintained through redundant attributes of the system;	**Some** changes in structure due to loss of sensitive or rare native taxa; shifts in relative abundance of taxa but Sensitive-ubiquitous taxa are common and abundant; ecosystem functions are fully maintained through redundant attributes of the system	**Major** changes in structure due to replacement of some Sensitive-ubiquitous taxa by more tolerant taxa,; overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes	Sensitive taxa are nearly absent; conspicuously unbalanced distribution of major groups from that expected; organism condition shows signs of physiological stress; system function shows reduced complexity and redundancy; increased build-up or export of unused materials	Extreme changes in structure; wholesale changes in taxonomic composition; extreme alterations from normal densities and distributions; organism condition is often poor; ecosystem functions are severely altered
I Historically documented, long-lived or regionally endemic taxa Relies on fish and other vertebrates; May need to break out by basin*	As predicted for natural occurrence except for global extinctions (e.g., unarmored 3-spine stickleback, Pacific Treefrog, California newt, or garter snakes present); steelhead and goby in coastal reaches, stickleback and sculpin in lowlands	As predicted for natural occurrence except for global extinctions; 3-spine stickleback present in lowland	Some may be absent due to global extinction or local extirpation; 3-spine stickleback rare or extirpated	Some may be absent due to global, regional or local extirpation	Usually absent; stickleback very rare or absent.	Absent

* LA Basin may have historically more endemic fish species than either San Gabriel, Malibu, San Diego drainages. Also need to distinguish upland from lowland sites. Trout more upland; sticklebacks and sculpins lowland. Most long-lived species extinct in region; may be similarity between long-lived or endemics and sensitive-rare species.

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

	Biological Condition Gradient					
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
II Sensitive-rare taxa (currently rare)*	As predicted for natural occurrence, with at most minor changes from natural densities Sculpin (Cottus asper) (Ventura) lamprey ammocoetes in lowland streams; red-legged frogs present; Speckled dace – lowlands; 3 spine armored stickleback	Virtually all are maintained with some changes in densities	Some loss, with replacement by functionally equivalent Sensitive-ubiquitous taxa	May be markedly diminished	Absent	Absent
III Sensitive-ubiquitous taxa [% intolerant, prediator taxa]	As predicted for natural occurrence, with at most minor changes from natural densities Partially armored Stickleback common; speckled dace species present in upland streams. Trout present in higher elevation streams. > 40% Intolerant; > 12 EPT taxa; > 14 Predator taxa	Present and abundant; > 10 EPT taxa, > 10 predator taxa; > 20% intolerants Diatoms main form of periphyton; Achnanthes oblongella, ventralis; Cymbella amphioxys, gracilis, Amphora inariensis	Common and abundant; ≥ 8 EPT; ≥ 6 predator; > 10% intolerants	Present but some replacement by functionally equivalent taxa of greater tolerance. ≤8 EPT, ≤ 6 predator, < 10% intolerants	Frequently absent or markedly diminished; less sensitive EPT (e.g., Baetidae) may be present but not more sensitive taxa. < 3 EPT; < 4 predator; < 5 % intolerants	Absent ≤1 EPT taxa; ≤ 1% intolerant; ≤ 2 predator taxa

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

	Biological Condition Gradient					
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
IV Taxa of intermediate tolerance	As predicted for natural occurrence, with at most minor changes from natural densities Native sucker present Western toad Common stickleback	As naturally present with slight increases in abundance	Often evident increases in abundance Diatom species include: Achnanthes biasolettiana, Cymbella sinuata, Denticula tennis, Fragilaria construens, Navicula capitata.	Common and often abundant; relative abundance may be greater than Sensitive-ubiquitous taxa	Often exhibit excessive dominance	May occur in extremely high OR extremely low densities; richness of all taxa is low
V ***Tolerant taxa*** [non-insect taxa %tolerant taxa Collectors]	As naturally occur, with at most minor changes from natural densities Arroyo chub present <15% tolerant; <5% Non Insect taxa; <40% collectors	As naturally present with slight increases in abundance; <50% collectors; >30% intolerants; < 8% non-insects; coleopteran taxa present; <20% tolerant taxa Arroyo chub present	May be increases in abundance of functionally diverse tolerant taxa; <60% collectors; <12% non-insects; <25% tolerant Arroyo chub present	May be common but do not exhibit significant dominance; few coleopteran taxa; >12% non-insects; >20% tolerant taxa, >60% collectors Diatom indicators include: Nitzchia palea, Navicula atomus, minima, Fragilaria capucina, Cymbella affinis, Stephanodiscus. Attached green algae more prolific – Cladophora, Stigeoclonium, Oedogonium – as well as blue-greens such as Oscillatoria, Ababena Arroyo chub present	Often occur in high densities and are dominant; high percentage of collectors and non-insect taxa; few predator or EPT taxa >75% collectors; >33% tolerant taxa; >20% non-insect taxa; Arroyo chub less abundant	Comprise ≥ one-third of the assemblage; often extreme departures from normal densities (high or low); no coleoptera, sensitive EPT taxa, and few predator taxa. Mostly collector taxa and often high proportion of non-insect taxa >90% collectors; >45% non-insect taxa; >40% tolerant taxa; Arroyo chub scarce

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

	Biological Condition Gradient					
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
VI Non-native or intentionally introduced taxa Include riparian vegetation	Non-native taxa not present	Non-native taxa may be present, but in few numbers and very few species represented	Introduced non-native taxa may be more common in some assemblages (e.g. fish, amphibians, or macrophytes).	Non-native taxa fairly numerous but may not dominate assemblage	Some assemblages (e.g., fish, amphibians, or macrophytes) are dominated by non-native taxa (e.g., bluegill, bass, African clawed frog, carp in lowland streams).	Often dominant; may be the only representative of some assemblages (e.g., plants, fish, amphibians).
VII Organism Condition (especially of long-lived organisms) More data needed*[*]	Any anomalies are consistent with naturally occurring incidence and characteristics	Any anomalies are consistent with naturally occurring incidence and characteristics	Anomalies are infrequent	Incidence of anomalies may be slightly higher than expected	Biomass may be reduced; anomalies increasingly common	Long-lived taxa may be absent; Biomass reduced; anomalies common and serious; minimal reproduction except for extremely tolerant groups

[*] Percent fish anomalies (DELTS) higher in more stressed systems in the Central Valley (USGS report); should be useful attribute for LA region but unclear whether there are sufficient data available.

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

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VIII Ecosystem Functions	All are maintained within the natural range of variability. Algal as well as plant source of energy.	All are maintained within the natural range of variability	Virtually all are maintained through functionally redundant system attributes; minimal increase in export except at high storm flows	Virtually all are maintained through functionally redundant system attributes though there is evidence of loss of efficiency (e.g., increased export or decreased import)	There is apparent loss of some ecosystem functions manifested as increased export or decreased import of some resources,. Shift to almost entirely algal production: % Collector-filterers dominate the macroinvertebrate assemblage indicative of filamentous algae and DOC as the major energy sources.	Most functions show extensive and persistent disruption

* For southern California streams, may work in opposite direction? Limited connectance naturally, at least in uplands; greater connectance is artificially derived – leads to increase in exotics and decrease in natives.

Generalized Stressor Gradient (GSG)

The GSG attributes and characteristics developed for this project were based on qualitative information compiled from various regional references, from TAC members, and from knowledge developed as part of the arid west GSG (see Table 4). Southern California streams differ from most other arid west systems in the degree of natural flashiness in undisturbed reaches, the amount of channel braiding that occurs naturally, and the numbers of exotic species that profoundly affect the distribution of endemic biota. Therefore, departures from "natural" or minimally impaired systems (Level 1) are characterized in terms of the degree of departure from the natural hydrograph, the degree of channel and flood plain alteration, and the degree and types of exotic species present. Similar to results from other regions of the country, it is generally thought that Level 1, or completely natural streams, are unlikely to exist in southern California, except perhaps in remote foothill areas. Furthermore, because the hydrology is naturally variable in this region, it may be difficult to quantitatively characterize Level 1 in any case. The TAC suggested several changes to the national GSG framework to make it more relevant to southern California streams. These include:

- Habitat should be divided into two attributes: instream habitat and riparian habitat. The former includes substrate condition, channel morphology, and the presence of barriers or channel alterations such as culverts. Riparian habitat includes riparian vegetation condition (including native or lack of native species) and lateral connectivity with floodplain. Tetra Tech obtained and included metrics from the California Rapid Assessment Method (CRAM) for wetlands that pertain to riparian condition as well as hydrology.
- Water Quality should be divided into two attributes: conventional and naturally-occurring pollutants and anthropogenic toxics. The TAC agreed that tiered uses will not allow for water quality degradation. However, natural water quality characteristics could be a stressor.

Table 4. Stressor Condition Gradient Matrix: California Bight

	Stressor Condition Levels			
Attribute	**1**	**3**	**4-5**	**6**
Flow	Natural hydrograph; includes periodic seasonal floods and very low flows (dry conditions in some cases); dry season flow from natural sources; rising water has unrestricted access to floodplain; Most of channel characterized by equilibrium conditions.	Moderately changed hydrograph; more consistent flows seasonally through treated wastewater inputs and other sources; some irrigation withdrawals or groundwater removal for other human purposes; noticeable change in flashiness; lateral excursion of rising waters partially restricted by unnatural features; Some aggradation or degradation present but not severe.	Significantly changed hydrograph; both managed and natural flow factors present; stormwater runoff dramatically increases flows temporarily; lateral excursion of rising waters partially restricted by unnatural features; Most of channel actively degrading or aggrading.	Severely changed hydrograph; flow human-controlled; peaking flows, “rafting flows”, or water diversions common; stream is all treated wastewater effluent flow;; diversions such that stream is dry periodically; stream flow result of dam releases; rising waters completely contained within artificial banks; Channel has completely artificial hydrogeology and equilibrium.
Instream Habitat	Natural substrate and channel sinuosity; Braided channels common in lowlands; natural cover available for fish and other aquatic life.	Substrate somewhat modified (often tending to be smaller in size); channel morphology may be slightly modified.	Natural bottom but concrete sides or altered bottom. Substrate size typically fine. Culverts or instream structures present – clear effects on channel morphology	Severely changed channel morphology; channelized; concrete sides and bottom; substrate radically altered.
Riparian Habitat	lateral connection between stream and riparian corridor; native riparian vegetation predominates; underwater willow roots or other riparian plants serve as habitat for aquatic life; 75-100% of stream has riparian buffer; average buffer width ≥ 100m; intact soils.	some exotic-invasive riparian vegetation; connection with flood plain/riparian corridor mostly intact; 50-75% of stream has riparian buffer; average buffer width 60-99m intact or moderately disrupted soils.	25-50% of stream has riparian buffer; average buffer width 30-60m; moderate-extensive soil disruption.	exotic vegetation only if any at all; no connection to flood plain; < 25% of stream has riparian buffer; average buffer width < 30m; barren ground or highly compacted soils.
Conventional Water Quality parameters and naturally occurring chemicals	DO generally near saturation in upland streams – generally > 5 mg/L in lowland streams; temperature cool in upland streams – generally < 30 °C in lowland streams in the summer.	DO and temperature may be slightly altered but still satisfactory for native aquatic life.	Altered DO and/or temperature regimes; elevated concentrations of metals or other constituents naturally	DO and/or temperature radically altered – temperature often > 30° C in summer; conductivity, salinity, or dissolved solids generally much higher than typical for supporting aquatic life; metals or other chemicals naturally high and known to be toxic to aquatic life

Table 4. Continued

	Stressor Condition Levels			
Attribute	**1**	**3**	**4-5**	**6**
Anthropogenic Toxics	No anthropogenic toxics	Infrequent pollutant exceedences of standards; generally non-toxic conditions	Occasional exceedences of WQ objective(s); Stormwater runoff may decrease water quality in certain segments or over short time periods.	Toxics exceed water quality objectives; multiple toxic chemicals co-occur or multiple exceedences of a WQ objective
Watershed Condition	All natural land cover; natural longitudinal connectivity and connectivity with ground water; Contiguous natural riparian buffer between segments.	Mostly natural land cover – some human developed areas; longitudinal connectivity mostly in tact – some fragmentation of habitat or barriers	Mostly human land uses, Urban intensity moderate (30-50 out of 100); longitudinal connectivity fragmented, interrupted; agricultural uses may be relatively predominant	Nearly all human land uses; urban intensity > 50/100; connectivity severely altered; agricultural land uses dominant
Invasive Species	Exotics or introduced species absent. Riparian vegetation as naturally occurs.	A few non-invasive exotics may be present (e.g., crayfish, fathead minnow), including riparian plant species; but generally has little effect on native species or riparian habitat.	Some non-invasive exotics combined with one or two aggressive exotic species (e.g., brown trout; Tamerisk; Arrando).	Invasive, predatory, or aggressive exotic species common (e.g., bass, bluegill, African clawed frog, bull frog). Clear evidence of extirpation of native species due to exotic species. Highly altered riparian habitat due to invasive species present.

- Energy source attribute has questionable relevance to southern California streams. The TAC suggested deleting this attribute pending further discussions.
- Watershed condition attribute was added. This includes land uses and longitudinal and vertical connectivity issues. The urban intensity index, which Tetra Tech calculated for several sites in the Region is one descriptor that is useful here. The CRAM connectivity metric is also relevant here.
- Invasive species attribute was added. This includes riparian plants as well as fauna.

Urbanization, Hydrology and SoCal IBI

There also appears to be some separation in the GSG based on flow regimes and hydrology; streams with more constant flows year-round (e.g., effluent dominated streams) appear to have a higher likelihood of harboring exotic species. Highly urbanized areas are often subject to much greater wet weather runoff than normal resulting in much higher peak flows and a very altered hydrograph.

Plotting the SoCal IBI against the LDI, there are sites that appear to be better than most within its class of urban intensity (see labels in Figure 13). One possibility is that while potential urban sources are present (e.g., residential housing is relatively dense, many roads), the actual level of stressors is less because of the way road runoff and other human-derived stressors are routed. Another possibility is that the stream has certain features that help protect it from urban-related stressors (e.g., riparian vegetation). A third possibility is that sites with lower IBI scores for a given LDI are affected by non-urban stressors as well (e.g., agriculture derived stressors) and are therefore, subject to more stressors than those sites with better IBI scores. Future efforts should plan to compile what is known about these sites so that we can identify factors that mitigate urban effects and better define the GSG.

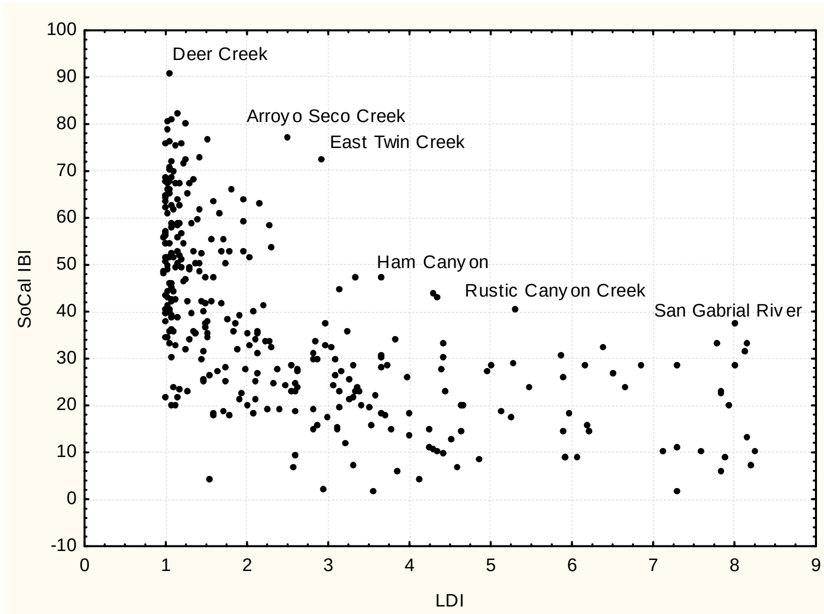

Figure 13. Plot of the southern California macroinvertebrate (SoCal) IBI in relation to the LDI. Higher IBI scores indicate better biological condition. Higher LDI values indicate greater landscape disturbance and probable urban stressors.

The results presented here can be described as a conceptual development of a Southern California BCG based on the existing SoCal IBI and its associated biological metrics. Although the conceptual BCG presented here is a promising step, a fully calibrated BCG is necessary in order for the biological and stressor data to be used in tiered aquatic life uses, as well as for use attainability analyses.

It is recommended that a workshop be organized to initiate development of a calibrated BCG. Individuals involved in the workshop should have extensive knowledge on the type of biological assemblage being investigated and should understand its responses in pristine to severely stressed conditions. Generally, these workshops last two to three days, depending on participants' familiarity with TALU and BCG concepts. The strong relationships of these biological measures with stress (as described by habitat quality and the LDI index), as well as the variation in biology among the two natural and two altered site classes, suggest that generating a calibrated BCG would be possible using the currently available data. To do this, macroinvertebrate data (and to the extent feasible, other types of biological data) need to be explored in more detail to identify specific taxa that are common, as well as sensitive, to the stressors found in the Southern California Bight region. Additionally, the knowledge of local experts must be used in order to reduce uncertainty associated with ambiguous or incomplete data. It may also be necessary to assemble a more comprehensive GSG based on a larger assemblage of data types (i.e., stressors).

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Appendix 9

Bioassessment tools in novel habitats: An evaluation of indices and sampling methods in low-gradient streams in California

Raphael D. Mazor, Kenneth C. Schiff, Kerry J. Ritter, Andy Rehn[1] and Peter Ode[1]

Abstract

Biomonitoring programs are often required to assess streams for which assessment tools have not been developed. For example, low-gradient streams (slope ≤1%) comprise 20 to 30% of all stream miles in California and are of particular interest to watershed managers, yet most sampling methods and bioassessment indices in the State were developed in high-gradient systems. This study evaluated the performance of three sampling methods: targeted riffle composite (TRC), reachwide benthos (RWB), and the margin-center-margin modification of RWB (MCM); and two indices: the Southern California Index of Biotic Integrity (SCIBI) and the ratio of observed to expected taxa (O/E) in low-gradient streams in California for application in this habitat type. Performance was evaluated in terms of efficacy (i.e., ability to collect enough individuals for index calculation), comparability (i.e., similarity of assemblages and index scores), sensitivity (i.e., responsiveness to disturbance), and precision (i.e., ability to detect small differences in index scores). The sampling methods varied in the degree to which they targeted macroinvertebrate-rich microhabitats, such as riffles and vegetated margins, which may be naturally scarce in low-gradient streams. The RWB method failed to collect sufficient individuals (i.e., ≥450) to calculate the SCIBI in 28 of 45 samples, and often collected fewer than 100 individuals, suggesting it is inappropriate for low-gradient streams in California. Failures for the other methods were less common (TRC:16 samples; MCM:11 samples). Within-site precision, measured as the minimum detectable difference (MDD), was poor but similar across methods for the SCIBI (ranging from 19 to 22). RWB had the lowest MDD for O/E scores (0.20 vs. 0.24 and 0.28 for MCM and TRC, respectively). Mantel correlations showed that assemblages were more similar within sites among methods than within methods among sites, suggesting that the sampling methods were collecting similar assemblages of organisms. Statistically significant disagreements among methods were not detected, although O/E scores were higher for RWB samples than TRC. Index scores suggested impairment at all sites in the study. Although index scores did not respond strongly to several measurements of disturbance in the watershed, % agriculture showed a significant, negative relationship with O/E scores.

Introduction

Large-scale biomonitoring programs are often confronted with the need to assess habitat types for which assessment tools have not been developed. This problem is severe in large heterogeneous regions like California (Carter and Resh 2005). Developing and maintaining unique assessment tools for multiple habitat types may be prohibitively expensive and may impede comparison of data from different regions. Therefore, assessing the applicability of tools in diverse habitat types is a critical need for large biomonitoring programs.

In southern California, biomonitoring programs use tools like the SCIBI (Ode *et al*. 2005), which were developed using reference sites that were predominantly in high-gradient (i.e., >1% slope) streams. However, low-gradient streams are a major feature in alluvial plains of this region (Carter and

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Resh 2005). According to the National Hydrography Dataset Plus (NHD+; USEPA and USGS 2005) approximately 20 to 30% of all stream miles in California have slopes below 1%. Because these habitats are subject to numerous impacts and alterations (SMCBWG 2007), several biomonitoring efforts in California specifically target low-gradient streams, even though the applicability of assessment tools created and validated in high-gradient streams has not been tested.

Low-gradient streams differ from high-gradient streams in many respects (Montgomery and Buffington 1997). For example, bed substrate is typically composed of fines and sands, rather than cobbles, boulders, or bedrock. In California and other semiarid climates, low-gradient channels are often complex, with ambiguous and dynamic bank structure. Frequent floods create new channels and cause streams to abandon old ones (Carter and Resh 2005). For bioassessment programs, an important distinction between high- and low-gradient streams is the scarcity of riffles and other microhabitats that are typically targeted by macroinvertebrate sampling protocols (e.g., Harrington 1999).

In this study, application of three sampling methods and two bioassessment indices for use in low-gradient streams in California were evaluated. Sampling methods were assessed for efficacy (i.e., the ability to collect sufficient numbers of benthic macroinvertebrates), comparability (i.e., community similarity and agreement among assessment indices), sensitivity (i.e., responsiveness of the indices to watershed disturbance), and precision of the assessment indices (i.e., power of assessments to detect differences among sites).

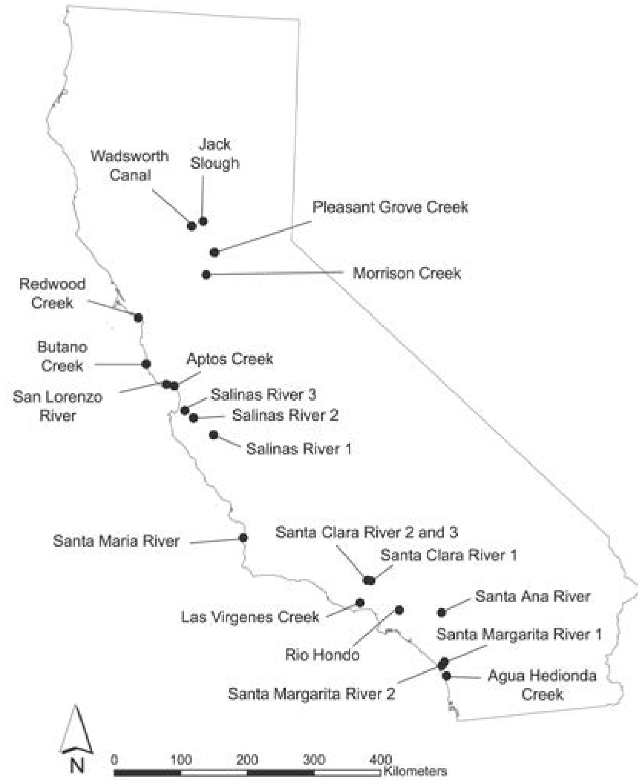

Figure 1. Location of study sites.

METHODS

Study Areas

Twenty-one low-gradient sites were sampled in several regions across California (Table 1; Figure 1). Most sites were in heavily altered rivers, although a few were in protected watersheds. Slopes were estimated from the NHD+ (USEPA and USGS 2005), or from digital elevation models (at Jack Slough, Wadsworth Canal, and the Santa Ana River, which lacked associated data in the NHD+). All sites were on reaches defined in the NHD+ as having slopes below 1%.

Sampling

At each site, TRC, RWB, and MCM sampling methods were used to collect benthic macroinvertebrates. The three sampling methods differ in the degree to which they target the richest microhabitats (e.g., riffles or vegetated margins). TRC and RWB are similar to methods used in the nationwide Environmental Monitoring and Assessment Program (EMAP; Peck *et al*. 2006), and both methods are currently used in California's bioassessment programs (Ode 2007). MCM is intended to capture marginal habitats not sampled by RWB, and has been adopted for use in low-gradient streams in California (Ode and van Buuren 2008). Samples were displaced upstream or downstream by 1 m when necessary to avoid interference among different methods. At 12 sites, triplicate samples were collected for each method (Table 1).

For the TRC method, 11 equidistant transects were established along the 150-m reach, and 3 1-ft^2 areas of streambed were sampled at three randomly selected transects. At each transect, field crews targeted the richest microhabitats and sampled a total of 9 ft^2 of streambed in three riffles. This method is

Table 1. Low-gradient sites included in the study. S = assessed using Southern California Index of Biotic Integrity; X = not assessed using an index of biotic integrity; WS = watershed; Local = within 500 m of sampling point; Ndel = ambiguous watersheds which could not be delineated; Ndet = ambiguous stream network for which stream order could not be determined; and * = triplicate samples collected.

Site	Watershed	County	Watershed Size (km^2)	Stream Order	% Developed		% Agricultural		% Open space	
					WS	Local	WS	Local	WS	Local
Within Central and Southern California										
Central Coast										
S	Aptos Creek*	Santa Cruz	200	3	18	92	0	0	82	8
S	Salinas River 1	Monterey	10940	6	14	71	0	1	86	28
S	Salinas River 2*	Monterey	10666	7	5	28	7	61	88	11
S	Salinas River 3	Monterey	9141	7	5	13	4	27	90	60
S	San Lorenzo River	Santa Cruz	378	4	5	7	6	56	88	37
S	Santa Maria River*	Santa Barbara	1844	6	4	4	6	0	91	96
South Coast										
S	Agua Hedionda Creek*	San Diego	80	3	76	77	0	0	24	23
S	Las Virgenes Creek*	Los Angeles	63	3	19	29	0	0	81	71
S	Rio Hondo*	Los Angeles	325	3	70	83	0	0	30	17
S	Santa Ana River	Riverside	1965	6	25	78	1	0	74	22
S	Santa Clara River 1	Los Angeles	817	4	14	68	0	0	86	32
S	Santa Clara River 2	Los Angeles	1107	5	16	76	0	1	84	23
S	Santa Clara River 3	Los Angeles	1107	5	16	75	0	5	84	20
S	Santa Margarita River 1*	San Diego	1856	6	13	48	3	0	84	52
S	Santa Margarita River 2*	San Diego	1888	6	14	24	3	0	83	76
Outside Central and Southern California										
Bay Area										
X	Butano Creek	San Mateo	234	3	11	34	0	0	89	66
X	Redwood Creek*	Marin	44	2	4	10	2	24	94	67
Central Valley										
X	Jack Slough	Yuba	Ndel	3		7		91		2
X	Morrison Creek*	Sacramento	114	3	40	100	4	0	56	0
X	Pleasant Grove Creek	Placer	40	3	69	34	3	16	28	50
X	Wadsworth Canal	Sutter	Ndel	Ndet		12		87		1

similar to the targeted riffle composite method used by EMAP, which sampled a total of 8 ft^2 of streambed from four to eight riffles (Peck *et al*. 2006). A second difference was the fixed reach length of 150 m, in contrast to EMAP, which had a variable reach length set at 40 times the wetted width.

In contrast to TRC, which allowed the field crew to sample the richest microhabitats within transects, the RWB method used systematically distributed sampling locations. For RWB, eleven equidistant transects were established along the 150-m reach, and one sample was collected with a D-frame kick-n*et al*ong each transect at 25, 50, or 75% of the stream width (with the position changing at each transect). A total of 11 ft^2 of streambed was sampled. This method is similar to the Reach-Wide Benthos method used by EMAP, except that EMAP used variable reach length set to 40 times the wetted width (Peck *et al*. 2006).

The MCM method was identical to RWB with minor modification. Instead of collecting samples at 25, 50 and 75% of stream width, samples were collected at 0, 50, and 100%. Unlike RWB, MCM samples were collected from the margins, which in low-gradient streams often contain the richest, most stable microhabitats (e.g., vegetated margins). As with RWB, 11 ft^2 of streambed were sampled.

Benthic macroinvertebrates were sorted and identified to the Standard Taxonomic Effort Level 1 (i.e., most taxa to genus, with Chironomidae left at family) established by the Southwestern Association of Freshwater Invertebrate Taxonomists (Richards and Rogers 2006). When possible, at least 500 individuals were identified in each sample.

Data Analysis

For each sample, bioassessment metrics and indices were calculated and analyzed to evaluate the efficacy, comparability, sensitivity, and precision of the three sampling methods.

Calculation of indices and metrics

The SCIBI was calculated for 15 sites located on coastal drainages from Santa Cruz to San Diego Counties. No IBIs were calculated for the two sites in the San Francisco Bay Area and the four sites in the Central Valley because IBIs for these regions were not available at the time of the study. Furthermore, small sample sizes in these regions and unknown comparability of IBIs for different regions would limit the utility of including these sites. In order to calculate the SCIBI, benthic macroinvertebrate data were processed according to the index requirements. For example, samples containing more than 500 individuals were randomly subsampled with replacement to obtain 500 individuals per sample.

Calculation of O/E scores

Observed-over-expected scores were calculated for all sites using a predictive model developed for the state of California (Charles P. Hawkins pers. com.; Western Center for Monitoring and Assessment. Accessed online March 30, 2007: http://129.123.10.240/wmcportal/DesktopDefault.aspx). These scores are the ratio of observed to expected taxa, and are based on only those taxa with a probability of occurrence ≥50%. The original identifications were converted to operational taxonomic unit (OTU) names used in the models, and ambiguous taxa (i.e., those that could not be assigned to an OTU and those that could not be adequately identified, such as early instars), as well as all Chironomidae larvae, were eliminated. The resulting sample counts were reduced to 300, if more than 300 individuals remained after removal of ambiguous taxa. Sites were assigned to the appropriate submodel based on climate (i.e., low mean annual precipitation, and high mean monthly temperature), which were used to predict expected taxa occurrence (E) using longitude, percent sedimentary geology in the watershed, and log mean annual precipitation. Climatic data were obtained from the Oregon Climate Center (accessed online March 30, 2007: http://www.ocs.orst.edu/prism), and geologic data were obtained from a generalized geological map of the United States (accessed online March 30, 2007: http://pubs.usgs.gov/atlas/geologic). Details of these predictive models can be found in Ode *et al*. 2008.

The two Central Valley sites were located in streams with ambiguous watersheds, and therefore required that percent sedimentary geology be estimated, rather than calculated by geographic information systems (GIS). For this study, percent sedimentary geology was estimated at 100%. Using different percent sedimentary geology values (i.e., 0, 20, 40, 60, and 80%) had negligible effect on O/E scores; coefficient of variation for scores within each sample at the two Central Valley sites was <2%, (data not shown), perhaps as a result of the low numbers of observed taxa at these sites.

Evaluation of sampling methods and indices

Efficacy

To assess the efficacy of the sampling methods, the percentage of samples was calculated for each method that collected at least 450 individuals (within 10% of the minimum number for calculating the SCIBI) or at least 270 individuals (within 10% of the minimum number for calculating O/E, counting only unambiguous taxa). In bioassessment applications, smaller samples would be rejected and represent wasted resources. In order to minimize the effects of pseudoreplication, the percentage of samples containing an adequate number of individuals was calculated for each site; then, this percentage was averaged across all 21 sites. This rate estimated the likelihood of collecting adequate samples from the population of sites in the study. McNemar's test was used to test differences between methods (paired within sites) for statistical significance (Zar 1999, Stokes *et al*. 2000). Because McNemar's test requires binary data, within-site rates were rounded to 1 or 0 at replicated sites. A Bonferroni correction was used to account for multiple tests across methods (i.e., $\alpha = 0.05/3 = 0.017$).

Comparability

To see if the different sampling methods collected similar types of organisms, community structure between sampling methods was compared using a Mantel test (Mantel 1967). Mantel tests provide a measure of correlation (Mantel's R) between two sampling methods. Sorensen distance was used as a dissimilarity measure. For sites where multiple samples were collected, mean distances were used; that is, matrices comprised mean or observed distances between pairs of sites, not samples. All samples were included in this analysis, regardless of the number of individuals collected. Significance was tested against correlation values for 999 runs with randomized data.

A Bonferroni correction was used to account for multiple tests across methods (i.e., $\alpha = 0.05/3 = 0.017$). PC-ORD [Version 5.12] was used to run Mantel tests (MJM Software Design, Glendeden Beach, OR).

To determine the relative influence of sampling method on assessment indices, a variance components analysis was used to determine how much of the variability was explained by differences among sites, sampling methods, and their interaction. Restricted maximum likelihood (REML) was used to calculate variance components because of the unbalanced design. SAS was used for all calculations (using PROC VARCOMP method=REML, SAS Institute Inc. 2004). Unlike the mean square method of estimating variance components, REML ensures that all components are greater than or equal to zero (Larsen *et al*. 2001). Because sites were a fixed factor and not a random factor, the variance component attributable to site must be considered a finite, or pseudo variance (Courbois and Urquhart 2004). Only sites where all three sampling methods were represented (after excluding samples containing inadequate numbers of organisms) were used in this analysis.

To assess agreement among the sampling methods, mean SCIBI and O/E values were calculated and regressed for each pair of methods. Slopes were tested against 1 and intercepts to 0 ($\alpha = 0.05$); Theil's test for consistency and agreement, which is based on differences between sampling methods, was used as an additional test of comparability (Theil 1958). Pairwise differences between mean SCIBI and O/E scores were regressed against log watershed area and stream order to see if these gradients contributed to the observed disagreements. A Bonferroni correction was not used for either analysis in order to increase the ability to detect disagreements. Bias was not explicitly assessed because none of the methods could be assumed to represent a true value. Only samples with adequate numbers of individuals were used in this analysis.

<u>Sensitivity</u>

The sensitivity of the assessment indices to watershed alteration was assessed by correlating mean SCIBI and O/E scores against land cover metrics, including percent open, developed, and agricultural land within the watershed for all sites with unambiguous watersheds (Table 1). This analysis assumed that the biology of the streams respond to these watershed alterations. Open water was excluded from all calculations. Land cover data was obtained from the National Land Cover Database (USGS 2003). Relationships were assessed by calculating the Spearman rank correlation, which is robust to non-normal distributions and extreme values in land cover metrics (Zar 1999). Only samples with the minimum number of individuals for each index were used in this analysis. Data from each sampling method were analyzed independently. A Bonferonni correction was used to account for multiple comparisons ($\alpha = 0.05/6 = 0.008$) across two indices and three land cover classes within each method.

<u>Precision</u>

Precision was evaluated by calculating the MDD of each sampling method for SCIBI and O/E scores (Zar 1999, Fore *et al*. 2001). The MDD was calculated using the mean squared error from a nested ANOVA (replicates within site) as an estimate for average within-site variance. Only data from site and method combinations with replication (after exclusion of samples lacking adequate numbers of individuals) were used to estimate variability. These estimated variabilities were applied to a two-sample *t*-test ($\alpha = 0.05$, $\beta = 0.10$) with three replicates in each sample. Additionally, the coefficient of variation (CV) of the indices for each method, averaged across sites, was calculated.

Results

One hundred thirty-five samples were collected at 21 sites throughout the state; 15 of these sites were located along the southern and central California coast. All three methods were used at each site, and 196 taxa were identified. For all sampling methods, SCIBI and O/E scores were low at most sites (Figure 2). For example, mean SCIBI scores were well under 39 (the impairment threshold) at all but one site (Aptos Creek). Observed-over-expected scores indicated impairment in nearly every sample, as scores were below the impairment threshold of 0.66 in all but three samples.

Efficacy

Efficacy was low for all methods, and many samples contained fewer than the required number of individuals. Ideally, each sample should have contained at least 500 individuals. However, only 46 of 135 samples met this target; 34 of the remaining 89 samples had at least 450 individuals, the minimum required for calculation of the SCIBI. For the 55 samples with fewer than 450 individuals, IBIs may

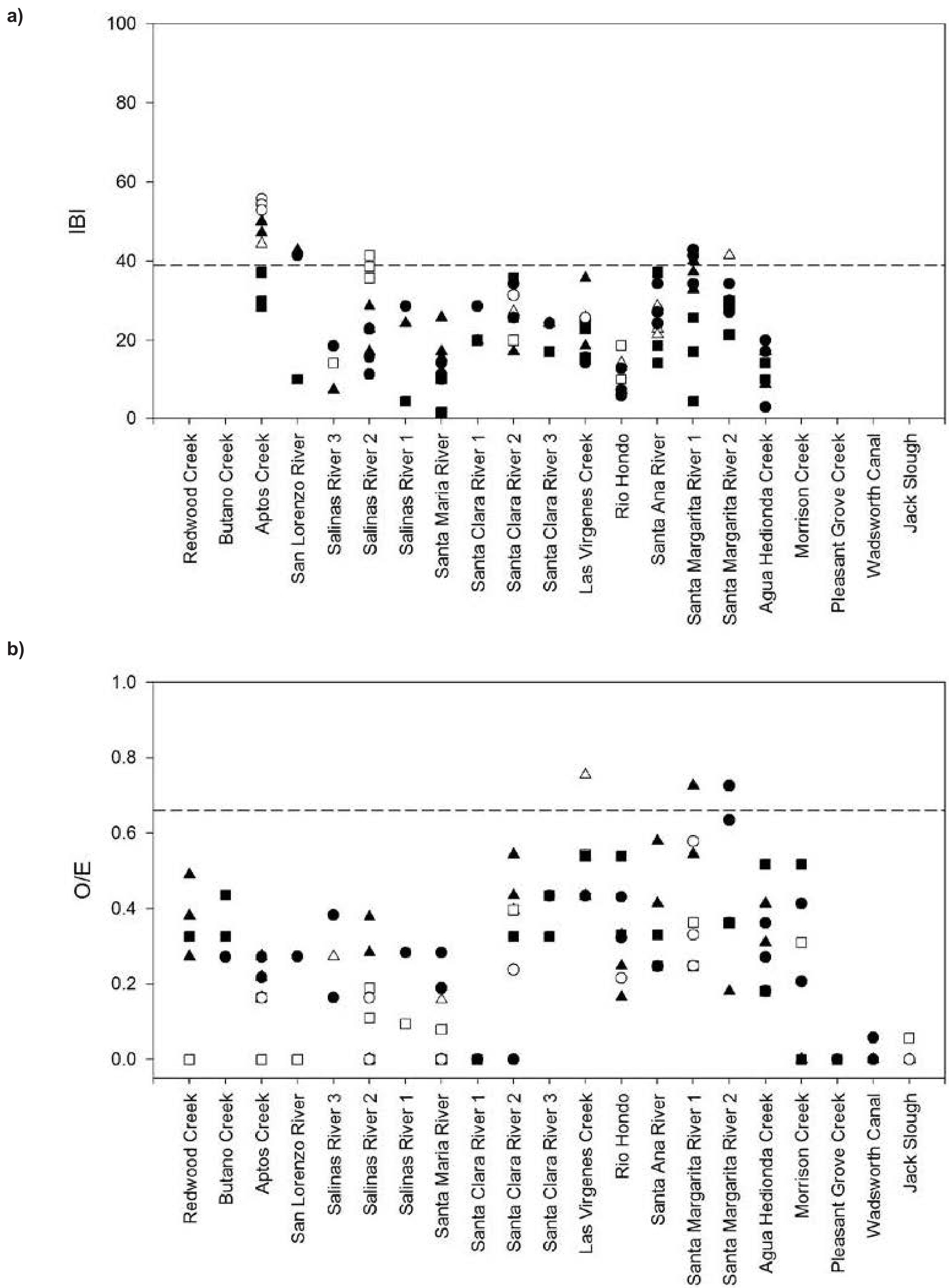

Figure 2. Southern California Index of Biotic Integrity (SCIBI; a) and Observed/Expected (O/E; b) scores by site and method. Each point represents an individual sample. Triangles represent MCM samples. Squares represent RWB samples. Circles represent TRC samples. Black symbols are samples containing sufficient individuals for index calculation, and white symbols are samples containing insufficient individuals for index calculation. Dashed lines represent the threshold for identifying impairment with each index (i.e., 39 for the SCIBI, and 0.66 for the O/E).

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not be valid. Furthermore, 55 samples had fewer than 270 unambiguously identified individuals, meaning that O/E scores may not be valid for these samples.

Several samples had extremely low counts (e.g., four individuals; Table 2). Most of these samples were collected by the RWB sampling method. Nearly half (21 out of 45) of RWB samples had fewer than 450 individuals. In contrast, only 2 MCM samples and 6 TRC samples had fewer than 450 individuals. The adjusted efficacy rate, a site-adjusted estimate of sampling efficacy, for the MCM method (54%) was twice that of RWB (27%). The adjusted efficacy rate for TRC (46%) was nearly as high as that of the MCM method. However, these differences fell short of statistical significance after Bonferroni corrections were applied (i.e., $p > 0.017$). The rates were slightly higher for samples with at least 270 individuals at 67, 32, and 67% for MCM, RWB, and TRC, respectively, and these differences were statistically significant (McNemar's test $p = 0.0039$).

Comparability

Sampling methods comparability was good in terms of both multivariate community structure and index scores. Mantel's test showed significant correlations among benthic macroinvertebrate communities collected by all three sampling methods (Table 3). However, the RWB method had weaker correlations with both TRC (0.40) and MCM (0.45), compared to the higher correlation observed between TRC and MCM (0.69). In all cases, the correlations were significant ($p < 0.002$).

Variance components analysis showed that the methods were highly comparable and that site accounted for nearly all of the explained variance in both indices. The analysis of SCIBI scores included 7 sites and 26 samples; the analysis of O/E scores included 10 sites and 52 samples. Site accounted for 100% of the explained variance in SCIBI scores and 95% in O/E scores. Method and interaction between site and method explained none or negligible components of the variance in these indices (0 to 5%).

Table 3. Mantel correlations between sampling methods. Asterisk denotes statistical significance (p <0.017).

Method 1	Method 2	Mantel's R	P
RWB	MCM	0.45	0.001*
RWB	TRC	0.40	0.002*
MCM	TRC	0.69	0.001*

Significant disagreements between pairs of sampling methods were not observed for either index (Table 4; Figure 3). Slopes for all three comparisons were not significantly different from 1, and no intercepts were significantly different from 0. Consistency among SCIBI scores was best (i.e., slope closest to 1) between the MCM and TRC methods (slope = 0.96) and worst for the MCM and RWB methods (slope = 0.62). In contrast, consistency among O/E scores was best between the MCM and RWB methods (slope = 0.97) and worst for the RWB and TRC methods (slope = 0.72). Theil's test confirmed the lack of significant disagreements among IBI and O/E scores between pairs of methods. No differences between sampling methods were significantly related to log watershed area or stream order (regression slope and intercept $p > 0.05$).

Sensitivity

Sensitivity of both indices to gradients in land cover was poor, although to some extent the relationships were affected by sampling method, specific cover type, and geographic scale (Table 5; Figure 4). For example, O/E scores were strongly and negatively correlated with agricultural land cover in the

Table 2. Samples, sites, and efficacy by method. Adjusted Rate = site-adjusted estimate of efficacy rate.

Method	Total		≥ 450 Organisms			≥ 270 Organisms		
	Samples	Sites	Samples		Adjusted Rate	Samples		Adjusted Rate
MCM	45	21	34	76%	54%	32	71%	67%
RWB	45	21	17	38%	27%	14	31%	32%
TRC	45	21	29	64%	46%	30	67%	67%

Table 4. Regressions of mean IBI and O/E scores for each method. Slopes were tested against 1 and intercepts were tested against 0. Methods 1 and 2 plotted on x and y axis, respectively, in Figure 3. SE = Standard error.

Index	Method 1 (x)	Method 2 (y)	n	r^2	Slope	SE	p	Intercept	SE	p
SCIBI	MCM	TRC	14	0.77	0.96	0.15	0.803	2.52	3.96	0.537
	MCM	RWB	7	0.45	0.62	0.25	0.194	6.31	5.53	0.305
	MH	TRC	7	0.74	1.18	0.28	0.540	-0.30	5.63	0.959
O/E	MCM	TRC	14	0.78	0.86	0.13	0.284	0.02	0.04	0.633
	MCM	RWB	8	0.90	0.97	0.13	0.816	0.02	0.04	0.653
	RWB	TRC	8	0.71	0.72	0.19	0.185	0.06	0.06	0.401

watershed (Spearman's ρ ranged from -0.46 to -0.89 across sampling methods). However, most relationships between index scores and land cover metrics were not statistically significant (i.e., $p < 0.008$). Only the relationship between O/E scores from RWB samples were significantly correlated with agricultural land use in the watershed ($\rho = -0.89$, $p = 0.003$). Although the direction of correlation often met expectations (e.g., % open space in the watershed vs. SCIBI; Figure 4c), a few showed no clear relationship (e.g., % developed land in the watershed vs. O/E; Figure 4d).

Precision

Sampling method affected the precision of both the SCIBI and O/E scores (Table 6). For example, the RWB sampling method had the largest MDD for the SCIBI: 22 vs. 19 for the other two methods. However, RWB had the lowest MDD when O/E

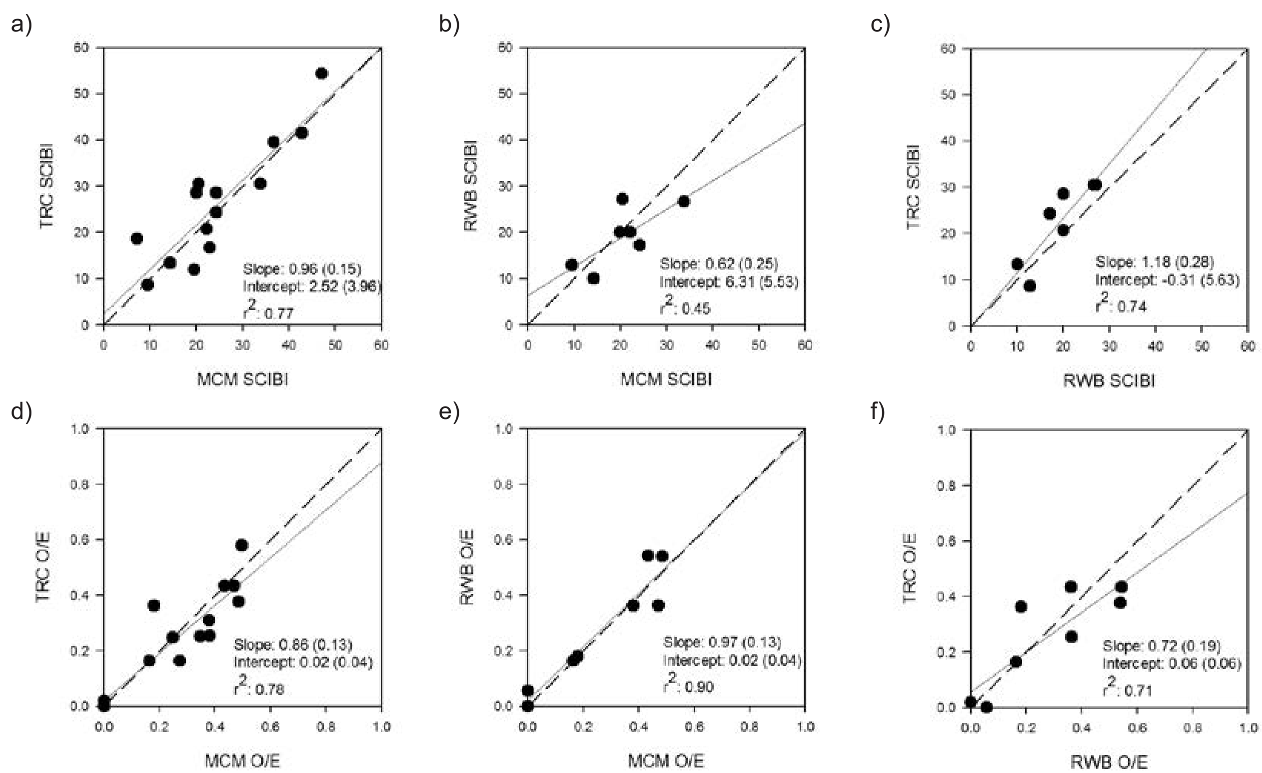

Figure 3. Agreement between the sampling methods for Southern California Index of Biotic Integrity (SCIBI; a – c) and Observed/Expected (O/E; d – f) scores Each point represents the mean index score at a site. Solid lines represent linear regressions, and dashed lines represent perfect 1:1 relationships. Numbers in parentheses are standard errors. Slopes were tested against 1, and intercepts were tested against 0.

Table 5. Spearman rank correlations (ρ) between bioassessment indices and landscape metrics. * = statistical significance (p <0.008).

Index	Land Cover	Method	Watershed			1 km radius		
			n	ρ	p	n	ρ	P
SCIBI	% Developed	MCM	15	-0.08	0.783	15	0.11	0.685
		RWB	7	-0.75	0.054	7	-0.59	0.159
		TRC	14	-0.32	0.914	14	0.20	0.487
	% Open	MCM	15	-0.04	0.892	15	0.09	0.742
		RWB	7	0.62	0.139	7	0.67	0.102
		TRC	14	-0.04	0.890	14	-0.08	0.782
	% Agricultural	MCM	15	0.06	0.842	15	-0.11	0.689
		RWB	7	0.12	0.799	7	0.22	0.628
		TRC	14	0.00	0.991	14	-0.02	0.954
O/E	% Developed	MCM	15	0.14	0.640	15	0.35	0.202
		RWB	8	-0.28	0.509	8	-0.07	0.866
		TRC	17	0.23	0.370	17	0.31	0.222
	% Open	MCM	15	-0.05	0.857	15	0.01	0.980
		RWB	8	0.40	0.333	8	0.17	0.693
		TRC	17	-0.24	0.355	17	0.02	0.948
	% Agricultural	MCM	15	-0.67	0.009	15	-0.24	0.388
		RWB	8	-0.89	0.003*	8	-0.15	0.719
		TRC	17	-0.46	0.064	17	-0.31	0.220

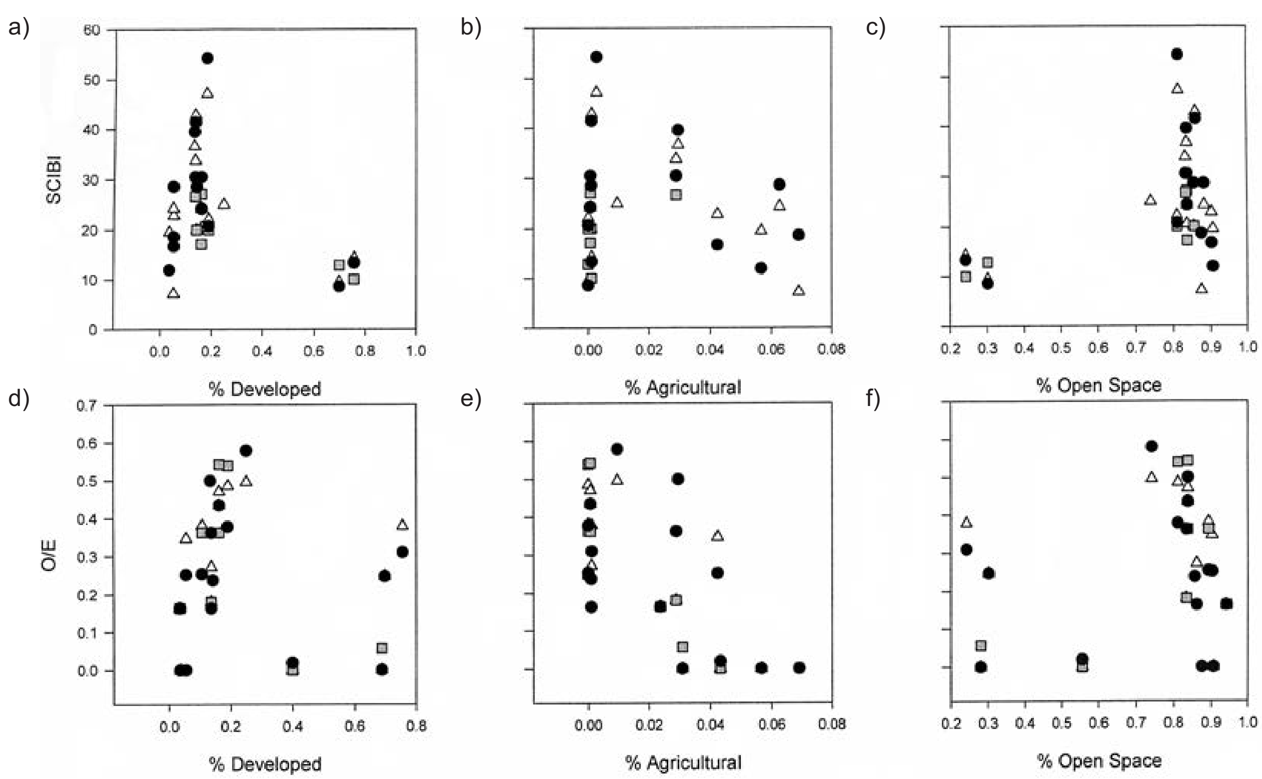

Figure 4. Index scores versus land cover metrics. Each point represents the mean of all samples collected by one method at each site. White triangles represent MCM samples. Gray squares represent RWB samples. Black circles represent TRC samples.

Table 6. Within-site variability (expressed as mean square error, MSE) and minimum detectable difference (from a two-sample, 2-tailed t-test with n = 30, α = 0.05, and β = 0.1) for each of the sampling methods. d.f.: degrees of freedom. SS: sum of squares. MSE: mean square error. MDD: mean detectable difference.

Index	Method		d.f.	SS	MSE	F	p	MDD
SCIBI	TRC	Sites	7	2507	358	12.5	>0.0001	19
		Residuals	15	430	29			
	RWB	Sites	3	403	134	3.7	0.0701	22
		Residuals	7	254	36			
	MCM	Sites	8	1745	218	8.0	0.0002	19
		Residuals	16	437	27			
O/E	TRC	Sites	8	0.625	0.078	12.7	>0.0001	0.28
		Residuals	13	0.074	0.006			
	RWB	Sites	3	0.115	0.038	14.5	0.0037	0 20
		Residuals	6	0.016	0.003			
	MCM	Sites	9	0.860	0.096	20.9	>0.0001	0.24
		Residuals	17	0.078	0.005			

scores were used: 0.20 vs. 0.28 for TRC and 0.24 for MCM. Coefficients of variation showed similar trends in variability among methods when SCIBI scores were used, (ranging from 22 to 27%), and lower CVs for RWB when O/E scores were used: 12 vs. 20% for MCM and 45% for TRC.

The low number of samples containing adequate numbers of individuals meant that estimates of within-site variance were sometimes based on very small samples. For example, only four sites in the region using the SCIBI had multiple samples with sufficient numbers of organisms collected by the RWB method. This problem was less severe for estimates based on O/E scores because fewer individuals per sample are required for index calculation, and because sites in the Central Valley and San Francisco Bay area could be included in the estimates.

Discussion

Low-gradient streams are distinct from other streams in many aspects, such as substrate material, bed morphology, and the distribution of microhabitats (Montgomery and Buffington 1997). As a consequence of these differences, traditional bioassessment approaches in California that were developed in high-gradient streams with diverse microhabitats have limited applications in low-gradient reaches. The sampling methods evaluated in this study differed in the extent to which they targeted the richest microhabitats (such as riffles, or vegetated margins). For example, the TRC method allows field crews to select the richest microhabitats specifically. In contrast, the RWB method may systematically undersample or miss these habitats entirely, as the richest areas in low-gradient streams are typically found at the margins (Montgomery and Buffington 1997). The MCM method, a modification of the RWB method, was designed so that these margins could be targeted.

Caution should be used when applying sampling methods or assessment tools that were calibrated for specific habitat types (e.g., high-gradient streams) to new habitats (e.g., low-gradient streams). The present study's evaluation of assessment tools unveiled a number of shortcomings that weaken application of these tools in low-gradient streams, including the inability to collect adequate numbers of organisms, poor sensitivity of assessments, and low precision of the sampling methods. Significant disagreements among the methods were not detected, although power was low because of the low number of samples. The inability of the RWB sampling method to collect an adequate number of individuals in nearly half of all samples makes it unsuitable for low-gradient streams, even though this method is widely used by bioassessment programs in California (Ode 2007) and across the USA (Peck *et al*. 2006). Although biomonitoring programs must assess a diverse range of habitat types with available tools, the present study indicates that these programs may be well served by evaluating tools in novel habitats where monitoring activities occur.

Variance components analysis of assessment indices showed that differences among sites explained more of the variance in index scores than differences among sampling methods, suggesting that similar types of benthic macroinvertebrates are collected by the different methods. However, analysis of disagreements among the methods indicated that some samples collected by RWB were distinct from those collected by TRC, and samples collected by MCM were intermediate between the other two. For example, samples collected by TRC had lower O/E scores than samples collected by MCM, which in turn were lower than those collected by RWB. However, differences among these methods did not reach statistical significance.

Other studies comparing single, targeted habitat sampling methods (e.g., TRC) to multi-habitat sampling methods (e.g., RWB) have shown similar results. For example, MDDs reported in other studies (or calculated from reported variabilities) were comparable to those reported here, although generally larger (Rehn *et al*. 2007, Blocksom *et al*. 2008). However, these studies found that multi-habitat sampling reduced variability in multimetric indices, whereas the present study found that variability was lower for the single habitat method (i.e., TRC; Table 7). As in Rehn *et al*. (2007), the present study found that TRC samples had higher O/E scores than RWB samples, but that the strength of disagreement was inconsistent in the largest watersheds.

The generally weak response of the indices to land cover metrics suggests that the SCIBI and O/E may not be sensitive to variability in watershed-scale disturbance in low-gradient streams. This conclusion is tempered by small sample sizes that limited power, and sensitivity to reach-scale degradation was not explored in this study for lack of data. Several studies have shown the strong impact of reach-scale factors on benthic macroinvertebrates, which may exceed the influence of watershed-scale stressors (e.g., Hickey and Doran 2004, Sandin and Johnson 2004). Furthermore, most of the watersheds in the study were highly altered, particularly those in the region of the SCIBI, and portions of the disturbance gradient to which these indices are more sensitive may not have been adequately sampled. Several studies have found that biota responds to disturbance gradients ≤10% development in a watershed, but responses above this gradient are muted (e.g., Hatt *et al*. 2004, Walsh *et al*. 2007). Agricultural land cover, which was low in most watersheds (<10%), showed strong responses with the indices, suggesting that the study was able to capture portions of this gradient to which both the SCIBI and O/E were sensitive.

The low numbers of organisms collected from the low-gradient streams in the study may reflect the naturally low population densities of benthic macroinvertebrates in these reaches. The River Continuum Concept hypothesizes that higher order streams with larger watersheds have a lower energy base because of reduced allochthonous input and depressed autochthonous productivity (Vannote *et al*. 1980). This lower energy base would be expected to support reduced biomass. However, observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated margins) may account for the reduced numbers of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low-gradient streams in California. A well known, but extreme, example of the impact of shifting sandy substrates on maintaining low densities of benthic macroinvertebrates are the migrating submerged dunes in the lower

Table 7. Minimum detectable differences in multimetric indices. Southern California Index of Biotic Integrity (SCIBI); Northern California Index of Biotic Integrity (NICIBI); Virginia Stream Condition Index (VSCI); Macroinvertebrate Biotic Integrity Index (MBII); California O/E Index (O/E); and NT = not tested.

Index type	Method	Present study	Rehn *et al*. 2007	Blocksom *et al*. 2008	
Multimetric index	Single-habitat	19.2 (SCIBI)	19.7 (SCIBI + NCIBI)	19.88 (VSCI)	29.79 (MBII)
	Multi-habitat	22.6 (SCIBI)	15.5 (SCIBI + NCIBI)	17.37 (VSCI)	17.91 (MBII)
Predictive model	Single-habitat	0.28 (O/E)	0.22 (O/E)	NT	NT
	Multi-habitat	0.20 (O/E)	0.19 (O/E)	NT	NT

Amazon River (Sioli 1975, Lewis, Jr. *et al*. 2006). Although very high productivity of Chironomidae and other benthic macroinvertebrates has been observed in low-gradient sandy rivers of the southeastern United States, this productivity was attributed to snags and other stable microhabitats, more than to the shifting sandy substrate (Benke 1998). Thus, the vast majority of the macroinvertebrate activity in a large reach of river was found in small areas containing snags (Wallace and Benke 1984). Snag microhabitats are arguably less common in streams of the arid Southwest, which lack dense riparian forests to contribute snag-forming woody debris and may be less likely to be sampled using a systematic sampling method like RWB.

Bioassessment programs are often required to make do with available tools to fulfill regulatory mandates, yet they lack resources to evaluate the tools for applications in all habitats of concern. Although all sampling methods in this study suffered from poor efficiency in collecting organisms, the MCM method greatly improved efficacy and reduced the frequency of rejected samples. Furthermore, the lack of significant disagreements and inconsistencies suggests that the MCM method produced results that were comparable to the other methods already in use in California, which may facilitate integration of historical data sets (Cao *et al*. 2005, Rehn *et al*. 2007). Therefore, the present study supports the use of MCM in low-gradient streams in California as a substitute for the currently preferred RWB method. Overall, bioassessment programs can improve data quality and avoid unnecessary expenses by explicitly evaluating assessment tools when assessing novel habitat types.

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Appendix 10

B309

SWAMP
Surface Water Ambient Monitoring Program

Final Technical Report | **2009**

Evaluation of the California State Water Resource Control Board's Bioassessment Program

March 15, 2009

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B310

Evaluation of the California State Water Resource Control Board's Bioassessment Program

March 15, 2009

Final Report to U.S. EPA-OST and Region IX

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EXECUTIVE SUMMARY

The State of California's bioassessment, monitoring and assessment (M&A), and water quality standards (WQS) programs were reviewed in January 2008 using the U.S. EPA's Critical Technical Elements and Programmatic Review process (Barbour and Yoder 2008; Quasney and Yoder 2008), which evaluates key components of these state programs and existing and planned capacities. The review process results in technical, policy, and management recommendations for building, refining and maintaining functional and effective bioassessment and M&A tools that support the full spectrum of WQS and management programs. This review was conducted by a two person review team with national expertise at evaluating, building, and implementing state and tribal programs.

Bioassessment, the use of resident aquatic biota as direct indicators of the biological integrity of water bodies, is a powerful tool for water resource regulatory programs. The need for state water quality agencies to develop and maintain robust bioassessment programs is underscored by the National Research Council's critical review of state TMDL, M&A, and WQS programs (National Research Council 2001). The NRC's review makes clear that all states need better biological endpoints, adequate M&A, and tiered aquatic life uses (TALU) in order to develop and refine appropriate and effective WQS that result in more accurate and appropriate management outcomes including TMDLs.

While the federal Clean Water Act (CWA) has long required states to protect and restore the chemical, physical, **and** biological integrity of the nation's waters, California has only recently begun to consider the developments that it will need in order to implement modernized WQS that lead to more effective water quality management programs. Because of the prior investment in the development of bioassessment tools since the mid-1990s, California is now positioned to initiate the process of integrating bioassessments into their WQS and monitoring and assessment programs via the development and implementation of narrative and numeric biocriteria.

Key Findings of the Review:

1. California's bioassessment program has made great strides in recent years due primarily to investments made by the Dept. of Fish and Game's Aquatic Bioassessment Laboratory (DFG-ABL) and the Water Board's Surface Water Ambient Monitoring Program (SWAMP). With continued management support, SWAMP is capable of building, maintaining and refining the technical tools that the Water Boards will need to incorporate biological criteria and assessments into their water quality programs.

2. As determined by the U.S. EPA Critical Technical Elements methodology California's bioassessment program is currently at an above average level of rigor (Level 3; 88.3%) and is being used in statewide 305(b) assessments, the 303(d) listing/delisting process, and in support of specific regulatory needs in selected Regions. Continued investment

and active management support will be needed to achieve a fully functional (CE Level 4) program that will provide more comprehensive support for the suite of regulatory needs and in all Regions.

3. California's bioassessment program is currently capable of addressing wadeable perennial streams. Additional investment and technical development will be needed to address other waterbody types including large non-wadeable rivers, non-perennial streams, lakes, and wetlands.

4. SWAMP has invested a significant amount of financial resources to develop the current bioassessment infrastructure. However, full implementation of California's bioassessment program is constrained by the fact that most of the program is conducted by contractors. This review affirms the findings of prior peer reviews that the Water Board needs its own in-house bioassessment coordinator and staff. This will enhance the integration of monitoring and assessment results in al facets of water quality management.

5. While the DFG-ABL, SWAMP, and their contractors are building a solid technical foundation for a robust freshwater bioassessment program, they can only provide the technical tools for developing biological endpoints and Tiered Aquatic Life Uses (TALUs). The State and Regional Water Boards will need additional biologists and planning staff to develop, refine and implement narrative/ numeric biocriteria and TALUs in support of all applicable regulatory programs and at the same spatial scale at which they are being applied.

Management Recommendations:

1. The Water Boards should revise the structure and content of the beneficial uses and criteria related to aquatic life uses to more accurately reflect the natural attributes of the diversity of watersheds through the state. This is consistent with recommendations from the NRC (2001) and the SPARC (2006).

2. The Water Boards should integrate biological assessment tools into their water quality programs (WQS, NPDES, and TMDLs). This represents a fundamental paradigm shift that will require strong management understanding and support.

3. The State Water Board should develop statewide narrative biocriteria which incorporate numeric biological endpoints to interpret the narrative objectives for aquatic life use protection as soon as possible.

4. The Water Boards should require key program units (e.g., WQS, NPDES, TMDL) to incorporate biological assessments into their programs and program evaluation. Adopting biological criteria within a framework of TALUs would enhance its implementation in these programs.

5. The Water Boards should assign staff and provide training to programs incorporating biological assessments. This includes support for statewide efforts and ongoing efforts at the Regional Boards.

6. The State Water Board should create and maintain a specialist position for a state-wide bioassessment policy coordinator. This is consistent with the recommendation made in a prior external peer review of SWAMP's bioassessment program (Barbour and Hill 2003).

Technical Recommendations: [NOTE: the following recommendations are based in part on the Critical Elements evaluation conducted during the January 2008 program review and are based on elevating the technical rigor of the statewide and regional board programs to level 4.]

1. SWAMP should continue to support the technical infrastructure development strategy outlined in its FY06-07 and FY07-08 bioassessment work plans.

2. SWAMP should establish reference conditions for the objective interpretation of biological data and implement the reference condition management plan. This investment will pay dividends to all water quality programs using biological assessments. This would also serve the development of chemical/physical endpoint s and indicators as part of a program of integrated bioassessment.

3. SWAMP should develop additional indicators of ecological condition to supplement the benthic macroinvertebrate indicators currently in use. The consistent addition of a second assemblage in the bioassessment process is needed to elevate the program to level 4. Options for this include an algal assemblage indicator (currently in development by SWAMP), a wetland indicator (CRAM, also in development), and fish assemblage indicators (currently in development by USGS). SWAMP should continue to support efforts to determine which supplemental indicators are best suited to California's needs and for specific waterbody ecotypes (perennial wadeable streams, non-perennial streams, non-wadeable large rivers, wetlands).

4. SWAMP should continue to support development and maintenance of the biological component of the database. This provides the essential framework for statewide integration of biological and physical habitat data. Two priorities are tools to calculate biological metrics for water resource managers and tools to convey results to the public.

5. SWAMP should develop a QA/QC oversight program for the collection of ambient biological data. This would set the standard for SWAMP comparability for other Water Board programs and provide guidance to other agencies wishing to become SWAMP compatible. Adopting biocriteria and TALUs in the WQS would contribute to the compulsory standardization of the use of biological assessment data throughout the state and between the regions.

6. SWAMP should continue to support the statewide perennial stream assessment. This addresses the need to assess the condition of a major class of surface waters in California and provides a solid framework for integrating stream monitoring with other programs in the state.

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INTRODUCTION

U.S. EPA has supported the development of state and tribal bioassessment programs via the production of methods documents, case studies, regional workshops, and evaluations of individual state and tribal programs since 1990. Since 2000, EPA has fostered a more detailed and “hands on” developmental and implementation process for incorporating tiered aquatic life uses (TALUs) and numeric biocriteria in state and tribal water quality programs. The successful development and implementation of biocriteria and TALUs is directly dependent on the rigor, comprehensiveness, and integration of monitoring and assessment (M&A) with state water quality standards (WQS) and water quality management programs. This framework can also provide measures to evaluate the effectiveness of major water quality management programs such as NPDES permitting, TMDLs, nonpoint source management, stormwater management, and watershed planning.

On January 23-24, 2008 the U.S. EPA sponsored an evaluation of the Water Board’s biological assessment program. The purpose was to evaluate both the State’s technical program elements and its regulatory structure in order to make recommendations that will enhance CA’s ability to make informed decisions about the ecological condition and management of California’s rivers and streams. The scope of the review included a range of topics about the surface water monitoring and assessment program, the structure of the existing WQS, the development of bioassessment tools to delineate impaired waters and determine stressor effects, and the use of biological data to support Water Board programs including NPDES permitting, non point source management, stormwater management, and TMDLs.

The evaluation process consisted of direct interactions with state program management and staff to evaluate the status of their bioassessment, M&A, and WQS programs and to describe how each is used to support water quality management. The following include the principal reports and products of the EPA TALU development and implementation process since 1998.

1) *Important Concepts and Elements of a State Watershed Monitoring and Assessment Program (Yoder 1998):* This document was developed as a state oriented document following the Intergovernmental Task Force on Monitoring Water Quality and the U.S. EPA environmental indicators initiatives of the 1990s. It outlines the essential concepts and elements of what is referred to as an “adequate” state monitoring and assessment program. The term adequate was chosen to represent a cost-effective, yet comprehensive approach to monitoring that assures the use and development of chemical, physical, and biological indicators collected and arrayed in a strategic manner that results in supporting water quality management decisions at all relevant scales.

2) *Use of Biological Information to Better define Designated Aquatic Life Uses in State and Tribal Water Quality Standards: Tiered Aquatic Life Uses (August 2005):* This document serves as a detailed presentation of methods for developing and implementing TALUs in state WQS. It consists of detailed descriptions of the baseline elements of TALU – the

Biological Condition Gradient, elements and milestones for the incorporation of TALUs in WQS.

3) *Critical Elements Technical Elements of a Bioassessment Program (November 2007; updated September 2008):* The rigor of a state's program is evaluated in order to determine the capacity to assess ecological condition and diagnose impairment. This evaluation consists of thirteen technical elements associated with design, methods, and interpretation features of a bioassessment program that are rated jointly with the state program management and staff. The cumulative rating of the elements provides a level of rigor (ranging from level 1, the lowest level of rigor, to level 4, the highest and best suited for full program support) of the overall bioassessment program. The capacity to accurately address a suite of management questions and issues is dependent upon the level of rigor. A critical technical elements evaluation of the California bioassessment program was completed using the standardized checklist and scoring methodology (Barbour and Yoder 2007, 2008).

Part 1. Use of Bioassessment in State Water Board Programs

1. Monitoring and Assessment Program

The Surface Water Ambient Monitoring Program (SWAMP) is a statewide effort designed to monitor and assess the conditions of surface waters throughout the state of California. SWAMP was proposed in 2000 (SWRCB 2000) in response to a legislative directive to integrate existing water quality monitoring activities of the State Water Resources Control Board and the nine Regional Water Quality Control Boards (Regional Water Boards), and to coordinate with other monitoring programs. The needs of an emerging TMDL process, inconsistencies between regional boards, and information needs for regulatory decision-making were some of the principal drivers.

SWAMP has fostered the development of biological assessments because they provide a direct and quantitative measure of aquatic life use protection. A major review of the program was conducted in 2003 (Barbour and Hill 2003). In 2005, the SWAMP Scientific Planning and Review Committee (SPARC 2006) recommended "The State Board should adjust water quality management approaches to take advantage of the more direct measures SWAMP is developing of aquatic life condition through bioassessment monitoring".

Tools for assessing biological assemblages in perennial wadeable streams are currently the most well-developed of the biological monitoring tools; this is largely the result of investments made by the Department of Fish and Game's Aquatic Bioassessment Laboratory (DFG-ABL) and SWAMP since the mid 1990s. The State has made significant progress with the use of benthic macroinvertebrates in stream bioassessments, but has recently begun to develop and implement an Algae Plan (SCCWRP 2008), and is also evaluating the utility of the California Rapid Assessment Methodology (CRAM) as a tool for assessing riparian wetland habitat. SWAMP is also considering the utility of fish bioassessments in California. It is also recognized that there are additional freshwater ecotypes and strata that need to be addressed to meet the goal of providing full water quality management program support (Table 1)

Ecotype	Habitat	Algae	Invertebrates	Fish
Ephemeral	Y			
Intermittent	Y	?	?	?
Perennial	pHab CRAM	□ cover Biomass Algal IBI	IBI or O□E	?
Rivers	pHab CRAM	Y	Y	Y
Lakes□Reservoirs	pHab CRAM	Y	Y	Y
Bay□Estuaries	CRAM	Y	BRI	Y
Coast□Ocean		Y	So Cal BRI	So Cal Fish Index

Table 1. Summary of biological indicator development efforts in California by major aquatic ecotypes.

Additional investment will be needed to develop and maintain a program that is capable of addressing other waterbody types (e.g., large non-wadeable rivers, non-perennial streams, lakes, wetlands). Indicator work done on perennial streams may applicable to other waterbody types. For instance studies are underway to investigate the use of macroinvertebrate assemblages and periphyton to assess intermittent and ephemeral streams. The CRAM wetland methodologies can be applied to intermittent and ephemeral streams but also to lakes and estuaries. California has also participated in national and regional bioassessment projects such as U.S. EPA-EMAP and REMAP surveys, the National Wadeable Streams Assessment, the National Lakes Assessment, and the National Rivers and Streams Assessment each of which lends experience with these other waterbody types.

California has begun moving from conducting simple biosurveys (i.e., the collection of limited sets of biological samples) to more spatially robust bioassessments of ecological condition. This has occurred within selected Regional Boards and these can serve as a template for all Water Boards. The next challenge will be the development of biological criteria to better inform and guide water quality management decision-making. While SWAMP and the selected Region Board programs have contributed the technical rigor required by this process, it will require considerations that apply within specific regions of the state. Hence it needs to be a coordinated effort with consistent participation and integration between the state and regional water boards.

2. Role of Bioassessment in Listing Decisions

Waterbody listings are presently based on exceedences of water quality criteria. The State Board's listing policy (SWRCB, 2004) provides detailed guidance on the interpretation of chemical and toxicity data. Listing and de-listing decisions are based on the frequency with which numeric water quality criteria are exceeded as defined in the listing policy and interpreted through the use of a binomial probability distribution. Assessment of physical and biological data is more difficult because there are no numeric criteria. Listings are therefore based on the interpretation of narrative criteria.

A water body may be listed if there is significant degradation in biological populations and/or assemblages as compared to reference site(s), but only if it is associated with a pollutant. The analysis of biological communities must rely on measurements conducted using published protocols from at least two stations and requires that comparisons to reference site conditions shall be made during similar seasonal and/or hydrological periods.

Regional Boards using biological information in the listing process are required to: 1) identify appropriate reference sites and document methods for the selection of reference sites, 2) document the sampling methods, index period and quality assurance/quality control procedures for the habitats being sampled, and 3) compare bioassessment data to conditions at reference sites and evaluate physical and other water quality data to support any assessment conclusions. The listing policy encourages the use of indices of biological integrity (such as the IBIs developed by SWAMP).

A significant number of waterbodies have been listed in the past for sediment, excess algae, hydromodification, and water diversions using best professional judgment to interpret narrative standards in the Basin Plans. The lack of a quantitative biological endpoint or numeric biocriteria for attainment of aquatic life can create challenges for managers.

3. Water Quality Standards

Water quality standards (WQS) provide the objectives for both developing the requirements for and judging the effectiveness of pollution controls and management programs. The California WQS are comprised of beneficial uses, numeric and narrative criteria (objectives) to protect those beneficial uses, and an antidegradation policy.

Beneficial Uses. At present there are 6 defined "beneficial uses" that apply to the protection of aquatic life use in fresh water across the state. These are cold fresh water habitat (COLD), warm fresh water habitat (WARM), spawning (SPAWN) and migration (MIGR) of aquatic species, habitat for wildlife in general (WILD) and for rare, threatened, and endangered species (RARE), and the preservation of biological habitats of special significance (BIOL). These uses are applied to specific watersheds through Regional Water Quality Control Plans (Basin Plans) that are developed, administrated and enforced by the Regional Water Boards. Two Regional Boards have wetland habitat (WET) as a defined beneficial use and the State Board is considering application of the wetland use as part of a hydromodification policy.

These aquatic life use designations define the general types of organisms, assemblages and habitats that are being protected. For instance, COLD use designation protects "uses of water that support cold water ecosystems including, but not limited to, preservation and enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates". Aquatic life use support assessment is challenging in California because expectations for the aquatic life use support will naturally vary across the state. The current generic aquatic life use designations simply do not account for the natural variability in rivers and streams across the broad biogeographic regions of the state.

The SPARC recommended that the Water Boards use the National Research Council (2001) recommended framework to revise and refine the designated uses, the supporting protective criteria, and the attainment assessment procedures to more fully reflect the diversity of watersheds and their respective/desired attainable human and aquatic life uses. U.S. EPA (2005) largely followed the NRC (2001) recommendations in their methodological guidance for developing and implementing a TALU approach to WQS and monitoring and assessment. That framework and the technical developments to date are the basis for this review.

<u>Numeric and Narrative Objectives</u>. There are relatively few numeric objectives for the protection of aquatic life. The California Toxics Rule contains numeric water quality objectives for 22 chemicals. The Basin Plans have limited objectives for additional toxics. Narrative objectives in the Basin Plans related to the protection of aquatic life use are generally expressed in the form of "no toxics in toxic amounts", "no significant degradation", or "no significant deviation from reference". State and Regional Board staff engaged in assessments have little guidance on how to interpret these narrative objectives. A TALU framework and numeric biocriteria would greatly clarify these endpoints.

The biological information being generated through SWAMP can be used to establish biological expectations for different waterbodies across the state. This is a first step in the establishment of biological criteria. Such information and data may also be used to support the development or refinement of other water quality objectives (e.g. temperature, dissolved oxygen or nutrient criteria) or program applications (e.g., 401 certifications) across the state. The SWAMP Reference Condition Management Plan (Ode and Schiff, 2008) lays out a strategy for establishing biological expectations.

<u>Antidegradation</u>. The state's antidegradation policy is incorporated in the Basin Plans by reference. Biological information is not typically used in antidegradation analyses, but it has the potential to enhance their application. Biological assessment could be used as a direct measure of instream aquatic life use and to provide a trigger for antidegradation analyses when such assessments indicate that there is degradation of water quality. The biological assessment tools developed already provide a method to measure condition incrementally thus enhancing

its utility for detecting incremental changes that may not reflect a violation of standards. This capacity will enhance its usefulness in new antidegradation applications.

4. Use of Bioassessment in other Board Programs

Monitoring and assessment activities should be designed to provide information and tools to support multiple programmatic activities with the same data and information. As biological assessments provide a direct measure of aquatic life use they can help program managers prioritize management actions to protect and restore beneficial uses. They can also be used as outcome measures to evaluate the effectiveness of various programs (e.g., NPS, NPDES, and TMDLs) to protect and restore beneficial uses.

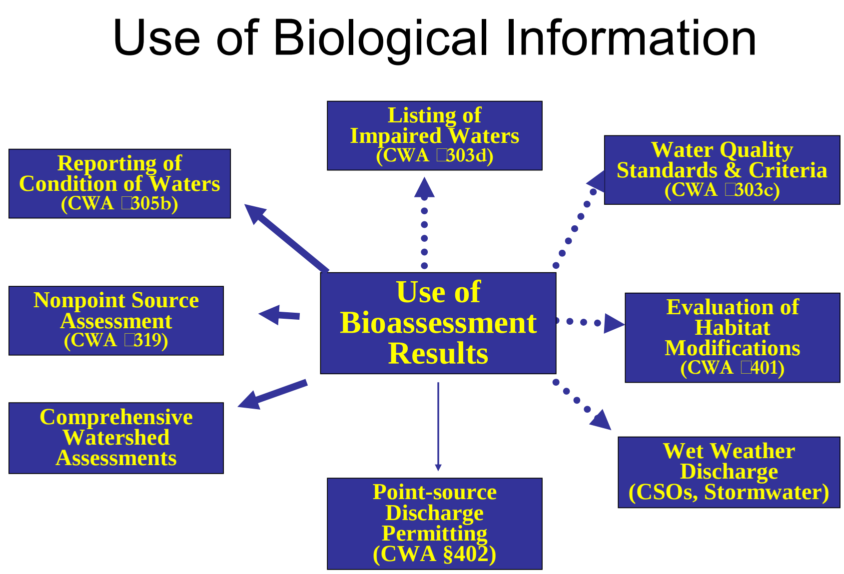

Figure 1. Efforts to develop strong monitoring and assessment programs lead to support for multiple water quality management programs.

NPDES. The use of biological data in NPDES permits and WDRs in California dates back to the early 1990's. Bioassessments have been used mostly in "upstream-downstream" designs to assess the impact of point source dischargers such as POTWs, but are also increasingly being used in stormwater permits. In Southern California alone, 323 bioassessment samples are collected by stormwater agencies each year as part of their MS4 permit requirements. The State Board's SWAMP program is developing draft permit language to assist Water Board staff that wish to incorporate freshwater bioassessment into permit requirements and/or other Water Board programs or projects. The boilerplate language will include guidance on field and lab methods, index periods for sampling, and the required QA and data submittal procedures. Interpretation of bioassessment results have largely been relative to reference site or locally derived IBIs, where available.

NPS. Bioassessments have been used in a number of nonpoint source projects to assess the effectiveness of actions on water quality (instream biota). The State Board's nonpoint source program has helped fund monitoring of perennial streams to identify the extent of the states streams that are impacted by nonpoint source pollution and to identify the stressors that are impacting streams (Ode, 2007). Funds have also been used to support development of stressor identification tools (Rehn, 2006) and improve understanding of associations between biological assemblages and key stressors associated with NPS activities (e.g., agricultural and urban land uses).

TMDLs. Bioassessments have been used primarily as targets for TMDL monitoring in California rather than as direct biological endpoints. The endpoints in most TMDLs are primarily water quality endpoints rather than biological endpoints. However, the translation of bioassessment results to relevant TMDL endpoints is a next step in increasing the programmatic uses of bioassessment information in California. It will also enhance the comprehensiveness, relevancy, and applicability of TMDLs by focusing on the most limiting factors beyond the expected impact of individual pollutants by also highlighting their associated interactions and co-occurring stressors such as habitat and land use.

Part 2. Critical Elements Evaluation

The critical technical elements of bioassessment programs are described and divided into four general levels of rigor supported by a sliding scale of resolution and development (Barbour and Yoder 2007, 2008). A level 4 program is the most rigorous and the most capable of fully addressing the myriad of management issues regarding aquatic resources that are commonly faced by states and tribes. The remaining three levels of bioassessment rigor may be appropriate for some, but not all of the water quality management program support needs of state programs. Delineating the extent and severity of aquatic life impairments and diagnosing categorical and parameter-specific stressors are the primary tasks for a TALU based approach to monitoring and assessment that is intended to support multiple water quality management programs (Yoder and Barbour 2009).

A critical elements (CE) evaluation was conducted by proceeding through the CE checklist in accordance with the methodology in Barbour and Yoder (2007). The statewide program yielded a raw score of 53 out of the maximum possible score of 60 which equates to a mid-level 3 program; the two Regional board programs that were also evaluated were borderline level 3. The results for each element are discussed below (See Appendix 2 for checklist):

1. Index Period. *An index period is a consistent seasonal time frame for sampling the assemblage that is a cost-effective alternative to sampling on a year-round basis to account for seasonal variations. Ideally, the optimal index period corresponds to recruitment cycles of the organisms (based on reproduction, emergence, growth, and migration patterns). Sampling during an index period minimizes between-year variability*.

The statewide program adheres to a standardized index period (April to October) that slides from north to south to reflect differences in temperature. In southern California the index period is from April to October for the multimetric index (April to June for the O/E models); in northern California the index period is generally from August to September. Most Regional Boards adhere to this but there is some accommodation to support program needs. A CE score of 4.0 out of 4.5 was given to the California program.

2. Spatial Coverage. *Available resources and the desired outcome of the sampling design are key determinants in achieving adequate coverage.*

The “universe” of monitoring and assessment needs in California is spatially extensive and diverse. The nine regional boards incorporate a wide diversity of hydrological, landscape, and natural regional strata. No single design can meet all the State of California’s monitoring objectives.

SWAMP is using a probabilistic sampling design to obtain unbiased estimates of the biological conditions of perennial streams across the state and to track trends in biological conditions over time. The design of the SWAMP Perennial Stream Assessment (PSA) survey is cost effective because the entire resource need not be sampled – only a representative sample of streams. Another advantage of the probability-based design is that it allows the coordination/integration of other probability-based designs. In California the perennial stream survey is being coordinated with national stream assessments, regional watershed assessments being performed by Regional Boards Southern California (i.e., RB4, RB8 and RB9) and includes significant contributions from the regulated community including the Stormwater Monitoring Coalition in southern California and the Regional Monitoring Program in the San Francisco Bay area. The principal spatial designs include a statewide probabilistic network consisting of approximately 100 sampling sites per year, stratified by 6 ecological regions.

Many Regional Boards use targeted monitoring designs. These might involve watershed scale designs that include a resolution at an 8-11 digit HUC spatial scale to meet their specific needs. The designs vary from upstream/downstream sampling to bottom-of-watershed monitoring designs to more distributed networks. Some Regional Boards are using a rotating watershed approach, with a goal of sampling all watersheds in a region within a fixed time period (5 years is a common goal). The actual numbers of targeted sites are dependent on regional funding levels and annual monitoring priorities. Measurements include core chemical, physical, and biological parameters per the statewide SWAMP methodology with supplemental parameters added based on region-specific needs. The results from the statewide SWAMP perennial stream surveys provide context for local sampling.

The combined score of 4.0 reflects the practical integration of the statewide (which includes a combination of probability and targeted sites) and partial integration of Regional Board programs into the overall State Board effort.

3. Natural Classification. *In developing a bioassessment program, USEPA recommends classifying waterbodies more specifically than simply by waterbody type (e.g., river, lake, etc.), because it is highly unlikely that the biological condition of any given waterbody type is uniform throughout any anthropogenically-defined boundary. The classification of waterbodies is useful* *in partitioning natural variability and distinguishing it from variability resulting from human-induced changes. Classification of waterbodies can be based on a combination of characteristics, i.e., watershed drainage size, ecological regions, elevation, temperature, and other physical features of the landscape and/or waterbody for each waterbody type (e.g., large rivers, wadeable streams, headwater streams). The number of sites sampled and the availability of candidate reference sites within each class may limit the number of classifications*.

The challenge for the SWAMP program is to develop a program accounts for biological variation caused by natural environmental gradient and balances statewide consistency with the flexibility to adapt to California's diverse regional settings. In the present scheme, California will be divided into different geographic regions based on coarse biogeographic similarities in order to partition some of the natural variability among regions. These boundaries are consistent with those being used in the SWAMP perennial stream survey. Within the biogeographic classification, additional factors such as watershed size, elevation, and precipitation may be used to define biological expectations.

The CE score of 3.5 will be elevated to 5.0 with the developments that are already underway.

4. Criteria for Reference Sites. *A reference site should be natural or minimally disturbed while maintaining essential attributes. When reference sites are used to establish reference conditions, the State needs to document how it selects reference sites (by what criteria) and how it uses them to define regional reference conditions. Factors to be considered in selecting reference sites include human population density and distribution, road density, and the proportion of mining, logging, agriculture, urbanization, grazing, or other land uses. Candidate reference sites are evaluated for these factors to determine the degree of human modification that has occurred. Sites are eliminated if they have undergone direct human modification.*

The SWAMP strategy for selecting and sampling reference sites is documented in its Reference Condition Management Plan (RCMP, Ode and Schiff, 2008 In Prep)". The SWAMP RCMP program has proposed a general strategy for identifying reference sites. California will be classified into broad biogeographic regions. A pool of reference sites will be assembled within each region through a sequential process of identification and screening of candidate sites. This pool of reference sites will be managed through an iterative review of data to refine regional boundaries, ensure continued stability of sites and ensure adequate representation of natural gradients. Finally a monitoring design will be created for sampling this pool of reference sites to document the range of biological and physical condition at reference sites, and to monitor changes to this condition over time.

Screening of candidate sites will be done primarily through a combination of evaluation of existing data, GIS techniques, expert knowledge and site visits. It is recognized that high quality reference sites may not exist in certain areas of the state such as the agriculturally dominated Central Valley or the intensely urbanized southern California coastal plain. An alternate model for site selection will be used in these cases.

The score of 5.0 for the statewide program reflects the high degree of development of reference site selection criteria and procedures. These criteria and procedures are likely to be refined as the RCMP is implemented.

5. Reference Conditions. *The issue of reference conditions is critical to the interpretation of biological data. Generally, USEPA recommends the use of a regional reference condition based on an aggregate of sites that allows for broader application in State water resource programs than site-specific conditions. There must be a sufficient number of reference sites to capture regional stratification and the range of natural variations in biological assemblages due to geology, climate, and other natural physicochemical differences. Ideally, reference conditions represent the highest biological conditions found in waterbodies undisturbed by anthropogenic stressors. Recognizing that pristine habitats are rare or non-existent, resource managers must decide on an acceptable level of disturbance to represent an attainable or existing reference condition. Reference condition can be derived from reference sites, an empirical model of expectations that may include knowledge of historical conditions, or a model extrapolated from ecological principles. Usually, data from sites that represent best attainable conditions (i.e., least disturbed) of a waterbody are used.*

The SWAMP plan for development of reference conditions is embodied in the RCMP (Ode and Schiff 2008). Currently, reference condition is being determined from a still growing network of 300+ "least impacted" reference sites (1998-present). The reference site plan envisages sampling at 50-75 sites/year. The design includes ecoregional stratification and representation of the full range of regionally important natural gradients (e.g., elevation, precipitation, etc.). Development of regional reference condition is in progress – not yet completed for all regions. The goal is to have 50 sites per region.

The CE score of 3.5 should improve to 4.0 with the addition of regional reference sites that are being established as part of the ongoing improvements above.

6. Taxonomic Resolution. *An assemblage is defined as an association of interacting populations of organisms in a given waterbody. Although a single assemblage may be sufficient to make an attainment determination, USEPA recommends the use of at least two to enhance confidence in the assessment findings (USEPA 1996) because each assemblage serves a different function in the aquatic community and may be susceptible to stress in varying manners and degrees. Taxonomic identification of each assemblage to genus or species level provides reliable information about sensitivity, tolerance, and ecological/environmental relationships. Genus/species identifications improve assessments using richness values or metrics as key endpoints. Identification to family level requires less expertise to perform and usually speeds up the assessment process.*

For macroinvertebrate taxonomic identifications, the SWAMP program has recommended resolution to genus/species for development datasets; scoring tools are usually calibrated to work with genus level identifications. To ensure consistency and rigor in taxonomic data, SWAMP provides primary support for the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT), which establishes and maintains taxonomic standards.

SWAMP should also support the activities of an algal taxonomic workgroup, similar to SAFIT, to develop a standard algal taxonomic effort as recommended by Fetscher and McLaughlin (2008). SWAMP is currently leveraging the efforts and expertise of its partners to develop algal indices in southern California and the central coast. In both these efforts, soft algae and diatoms are currently analyzed to the lowest practicable taxonomy (usually genus/species), but recommendations for level of taxonomy for general assessment purposes are pending the results of the index development process.

The CE score of 4.5 reflects the full development of the macroinvertebrate assemblage and the in progress development of a periphyton indicator. Reaching the CE score of 5.0 is contingent on the full development and use of a second assemblage.

7. Sample Collection. *Standardization of field methods is necessary to establish the validity and reliability of biological data used in an assessment. Thorough training of investigators, coupled with rigorous certification processes, enhances the ability to provide a consistent unit of effort. Strong oversight of activities and leadership of apprentice professionals are critical. Standardization is especially important when information will be used in later trend analysis. The development of standard operating procedures (SOPs) for field and laboratory methods must include an effective quality assurance (QA) program with QC checks.*

The SWAMP program has developed a statewide protocol for macroinvertebrate sampling and physical habitat characterization that is derived from the EPA's national EMAP protocols (Ode 2007b). The SWAMP bioassessment group will work closely with the SWAMP QA Officer to develop comprehensive Quality Assurance Oversight Plan for quality assurance and quality control of bioassessment data. This guidance will cover personnel qualifications, training and field audit procedures, procedures for documenting sources of field and lab (including taxonomic data) error, procedures for chain of custody documentation, requirements for measurement precision, health and safety warnings, cautions (actions that would result in instrument damage or compromised samples), and interferences (consequences of not following the standard operating procedure). As most of the SWAMP sampling is performed by the California Department of Fish and Game, the procedures for quality assurance and quality control are currently addressed in the Quality Assurance Project Plan.

The SWAMP program is currently sampling periphyton using procedures developed for the EMAP program. However methods for field and laboratory protocols for algal sampling, identification and quantification used by various agencies have not been standardized across the state. The recently drafted SWAMP Algae Plan (Fetscher and McLaughlin, 2008) details key considerations for algae-based bioassessments, including the need to standardize sample collection and taxonomic methods across the state.

The CE score of 5.0 reflects the full development of the macroinvertebrate and partial development of the periphyton assemblage methodologies for the statewide and regional programs.

8. Sample Processing. *A systematic treatment of samples is needed to ensure the greatest extent of accuracy and precision. A strong QA/QC program is desired to ensure that (1) sample sorting procedures are being followed and no organisms are missed in the sample, and (2) the taxonomy is consistent and accurate.*

The CE score of 5.0 out of 5.0 for the statewide program reflects the full development of sample processing procedures for macroinvertebrates (Ode, 2008). The State also has a plan to develop standard statewide sample processing methods for periphyton (Fetscher and McLaughlin, 2008).

9. Data Management. *A reliable, efficient and quality assured database management system is fundamental to a program's ability to use monitoring information effectively to solve environmental problems. A proper system for aggregating data and performing the necessary quality control checks is essential. Furthermore, integration of assessment information from multiple assemblages (fish, macroinvertebrate, algae, etc) can contribute important diagnostic information. Data management includes not only proper stewardship of raw data elements but also proper computation of biological metrics and biocriteria threshold information. A strong geographic information system (GIS) linked to a well-designed relational database moves programs toward a more comprehensive watershed perspective in interpreting monitoring data and improves the ability of biological data to meet the increasing information demands of State and federal programs, responsible parties, and the public.*

The SWAMP 2.5 database is a relational database that encompasses all SWAMP monitoring data and links to a large distributed network of state and federal monitoring data (CEDEN). New bioassessment modules for entering, storing and reporting bioassessment data are nearly complete. Future work includes the development of tools to facilitate QA/QC procedures, summarize physical habitat data, and calculate bioassessment metric and IBI calculations. The CE score of 4.5 for the statewide program can be improved to 5.0 once the current data management system includes all reporting fields and calculation routines.

10. Ecological Attributes. *Ecological attributes are those aspects of an aquatic assemblage or community that correspond to the structure and function of that assemblage or community for a given condition. EPA has suggested 10 primary ecological attributes that form a continuum of responses to human disturbance (USEPA 2005). Ten primary ecological attributes have been identified as the basis for evaluating the BCG (USEPA 2005; Davies and Jackson 2006). The first six attributes relate to taxonomic identity, composition, and tolerances. They are 1) historically documented, sensitive, long-lived, or regionally endemic taxa, 2) sensitive rare taxa, 3) sensitive ubiquitous taxa, 4) taxa of intermediate tolerance, 5) tolerant taxa, and 6) non-native taxa that tend to displace endemic taxa. The seventh attribute is organism condition, which provides* *information on individual health. The remaining three attributes are functional integrity, ecosystem connectance, and spatial and temporal extent of stressors.*

The SWAMP program has developed several regional macroinvertebrate MMIs that use ecological attribute metrics in their calibration. SWAMP will continue to refine ecological attribute characterizations as it completes/ revises future MMIs. The State is also in the early stages of developing periphyton indices for coastal stream and has developed a plan for the use of periphyton in stream assessments (Fetscher and McLaughlin 2008).

The CE score of 4.0 out of 4.5 should increase with the development of the macroinvertebrate MMI and O/E model for all bioregions and the addition of a second assemblage.

11. Biological Endpoints & Thresholds. *State bioassessment programs should implement index development and threshold selection. Numerous methods are available for analyzing biological indicator data to assess attainment status, including both univariate and multivariate analysis techniques. Thresholds are the benchmarks from which the biological condition needed to support designated uses are described Selecting this threshold is perhaps the most critical aspect in reporting and documenting attainment status.*

Multimetric indices for macroinvertebrate data have been developed for perennial streams in the North Coast (Rehn and Ode, 2005), for perennial streams in Southern California (Ode et al., 2005) and for perennial streams in the Sierra Nevada (Herbst and Silldorff 2008, Rehn 2007). The State is also using a set of three predictive models based on the River Invertebrate Prediction and Classification System (RIVPACs), which compares the list of taxa observed at a site (O) to the list of taxa expected (E) to occur at a given site in the absence of human disturbance. The statewide California RIVPACs models (C. Hawkins unpublished) incorporates geographic coordinates (latitude and longitude), watershed area, average precipitation, average temperature and percent sedimentary geology into its predictions.

The SWAMP program uses statistical criteria to generate impairment thresholds. In the case of the northern and southern coastal IBIs, thresholds separating impaired from non-impaired were set at 2 standard deviations below a mean reference score. For the RIVPACS scores categorization to into “Good”, “Poor” and “Very Poor used thresholds of 1.5 and 3 standard deviations below an O/E score of 1.0 (the score expected under no impairment).

The State Board is funding projects in Southern California and the Central Coast to develop periphyton indices. The products from these two studies are expected in 2009. The State is currently testing the use of the California Rapid Assessment Methodology (CRAM) for assessment of riparian habitat. As with the macroinvertebrate scores, it is likely that threshold values for these indices will be derived statistically from reference populations.

The CE score of 3.5 out of 4 will improve with the full development of the macroinvertebrate MMI and O/E models, a second assemblage, and the derivation of appropriately detailed numeric biocriteria

12. Diagnostic Capability. *The diagnostic capacity of bioassessment data and results is dependent on the development of patterns and response signatures from a database that includes a variety of stressors and the full gradient of human disturbance and biological response. This increases the value of biological data beyond the determination of status (attainment/non-attainment) to include inferences and decisions about causal associations and elimination of candidate causes in a stressor identification process. The development and use of a diagnostic capability is only possible within programs that have specifically developed methods and for which precision and accuracy issues have been addressed.*

The SWAMP and the NPS program have made some tentative steps in this direction. With funding from the NPS program the perennial stream survey (formerly known as CMAP) was modified to investigate associations between bioassessment scores and land use using associative techniques such as relative risk assessment. The NPS program also funded research to associate benthic invertebrate assemblages with land use (e.g., agricultural, forested and urban land uses). SWAMP has also funded the development of stressor specific tolerance values for benthic macroinvertebrates. The SWAMP bioassessment program receives a score of 2.5 out of a possible 4.0. For perspective, this score is similar to that of other states that have been reviewed.

13. Professional Review and Documentation. *Subjecting documented methods and assessment reports to a rigorous peer review is ultimately the best way to ensure an agency's credible data and scientific underpinnings. Inherent in a review is that it is conducted in an objective and independent manner (outside the agency and with no vested interest in the outcome) by technical and policy experts able to provide valid critique and suggestions, and recommendations for improvement and refinement are taken in good faith. Validation of standard operating procedures for all aspects of the assessment and monitoring program by outside experts is an initial step in establishing confidence in the resulting data. Programs that do not address and implement critical recommendations fail to benefit from an independent endorsement of their procedures and assessments.*

The SWAMP has a solid peer-review process for evaluating individual technical studies and reports. The overall SWAMP program underwent a technical review in 2005 (SPARC, 2006). There was a review of the bioassessment program in 2003 (Barbour and Hill, 2003) and this critical elements review also serves as peer review. The program receives a CE score of 4.5 out of 4.5.

Summary

The SWAMP bioassessment program is presently operating a high quality program at the state level and in selected regions. The information that we gathered and reviewed shows that the program operates at level 3 and is appropriate for 305(b) assessments and to support 303(d) listings. Ongoing development activities will eventually result in a level 4 program capable of being used more rigorously in regulatory decisions in perhaps 4-5 years.

Improvements that are planned or already underway will directly affect 9 elements and increase the CE score by 5-7 points resulting in a level 4 program for both the statewide and regional programs. Achieving a L4 program is contingent on the (1) full development and use of a second assemblage, (2) developing more detailed diagnostic capabilities, (3) improving data management and (4) developing the capacity of the other regional boards and linking regional monitoring to statewide efforts. This will take time to accomplish, perhaps 4-5 years depending on the rate of progress, resources devoted to the developmental effort, etc. Making these improvements should lead to an improved delineation of condition along the BCG and an improved diagnostic capability via an increased capacity to detect biological responses to specific types of stressors, provided that adequate and concurrent data about relevant stressors are also collected and analyzed.

The consistent addition of a second assemblage in the bioassessment process is needed to elevate the program to level 4. Three commonly used bioassessment assemblages (benthic macroinvertebrates, algae and fish) all provide unique perspective on the biological condition of a stream and its watershed. To be clear we advocate the use of *a minimum* of two assemblages in a given stream or river, but recommend that all three be available to choose from as each is applicable. The decision about which assemblage(s) to use in a particular situation should be made from all perspectives in addition to the obvious logistical and resource related perspectives. SWAMP has made strong progress toward developing algal indicators as a second indicator, but options for a third indicator are still under consideration. The use of fish indicators in CA is complicated by the State's limited fish fauna and may be not be a cost-effective indicator, but this should be explored further because fish can provide information about larger scale ecological condition (e.g., watershed connectivity, loss of spawning and other habitats, impacts of introduced species, etc.) that other assemblages cannot. Alternately, riverine wetland tools (e.g., CRAM) currently being explored by SWAMP may provide a means of partially filling the need for larger scale context.

We recommend that a follow-up CE review be conducted when these decisions are being made and upon the implementation of the improvements that are more immediately attainable. We would recommend in this case that new assemblages be developed and applied alongside macroinvertebrates based on the resource and management issues at hand.

The integration of the bioassessment results with chemical/physical data and other stressor information that is already included in the SWAMP will lead to a better understanding how human disturbance influences measurable biological response and lead to better support for all water quality management programs. Case examples of how this can be accomplished are available in the EPA TALU document (U.S. EPA 2005). Finally, these improvements will enable California to more fully develop a TALU (Tiered Aquatic Life Use) framework that will improve its current WQS and enhance the utility of aquatic life designated use classes for regulatory and other management applications.

Part 3. Moving from Bioassessment to Biocriteria

California's bioassessment program has made great strides in recent years due primarily to investments made by the Dept. of Fish and Game's Aquatic Bioassessment Laboratory (DFG-ABL) and the State Water Board's Surface Water Ambient Monitoring Program (SWAMP). California's bioassessment program is currently at a fairly high level (Level 3) and is being used within the recommended scope of that level to support 305(b) assessments and 303(d) listing. Continued investment and active management support will be needed to achieve a fully functional (Level 4) program that will support other regulatory needs and at relevant spatial scales of implementation.

It is clear from the extensive and well organized documentation that was provided before and during the review that California's scientists have a solid conceptual understanding of the steps required to reach the end goal of numerical biological criteria in the state's WQS in order to provide support for all relevant water quality management programs. It is equally clear that there is inadequate management support and commitment to achieve timely implementation of biocriteria in California.

While the DFG-ABL, SWAMP and their contractors are building a solid technical foundation for a robust freshwater bioassessment program, they can only provide the technical tools for developing biological endpoints and Tiered Aquatic Life Uses (TALUs). The State and Regional Water Boards need additional biologists and planning staff to develop, refine and implement TALUs as envisioned by the USEPA. This review affirms the findings of past peer reviews that the State Water Board needs its own in-house bioassessment coordinator and staff.

Managers at the State Water Board should be aware that the SWAMP program is, with continued management support, capable of building, maintaining and refining the technical tools that the Water Boards will need to incorporate biology into their water quality programs. Implementation of these tools including the development of TALUs, biocriteria and biological endpoints for TMDLs will be a fundamental paradigm shift that will require the detailed involvement of qualified biologists and planning staff. The Water Board's SWAMP program cannot be expected to fulfill those planning and implementation roles. Following U.S. EPA directives and the examples set by many other states, managers at the Water Boards should seek to provide the resources that are necessary to implement the technical bioassessment tools being developed by SWAMP.

As a first step, and consistent with the prior external peer review of SWAMP's bioassessment program (*see* Barbour and Hill 2003), the State Water Board should strive to create and maintain a specialist position for a state-wide bioassessment policy coordinator. The State Water Board needs a high-level in-house bioassessment policy coordinator to shepherd the implementation of the technical tools currently being developed by SWAMP into regulatory framework that is biocriteria and TALU. As the program develops, the State Board should create a team of staff that will work with the coordinator to integrate bioassessment/ biocriteria into the State's water regulatory programs.

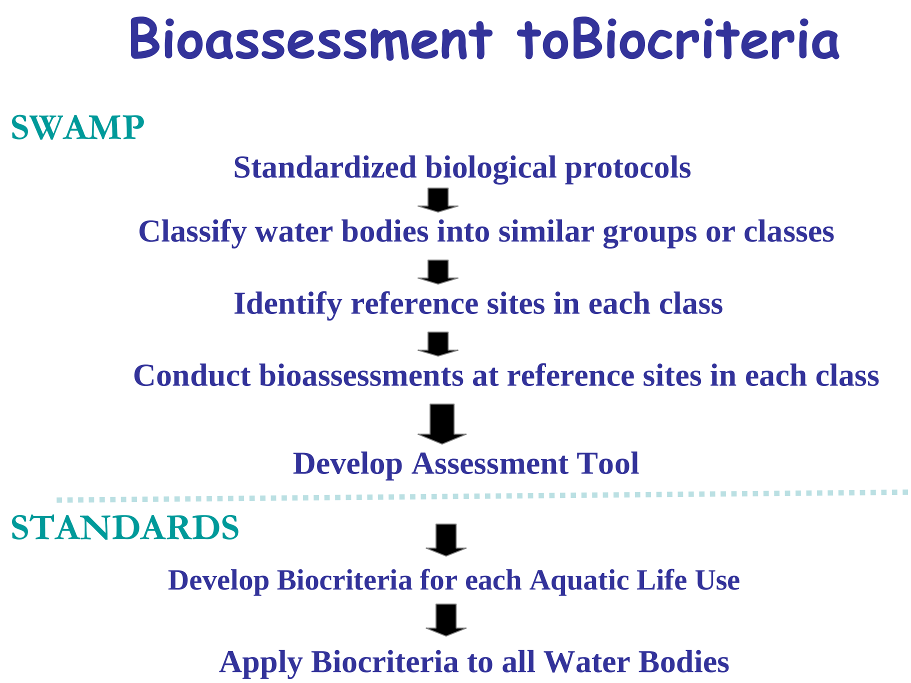

Figure 2. Schematic framework for moving from bioassessment to biocriteria n California.

1. Refine Beneficial Uses. Use refinement is a broad term that encompasses any activity undertaken by a state to review and revise the designated uses applied to its waters. A state may refine its designated uses by revising the language defining what it intends to protect with this particular designated use or by revising a designated use by adopting more refined or specific designated uses in its place.

As recommended by the NRC (2001) and the SPARC (2006), the Water Board should consider refining beneficial uses relating to aquatic life use support. Generic beneficial use designations such as cold water habitat (COLD) simply do not account for the natural variability in rivers and streams across broad biogeographic regions. Cold water habitat in the North Coast is clearly different than cold water habitat in southern California. The State Board should develop a structure for examining the existing structure of designated uses to determine what parts, if any, will need to be changed or refined. This should be consistent with the principles and structure of the Biological Condition Gradient (BCG; U.S. EPA 2005; Davies and Jackson 2006).

The State Board should consider subclassifications of waterbodies in their use refinement process. Subclassifications based on similarities in the natural conditions of the waters could be established from major flowing water classes (such as large rivers, perennial stream, intermittent streams and ephemeral streams) or ecoregions (areas of biogeographic similarity) or a combination of these.

The State Board should support regional efforts to develop tiers of aquatic life uses and expand these efforts statewide. Tiers are subdivisions within subclasses of water based on similarities in the history of anthropogenic disturbance, the resulting biological condition, and the recovery potential within a tier (Figure x). Tiering of uses based on potential for recovery would also provide a framework for use attainability analyses. We advocate that UAAs be developed carefully and from the perspective of achieving the highest potential for each waterbody. It is tempting to plunge into a UAA process prematurely as a way to resolve impaired waters listings in the short-term, but we recommend that this be reserved for a time when the biocriteria and TALUs are sufficiently developed.

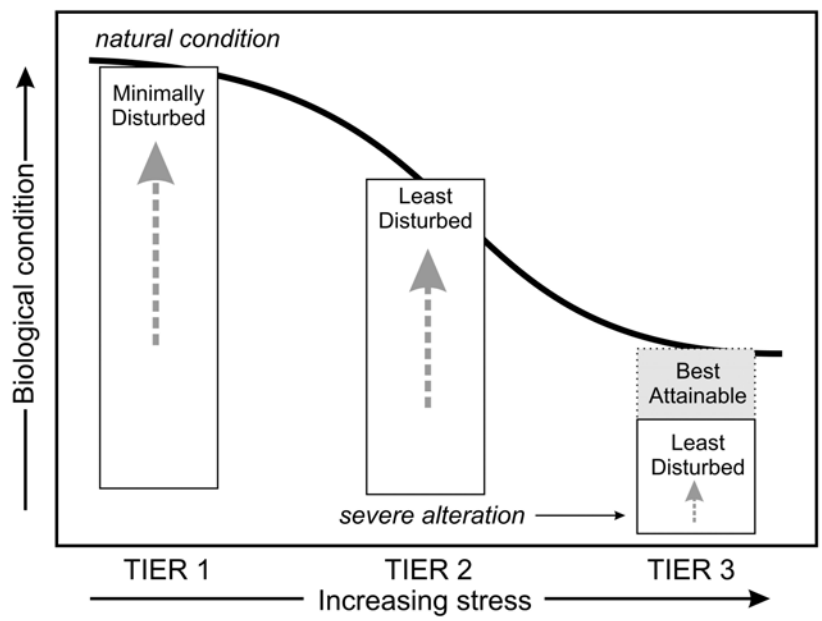

Figure 3. The biological condition gradient (BCG) used to define stream condition tiers in the TALU framework. Boxes indicate the expected range of biological condition scores at sites within each tier. Figure modified from Stoddard et al. 2006.

2. Develop Biological Objectives. The Water Board should develop statewide narrative biological objectives (biocriteria) to protect beneficial uses in Basin Plans that are associated with aquatic life use support. This should not preclude efforts by Regional Water Boards to develop biocriteria. However, many Regional Water Boards lack tools for interpreting existing narrative objectives in their Basin Plans. Currently, bioassessment data are used by Regional Water Boards in an “informal” manner where the assessments are used to support attainment decisions, but they lack any formal linkage to a designated aquatic life use. This lack of formal regulatory linkage to beneficial uses will limit the fuller use and true potential of bioassessment as a regulatory tool.

Biocriteria should be developed at both the State Board and Regional Board levels. However, development of numeric biocriteria will need to proceed in a series of phases. A key first step is the development of a statewide narrative objective that would set a common framework for the development and application of bioassessment tools to beneficial use protection. The interim step of developing statewide narrative biocriteria following the model set forth by Oregon Department of Environmental Quality (ODEQ) is likely to be an effective first step in California.

Numeric biological criteria could then be achieved with the addition of defining language that pertains to the subclassification of different types of streams and rivers, ecotype specificity, biogeographical regions, and the level of protection afforded by tiered uses. It may be possible to use the predicted taxa list generated by the RIVPACs model to help identify highest attainable use for perennial streams across the state.

ODEQ's Statewide Narrative Criterion

Waters of the State shall be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.

Without detrimental changes in the resident biological communities means no loss of ecological integrity when compared to natural conditions at an appropriate reference site or region.

Ecological integrity means the summation of chemical, physical, and biological integrity capable of supporting and maintaining a balanced, integrated adaptive community of organisms having a species composition, diversity, and functional organization

3. Develop Implementation Plan for Narrative Criteria: Biological criteria may appear to be more complicated to implement than traditional water quality criteria, but mostly because they achieve a congruence with natural factors that chemical criteria can not. A plan should be written which describes the technical components of the biocriteria (i.e., how to interpret biological data) as well as the policy components of the biocriteria (i.e., how they are to be used in programs. Technical tools and training will be necessary for staff, permittees and the general public. Policies will need to be developed regarding use of biocriteria in 305(b) assessments, 303(d) listings, NPDES monitoring, compliance and enforcement and in TMDLs. The State Water Board needs a high-level in-house bioassessment policy coordinator in order to shepherd the implementation of the technical tools currently being developed by SWAMP.

Part 4. Summary Conclusions

The State Board monitoring and assessment program is presently operating a high quality bioassessment program at the state level and in selected regions. The information that we gathered and reviewed shows that the statewide program operates at level 3 (the two regional board programs are borderline L3), and that the ongoing development activities will eventually result in a level 4 program in perhaps 4 - 5 years. These developmental tasks are one and the same as those that are necessary for developing biocriteria within a TALU framework. Hence this developmental process should deliver the technical capacity to support full TALU implementation.

SWAMP has and is making very effective use of their current resources to develop bioassessment tools which will support water quality programs (Figure 1). This means that SWAMP is positioned to provide data and information for more than general status assessments as required by Sections 303d and 305b, but to all Water Board programs including NPDES, NPS and TMDLs. These programs rely on monitoring and assessment information to provide an accurate and complete delineation of waterbody impairments and their associated causes. SWAMP data can also provide measures of the overall environmental outcomes produced by Water Board programs.

It is clear from examples in other States (Rankin 2003; U.S. EPA 2005) that a TALU based program will be a direct benefit to the California WQS, TMDL, NPDES permitting, and other water quality management programs (Figure 4). A TALU based approach would result in more refined aquatic life use designations that are appropriate to various water body types throughout the state. It would also lead to more specific biological objectives that are tailored to protect aquatic life in these waterbodies.

These biological objectives could be used to support listing and delisting decisions made by the Regional Boards. The tiered objectives can be used by Water Board programs to establish incremental goals for improvement for impaired waters. The objectives can also be used by the Water Boards to identify the high quality waters in the state and serve as backstops to ensure that these high quality waters are not degraded

The SWAMP program is developing a white paper to outline the technical infrastructure elements and identify current and future research needs to support bioassessments in California. A second white paper is being developed to identify the programmatic and policy issues that are necessary to move from bioassessments to biocriteria and TALU. These would provide the framework for developing TALU in California. Both Maine and Ohio provide case histories that describe the evolution of each program's WQS and monitoring and assessment program to the attainment of level 4. These case studies are included in the EPA TALU document (U.S. EPA 2005; Appendices A and B). In addition, states that are involved in detailed developmental projects (e.g., Minnesota) can also provide a measure of comparability via their experiences.

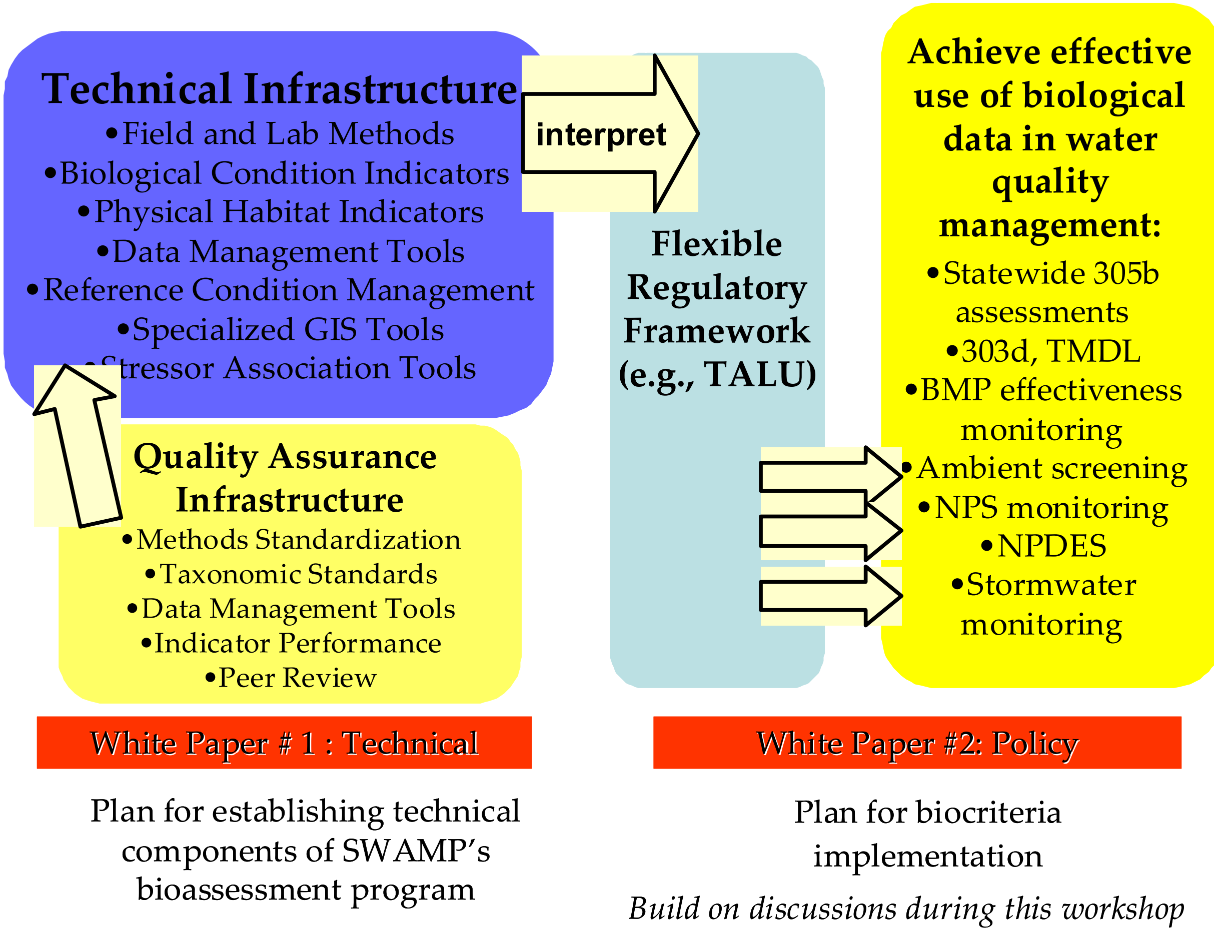

Figure 4. Process being used by the State Water Board to develop the technical infrastructure needed to use biological assessments and biocriteria within a TALU framework to provide full water quality management program support.

It is recognized here that this evaluation is a first step towards identifying the specific actions and needs of the California program to attain a level 4 program and achieve the support role for all management programs that is envisioned by the TALU process (U.S. EPA 2005; Barbour and Yoder 2007). Chapter 5 of the EPA TALU document describes the general milestones that a state program can use to gauge their own progress. This is now amplified in the 2008 update of the Critical Elements document using an active state development process as a working example (Barbour and Yoder 2008). The State Board should consider using the framework outlined in Figure 5 below to determine their existing position. This would accomplish an "inventory" of the existing program and determine what components are "TALU ready" and which areas are in need of further development and in which priority. Once this is done, a specific plan and timeline can be developed. At this time, we would estimate at least 5+ years to accomplish the tasks associated with full TALU development, but some aspects could be done more quickly if given a higher priority.

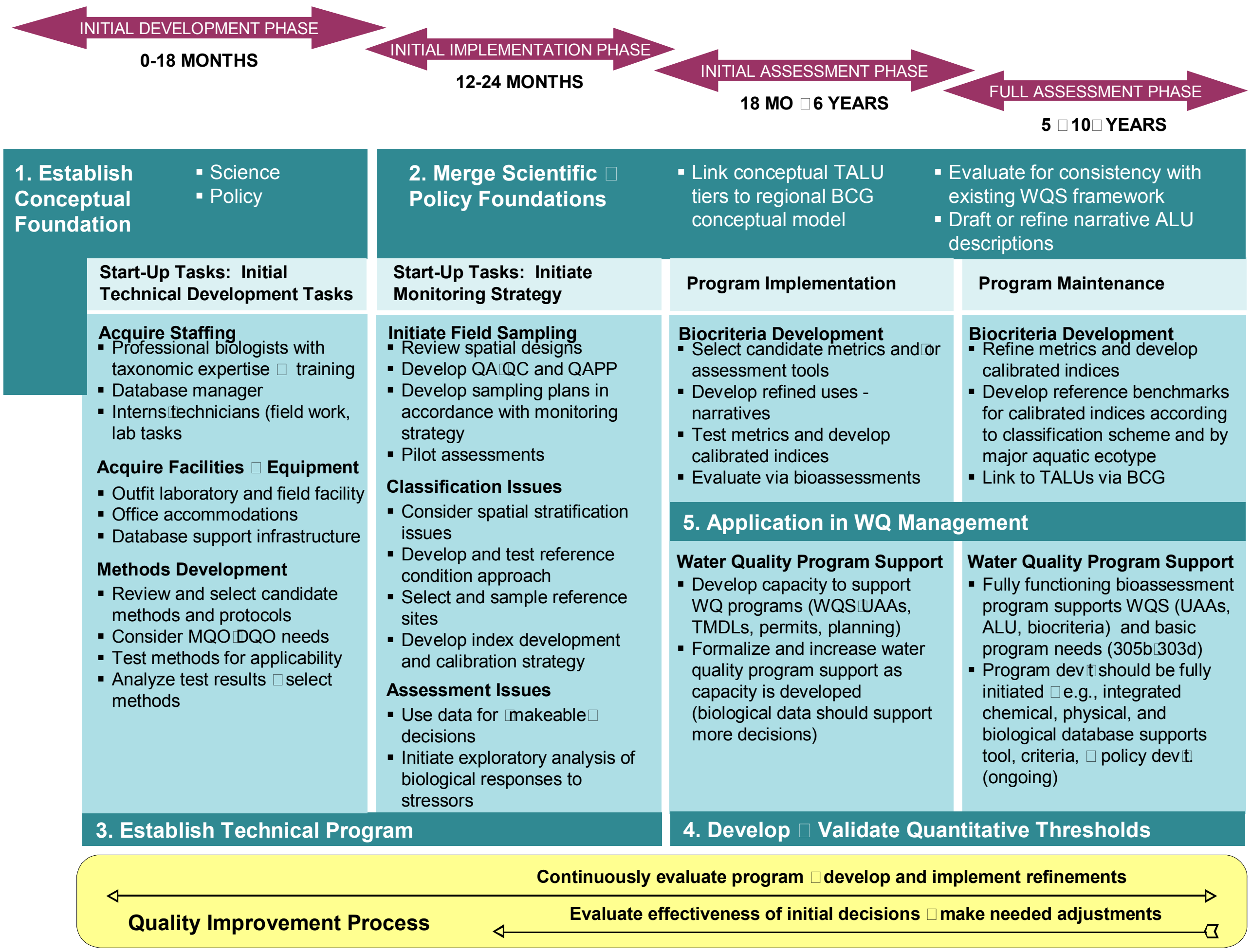

Figure 5. Hypothetical timeline for moving from bioassessment to biocriteria (U.S. EPA 2005).

The review of the California WRCB monitoring and assessment and WQS programs and the Critical Technical Elements results can be used to identify the specific technical and programmatic aspects that are in need of further development, refinement, and/or additional resources to accomplish full TALU program development. This review process is an essential component of the implementation process as generalized in *"Use of Biological Information to Better define Designated Aquatic Life Uses in State and Tribal Water Quality Standards: Tiered Aquatic Life Uses (August 2005)"* (U.S. EPA 2005). This includes general guidance and case examples for developing and implementing a TALU-based approach to monitoring and assessment and water quality standards (WQS) by States and Tribes. It contains a hypothetical timeline (Figure 5) that describes a sequence of steps including the development of a baseline bioassessment program (already in place via SWAMP), initial support for baseline management programs (partially in place and in selected Water Boards), development of narrative and numeric biocriteria (concept in place), increasingly sophisticated support for all relevant water quality management programs (yet to be accomplished), and long term maintenance of the program (the result of full TALU program development and implementation). The ultimate goal is the adoption of numeric biocriteria and Tiered Aquatic Life Uses (TALU) in the California WQS.

This template provides a framework within which the State can first determine where their program is along the timeline in Figure 5.

We expect that California will be positioned "somewhere" along the TALU timeline once a detailed exercise is undertaken to inventory the existing program. The "position" along the timeline is determined by first conducting a baseline review of the state programs and its technical elements, which is represented by this memorandum. The development of a full TALU program could take several years if a State or Tribe is starting from "scratch". However, it is likely that States and Tribes already operate at least a basic program (i.e., Level 2; Yoder and Barbour 2009) and will likely determine that the time for implementing a more refined program consistent with Level 4 is considerably less than the 10 years depicted in Figure 5. Based on the information garnered by this baseline review we expect that the development of the bioassessment program via SWAMP and select Region Boards will show California to be further along this timeline than most states given the Level 3 status of the current program. We do recommend that this be done considering the unique roles of the statewide SWAMP program and the Regional Board programs in TALU implementation.

We recommend that the next step for California is to use this process to determine "where" the program currently stands and what tasks are yet to be accomplished to reach the above stated program goals. This process is a prerequisite to producing a detailed plan for the eventual development and adoption of TALU based narrative and numeric biocriteria in the California WQS, supported by a Level 4 program. The example in the latest draft of the Critical Technical Elements (Barbour and Yoder 2008) represents a working example of how California can use the results of the baseline program review and CE process to develop a "blueprint" for making orderly improvements and attaining full TALU status. This will include a mix of technical and policy development tasks.

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Appendix Table 1. List of Participants

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Appendix Table 2. A checklist for evaluating the degree of development for each technical element of a bioassessment program and associated comments on the elements for the California WRCB bioassessment program (both SWAMP and applicable Regional Boards). The point scale for each element ranges from lowest to highest resolution (na – not applicable).

Element 1	(Lowest) 1.5 / 2.0	2.5 / 3.0	3.5 / 4.0	4.5 (Highest)	Comments
Index Period	Collection times are variable throughout the year, and sampling is performed without regard to seasonal influences.	An index period is conceptually recognized, but sampling may take place outside of this period for convenience or to match existing programs; sampling outside of the index is not adjusted for seasonal influences.	A well-documented seasonal index period(s) is calibrated with data for reference conditions, but sampling may take place outside of this period for convenience or to match existing programs; sampling outside of the index is adjusted for seasonal influences. Index periods are selected based on known ecology to minimize natural variability, maximize gear efficiency, and maximize the information gained about the assemblage.	Same as Level 3, but administrative needs and index periods fully reconciled. Scientific basis of temporal sampling influences management decision framework.	April-October seasonal index period that "slides" from south to north: SoCal – April to early June; NoCal – August to September; most regional boards adhere to this, but some do not to accommodate program support needs. **Points** **Statewide: 4.5** **Regional: 4.0**

Element 2	(Lowest) 1.5 / 2.0	2.5 / 3.0	3.5	4.0 / 4.5 (Highest)	Comments
Spatial Coverage	An individual site is used for assessment of watershed condition; simple upstream/ downstream and fixed station designs prevail; assessments at local scale.	Multiple sites are used for watershed assessment; spatial coverage only for questions of general status or locally specific problem areas; synoptic (non-random) design at coarse scale (e.g., 8-digit HUC common); spatial extrapolation is based on "rules of thumb"; may be supplemented by simple upstream/downstream assessments.	Spatial network suitable for status assessments; statewide spatial design using rotating basins with single purpose design at coarse scale (e.g., 8 digit HUC); may be supplemented by occasional intensive surveys.	Comprehensive spatial network suitable for reliable watershed assessments in support of multiple water quality management programs at more detailed scale (e.g., 11-14 digit HUC); statewide rotating basin approach or similar scheme to complete statewide monitoring in a specified period of time; multiple spatial designs appropriate for multiple issues.	Statewide probability design (WEMAP) and "pour point" integrator sites at 8 digit HUC scale; Regional boards employ watershed scale intensive survey designs at HUC 11 scale (currently in 4 of 9 regions). **Points** **Statewide: 3.5** **Regional: 4.0** **Combined: 4.0**

Appendix Table 2. (continued)

Element 3	(Lowest) 2.0	2.5 3.0	3.5 4.0	4.5 5.0 (Highest)	Comments
Natural Classification	No partitioning of natural variability in aquatic ecosystems. Minimal classification limited to individual watersheds or basins with generalized stratification on a regional basis; does not incorporate differences in stream characteristics such as size, gradient.	Classification recognizes one stratum, usually a geographical or other similar organization such as fishery based cold or warmwater, and is applied statewide; lacks other intra-regional strata such as watershed size, gradient, elevation, temperature, etc.	Classification is based on a combination of landscape features and physical habitat structure (inter-regional); achieves highest level of classification possible by considering all relevant intra-regional strata and subcategories of specific stream types.	Fully partitioned and stratified classification scheme based on a true regional approach that transcends jurisdictional (i.e., State) boundaries to strengthen inter-regional classification and recognizes zoogeographical aspects of assemblages.	Classification includes intra-regional factors such as watershed size, elevation, and other stratifying factors; not yet developed for all bioregions. **Points** **Statewide: 3.5** **Regional: na**

Element 4	(Lowest) 2.0	2.5 3.0	3.5 4.0	4.5 5.0 (Highest)	Comments
Criteria for Reference Sites	No criteria, except informal BPJ selection of control sites. May be little documentation and supporting rationale.	Based on "best biology", i.e., BPJ on what the best biology is in the best waterbody; minimal non-biological data used.	Non-biological criteria supported by narrative descriptors only; combine BPJ with narrative description of land use and site characteristics; may use chemical and physical data thresholds as primary filters.	Quantitative descriptors used to support non-biological criteria; characteristics of sites are such that the best biological organization expected to be supported; chemical and physical characteristics of sites used only as secondary and tertiary filters to avoid circularity in other criteria.	A quantitative procedure for screening reference sites is used; **Points** **Statewide: 5.0** **Regional: na**

Appendix Table 2. (continued)

Element 5	(Lowest) 1.0	1.5	2.0	2.5	3.0	3.5	4.0 (Highest)	Comments
Reference Conditions	No reference condition; presence and absence of key taxa or best professional judgment. rather than established reference conditions may constitute the basis for assessment.		Reference condition based on biology of a 'best' site or waterbody; a site-specific control or paired watershed approach may be used for assessment; regional reference sites lacking.		Reference conditions based on site-specific data, but are used in watershed scale assessments; regional reference sites are conceptually recognized, but are too few in number and/or spatial density to support the deviation of biocriteria.		Applicable regional reference conditions are established within the applicable waterbody ecotypes and aquatic resource classes; consist of multiple sites that either represent reference or are along the BCG in such a manner to allow extrapolation of expected conditions for assessing and monitoring within waterbody ecotype. Re-sampling of reference sites done systematically over a period of years.	Development of regional reference condition is in progress – not yet completed for all regions. **Points** **Statewide: 3.5** **Regional: na**

Element 6	(Lowest) 2.0	2.5	3.0	3.5	4.0	4.5	5.0 (Highest)	Comments
Taxonomic Resolution	Gross observation of biota; single assemblage only; very low taxonomic resolution (e.g., order/family level for macro-invertebrates.; family for fish by non-biologists).		Single assemblage (usually macroinvertebrates); low taxonomic resolution (e.g., family level) by experienced biologists.		Single assemblage with high taxonomic resolution (e.g., "lowest practical" i.e., genus/species); if multiple assemblages, others are lower resolution or infrequently used.		Two or more assemblages with high taxonomic resolution (e.g., "lowest practical" i.e., genus/species); capacity to use each assemblage concurrently is maintained; practitioners are certified in accordance with available offerings (e.g., NABS, state credible data provisions).	Statewide program employs lowest practicable taxonomy (usually genus/species); SoCal employs genus level; second assemblage (periphyton) is under development; fish may be used regionally. **Points** **Statewide: 4.5** **Regional: 4.5**

Appendix Table 2. (continued)

Element 7	(Lowest) 2.0	2.5 3.0	3.5 4.0	4.5 5.0 (Highest)	Comments
Sample Collection	Approach is cursory and relies on operator skill and BPJ, producing highly variable and less comparable results; Training limited to that which is conducted annually for non-biologists who compose the majority of the sampling crew. Documentation of methods more as an overview.	Textbook methods are used rather than in-house development of detail of SOPs to specify methods; a QA/QC document may have been prepared; training consists of short courses (1-2 days) and is provided for new staff and periodically for all staff.	Methods are evaluated and refined (if needed) for State purposes; detailed and well documented; SOPs are updated periodically and supported by in-house testing and development; a formal QA/QC program is in place with field replication taken; rigorous training is for all professional staff, regardless of skill mix to raise skill levels and enhance interaction and consistency.	Same as Level 3, but methods cover multiple assemblages.	Sample collection methods are fully developed for two assemblages (macroinvertebrates, periphyton); fish methods also exist in other agencies. **Points** **Statewide: 5.0** **Regional: 5.0**

Element 8	(Lowest) 2.0	2.5 3.0	3.5 4.0	4.5 5.0 (Highest)	Comments
Sample Processing	Biological samples are processed in the field using visual guides; sorting and identification are dependent on operator skill and effort.	Organisms are identified and enumerated primarily in the field prohibiting ample QC but done by trained staff; for fish cursory examination of presence and absence only; no in-house development of SOPs.	Laboratory processing of all samples (except for fish); A formal QA/QC program is in place; rigorous training is provided; vouchering of organisms done for ID verification.	Same as Level 3, but is applicable to multiple assemblages; subsampling level tested. Notations made on fish as to diseased, erosion, lesion, tumors.	Sample processing fully developed for statewide program and for two assemblages; some regional programs are not as well developed. **Points** **Statewide: 5.0** **Regional: 4.0**

Appendix Table 2. (continued)

Element 9	(Lowest) 2.0 / 2.5	3.0 / 3.5	4.0 / 4.5	5.0 (Highest)	Comments
Data Management	Sampling event data organized in a series of spreadsheets e.g., (by year, by data-type, etc); QC cursory and mostly for transcription errors.	Separate quasi-databases for physical-chemical and biological data (Excel, Access, dBase, etc) with separate GIS shape files of monitoring stations; data-handling methods manuals available; QC for data entry, value ranges, and site locations.	True relational database containing biological and sampled site info (Oracle, etc); fully documented and implemented data QAPP.	Relational database of bioassessment data (including indices and biocriteria) with real-time connection to spatial data coverage showing monitored sites in relation to other relevant spatial data layers (population density; impervious surfaces; vegetation coverage, low-flight photos, nutrient concentrations, ecoregion, etc); fully documented and implemented data QAPP; data available from multiple assemblages to enable integrated analysis.	**Points** **Statewide: 4.5** **Regional: 3.0**

Element 10	(Lowest) 1.5 / 2.0	2.5 / 3.0	3.5 / 4.0	4.5 (Highest)	Comments
Ecological Attributes	Linkage to the BCG or adherence to the basic ecological attributes as a foundation is lacking; simple measures of presence/absence.	Only inferences can be made for a few of the comparatively simple ecological attributes, e.g., sensitive/tolerant taxa of a ubiquitous nature; single dimension measures used.	Ecological attributes used as a foundation for bioassessment, but may not be fully developed, or may be lacking. BCG incorporated into conceptual underpinnings.	The ecological attributes of the BCG form the conceptual foundation; level of rigor represents or extends to all underpinnings of the ecological attributes.	Statewide O/E model and 3 regional MMIs have been developed; periphyton index under development. **Points** **Statewide: 4.0** **Regional: na**

Appendix Table 2. (continued)

Element 11	(Lowest) 1.0	1.5	2.0	2.5	3.0	3.5	4.0 (Highest)	Comments
Biological Endpoints and Thresholds	Assessment may be based only on presence or absence of targeted or key species; (Some citizen monitoring groups use this level); attainment thresholds not specified; this approach may be sufficient for Coarse problem identification. Coarse method (low signal) and detects only high and low values.		A biological index or endpoint is established for specific water bodies, but is likely not calibrated to waterbody classes or statewide application; index is probably relevant only to a single assemblage; presence/absence based on all taxa; BPJ thresholds based on single dimension attributes. Limited to pass/fail determinations of attainment status that does not reflect incremental measurement along the BCG.		A biological index, or model, has been developed and calibrated for use throughout the State or region for the various classes of a given waterbody type; the index is relevant to a single assemblage; attainment thresholds are based on discriminant model or distribution of candidate reference sites, or some means of quantifying reference condition. Can distinguish 3-4 increments along the BCG; supports narrative evaluations based on multimetric or multivariate analysis that are relevant to the BCG.		Biological index(es), or model(s) for multiple assemblages is (are) developed and calibrated for use throughout the State or region and corresponds to the BCG; integrated assessments using the multiple assemblages are possible, thus improving both the assessment and diagnostic aspects of the process; multiple parameters for evaluation, based on integrated data calibrated to regional reference condition. Able to detect status (integrated signal) on a continuous scale along the BCG; power to detect at least 5-6 categories of condition.	O/E model is statewide; MMI developed for selected regions; periphyton in development. **Points** **Statewide: 3.5** **Regional: na**

Element 12	(Lowest) 1.0	1.5	2.0	2.5	3.0	3.5	4.0 (Highest)	Comments
Diagnostic Capability	Diagnostic capability lacking.		Coarse indications of response via assemblage attributes at gross level, i.e., general indicator groups (e.g., EPT taxa); Supporting analysis across spatial and temporal scales limited.		More detailed development of indicator guilds and other aggregations to distinguish and support causal associations; usually involves refined taxonomy (at least genus level); supported by analysis of larger datasets and/or extensive case studies; patterns repeatable across different sources; developed for a single assemblage only.		Response patterns are most fully developed and supported by organized and extensive research and case studies across spatial and temporal scales; results are actively used in biological assessment and in assigning associated causes and sources for program support purposes; involves refined taxonomy; accomplished for two assemblage groups.	Baseline research to support diagnosis has not been completed; baseline database is being developed – need to assure full range of stress:response in statewide and regional datasets. **Points** **Statewide: 2.5** **Regional: na**

Appendix Table 2. (continued)

Element 13	(Lowest) 1.5	2.0 2.5	3.0 3.5 4.0	4.5 (Highest)	Comments
Professional Review and Documentation	Review limited to editorial aspects.	Internal scientific review only, Outside review for objectivity left for higher levels.	Outside review of documentation and reports conducted. However, selection of peer review can be subjective.	Formal process for technical review to include multiple reference and documented system for reconciliation of comments and issues. Process results in methods and reporting improvements. Can include peer-reviewed journal publications.	A formal process is in place and is used; methods and protocols are in the process of being published in journals. **Points** **Statewide: 4.5** **Regional: na**

Statewide CE Score = 53 (Regional = 50.5)
Statewide CE % = 88.3% (Regional = 84.2%)
Statewide Level = L3 [85-95%] (Regional Level = L2 [70-85%])

Appendix Table 3. Summary of the critical technical elements evaluation for the California WRCB statewide bioassessment program conducted January 23-25, 2008.

Element	Comment
Element 1: Index Period Maximum score = 4.5 Statewide = 4.5 Regional = 4.0	The statewide program adheres to a standardized index period that slides from north to south. The regional board score will improve to 4.5 once the standard permit boilerplate language developed by the Lahontan Region is standardized statewide.
Element 2: Spatial Coverage Maximum score = 4.5 Statewide = 3.5 Regional = 4.0 Combined = 4.0	The current score of 3.5 for the statewide program reflects the statewide probabilistic design and "pour point" design for integrator sites. Regional boards apply watershed scale designs that include a resolution at an 8-11 digit HUC spatial scale and other designs such as upstream/downstream sampling. The regional board score of 4.0 reflects the watershed design and rotating subbasin approach applied by some, but not all boards. The combined score of 4.0 reflects the practical integration of the statewide and regional board programs as a reflection of the overall WRCB effort. Attaining a score of 4.5 will be realized when the watershed design is applied by all of the regional boards.
Element 3: Natural Classification Maximum score = 5.0 Statewide = 3.5 Regional = na	The CE score of 3.5 will be elevated to 5.0 with the developments that are already underway including the inclusion of other bioregions (the na score for the regional boards reflects the relevancy of this element to a statewide setting).
Element 4: Criteria for Reference Sites Maximum score = 5.0 Statewide = 5.0 Regional = na	The score of 5.0 for the statewide program reflects the high degree of development of reference site selection criteria and procedures (the na score for the regional boards reflects the relevancy of this element to a statewide setting).
Element 5: Reference Conditions Maximum score = 4.0 Statewide = 3.5 Regional = na	The CE score of 3.5 should improve to 4.0 with the addition of regional reference sites that are being established as part of the ongoing improvements described for elements 3 and 4 (the na score for the regional boards reflects the relevancy of this element to a statewide setting).

Appendix Table 3. (continued).

Element	Comment
Element 6: Taxonomic Resolution Maximum score = 5.0 Statewide = 4.5 Regional = 4.5	The CE score of 4.5 reflects the full development of the macroinvertebrate assemblage and the in progress development of a periphyton indicator. Fish may be applicable in certain regions pending developments by USGS. Reaching the CE score of 5.0 is contingent on the full development and use of a second assemblage.
Element 7: Sample Collection Maximum score = 5.0 Statewide = 5.0 Regional = 5.0	The CE score of 5.0 reflects the full development of the macroinvertebrate and periphyton assemblage methodologies for the statewide and regional programs. Fish methods also exist n other agencies.
Element 8: Sample Processing Maximum score = 5.0 Statewide = 5.0 Regional = 4.0	The CE score of 5.0 for the statewide program reflects the full development of the macroinvertebrate and periphyton assemblage sample processing methods. The regional boards have the capacity to apply the macroinvertebrate assemblage. Reaching the CE score of 5.0 is contingent on the full use of a second assemblage by the regional boards.
Element 9: Data Management Maximum score = 5.0 Statewide = 4.5 Regional = 3.0	The CE score of 4.5 for the statewide program can be improved to 5.0 once the current data management system includes all reporting fields and calculation routines. The regional board score should likewise improve when their data is routinely uploaded to the statewide data management system.
Element 10: Ecological Attributes Maximum score = 4.5 Statewide = 4.0 Regional = na	The CE score of 4.0 should increase with the development of the macroinvertebrate MMI and O/E model for all bioregions and the addition of a second assemblage (the na score for the regional boards reflects the relevancy of this element to a statewide setting).
Element 11: Biological Endpoints & Thresholds Maximum score = 4.0 Statewide = 3.5 Regional = na	The CE score of 3.5 will improve with the full development of the macroinvertebrate MMI and O/E models, a second assemblage, and the derivation of appropriately detailed numeric biocriteria (the na score for the regional boards reflects the relevancy of this element to a statewide setting).

Appendix Table 3. (continued).

Element	Comment
Element 12: Diagnostic Capability Maximum score = 4.0 Statewide = 2.5 Regional = na	The comparatively low CE score of 2.5 is a common characteristic of bioassessment programs that are in development and/or which have singularly been focused on status assessments. Improving the score for this element will occur as a result of addressing preceding elements 2, 3, 6, 10, and 11 and gaining a familiarity with how diagnostic capacity is developed; a familiarity with the concepts involved is encouraging. This will require some dedication to exploratory analyses in which the response of the biological assemblages is evaluated along the stressor axis of the BCG.
Element 13: Professional Review Maximum score = 4.5 Statewide = 4.5 Regional = na	The CE score of 4.5 reflects a thorough and complete peer review process. Statewide methods and procedures are in the process of being published in refereed journals.

Appendix 11

B354

2015 Report on the SMC Regional Stream Survey

Special study on engineered channels

Program update

Preliminary results from new indicators

Applications of SMC data

Southern California Stormwater Monitoring Coalition
Regional Watershed Monitoring Program

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Cover photo: Los Angeles River at the confluence of Calabasas and Bell Creek.

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Program update

Overview of a redesigned survey

In 2015, the SMC initiated the first year of its redesigned stream bioassessment survey, sampling 102 sites and implementing several major changes to address information gaps identified in the initial five-year survey, including:

- Inclusion of nonperennial streams in the survey. Whereas nonperennial streams were previously excluded from sampling, we now attempt to include them among the 55 "condition" sites (i.e., sites selected in a probabilistic way to represent the typical condition of streams in the region) where bioassessment occurs. By shifting the sampling period earlier in the season (starting as early as March), intermittent streams that dry up before May are more likely to be represented in the survey.
- Improved trend detection through site revisits. A total of 47 "trend" sites that were sampled in the first cycle of the survey were revisited in 2015. With a sufficient number of revisits, the survey will be able to determine the extent of stream-miles that are improving or degrading over time, and identify factors that are associated with these trends.
- A change in analytes and indicators measured at each site. In order to focus on new priorities and concerns, SMC participants sampled a number of new indicators (highlighted elsewhere in this report), such as hydromodification impact potential, aquatic invasive vertebrate occurrences, hydrologic state, cellular bioassays, and non-target analysis of chemicals of emerging concern. Assessment of sediment contamination, although part of the updated survey workplan, was deferred so that a pilot study in limited areas could be completed in 2016.

What is the Stormwater Monitoring Coalition (SMC)?

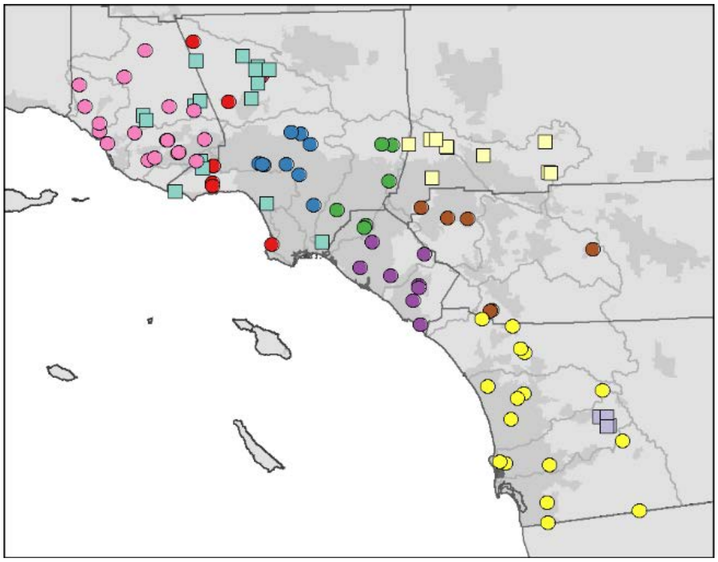
The SMC is a coalition of multiple state, federal, and local agencies that works collaboratively to improve the management of stormwater in Southern California. SMC members include regulatory agencies, flood control districts, and research agencies: County of Los Angeles Department of Public Works, County of Orange Public Works, County of San Diego Department of Public Works, Riverside County Flood Control and Water Conservation District, San Bernardino County Flood Control District, Ventura County Watershed Protection District, City of Long Beach Public Works Department, City of Los Angeles Department of Public Works, California Regional Water Quality Control Board—Santa Ana Region, Los Angeles Region, and San Diego Region, State Water Resources Control Boards, California Department of Transportation, Southern California Coastal Water Research Project (SCCWRP). In addition, the SMC collaborates with the U.S. Environmental Protection Agency Office of Research and Development. For more information, visit the SMC webpage at www.socalsmc.org.

The SMC has conducted a probabilistic survey of streams in the South Coast region since 2009. The goals of this survey are to provide the technical foundation for scientifically sound management of stormwater by answering three questions:

1. What is the biological condition of streams in the South Coast region?
2. What stressors are associated with streams in poor condition?
3. Are the conditions of streams changing over time?

The first five-year cycle of survey took place between 2009 and 2013. The results of the first cycle are summarized in a report available on SCCWRP's website. The survey continues with a new cycle that spans from 2015 to 2019, evolving to address new questions. This report summarizes the current status of the survey and describes major developments and accomplishments that occurred in 2015. A comprehensive report will be released after completion of the fifth year of the current cycle.

Changes in cost from the first cycle were minimized, as certain indicators (i.e., toxicity, metals, and pyrethroids in the water column) were dropped based on recommendations by the SMC workgroup. Priority indicators that were retained, such as benthic macroinvertebrates, algae, riparian wetlands (i.e., CRAM), physical habitat, nutrients, and major ions, were sampled at every site.



Sampling effort in 2015 by agency.

Stormwater agencies	Condition (□ sites)	Trend (□ sites)	Total (□ sites)
Ventura County	10	8	18
Los Angeles County	5	2	7
Los Angeles WMP	3	6	9
San Gabriel RMP	2	4	6
Orange County	5	3	8
Riverside County	3	3	6
San Diego WMAs	12	4	16
Water boards			
RB4	9	7	16
RB8	4	6	10
RB9	2	4	6
Total	55	47	102

San Diego Watershed Management Areas (black text) nested within SMC watersheds (brown text). Local jurisdictions take the lead in monitoring each WMA and setting management priorities, contributing to and making use of the SMC's regional survey.

New watershed-based permits enhance interactions with multiple agencies in San Diego County

Marking a major transition in the implementation of the SMC survey in San Diego County, smaller municipalities (including the cities of Oceanside, Encinitas, San Diego, and Imperial Beach) are now working directly alongside SMC member agencies to collect data for the survey, as opposed to working indirectly through San Diego County Public Works as a lead agency. This transition is intended to increase interaction between stormwater co-permittees and the San Diego Regional Water Quality Control Board, while also making the survey more useful to local managers. These municipalities contribute to the survey through coalitions focused within Watershed Management Areas (WMAs). The WMAs have the effect of spreading responsibility among the individual municipalities to fulfill the permit obligations. As a result, more municipalities are engaged with the regional monitoring program in supporting their management and regulatory needs.

The formation of WMAs began when the San Diego Regional Water Board consolidated municipal stormwater permits into a single regional stormwater permit. Whereas previously, all monitoring in San Diego County was coordinated through a single agency (i.e., the County of San Diego), each WMA coalition is now tasked with collecting data and identifying management priorities for its own WMAs. Survey data are used to develop a Water Quality Improvement Plan, or WQIP (see article on the San Juan WQIP below) for each WMA, with stakeholders responsible for identifying priority issues and associated stressors that each coalition should address. For watersheds that cross county borders (e.g., Santa Margarita), the WMAs facilitate cooperation among municipalities in the different jurisdictions.

Not only do the WMAs help the partners outside the SMC with the survey, but they also carry forward the SMC's vision of collaborative monitoring to the local level. Through minor adjustments to the SMC's sampling plan (e.g., allocating trend sites by watershed rather than by land use), combined with enhanced dialogue between permittees and the Regional Board, the new partners were able to acquire data for their own needs, as well as contribute to the regional assessment goals of the SMC survey.

What are the biological conditions in engineered channels?

The SMC survey helps managers evaluate biological conditions in engineered channels and understand the potential policy implications.

Engineered channels are common features in urban stormwater systems, protecting surrounding neighborhoods from floods that could damage property or endanger lives. However, this service often comes at a cost, as engineered channels do not provide the same quality habitat that natural stream channels provide. Additionally, engineered channels may reduce groundwater recharge, or degrade water quality through alterations of biochemical processes. Consequently, engineered channels often fail to support designated beneficial uses related to ecosystem health, such as those related to aquatic life or wildlife. Faced with these tradeoffs between competing uses, stormwater agencies and regulators encounter questions from stakeholders, such as what range of ecological conditions are possible in engineered channels? And what factors can be managed to support better conditions? The SMC stream survey provides a rich source of data to answer these questions. By developing methods to characterize engineered channels, analyzing bioassessment scores in different channel types, and exploring responses to water chemistry gradients, the SMC stream survey offers preliminary answers to these questions.

Key Points

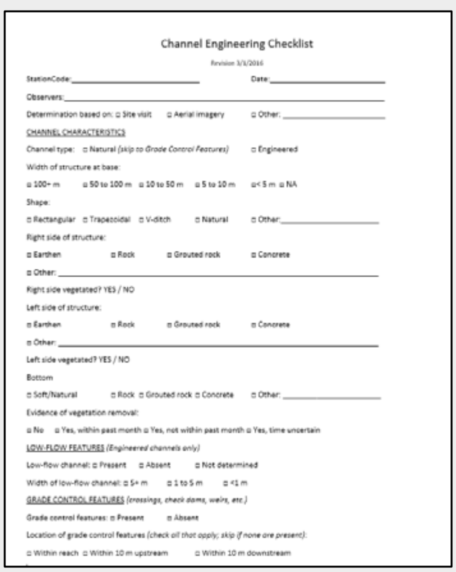
- Engineered channels surveyed to date are, generally speaking, in worse ecological health than natural channels based on biological indicators based on benthic macroinvertebrate and algae assemblages. These preliminary results suggest that tradeoffs between ecological health and flood protection may be unavoidable.
- While engineered channels invariably have poor scores for the California Stream Condition Index (CSCI) based on benthic macroinvertebrates, algal indices occasionally indicated better biological conditions—sometimes similar to reference condition. This wide range in index scores suggest that some engineered channels support more ecosystem functions than others.
- Within engineered channels, design and construction characteristics (e.g., armoring material or presence of low-flow features) did not influence index scores or other measures of ecological condition
- Within engineered channels, algal indices may reflect water quality conditions better than the macroinvertebrate index. For example, lower specific conductivity was associated with higher diatom index scores, but not CSCI scores. However, both types of indices have some capacity to respond to stressor gradients in these systems.
- Targeted sampling (particularly from hardened channels with good water quality, or engineered channels with high bioassessment index scores) and experimental studies may clarify the factors that support better ecological conditions.
- Survey data can provide a context for evaluating the biological condition of streams in engineered channels, thereby helping managers recognize factors, such as water quality or stream temperature, that may lead to better conditions.

Bioassessment indices, such as the California Stream Condition Index (CSCI, based on benthic macroinvertebrate communities) and the Southern California algal Indices of Biotic Integrity (IBIs), are the key indicators used by the State and Regional Water Boards to assess attainment of aquatic life beneficial uses in streams. These indices will have a central role in the implementation of the State's bio-integrity policies; it is therefore necessary that stormwater managers understand how these indices work in engineered channels. Aquatic organisms have diverse life history traits with sensitivities to a wide range of stressors. As a result, bioassessment indices provide a holistic measure of the combined impacts of poor water quality, habitat alteration, hydrologic modification, and other disturbances. This integration allows assessment of cumulative and diverse impacts on ecosystem health. Three indices are sampled in the SMC program: the CSCI, a diatom index, and a soft algal index; each of these three indices provide an independent measure of a stream's ability to support aquatic life.

To assess the range of biological conditions in engineered channels, the SMC took advantage of the extensive bioassessment data collected by the survey since its inception in 2009. In prior years, the SMC collected benthic macroinvertebrates and algae samples at hundreds of sampling reaches across Southern California, many of which were in engineered channels. In order to make the use of these data, the SMC bioassessment workgroup developed a simple procedure for characterizing and classifying the different types of channels found in the region (Sidebar 1). The protocol was designed for rapid application in the field or in the office (if aerial imagery or other data are available). This ease of use meant that the SMC could generate a large data set from recent and older data that would support robust analyses on the features of engineered channels associated with variability in bioassessment scores. Elements of this protocol have been adopted by the Surface Water Ambient Monitoring Program (SWAMP), and resource managers throughout the state are looking to the SMC to provide guidance on how to evaluate engineered channels in their regions. These data will also be used in mapping and modeling efforts to determine locations of engineered channels in the landscape.

Characterizing engineered channels

Modification of stream channels takes many forms, exhibiting a variety of designs and constructions. To characterize the diversity of engineered channels, the SMC developed simple forms to record key features, like shape, material, size, and presence of low-flow channels. These forms were filled out during site visits for the 2015 sampling season, as well as for sites visited in earlier years (relying on aerial imagery, photographs, data from earlier field visits, and other sources of information). Elements of the SMC's approach for characterizing engineered channels have been incorporated into SWAMP's standard bioassessment protocols.


Channel Engineering Checklist

Revision 3/1/2016

StationCode:____________ Date:____________

Observers:____________

Determination based on: ☐ Site visit ☐ Aerial imagery ☐ Other: ____________

CHANNEL CHARACTERISTICS

Channel type: ☐ Natural *(skip to Grade Control Features)* ☐ Engineered

Width of structure at base:

☐ 100+ m ☐ 50 to 100 m ☐ 10 to 50 m ☐ 5 to 10 m ☐ < 5 m ☐ NA

Shape:

☐ Rectangular ☐ Trapezoidal ☐ V-ditch ☐ Natural ☐ Other:____________

Right side of structure:

☐ Earthen ☐ Rock ☐ Grouted rock ☐ Concrete

☐ Other: ____________

Right side vegetated? YES / NO

Left side of structure:

☐ Earthen ☐ Rock ☐ Grouted rock ☐ Concrete

☐ Other: ____________

Left side vegetated? YES / NO

Bottom

☐ Soft/Natural ☐ Rock ☐ Grouted rock ☐ Concrete ☐ Other: ____________

Evidence of vegetation removal:

☐ No ☐ Yes, within past month ☐ Yes, not within past month ☐ Yes, time uncertain

LOW-FLOW FEATURES *(Engineered channels only)*

Low-flow channel: ☐ Present ☐ Absent ☐ Not determined

Width of low-flow channel: ☐ 5+ m ☐ 1 to 5 m ☐ <1 m

GRADE CONTROL FEATURES *(crossings, check dams, weirs, etc.)*

Grade control features: ☐ Present ☐ Absent

Location of grade control features *(check all that apply; skip if none are present)*:

☐ Within reach ☐ Within 10 m upstream ☐ Within 10 m downstream

Forms developed by the SMC to characterize engineered channels are simple enough to complete within minutes during field visits, or from the office if aerial imagery and other data are available.

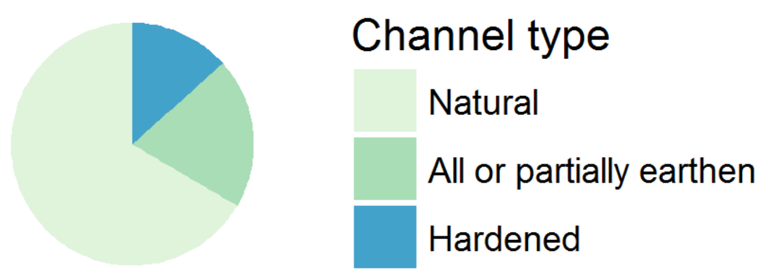


Figure 1. Proportion of stream types observed in the study

Armed with this protocol, the SMC bioassessment workgroup evaluated 724 unique bioassessment sites, with about 20% of these evaluations being made in the field. About two-thirds of the sites were natural, lacking any evident armoring, artificial structures (apart from road or bridge crossings), or straightening (Figure 1). Ninety-seven sites were entirely hardened, with concrete or grouted rock banks and a hardened bottom. The remaining 145 sites retained some earthen elements—typically a natural bottom, with earthen or partially armored banks. Because CSCI and algae IBI scores had already been calculated for these sites from the previous survey cycle, and because water chemistry and habitat quality measurements were also available, the data set was a good starting point for analyzing biological conditions in engineered channels.

Engineered channels are largely in poor condition, but some are in better condition than others

Nearly all engineered channels were in poor health, as measured by both the CSCI and the algal IBIs (Figure 2). Although a wide range of invertebrate CSCI scores was evident in engineered channels (inter-quartile range: 0.44 to 0.66), they rarely exceeded 0.79 (the threshold used in previous SMC reports to identify healthy streams similar to reference conditions). None of the entirely hardened channels met this benchmark, and only 14% of the earthen or partially hardened engineered channels did so. In contrast, 63% of the natural channels in the analysis met the healthy stream benchmark. Aquatic insect communities appear to be strongly affected by partial or complete channel hardening (see Sidebar 2).

Algal indices, however, provided different insights into stream condition. While the diatom and soft algae IBIs, like the CSCI, showed that engineered channels were generally in worse condition than natural channels, high algal IBI scores indicative of healthy (i.e., similar to reference) conditions were not uncommon. In fact, 43% of hardened channels had diatom IBI scores above the reference threshold, and 20% had high soft algae IBI scores. Whereas the CSCI indicated almost exclusively poor conditions in engineered channels, algal indicators suggest that engineered channels can support healthy streams under conducive conditions (such as good water quality).

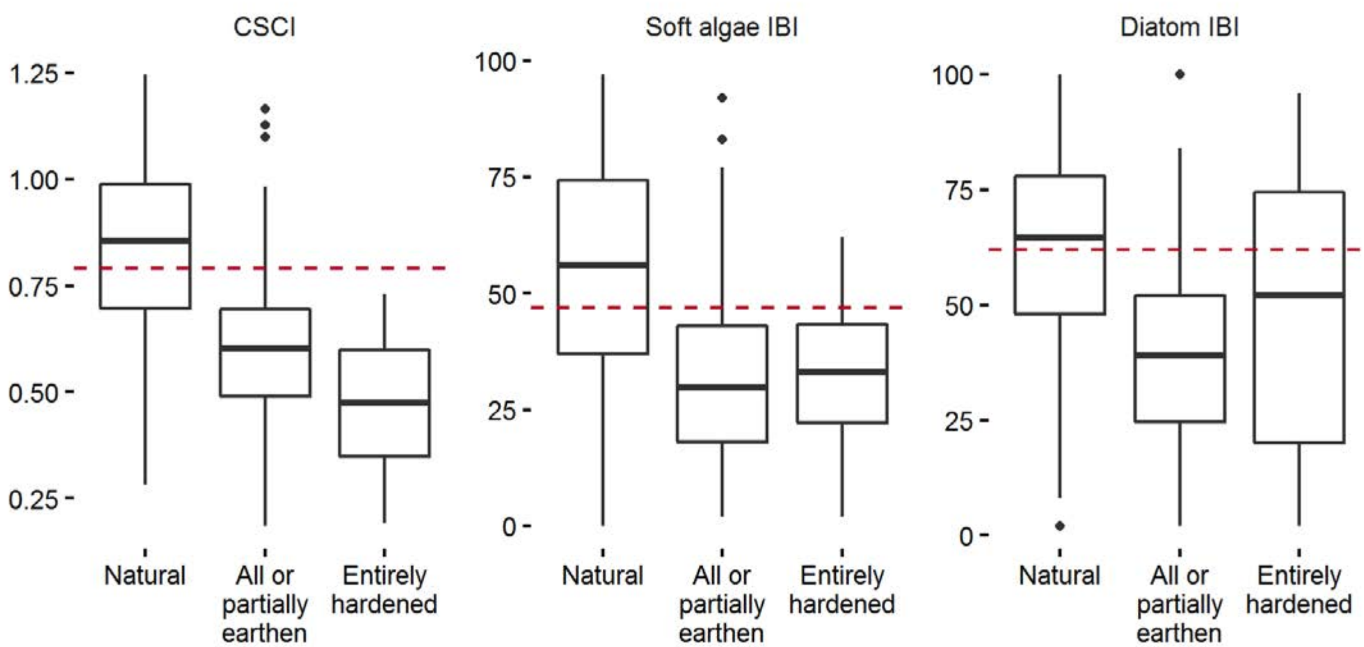


Figure 2. Bioassessment scores were typically higher in natural channels than in engineered channels. However, high scores for the algal indices were sometimes observed in engineered channels, occasionally exceeding the threshold for identifying sites in reference condition (red dashed line).

What kind of organisms are found in engineered channels?

Despite the poor in-stream ecological condition noted in this study, engineered channels do, in fact, support aquatic life, as well as terrestrial wildlife that depend on streams and rivers. Because of their accessibility and proximity to populated areas, engineered channels are frequently enjoyed for their wildlife-viewing opportunities, particularly for waterfowl and wading birds that forage in shallow areas. Although fish and amphibians are sometimes observed as well, these are almost exclusively non-native species, such as carp (*Cyprinus carpio*), tilapia (Cichlidae), bullhead (*Ameiurus*), and mosquito fish (*Gambusia affinis*).

Great blue herons and black-necked stilts forage on the concrete banks of the San Gabriel River.

Photo courtesy of Kerry Matz

***Dasyhelea*, a fly in the family of biting midges (*Ceratopogonidae*), are particularly common in hardened channels.**

The benthic macroinvertebrates found in engineered channels are only a small subset of the diversity of species found in the natural channels, typically with life history adaptations that provide resilience to disturbance (for example, rapid life-cycles with multiple generations per year, or tolerance to temperature extremes). A few invertebrate species show a particular affinity for engineered channels: Biting midges (*Dasyhelea*), soldier flies (*Euparyphus*), minnow mayflies (*Fallceon*), snails (*Physa*), worms (Oligochaeta), flatworms (Turbellaria), and seed shrimp (Ostracoda) were all more common than expected within hardened channels. Species that require complex substrates, such as those that burrow in the substrate (e.g., midges in the subfamily Tanypodinae) were less common than might be expected in a natural channel. Most sensitive and moderately tolerant species (e.g., net-spinning caddisflies, like *Hydropsyche*) were entirely eliminated. The abundance of tolerant species, and rarity of sensitive species, is reflected in the lower CSCI scores observed in engineered channels.

As with macroinvertebrates, algal assemblages within engineered channels contained subsets of species found in natural channels. Many planktonic diatoms, such as species in the *Scenedesmus* genus, were common, as well as the green filamentous algae *Cladophera glomerata*, found at nearly all concrete channels. These species are sometimes a concern. For example, *C. glomerata* form large, unsightly mats that trap debris, smother streambeds, and create odor problems.

The green alga *Cladophora glomerata* often proliferates in engineered channels, particularly if nutrient inputs are high and shading has been reduced.

What factors support higher bioassessment scores in engineered channels?

Why do some engineered channels score better than others? And why are high scores more common for algal IBIs than for the invertebrate CSCI? Design features (such as construction material or presence of a low-flow channel) had no discernible impact on either CSCI or algal IBI scores, so perhaps water quality or other habitat features were more important. That is, relatively high scores in engineered channels may indicate better water or habitat quality than lower scores.

Analyses of the data provide some support for this hypothesis. The diatom index responded to a range of water quality conditions, even within concrete channels (Figure 3, Table 1). For example, the diatom IBI declined with increasing specific conductivity in all channel types, whereas scores for the soft algae index and the CSCI exhibited responses within natural or partially earthen channels. The hypothesis that the constraints within engineered channels overwhelm the ability of bioassessment indicators to respond to stress is not well supported for diatoms.

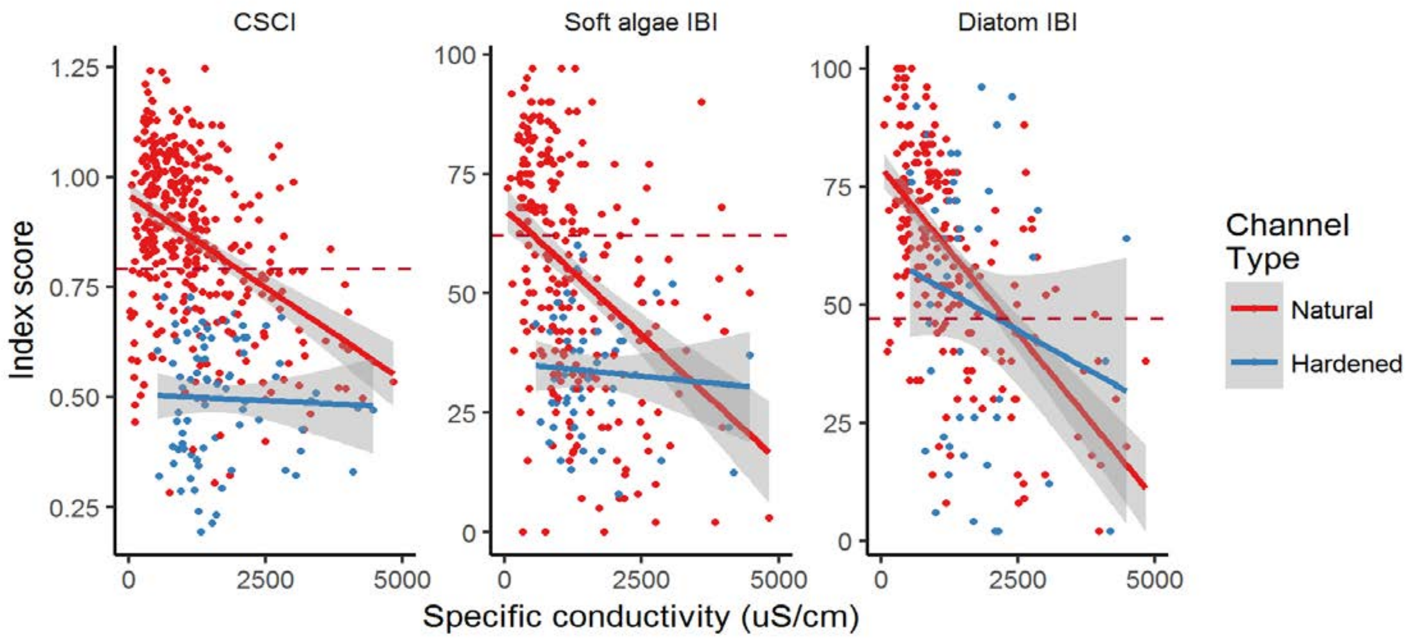


Figure 3. Specific conductivity versus bioassessment index scores in hardened and natural channels. The red dashed line is the threshold for sites in reference condition. For clarity, earthen and partially hardened channels are excluded from this plot.

Factors related to habitat showed a similar pattern of responses. For example, high levels of sands and fines in the streambed were associated with lower scores for all indices, but the relationships within hardened channels were strongest for the diatom index (Figure 4). Although the CSCI did not respond to many water chemistry and physical habitat gradients within hardened channels, shading and temperature appears to be important for this index, with higher scores observed in hardened channels where shading was high (Figure 5). Stream-side vegetation, which is often removed for flood control purposes, may provide the conditions that improve CSCI scores. However, shading had the opposite relationship with diatom IBI scores, and no relationship with soft algae IBI scores.

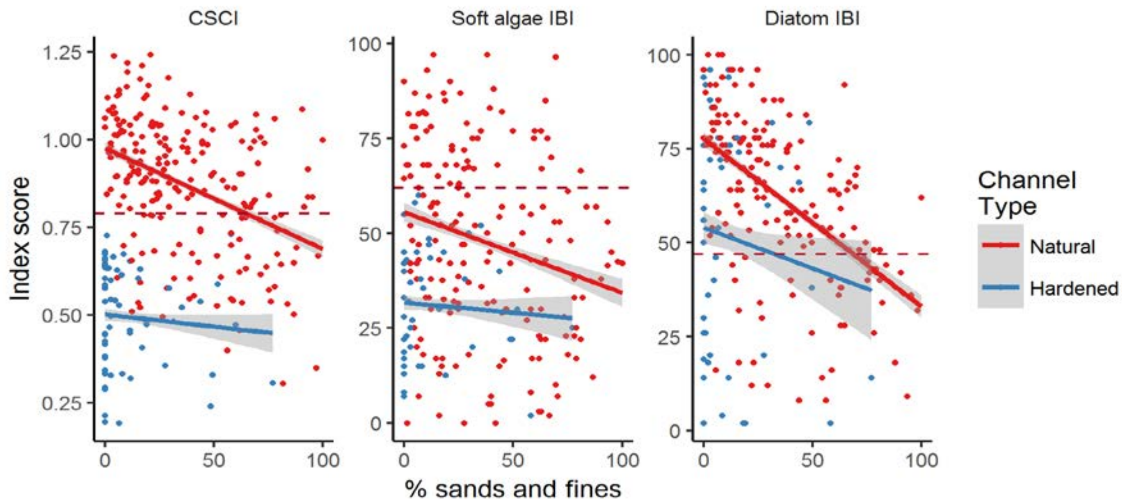


Figure 4. Percent sands and fines in the streambed versus bioassessment index scores in hardened and natural channels. The red dashed line is the threshold for sites in reference condition. For clarity, earthen and partially hardened channels are excluded from this plot.

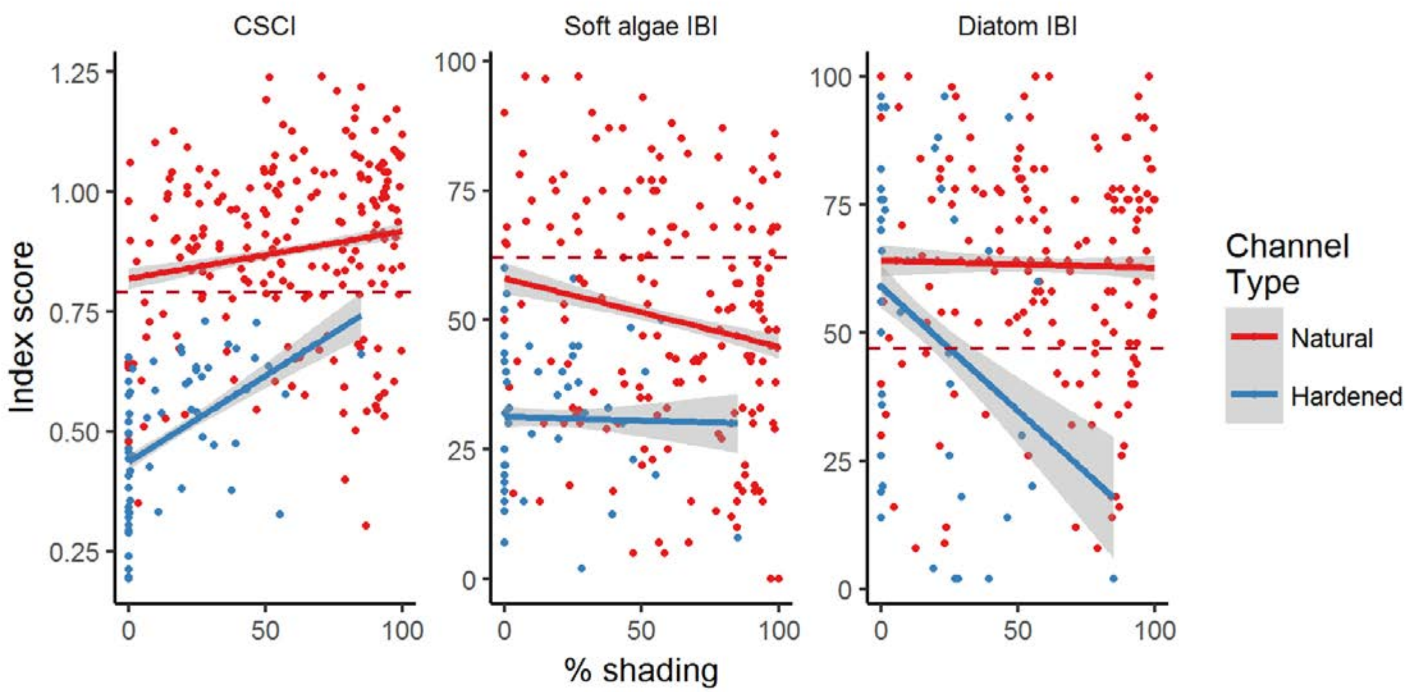


Figure 5. Shading versus index scores in natural and hardened channels. The red dashed line is the threshold for sites in reference condition. For clarity, earthen and partially hardened channels are excluded from this plot.

Table 1. Correlations between water quality and habitat variables and index scores in different channel types. ρ: Spearman rank correlation coefficient. Coefficients indicating stronger relationships (ρ > 0.3) are highlighted in blue. □: p-value □0.05.

	CSCI			Diatom IBI			Soft Algae IBI		
	Natural	Partial	Hardened	Natural	Partial	Hardened	Natural	Partial	Hardened
	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Water quality									
Alkalinity	-0.30 □	0.02	0.21	-0.49 □	0.18	-0.39	-0.31 □	-0.16	-0.16
Chloride	-0.66 □	-0.52 □	-0.05	-0.73 □	-0.19	-0.30	-0.44 □	-0.34	-0.10
Total Nitrogen	-0.44 □	-0.38 □	-0.42	-0.52 □	-0.42 □	0.23	-0.51 □	-0.43 □	-0.38
pH	0.25 □	-0.16	0.08	0.15	-0.36 □	0.04	-0.05	-0.20	0.22
Temperature	-0.36 □	-0.21	-0.30	-0.42 □	-0.23	-0.13	-0.11	-0.38 □	0.11
Specific conductivity	-0.58 □	-0.51 □	-0.05	-0.66 □	-0.16	-0.25	-0.46 □	-0.29	-0.11
Physical habitat									
□ fast-water	0.45 □	0.31	0.24	0.53 □	-0.11	-0.44 □	0.09	-0.18	-0.37
□ thick algae cover	-0.31 □	-0.35	-0.16	-0.45 □	0.01	0.55 □	-0.03	-0.60 □	0.09
□ sands and fines	-0.51 □	-0.64 □	-0.23	-0.64 □	-0.36 □	0.15	-0.19	-0.56 □	0.17
Flow diversity	0.29 □	0.36 □	0.43 □	0.31 □	-0.06	-0.27	0.15	0.23	0.01
Habitat diversity	-0.01	0.14	0.18	-0.28 □	0.14	0.40 □	-0.07	0.24	0.34
Substrate diversity	0.09	0.30	-0.18	0.09	0.25	0.20	0.23 □	0.45 □	0.20
Riparian disturbance	-0.36 □	-0.23	-0.25	-0.22 □	-0.31	0.22	-0.33 □	-0.38 □	0.24
Shading	0.13	0.43 □	0.63 □	-0.03	0.23	-0.10	-0.13	0.41 □	0.40 □
Riparian vegetation	-0.17	0.21	0.47 □	-0.20	0.20	-0.06	0.03	0.14	0.28

Little Dalton Wash: An example of a high-scoring engineered channel

Figure 6. Little Dalton Wash.

Index	Score	Percentile of reference	Percentile of hardened channels
CSCI	0.73	3	92
Diatom IBI	92	84	92
Soft algae IBI	23	0	15

Table 2. Index scores at Little Dalton Wash compared to reference sites and to other hardened channels. Percentiles calculated through a normal approximation.

Perhaps the most valuable insight provided by the SMC's study of engineered channels is that it helps managers identify examples of high-scoring sites, providing a target for managing streams in poorer condition. One such site is Little Dalton Wash, part of the San Gabriel River watershed in Azusa (Figure 6). Although the CSCI score of 0.73 was somewhat lower than the threshold of 0.79 for identifying sites in reference condition, it was higher than nearly all other hardened channels in the data set. Moreover, the diatom IBI score of 92 was well above the threshold of 62, although the soft algae IBI score was low (23). When compared to other hardened channels in the SMC survey, the unusually high scores at Little Dalton Wash are evident (Table 2).

The field conditions at Little Dalton Wash are not different from other hardened channels in any obvious way. The sampled reach is in a rectangular concrete box that lacks low-flow features. Located in the midst of a heavily developed area, it receives drainage from a 27-km^2 watershed that is more than one-third urbanized. However, comparison with survey data from other hardened channels suggest a few possibilities. Several water quality analytes, as well as physical habitat metrics, were better at Little Dalton Wash than at lower-scoring hardened channels, including chloride, total nitrogen, temperature, and specific conductivity (Figure 7). The diversity of flow microhabitats (e.g., riffles and glides) was high as well. These factors may explain the higher scores observed at this site.

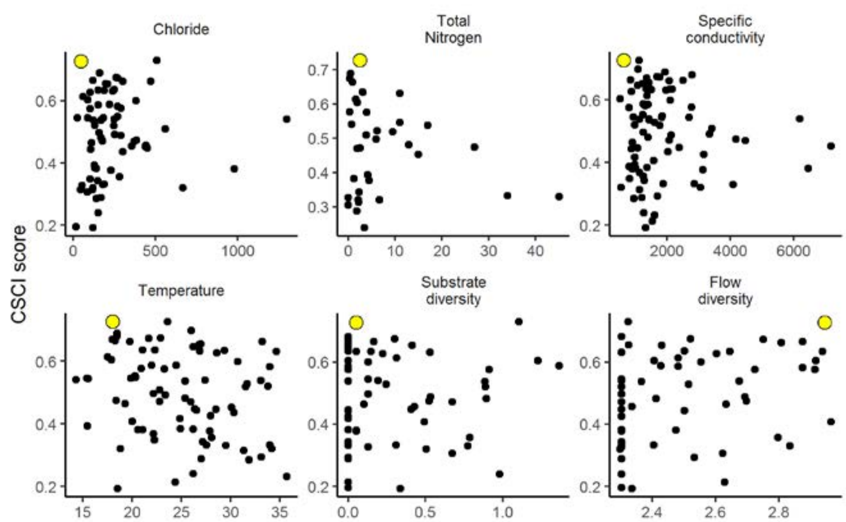


Figure 7. CSCI scores versus water quality and habitat metrics in hardened channels. The large yellow symbol represents Little Dalton Wash.

Conclusions

These preliminary results suggest that, although ecological health is clearly degraded in hardened channels, higher bioassessment index scores could be supported in certain reaches if water quality and in-stream habitat conditions are good. The ranges of observed index scores provide a starting point for managers, regulators, and stakeholders to discuss which types of actions are needed to achieve the desired level of health in modified channels, or in downstream receiving waters.

The SMC survey has cleared up a few major questions about engineered channels. It demonstrated that, although conditions in engineered channels are generally poor, some channels support better conditions than others. Additionally, this analysis underscores the value of a multi-indicator approach to ecological health assessment, as each assemblage adds to a more well-rounded view of the condition of engineered channels. Additional data may help further identify the factors that lead to better ecosystem health in engineered channels, including targeted sampling of concrete channels with good water quality, monitoring after the removal of concrete features from a channel (see Sidebar 3), and tracking water quality improvements following the implementation of best management practices that remove pollutants. Although this opportunistic analysis of available SMC survey data suggests that an engineered channel may not be able to support aquatic life as well as natural streams can, and tradeoffs between flood protection and ecological condition may be unavoidable, it shows that a range of conditions is possible, and that better conditions may be possible through management of water quality and habitat.

Restoration of engineered channels

Restoring natural features in engineered channels is sometimes proposed as a way to improve ecological conditions, as well as create amenities like improved flood control and enhanced recreational opportunities. In the County of San Diego, concrete walls and bank armoring were removed from a 1.2-mile segment of Forester Creek in 2006 at a cost of $36 million, returning the channel to a more naturalistic, vegetated form. Some water quality impairments improved following restoration (e.g., pH), while others did not (e.g., total dissolved solids). Bioassessment scores (measured with the Southern California IBI, which preceded the CSCI) increased from 25 to 40 points, although too few samples have been collected to see if this difference is statistically significant.


Left: Forester Creek upstream of the restoration site. Right: The restored portion of Forester Creek.

The Los Angeles River provides a much larger-scale example. The revitalization master plan for the Los Angeles River calls for the removal of concrete walls from up to 32 miles of the river, wherever it is safe and feasible to do so. This project may be one of the largest urban river restoration efforts undertaken in the country. With a cost that will exceed $1 billion, the impact on the river's ability to support aquatic life are not clear. Fortunately, the SMC stream survey provides abundant data, both from the Los Angeles River itself, as well as from comparable hardened and restored rivers, to provide benchmarks that enable the success of this effort to be evaluated.

Updates on new indicators

Cell bioassays evaluate the potential for harm from chemicals of emerging concern

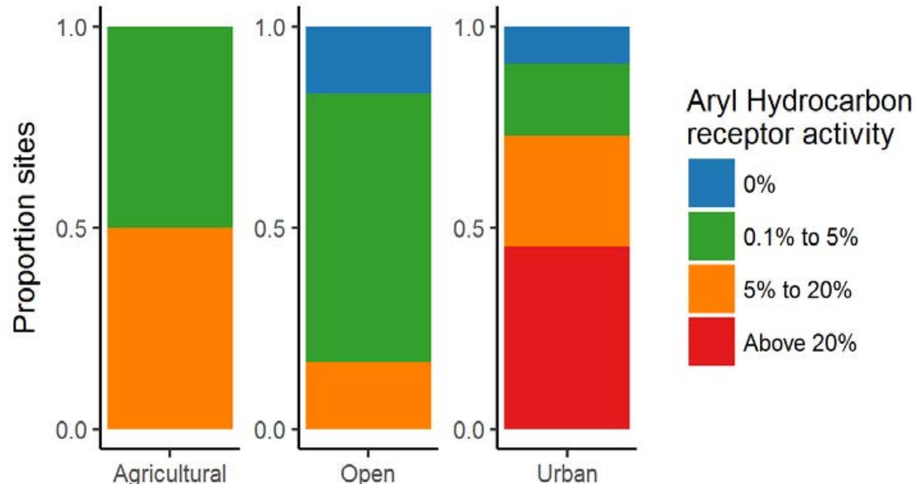


Figure 1. Aryl hydrocarbon receptor (AhR) responses were measured at sites representing different land uses within the SMC stream survey area.

Chemicals of emerging concern (CECs) have the potential to degrade ecological condition and harm human health through endocrine disruption and other physiological pathways. Comprising over 10,000 distinct chemical compounds, CECs come from pharmaceuticals, personal care products, and other sources. Many of them are biologically active, with the potential to disrupt hormonal pathways of organisms. With hundreds of new compounds being added to commercial markets every year, most without disclosure of their composition, measuring the extent and impact of CECs in the environment through traditional (i.e., single-compound) approaches is unrealistic.

The SMC survey tested an alternative approach that promises to be more effective and less expensive than traditional methods. First, samples are used in bioassays to detect cellular-level responses, followed by a non-target (i.e., multiple-compound) analysis to identify the compounds that could cause the observed response. This screening approach provides new information about potential risks of contaminant exposure to humans, aquatic life, and wildlife. For example, estrogen receptor (ER) assays can help detect the presence of hormone-mimicking chemicals that affect growth, development, and reproduction. The SMC screened 31 samples collected in 2015—one of the first applications of this new technology to a stream biomonitoring program.

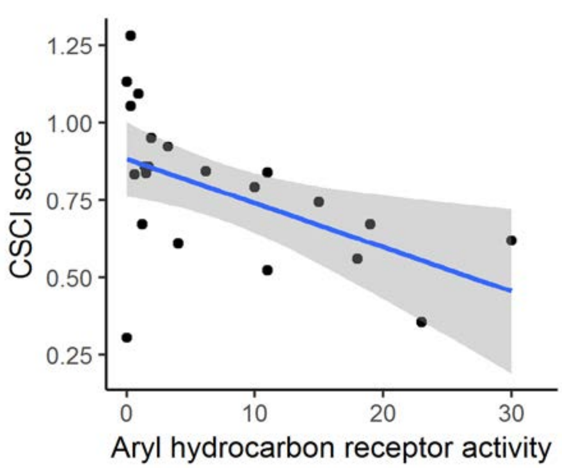


Figure 2. Aryl hydrocarbon receptor response versus CSCI scores

Responses for receptors of steroid hormones, such as glucocorticoid and estrogen, were rare, affecting only 2 and 8 sites respectively. In contrast, aryl hydrocarbon receptor (AhR) responses were widespread, affecting 28 of the 31 sites; furthermore, AhR responses were stronger at urban sites than at undeveloped sites (Figure 1). The AhR receptor is thought to play a role in mediating environmental toxicity and immune response, as well as supporting normal vascular development. Dioxins and other pollutants are known to provoke AhR responses.

Bioassay responses may explain why some sites are in poor biological condition. For example, AhR activity was negatively correlated with CSCI scores ($r = -0.84$, Figure 2), suggesting that contaminants known to cause AhR responses (e.g., polycyclic aromatic hydrocarbons, commonly associated with runoff from asphalt or combustion) may alter benthic macroinvertebrate assemblages (Figure 2). Follow-up targeted chemical analyses found sunscreen ingredients at sites with ER activity and flame retardants at sites with AhR activity, although concentrations were generally too low to explain the observed responses, meaning that other, unmeasured compounds are responsible. Field blanks were clean, meaning that contamination of the samples was not a likely cause of the response. Non-targeted analyses to identify these unknown chemicals are underway.

Assessing the ability of streams in southern California to support aquatic vertebrates

Figure 1. California tree frog (*Pseudacris cadaverina*), one of the more common native species of vertebrate found in Southern California streams.

Although the initial SMC stream survey provided a great quantity of data about stream condition based on benthic macroinvertebrates and algae, a lingering question remained about what our findings meant for higher trophic levels, such as fish, amphibians, and other vertebrates (Figure 1). Although a thorough investigation of this question is beyond the scope of the current regional monitoring program, the SMC found a way to get some answers, and at remarkably low costs.

In 2015, SMC field crews received training in identifying common aquatic vertebrates in the region, and began reporting observations of species they encountered during normal bioassessment sampling (that is, no additional time was spent trying to observe vertebrates). This effort began as a collaborative venture initiated by the SMC, the US Geological Survey (USGS), the US Fish and Wildlife Service (USFWS), and SWAMP, all of whom were hoping to improve their understanding of the spatial distributions of both native and non-native vertebrates in the region. The survey provided a concrete example of how the core regional monitoring program can be used to opportunistically collect data to answer important management questions. The resources necessary to successfully complete the survey were relatively trivial for several reasons: the SMC field teams were already visiting the sites; the teams already included biologists easily trained to identify stream vertebrates; and the sampling design was based on a time-saving casual observation approach, instead of a more traditional rigorous search at each site.

Despite the low costs, this survey provided a great deal of new and valuable data on vertebrates in the region's streams, with observations attempted at a total of 95 sites (Figure 2). Vertebrates were seen at 46% of the sites, and surprisingly, the distributions of native frogs were fairly widespread across urban, agricultural and open land use types. These native amphibians were unexpectedly tolerant to the presence of non-native fish, frogs or crayfish. In contrast, native fish species were only observed at five mountainous sites. Mosquito fish (*Gambusia affinis*) were observed at 21 sites and were the most common non-native fish species, likely as a result of deliberate introduction as a vector-control measure.

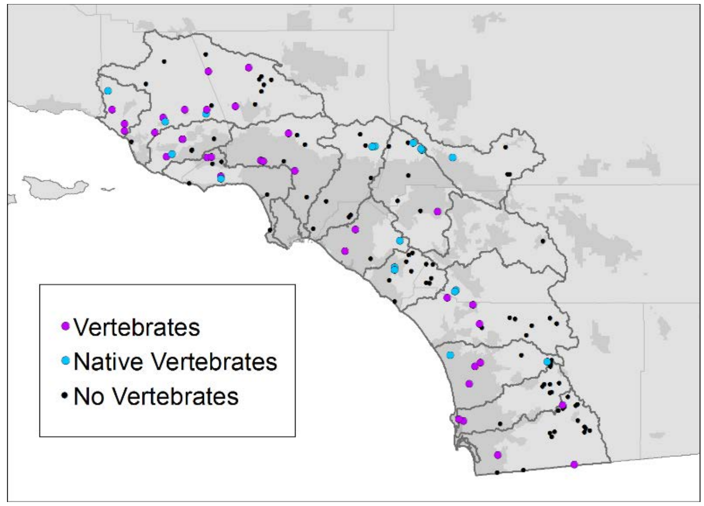


Figure 2. Location of vertebrate observations conducted in 2015.

Of the sites located on agricultural land, 68% supported vertebrates, although the many of these were non-natives (47%). In contrast, 49% of open land sites supported vertebrates, but only 17% of these were non-natives. It is important to note that these numbers likely underestimate the actual distribution of vertebrates because the field crews did not conduct exhaustive surveys of each site.

The addition of vertebrate observations to the survey yielded detailed information regarding the distributions of vertebrates throughout the southern California region, despite the limited amount of resources and training required to successfully implement it. Although more intensive efforts may have detected more species (especially nocturnal or cryptic species), opportunistic sampling was sufficient to improve our understanding of the ability of Southern California streams to support wildlife. Future work for this program might focus on the environmental and habitat factors that contribute to the presence or absence of vertebrates on agricultural, urban and open land use types; investigation of the relationships among vertebrates and other biological condition indicators including the CSCI, CRAM and Southern California algal IBIs; and improving our understanding of the spatial distribution of these important taxa by combining the SMC vertebrate dataset with those from iNaturalist, regional fish surveys, the USFWS, the USGS, and the California Department of Fish and Wildlife.

Applications of survey data

A water-quality improvement plan supported by survey data

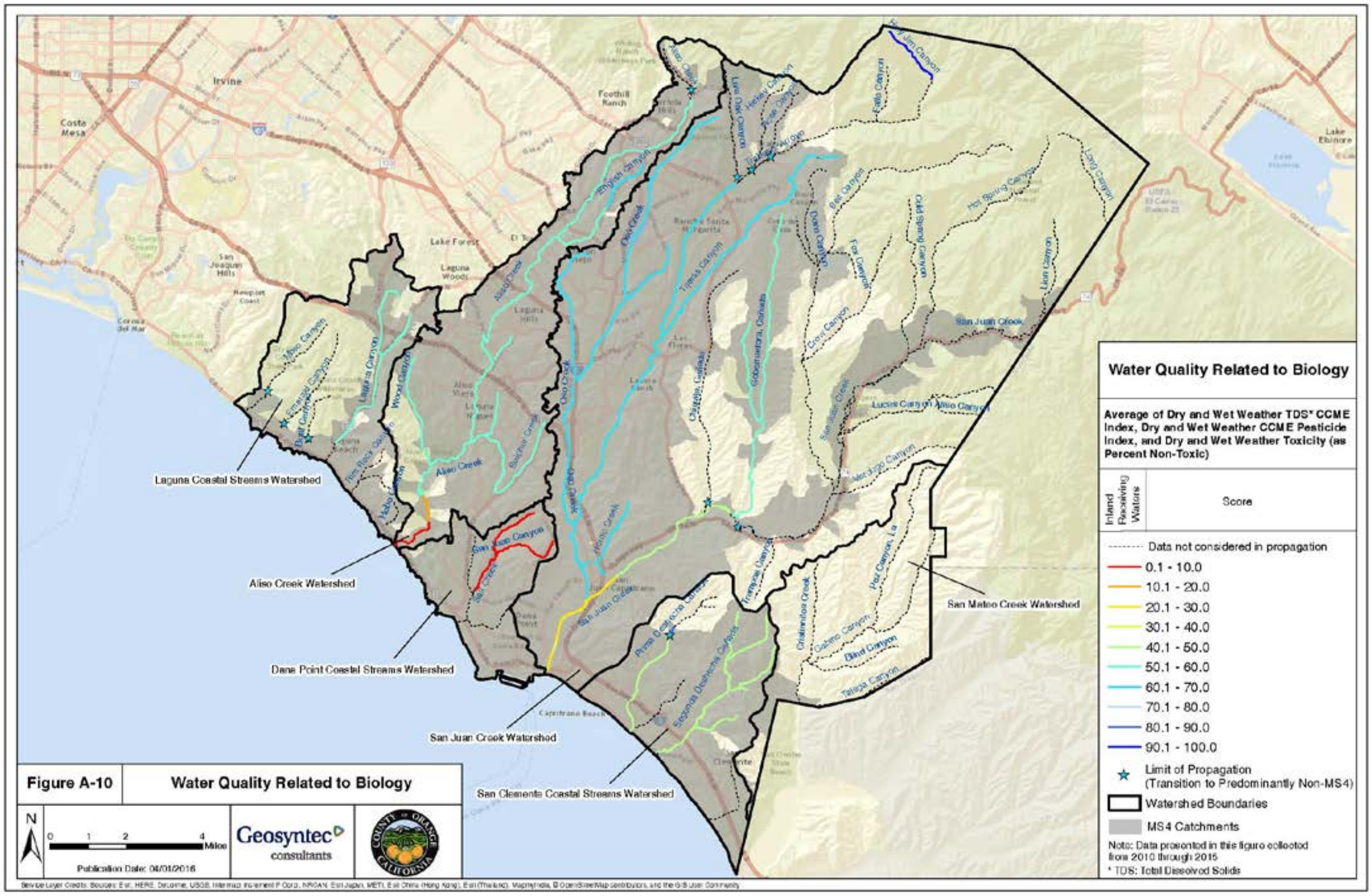


Figure 1. Excerpt from the San Juan Water Quality Improvement Plan shows how the County of Orange used SMC bioassessment and water quality data to prioritize problem areas in the watershed. Red, orange, and yellow stream segments have low-scoring bioassessment sites, in conjunction with measures of poor water quality. A separate analysis identifies stream reaches where low-scoring bioassessment occur in conjunction with geomorphic alteration.

A key objective of the SMC stream survey is to provide participants with data that helps them manage watersheds. One recent notable example is Orange County's Water Quality Improvement Plan (WQIP) for the San Juan Hydrologic Unit, which prioritizes problems in the watershed based on SMC data, emphasizing biological indicators like benthic macroinvertebrates and algae. The goal of the WQIP is to 1) determine high-priority water-quality problems; 2) identify goals, strategies, and schedules to address them; and 3) propose an approach to monitor and assess progress. In all three elements, the SMC survey provides the foundation and the framework for implementing these goals.

The WQIP identified three priority problems, and two of them were determined through bioassessment data: geomorphic alteration, and unnatural flow regimes. These problems were identified by the association of stressors related to these problems (e.g., hydromodification and habitat degradation), and their relationships with poor bioassessment index scores (Figure 1). Best management practices to mitigate these stressors will be identified, and their success will be partly determined in terms of improvements in biological condition. The monitoring and assessment component of the WQIP is currently under preparation, and it is expected that biological monitoring through the SMC stream survey will play a crucial role in this component.

Regional flow targets to support biological integrity

The SMC stream survey data provides a strong foundation to explore the problems affecting streams in the region, such as hydrologic alteration, which previous surveys suggested is a major factor affecting biological condition. Hydrologic alteration results from water diversions, inter-basin transfers, and increased imperviousness that alter the natural flow regime in a stream. Taking advantage of a new ensemble-modeling approach to estimate current and historic flows at ungauged streams, hydrologic alteration was estimated at 572 bioassessment sites, most of which are part of the SMC stream survey. The ensemble was built by calibrating simple rainfall-runoff models at 26 stream gauges in Southern California, then assigning one model to ungauged sites with similar catchment properties. Biological responses (e.g., California Stream Condition Index [CSCI] scores) were modeled against metrics reflecting hydrologic alteration, thresholds of biological response were established for multiple flow metrics, and metrics were combined into an overall index of hydrologic alteration with scores ranging from 0 (no alteration) to 14 (all metrics severely altered).

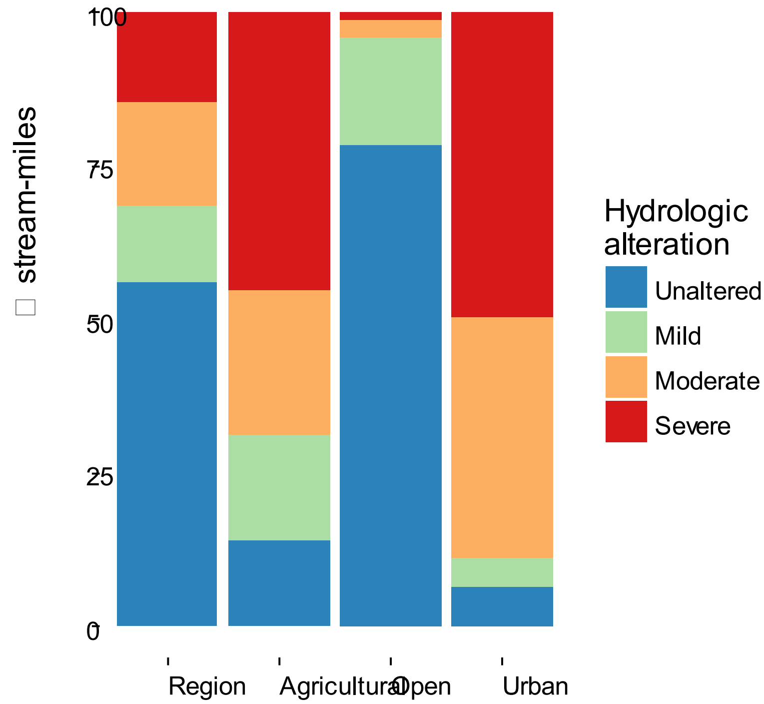


Figure 1. Extent of hydrologically altered streams in the region, as well as within three land-use classes.

Because this index was applied to survey data, it allowed the first-ever estimate of the extent of hydrologic alteration in the region. Approximately 34% of stream-miles in Southern California were estimated to be moderately or severely hydrologically altered, and alteration was more pervasive in urban (91% stream-miles altered) and agricultural (80%) than undeveloped (11%) streams (Figure 1).

The index also allowed rapid setting of management priorities and causal assessment screenings (Table 1, Figure 2). Among the biologically healthy sites (i.e., CSCI scores > 0.79), hydrologically unaltered sites (52% of total stream-miles) were prioritized for protection, and hydrologically altered sites (4%) were prioritized for monitoring. Among the biologically degraded sites, 30% were hydrologically altered, and prioritized for evaluation of flow management (such as increased stormwater detention or groundwater infiltration). Evaluation of other stressors was prioritized at the remaining 14% of stream-miles.

Table 1: Management action priorities based on measures of biological condition and hydrologic alteration.

	Unhealthy biology	Healthy biology
Altered hydrology	Evaluate flow management: 30□	Monitor: 4□
Unaltered hydrology	Evaluate other stressors: 14□	Protect: 52□

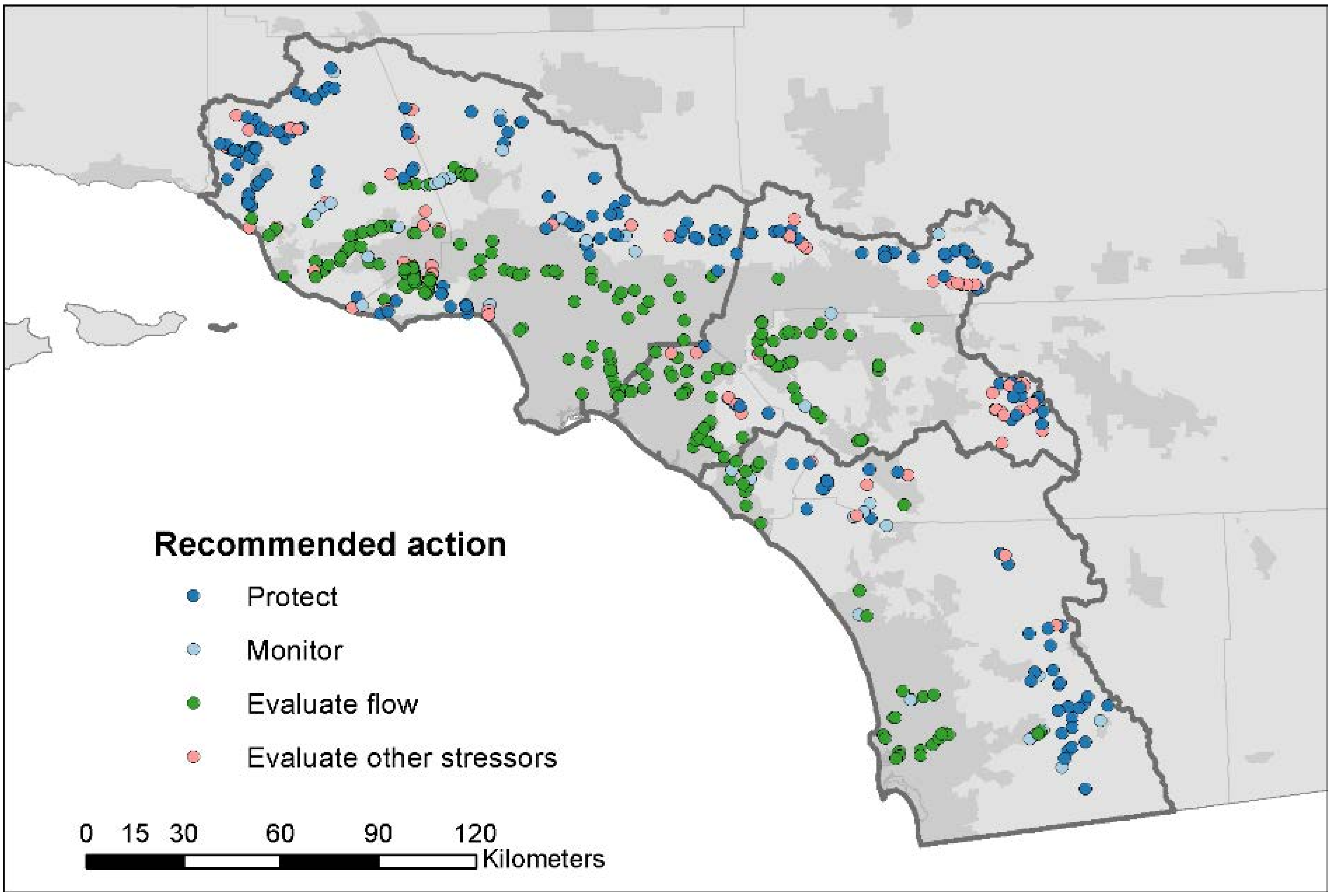


Figure 2. Management priorities for streams in the SMC region, based on estimates of hydrologic alteration and biological condition.

Regionally derived, biologically based targets for flow allow watershed managers to rapidly prioritize activities and conduct screenings for causal assessments at many sites across large spatial scales. Furthermore, regional tools pave the way for incorporation of hydrologic management in policies and watershed planning designed to support or enhance biological integrity in streams. Development of regional tools should be a priority in regions where hydrologic alteration is pervasive or expected to increase in response to climate change.

Appendix 12

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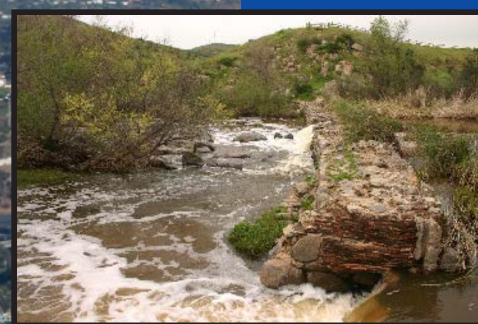
Application of Regional Flow-ecology to Inform Management Decision in the San Diego River Watershed



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EXECUTIVE SUMMARY

Changes to instream flow are known to be one of the major factors that affect the health of biological communities. Regulatory, monitoring, and management programs are increasingly using biological community composition, particularly benthic invertebrates, as one measure of instream conditions, stormwater project performance, or regulatory compliance. Understanding the relationship between changes in flow and changes in benthic invertebrate communities is, therefore, critical to informing decisions about ecosystem vulnerability, causes of stream and watershed degradation, and priorities for future watershed management.

Taking advantage of large, robust regional monitoring data sets and recently completed regional watershed models, the Southern California Coastal Water Research Project (SCCWRP) has developed a set of "flow–ecology" relationships for southern California that relate changes in specific flow metrics to changes in benthic invertebrate indices that have been shown to be indicative of stream health. These relationships are based on the Ecological Limits of Hydrologic Alteration (ELOHA) framework, which uses a variety of hydrologic and biologic tools to determine and implement environmental flows at the regional scale. Results of the ELOHA analysis can inform management decisions, such as release rates from dams, reservoirs or basins; diversion volumes for irrigation or water re-use, or flows associated with stream restoration.

The goal of this project is to demonstrate how regionally derived flow–ecology relationships can be implemented at a watershed scale to inform management decisions. Regional relationships allow us to describe general patterns of response in biological communities to changes in hydrology. Local case studies are critical to determine how these relationships can be applied to site-specific decisions, and to identify areas where the regional relationships may need to be refined to better support local application.

Our case study focused on the San Diego River Watershed in southern California, where the potential effects of urban growth and water/runoff management on stream flow and biological condition are currently being considered. We worked with a group of local watershed stakeholders to identify three questions that that would both inform local management decisions (along with other planning considerations) and demonstrate the utility of the regional flow–ecology relationships. Close coordination with the stakeholder group enhanced the relevancy of the analysis and helps to determine how the technical approach to establishing targets may be applied in other areas. The case study focused on the following management questions:

1. How will future land use changes affect flow conditions and impact biological endpoints in the San Diego River watershed? This involves a comparison of the current hydrologic conditions to modeled conditions based on San Diego County's 2050 land use projection. Future scenarios did not include any assumptions about best management practices, low impact development or hydromodification, which would be expected to reduce potential effects of future hydrologic alteration.

2. How can we use our understanding of current and expected future hydrologic conditions along with the regional flow–ecology relationships to prioritize regions of the watershed where flow management may be most critical to maintain or improve future stream health?

3. What are the biological implications of two future management decisions that will affect in-stream flow conditions:

4. What would be the effects of reduced discharge from Santee Lakes Reservoir due to increased capture and storage to meet demand for reclaimed water?

5. What would be the effect of disconnecting imperviousness and implementing stormwater capture strategies in a currently developed portion of the watershed?

These local management questions were addressed using regional flow-ecology relationships that relate changes in stream health to changes in hydrology. Stream health was assessed using the California Stream Condition Index (CSCI), a statewide index of benthic macroinvertebrates community composition. Hydrologic alteration was assessed based on the following hydrologic metrics, which were shown to have strong statistical and ecological relationships with the CSCI (Table ES-1; See Mazor et al. in review). Metrics were also selected to ensure representation of different components of the flow regime (e.g. duration, magnitude, etc.) and different climate conditions (e.g. wet vs. dry vs. average years).

Table ES-1. Priority hydrologic metrics used in the regional flow-ecology relationships. Metrics are grouped by the hydrograph component they represent. Metric effects on biology were typically strongest during either average, wet, or dry rainfall years, or all years combined (overall).

Hydrograph Component	Metric	Metric Definition	Critical precipitation condition
Duration	NoDisturb (days)	median annual longest number of consecutive days that flow is between the low and high flow threshold	Average
	HighDur (days/event)	median annual longest number of consecutive days that flow was greater than the high flow threshold	Wet
Magnitude	MaxMonthQ (m3/s)	Maximum mean monthly streamflow	Wet
	Q99 (m3/s)	streamflow exceeded 99% of the time	Wet
Variability	RBI (unitless)	Richards-Baker index of stream flashiness	Dry
	QmaxIDR (m3/s)	interdecile range of flow	Overall
Frequency	HighNum (events/year)	median annual number of events that flow was greater than high flow threshold	Dry

Effect of future land use change

Under current land use conditions, 44% of the catchments in the watershed were considered hydrologically altered based on the metrics shown in Table ES-1. There is a broad spatial gradient of hydrologic degradation in the watershed, with the most hydrologically intact areas in the upper watershed, moderately altered catchments in the middle watershed, and the most hydrologically altered catchments in the lower watershed (Figure ES-1). Hydrologic alteration is largely correlated with total impervious cover, with hydrologic alteration generally becoming measurable as the impervious cover reaches and exceeds 5%. Given this pattern, hydrologic conditions are expected to degrade under San Diego County's projected 2050 land use for the watershed (Figure ES-1). The majority of new impacts are expected to occur in the upper watershed where current open space may convert to low-density residential land use and exceed the 5% impervious cover level. Based on the regional flow-ecology relationships, we expect that future hydrologic changes will also manifest as declines in benthic invertebrate communities, reflecting an overall impairment of biological conditions. Efforts to reduce *effective impervious cover* through low impact development or hydromodification control (which act to disconnect total imperviousness from streams) would be expected to reduce future impacts.

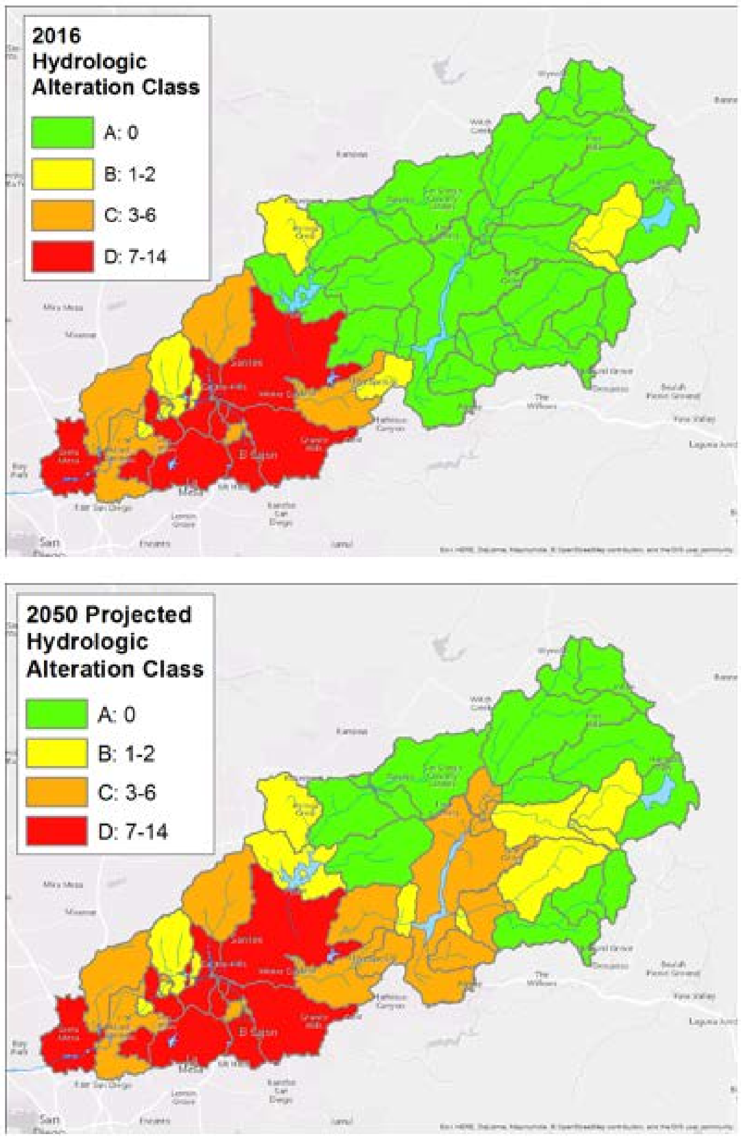

Figure ES-1. Hydrologic alteration under current (top) and 2050 projected (bottom) land use.

Prioritization of areas for various management actions

We prioritized areas of the watershed for various management actions using a combination of hydrologic alteration (see Figure ES-1) and biological condition based on existing bioassessment data (using the CSCI). The majority of upper watershed sites were considered intact and thus a high priority for preservation or protection (Figure ES-2). Two sites in the middle watershed had altered hydrology, but healthy biological communities. This suggests that the communities are either resilient or have not yet responded to the hydrologic alteration. Therefore, these sites should be monitored for potential future degradation. The lower watershed largely expressed both poor biological condition and altered hydrology. For sites in the lower watershed where both hydrology and biology were in altered, we examined available data on water quality and channel condition to better understand the relative contribution of flow alteration vs. other stressors to reduced biological health. This analysis allowed us to provide preliminary management recommendations that can be prioritized for each location (Figure ES-2). We estimate that flow alteration alone is the principle factor affecting biology at only 3 of the 13 biologically degraded sites in the lower watershed. At all other sites, flow management should be coupled with habitat or water quality remediation in order to improve biological conditions.

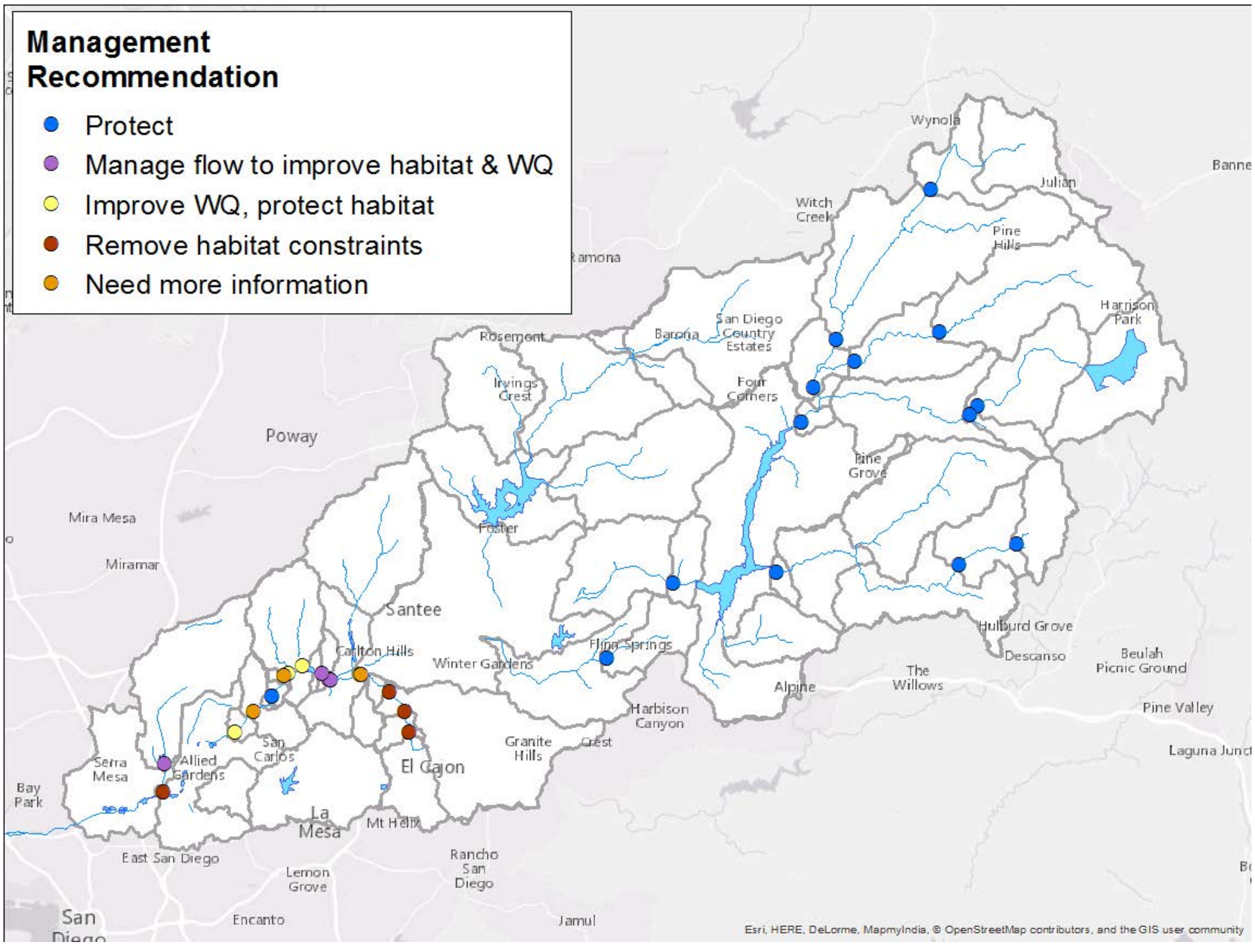

Figure ES-2. Recommended management actions for all sites based on a combination of hydrologic and biological condition. Recommendations are based on both flow-ecology information and available data on habitat and water quality obtained through the local regional monitoring program. Only sites with existing bioassessment data are included.

Evaluation of management scenarios

We demonstrated application of the flow–ecology tools to evaluate both a reservoir management scenario and an urban runoff management scenario. The reservoir management scenario involves eliminating discharge of treated wastewater into the Santee Lakes Reservoir and redirecting it for reuse to help meet increased demands for recycled water. This would reduce reservoir outflow and change hydrology of the downstream Sycamore Creek. Our analysis showed that modifying reservoir management would reduce several flow metrics closer to reference conditions; however, they will probably not fully return to reference condition due to the ongoing contribution of urban runoff. Overall, certain components of the hydrograph (usually under high flow conditions) in Sycamore Creek will improve, but is likely to remain in degraded hydrologic and biological condition, even if discharges from Santee Lakes Reservoir are eliminated following the proposed management scenario.

We modeled two urban runoff management scenarios: 1) disconnecting impervious areas from discharging to streams (i.e. reducing impervious cover), and 2) implementing stormwater retention facilities that can capture 85th percentile of a 24-hour rain event. Disconnecting imperviousness decreases the extent of hydrologic alteration in the downstream reaches. However, flow metrics do not return to levels associated with healthy biological communities until the total imperviousness is at or below 5%. Analysis shows that for most metrics, there is a 66% likelihood of meeting flow targets at 5% total impervious cover and an 80% likelihood of meeting flow targets at 2% total impervious cover (i.e. with stormwater control measures installed). The sensitivity of the creek to relatively low levels of impervious cover is consistent with past studies from southern California. In contrast, retention of the 85% storm event (as is currently required through the local stormwater permit) resulted in flow metrics that met all target values.

Utility of the ELOHA approach for establishing flow-ecology relationships

A major objective of this case study was to evaluate the ability to apply the flow–ecology relationships derived from the regional ELOHA analysis to inform local watershed-scale decisions. Our results illustrate that several of the stated advantages of the ELOHA approach do aid in such watershed-scale application. The ability to apply regionally derived flow targets to inform local decisions is a major advantage of the ELOHA approach. This eliminates the need to develop local flow–ecology relationships for every stream of interest, as is the case in more traditional instream flow methods. The tools developed through the regional analysis provided readily transferable tools for local stakeholders to produce measures of hydrologic change for any location of interest and to explore how those values would change under different land-use or management scenarios. This had the dual benefit of allowing for robust analysis and providing a vehicle for stakeholder engagement in setting management priorities related to instream flow. A potential downside of the ELOHA approach is that the regionally established flow targets may not fully address all concerns or considerations at a specific project location in the same manner as a site-specific analysis would. Ultimate policy decisions about how streams are managed must balance many competing needs. This case study shows how regional flow-ecology relationships can help inform these decisions.

Lessons learned for future implementation of regional flow-ecology relationships

Future efforts can build on the experiences from this case study and continue to refine an iterative process of developing flow targets that are scientifically defensible, practical (i.e., can lead to management actions), and consistent with local stakeholder needs. Key lessons learned from this effort include:

1. Include a broad set of engaged stakeholders, including regulatory agencies, municipalities, water agencies, non-governmental organizations, and researchers. This ensures a broad perspective in the deliberations and increases the likelihood of developing balanced recommendations.
2. Invest in educating the stakeholders early in the process on the underlying science and the rationale behind how regional flow targets were developed. This promotes engagement and fosters creative solutions to the complex challenges of flow management.
3. Invest the time to compile high quality local data sources and show how local data can be used in the evaluation process. Identify the areas were future data collection can most improve outputs of

the flow–ecology analysis (e.g., local rainfall data, more refined land use, water quality data). This can inform future monitoring.

4. Develop documentation that clearly illustrates how the products of the flow–ecology analysis can be used in the context of existing regulatory or management programs.

The San Diego River implementation case study also produced several technical recommendations that can improve our ability to apply flow-ecology relationships to manage southern California streams:

1. Several flow metrics, particularly those associated with flow duration, may require modification for use in streams where the natural condition is intermittent or ephemeral. Application of regionally derived flow thresholds to specific streams that may have been naturally intermittent can lead to erroneous results.

2. Metrics associated with flow durations should be calculated on a single threshold value based on reference conditions. Estimating hydrologic change based on a moving threshold estimated separately for current and reference conditions may produce erroneous results.

3. Need to improve the representation of the drainage system to provide a more accurate hydrologic foundation for analysis. This would ultimately include improved mapping of discharges, diversions, stormwater control facilities, low impact development (LID), etc. for incorporation into modeling scenarios and effects.

4. Consider expanding the analysis to include additional elements in future case studies
    a. Include other stream or water body types
    b. Include other indicators (e.g. algae)
    c. Explore how consistent/transferable findings are from one watershed to another
    d. Explore application in watersheds that cross jurisdictional boundaries

INTRODUCTION

Flow regime has been shown to affect a broad suite of ecological processes and biological communities (Bunn and Arthington 2002, Naiman et al. 2002, Poff et al. 1997, Poff and Zimmerman 2010, Novak et al. 2015). Many studies have demonstrated that alterations of flow regime can be associated with changes in macroinvertebrate assemblages, which are used as key bioindicators for many regulatory and management programs globally (Pringle et al. 2000, Miller et al. 2007, DeGasperi et al. 2009, Poff & Zimmerman 2010). Although a basic understanding of the relationship between flow alteration and ecological response exists (Poff et al. 2010), few studies have demonstrated how to develop regulatory or management objectives (or targets) based on these relationships. Establishing quantitative and predictive relationships between change in flow and change in biological community composition is a critical step in using bioassessment indicators to establish measures of project performance or regulatory compliance.

Various approaches have been used to develop relationships between flow characteristics and biological response. Examples include use of habitat suitability models that relate flow change to requisite habitats for target taxa (e.g., MesoHABSIM, Parasiewicz 2009; and PHABSIM, Beecher et al. 2010); establishment of functional flow regimes to support species of management concern (McClain et al. 2014, Yarnell et al. 2015); and use of statistical ranges of sustainability based on unaltered hydrographs (Richter et al. 2011). Concepts from several of these approaches have been organized into the Ecological Limits of Hydrologic Alteration (ELOHA) framework (Poff et al. 2010). The ELOHA framework uses a variety of hydrologic and biologic tools to determine and implement environmental flows at the regional scale. Results of the ELOHA analysis can inform management decisions, such as release rates from dams, reservoirs or basins, diversion volumes for irrigation or water re-use, or flows associated with stream restoration. Because the ELOHA framework provides a way to assess the effect of flow alteration on the condition of biological communities (vs. individual taxa) on a regional basis, it is a useful approach for setting targets across a wide range of geographies and stream types where comprehensive detailed site-specific investigations are not practical. The ELOHA framework includes elements of stream classification, estimation of flow alternation (termed “delta H”) and development of flow ecology relationships based on the relationship between delta H and changes in the biological community (“delta B”).

There have been several recent applications of the ELOHA framework to develop flow targets for benthic invertebrates, fish, mussels, amphibians, and aquatic and riparian vegetation. Buchanan et al. (2013) completed the ELOHA approach in the mid-Atlantic region of the U.S. and was able to show clear relationships between changes in a subset of six flow metrics and six benthic invertebrate endpoints. This allowed the authors to recommend specific metrics that could be used for monitoring and assessment. McManamay et al (2013) applied ELOHA through a case study in North Carolina to assess the effect of a stream restoration on fish and riparian communities. Although the ELOHA framework worked well at documenting effects of the restoration projects, confounding factors (e.g., associations between delta H and water chemistry alteration) produced equivocal relationships between flow alteration and response of the fish community. The Nature Conservancy has developed ecosystem flow recommendations for the Susquehanna River Basin (DePhilip and Moberg 2010) and the upper Ohio River Basin (DePhilip and Moberg 2013) that provide seasonally differentiated targets for different stream classes and multiple biological endpoints (e.g., fish, mussels, amphibians, vegetation). Solans and Jalon (2016) used a series of flow alteration-ecological response curves to develop environmental flow standards for the Ebro River Basin in the Iberian Peninsula. Most recently, Mazor et al. (in review) capitalized on extensive regional biomonitoring data and a set of regional hydrologic models developed by Sengupta et al. (in review) to develop flow-ecology relationships for southern California based on benthic macroinvertebrate communities as a measure of stream health.

Previous studies have demonstrated the utility of the ELOHA framework for establishing flow targets and thresholds using relationships between changes in flow and changes in biological condition. Broad scale application of ecologically derived flow targets (or thresholds) can be informed by case studies that demonstrate how flow-ecology relationships can be used to inform actual management decisions. In addition to the study by McManamay et al (2013), the main place where flow-targets have been implemented to inform management actions is in the Juanita Creek Watershed in Washington State, USA (King County 2012). The Juanita Creek study evaluated the effectiveness of seven potential stormwater mitigation scenarios at achieving biologically relevant flow targets using a calibrated Hydrological Simulation Program-Fortran (HSPF) model; a single scenario was identified which would accomplish the stated watershed goals. To our knowledge, none of the previous cases studies attempted to apply regionally-derived flow-ecology relationships (such as those developed for southern California) to inform decisions at the watershed scale. Additional case studies that demonstrate this application can provide a template for future applications of flow-ecology based targets, and allow for consideration of lessons learned to refine these future applications. Such case studies are also important because they provide an opportunity to work with local watershed stakeholders to identify management needs and apply ecohydrology analyses to inform decisions in a way that balances consideration of ecological endpoints with other needs (e.g., water supply management, new infrastructure and development, flood control).

The goal of this project is to demonstrate how the regionally derived flow–ecology relationships developed by Mazor et al. (in review) can be implemented at a watershed scale to guide management targets/decisions. Regional relationships allow us to describe general patterns of response in biological communities to changes in hydrology. Local case studies are critical to determine how these relationships can be applied to site-specific decisions, and to identify areas where the regional relationships may need to be refined to better support local application.

METHODS

Study area

We conducted the demonstration in the San Diego River watershed, in San Diego County, California, where the potential effects of urban growth and water/runoff management on stream flow and biological condition are currently being considered (Figure 1). At 440 square miles (1,140 square km), it is among the largest watersheds in San Diego County and also has the highest population (~475,000), containing portions of five cities and several unincorporated communities. Important hydrologic resources in the watershed include five water storage reservoirs, a large groundwater aquifer, extensive riparian habitat, and coastal wetlands. Approximately 58% of the San Diego River watershed is currently undeveloped. The majority of this undeveloped land is in the upper, eastern portion of the watershed, while the lower reaches are more highly urbanized. The San Diego River watershed is a valuable case study because it includes a range of stream types, including reference (as defined by Ode et al. 2016) and highly impacted reaches; it is affected by several types of hydrologic alteration, including urban runoff, flood control, and reservoir management; it is relatively data-rich, benefiting from years of ambient and targeted monitoring programs (e.g., Mazor 2015); and there is an active and engaged watershed workgroup that is willing to participate in the demonstration project.

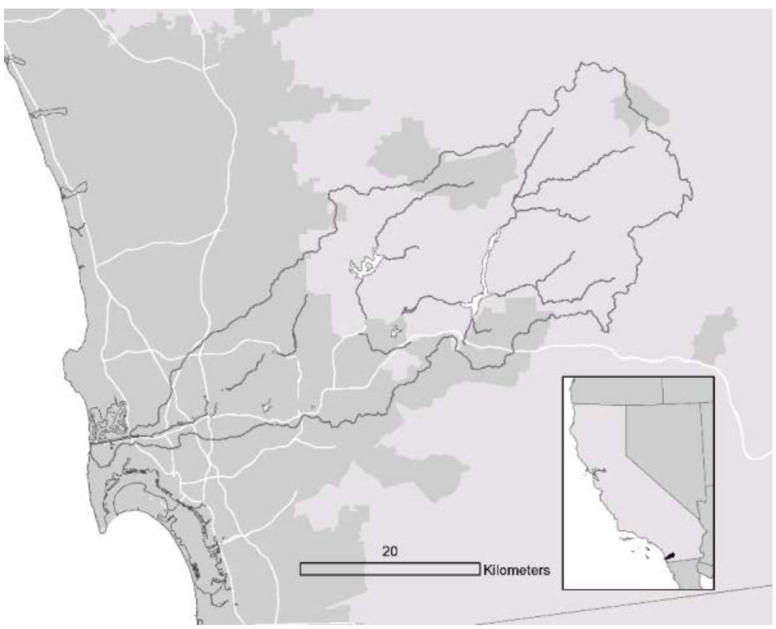

Figure 1. San Diego River Watershed

Stakeholder Process

Active stakeholder participation is integral to a successful demonstration case study because the stakeholders must identify the issues and interpret the utility of the recommendations resulting from the analysis. Stakeholders for the San Diego River case study included local municipalities, water districts, a land conservancy, a non-governmental organization, water quality regulatory agencies, the U.S. Forest Service as the upper watershed landowner and a local consulting firm (Table 1).

The stakeholder workgroup met monthly over an eight-month period and was facilitated by technical staff from the Southern California Coastal Water Research Project (SCCWRP), who had recently completed a regional ELOHA analysis (Mazor et al. in review). The workgroup was engaged in all aspects of the project including detailed scoping, assisting in modeling and analysis, and interpretation and refinement of findings. This intimate participation was key to developing products that would be acceptable for incorporation into future management decisions. A list of workgroup participants and topics for each workgroup meeting are provided in Appendix B.

Table 1. Stakeholders who participated in the San Diego River case study

- City of San Diego
- U.S. Forest Service
- Helix Water District
- Padre Dam Municipal Water District
- San Diego County
- Southern California Coastal Water Research Project
- San Diego River Conservancy
- The San Diego River Park Foundation
- San Diego Regional Water Quality Control Board
- San Diego State University
- AMEC Environmental

The stakeholder workgroup identified three questions that would both demonstrate the utility of the regional flow–ecology relationships and inform local management decisions.

1. How will future land use changes affect flow conditions and impact biological endpoints in the San Diego River watershed? This involves a comparison of the current hydrologic conditions to those that would be expected under a 2050 land use scenario.
2. How can flow–ecology relationships be used to prioritize regions of the watershed into various flow management classes that can inform future planning decisions?
3. What are the biological implications of two future management decisions that will affect in-stream flow conditions?
   a. reduced discharge from Santee Lakes Reservoir due to increased capture and storage to meet demand for reclaimed water
   b. disconnecting imperviousness, and implementing stormwater capture strategies in a currently developed portion of the watershed

Regional ELOHA (flow-ecology) analysis

The local management questions were addressed using regional flow-ecology relationships conducted for southern California that relates changes in stream health to changes in hydrology. Stream health was assessed using the California Stream Condition Index (CSCI), a statewide index of benthic macroinvertebrates community composition. Hydrologic alteration was assessed based on a series of hydrologic metrics, which were shown to have strong statistical and ecological relationships with the CSCI (Mazor et al. in review). Metrics were also selected to ensure representation of different components of the flow regime (e.g. duration, magnitude, etc.) and different climate conditions (e.g. wet vs. dry vs. average years). Because we lack measured flow data for both current and historic conditions at most bioassessment sites, both were estimated using watershed models.

Regional benthic macroinvertebrate data were obtained from the southern California regional bioassessment program (Figure 2, Mazor 2015). A total of 799 wadeable stream sites were sampled between 2008 and 2014 using a probabilistic sample design. Sites were randomly distributed across the entire stream network using a spatially balanced generalized random-tessellation design that ensured representation across all natural and anthropogenic gradients in the region (Stevens and Olsen 2004).

Benthic macroinvertebrates were collected using protocols described by Ode (2007). At each transect established for physical habitat sampling, a sample was collected using a D-frame kicknet at 25, 50, or 75% of the stream width. A total of 11 ft2 (~1.0 m2) of streambed was sampled. This method was identical to the Reach-Wide Benthos method used by EMAP (Peck et al. 2006). However, in low-gradient streams (i.e., gradient <1%), sampling locations were adjusted to 0, 50, and 100% of the stream width, because traditional sampling methods fail to capture sufficient organisms for bioassessment indices in these types of streams (Mazor et al. 2010). Benthic macroinvertebrates were collected and preserved in 70% ethanol, and sent to one of five labs for identification. At all labs, a target number of at least 600 organisms were removed from each sample and identified to the highest taxonomic resolution that could be consistently achieved (i.e., SAFIT Level 2 in Richards and Rogers 2006); in general, most taxa were identified to species and Chironomidae were identified to genus.

Figure 2. Locations of bioassessment sites used to support the regional flow-ecology analysis

Benthic macroinvertebrate data was used to calculate the California Stream Condition Index (CSCI; Mazor et al. 2016). The CSCI is a predictive index that compares observed taxa and metrics to values expected under reference conditions based on site-specific landscape-scale environmental variables, such as watershed area, geology, and climate. It includes two components: a ratio of observed-to-expected taxa (O/E) and a predictive multi-metric index (MMI) made up of 6 metrics related to ecological structure and function of the benthic macroinvertebrate assemblage. Because the CSCI and all of its components are based on site-specific reference expectations, scores are minimally influenced by major natural gradients. Therefore, CSCI scores, by definition, compare existing to reference conditions and can be used as a measure of biological alteration (delta B) under anthropogenic stress. CSCI scores and all components were classified as indicating “intact” or “altered” condition, using the normal approximation of the 10^{th} percentile of CSCI reference calibration scores as a threshold (Mazor et al. 2016). For the CSCI, this equates to a score of 0.79 (where 1 is the reference expectation) as the threshold between biologically intact and altered.

Hydrologic alteration was modeled at 584 of the 799 bioassessment sites using HEC-HMS (ACOE 2000). The remaining 215 bioassessment sites were dropped from the analysis because the rainfall data at those locations was insufficient or did not meet quality control criteria for use in model development. Past studies have assessed hydrologic alteration based on empirical observations, often using a space for time substitution (i.e. comparing distinct hydrologically intact vs. altered locations instead of comparing hydrologic change over time). Modeling provides a mechanism to estimate hydrologic alteration at any location where biological data is available, thereby allowing larger data sets to be included in flow-ecology analysis (DeGasperi et al. 2009). Given the size of the southern California data set (584 sites), there was a need to balance the desire to model hydrologic alteration with the practical considerations of needing a tool that could be readily applied to a high number of sites (Sengupta et al. in review). HEC-HMS provides the ability to produce a continuous time series of estimated flow through parameterization of relatively small number of variables in the model (HEC-HMS manual version 4.1, Xuefeng and Steinman 2009).

A set of 26 HEC-HMS models was developed as part of the regional flow-ecology analysis to represent the range of watershed conditions present in the region. Therefore, one of the 26 models can be applied to produce a daily flow time series for every bioassessment site based on basin properties draining to that site. This obviates the need to develop a unique model for every site. Inputs used to develop and parameterize the models are grouped in three categories (Table 2): 1) watershed-specific data (e.g., area, and imperviousness), 2) site-specific data (e.g., observed flow, precipitation) and 3) model-specific parameters (e.g., initial loss, number of reservoirs).

Table 2. Parameters used to develop HEC-HMS models for application to the regional bioassessment sampling sites. Parameters in bold were adjusted during simulation of natural conditions at each site.

	HEC-HMS Method	Parameters
Watershed Specific		Area
		Imperviousness
		Time of concentration
Site Specific		Observed flow
		Observed precipitation
Model Specific	Simple Canopy	Maximum Storage (in)
		Initial Storage (□)
	Simple Surface	Maximum Storage (in)
		Initial Storage (□)
	Deficit and Constant (Loss)	Initial Deficit (in)
		Maximum Deficit (in)
		Constant Rate (in□hr)
	Clark Unit Hydrograph (Transform)	**Time of Concentration (hr)**
		Storage Coefficient (hr)
	Linear Reservoir (Baseflow)	Ground Water (GW) 1 Initial Discharge (cfs)
		GW 1 Storage Coefficient (hr)
		□ of GW 1 Reservoirs
		GW 2 Initial Discharge (cfs)
		GW 2 Storage Coefficient (in)
		□ of GW 2 Reservoirs

Each model was sequentially calibrated for four criteria: visual hydrograph match, Nash-Sutcliffe efficiency (NSE), percent low flow days, and Richard-Baker Index of flashiness. These calibration endpoints were selected based on relevance for supporting the instream biological communities (Konrad and Booth 2005, Morley and Karr 2002). Calibrating to all four measures produced models tuned to simulate flow conditions relevant for supporting in-stream biological communities. Models were calibrated for a 3-year period and were then validated for temporal and spatial performance. For temporal validation, the calibrated models were run for years outside of the calibration period and matched with the observed flow data. In all cases, model performance (as measured by NSE) during the validation period was within 15% of performance during the calibration period.

To evaluate spatial performance, we applied statistical 'jackknifing' to all calibrated gages. In this analysis, each modeled gage is treated as an 'ungaged' site, and the remaining 25 models are used to predict flows at that site. The models were fitted to the 'ungaged' site by inputting watershed-specific data and model-specific parameters, but without changes to the model-specific parameters. These simulations were run for the 3-year calibration period. Approximately 75% of the sites had an acceptable NSE value higher than 0.5 (Moriasi et al. 2007). A final validation was performed by comparing modeled output to measured flow at 16 bioassessment sites with nearby flow gages (but not included in the model development). At 11 of the sites, the R^2 values averaged 0.61; the range varied from 0.20 to 0.95. Further details on the model validation for accuracy and bias are found in Sengupta et al. (in review).

One of the 26 validated models was assigned to each of 584 bioassessment sites with adequate rainfall data in the southern California region based on similarity of watershed characteristics that were associated with observed hydrology. The assignment was done with a model-selection tool built by 1) classifying the models into 8 clusters based on observed flow metrics; 2) creating a random forest model to predict cluster membership based on watershed characteristics (i.e., elevation maximum and range, mean annual temperature, watershed area, mean catchment-wide summer precipitation, and soil erodibility factor); and 3) calculating proximity values (i.e., the frequency that a site and a model are predicted to be in the same cluster) between novel sites and each of the 26 models. For each bioassessment site, the model with the highest proximity value was selected for further analysis. Details about the development of the model-selection tool, and its performance, are provided in Sengupta et al. (in review).

The watershed models were used to produce an hourly time series of flow for a period of 23 years (1990 - 2013) for the 584 bioassessment sites. A subset of 6 years was selected for each site to calculate specific flow metrics. The six years were chosen to include two wet, two dry, and two average rainfall years based on long-term climate records. The six years were also selected based on the availability of high quality, complete rainfall records (i.e. no missing values or apparent anomalies). A challenge of the ELOHA approach is the need to compare current hydrologic conditions to reference in order to estimate hydrologic change (delta H). Because we seldom have data on historical flows, we rely on modeling to estimate reference conditions. Hourly hydrographs were estimated for both current and reference conditions at each site following Sengupta et al. (in review). Hourly hydrographs were aggregated to daily discharge, and a suite of flow metrics that represent different aspects of flow were calculated for both current and reference conditions (Table 3) Metrics were calculated for wet, dry, and average precipitation conditions, as well as for all 6 years combined. Metric-precipitation combinations that validated poorly (i.e., $r^2 < 0.25$) with observed flow were excluded from further analysis. This resulted in a total of 116 metric–precipitation combinations for analysis. For each metric–precipitation combination, hydrologic alteration (delta H) was characterized as differences between simulated current and reference conditions. “Reference condition” was estimated by adjusting model parameters to reflect undeveloped watershed conditions. Delta H for magnitude metrics was normalized by reference condition or 0.0283 cms (whichever was larger) to account for the effect of catchment size on discharge magnitude. Details on the hydrological analysis and modeling approach can be found in Appendix A.

Table 3. Flow metrics sorted by metric type and period of evaluation. O=overall, W=wet years, A= average years, D=dry years. Unless otherwise noted, metrics are from Konrad et al. (2008), Konrad, personal communication, Colwell (1974), or Bledsoe (personal communication).

Metric			Description		O	W	A	D
Duration								
	LowDur	days/event	Median annual longest number of consecutive days that flow was less than or equal to the low flow threshold		•		•	•
	HighDur	days/event	Median annual longest number of consecutive days that flow was greater than the high flow threshold			•		•
	NoDisturb	days/year	Median annual longest number of consecutive days that flow between the low and high flow threshold		•	•	•	•
	Hydroperiod	proportion	Fraction of period of analysis with flows		•		•	•
	Per□LowFlow	proportion	Percent of time with flow below 0.0283 cms		•	•	•	•
Frequency								
	HighNum	events/year	Median annual number of events that flow was greater than high flow threshold, an event is a continuous period when daily flow exceeds the threshold		•	•	•	•
	FracYearsNoFlow	proportion	Fraction of years with at least one no-flow day		•			
	MedianNoFlowDays	days/year	Median annual number of no-flow days		•	•	•	•
Magnitude								
	MaxMonthQ	cms	Maximum mean monthly streamflow		•	•	•	•
	MinMonthQ	cms	Minimum mean monthly streamflow		•	•	•	•
	Q01	cms	1st percentile of daily streamflow		•	•	•	•
	Q05	cms	5th percentile of daily streamflow		•	•	•	•
	Q10	cms	10th percentile of daily streamflow		•	•	•	•
	Q25	cms	25th precentile of daily streamflow		•	•	•	•
	Q50	cms	50th percentile of daily streamflow		•	•	•	•
	Q75	cms	75th precentile of daily streamflow		•	•	•	•
	Q90	cms	90th precentile of daily streamflow		•	•	•	•
	Q95	cms	95th precentile of daily streamflow		•	•	•	•
	Q99	cms	99th percentile of daily streamflow		•	•	•	•
	Qmax	cms	Median annual maximum daily streamflow		•	•	•	•
	Qmean	cms	Mean streamflow for the period of analysis		•	•	•	•
	QmeanMEDIAN	cms	Median annual mean streamflow		•	•	•	•
	Qmed	cms	Median daily streamflow		•	•	•	•
	Qmin	cms	Median annual minimum daily streamflow		•	•	•	•
Timing								
	C□C	ratio	Colwell's constancy (C) a measure of flow uniformity.		•	•	•	•
	C□CP	ratio	Colwell's maximized constancy (C□P). Likelihood that flow is constant through the year		•	•	•	•

Metric			Duration					
	C□M	ratio	Colwell's contingency (M). Repeatability of seasonal patterns.		•	•	•	•
	C□MP	ratio	Colwell's maximized contingency (M□P). Likelihood that the pattern of high and low flow events is repeated across years.		•	•	•	•
	C□P	ratio	Colwell's predictability (P□C□M). Likelihood of being able to predict high and low flow events		•	•	•	•
	MinMonth	month	Month of minimum mean monthly streamflow				•	•
	MaxMonth	month	Month of maximum mean monthly streamflow			•		
Variability								
	RBI	Unitless	Richard Baker Index (flashiness)		•	•		•
	SFR	proportion	90th percentile of percent daily change in streamflow on days when streamflow is receding (storm-flow recession)				•	
	QminIDR	cms	Interdecile range of annual minima		•			
	QmeanIDR	cms	Interdecile range of annual means		•			
	QmaxIDR	cms	Interdecile range of annual maxima		•			

Hydrologic thresholds that result in biological response were evaluated for each flow metric-precipitation condition combination, based on nine biological response variables (i.e. the CSCI and its component metrics). Hydrologic metrics were evaluated for overall climatic conditions, as well as for wet, dry, or average precipitation years. The 116 metric-precipitation condition combinations were used to predict each of the nine biological response variables in boosted regression tree models using the gbm package in R (Ridgeway 2015, R Core Team 2016), and the importance of each predictor was ranked (Friedman 2001). Ranks were averaged across all models, and the best ranked precipitation condition within each metric was selected for further analysis. Ecologically derived targets were then established for each flow metric. Further detail about modeling biological responses to hydrologic alteration can be found in Mazor et al. (in review).

In order to set targets for hydrologic metrics based on biological response, we developed logistic regression models of the probability of healthy biological condition as a function of different levels of hydrologic alteration. Targets were set at the level of hydrologic alteration where the probability of healthy biological condition was 50% of the probability at hydrologically unaltered sites. It is important to note that these targets do not represent reference conditions. Increasing and decreasing gradients of hydrologic alteration were analyzed independently against each biological response variable. Across all biological response variables, the most conservative target was selected for further analysis. Logistic regression models were created using the glm function in R with a binomial error distribution and a logit link function (R Core Team, 2016). Metrics were scored 0 if they met targets, 1 if they failed targets, and 2 if they failed targets by more than twice the target value (Figure 3).

Metric	100% above UT	Upper Threshold (UT)	Within Threshold	Lower Threshold (LT)	100% below LT
Flow (Q min cfs)	0.04	0.02		-0.02	-0.04
Value	1.2	0.03	0.01	-0.025	-0.6
Score	**2**	**1**	**0**	**-1**	**-2**

Figure 3. Example scale for assigning hydrologic alteration scores

An objective of the regional flow-ecology analysis was to identify a subset of priority flow metrics that can be used to inform management actions. Metrics were prioritized based on the following criteria (Mazor et al. in review):

- Differentiate hydrologic condition at reference sites vs. altered sites
- Have the strongest relationship to biological condition based on boosted regression tree analysis and can produce a hypothesized ecological response
- Can be modeled under both current and reference conditions with a high level of confidence
- Are amenable to management actions and are expected to respond in predictable ways to deliberate changes in flow conditions
- Have minimal redundancy with other metrics; the goal is to select metrics that represent different components of the hydrograph (e.g. magnitude vs. duration)

Based on these criteria and the logistic regression analysis described above, Mazor et al. (in review) identified seven priority flow metrics and associated thresholds of biological response (Table 4). The importance of the seven priority flow metrics varied by climatic condition, with some metrics only being important during certain precipitation conditions (Table 4). Using a subset of metrics has the advantage of allowing management actions to focus on controlling a reasonable set of flow properties that will have the greatest biological effects, as opposed to trying to manage for all 116 metric-precipitation combinations.

Table 4. Priority hydrologic metrics and associated thresholds used in the regional flow-ecology relationships. Metrics are grouped by the hydrograph component they represent. Thresholds are expressed as the change in metric value (delta H) associated with poor biological condition (CSCI □0.79). Metric effects on biology were typically strongest during either average, wet, or dry rainfall years, or all years combined (overall). NT□no threshold established.

Hydrograph Component	Metric	Metric Definition	Critical precipitation condition	Decreasing Threshold	Increasing Threshold
Duration	NoDisturb (days)	median annual longest number of consecutive days that flow is between the low and high flow threshold	Average	-64	NT
	HighDur (days□event)	median annual longest number of consecutive days that flow was greater than the high flow threshold	Wet	-3	24
Magnitude	MaxMonthQ (m3□s)	Maximum mean monthly streamflow	Wet	NT	1.5
	Q99 (m3□s)	streamflow exceeded 99□ of the time	Wet	-0.01	32
Variability	RBI (unitless)	Richards-Baker index of stream flashiness	Dry	NT	0.25
	QmaxIDR (m3□s)	Interdecile range of flow	Overall	-5	2.5
Frequency	HighNum (events□year)	median annual number of events that flow was greater than high flow threshold	Dry	NT	3

Application of regional flow-ecology (ELOHA) relationships to guide watershed management actions

Current and future watershed hydrologic condition was evaluated for 52 distinct catchments defined by major stream nodes (Figure 4). For each catchment, we simulated current and reference hydrology using the most appropriate of the regional HEC-HMS models. Hydrologic alteration (delta H) was calculated for the seven priority flow metrics shown in Table 4, and each metric was scored based on its distance above or below the established threshold (Figure 3). To provide an easy way to convey general hydrologic condition, an overall composite hydrologic condition score was developed by adding the absolute values of the score for each individual metric. The hydrologic condition score ranged from 0-14 because each of the metrics can receive a score between zero and two depending on how far the score is from the threshold (see Table 3). This approach assumes that each metric is of equal importance and that positive or negative changes in metric values have comparable effects. Scores were binned into four categories as shown in Table 5 and each of the 52 catchments was assigned an A – D designation, representing its overall hydrologic condition.

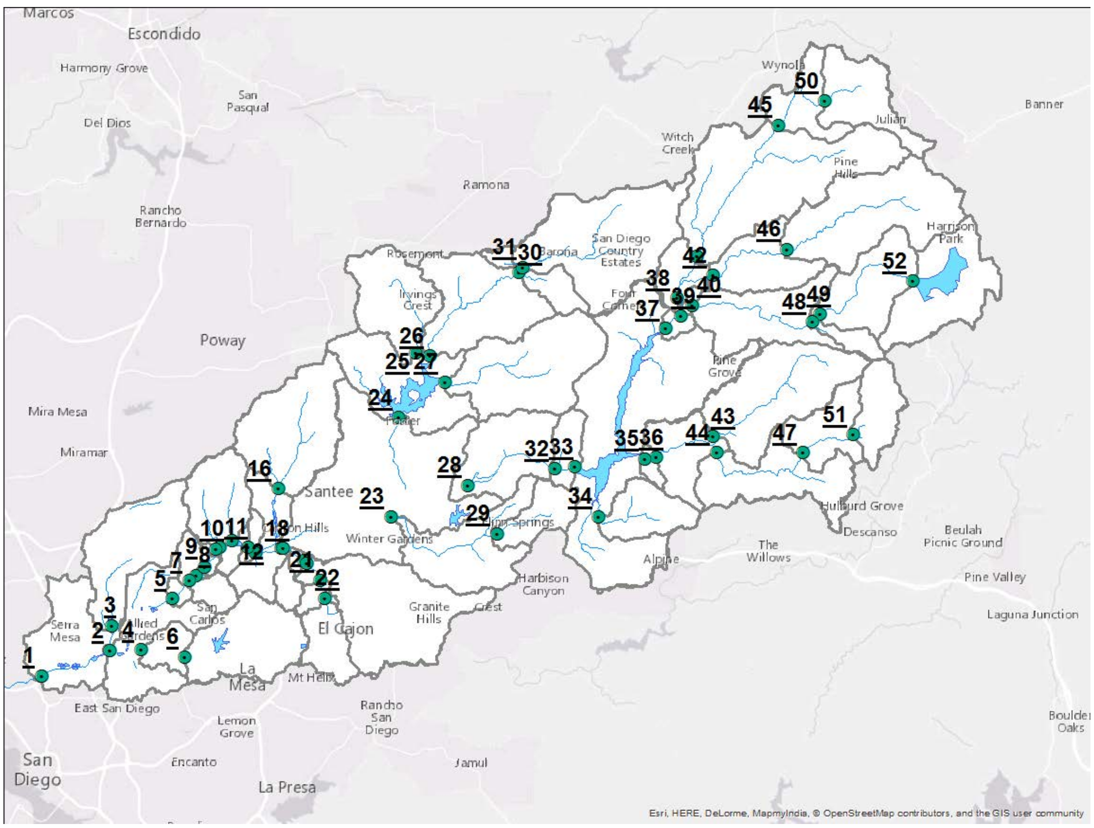

Figure 4. Individual catchments used for watershed analysis

Table 5. Definition of hydrologic condition score (0-14) based on how far each of the priority metrics is from its threshold value. See Figure 3 for explanation of scoring.

Overall Hydrologic Condition Score	Ranges of Metrics Above or Below Threshold
A	0
B	1-2
C	3-6
D	7-14

Flow management classes were assigned to each of the 29 locations where previous bioassessments had been completed. Sites were assigned to one of four classes based on their biological and hydrological status. Biological status was inferred using CSCI scores: Sites with scores greater than 0.79 were designated as biologically intact, and sites with lower scores were designated as biologically altered (Mazor et al. 2016). Hydrological status was assigned using the composite hydrologic condition score described above. Classes A and B were considered hydrologically unaltered when assigning sites to different management classes.

Hydrologically unaltered and biologically unaltered sites were put into a “protection” class; the good conditions at these sites should be protected from further designations. Hydrologically altered and biologically unaltered sites were put into a “monitoring” class; these sites may be resilient to stressors related to hydrologic alteration, but factors related to this apparent resiliency should be monitored to ensure that they continue to support biological health. Hydrologically altered and biologically altered sites were put into a “flow management” class; these sites should undergo a causal assessment to determine if flow management is likely to improve biological condition or if other constraints (e.g., channelization) may limit the ability of a stream to respond to improved flows. Hydrologically unaltered and biologically altered sites were put into an “other management” class; these sites should also undergo causal assessments, but other management options should be prioritized over flow management, such as habitat or water quality improvements (Table 6). Potential additional causes of biological alteration were evaluated for all locations where the CSCI was less than 0.79 based on additional stressor data such as water chemistry and physical habitat assessments that are routinely collected as part of the regional ambient monitoring programs (Mazor 2015).

Table 6. Management categories defined based on combination of hydrologic and biologic alteration

	Poor hydrologic condition	Good hydrologic condition
Poor biology (CSCI □ 0.79)	***Flow Management***: Evaluate hydrologic alteration among other stressors. Determine relative importance of flow management for improving biological condition, relative to other stressors.	***Other Management/Causal Assessment***: Evaluate other stressors to determine cause of poor biology. Evaluation of flow management not recommended.
Good biology (CSCI □ 0.79)	***Monitor***: Communities may be resilient to flow alteration. Continue to monitor for factors that may reduce resilience.	***Protect****:* Intact area. Target for preservation. Explore factors that may contribute to resilience or vulnerability.

Following the watershed mapping, the stakeholders prioritized management questions and scenarios for setting flow targets aimed at protecting (or recovering) instream biological health (as measured by CSCI). The scenarios retained for detailed analysis were selected based on consensus of the workgroup and represented a range of different management situations (e.g. reservoir operation, effluent recycling, and stormwater management). The most appropriate model was selected for each priority scenario using the model selection tool (described above) and was used to simulate both current hydrology and future hydrology based on the proposed management action. Future conditions largely consisted of changes in reservoir discharge, runoff capture, or reduction in impervious cover (i.e. low impact development). The subset of seven priority flow metrics based on the regional flow ecology analysis was calculated for each scenario (see Table 4). The projected delta H for each scenario (and each alternative within a scenario) was evaluated relative to the flow–ecology relationships and thresholds developed by the regional analysis. To aid in management interpretation of the results of the scenario analysis, the regional thresholds, which are expressed as *change in the metric value* were converted to the actual target values specific for the situation of the case study. The results of this analysis were used to develop flow management recommendations for each scenario. Ultimately, these flow recommendations should be considered in concert with other management needs for the watershed.

Results and Discussion

Effect of future land-use change on hydrologic condition

To address the question, "***how will future land-use changes affect flow conditions and impact biological endpoints in the San Diego River watershed?"*** we compared the current overall hydrologic condition to the expected future condition based on 2050 SanGIS land-use projections, assuming no installation of stormwater control device or low impact development features.

Under current conditions, 17 of the 52 catchments (33%) scored in the worst two categories of hydrologic alteration, while 35 of 52 (67%) scored in the least hydrologically altered category (Table 7). There appears to be a spatial gradient of hydrologic condition in the watershed, with the most hydrologically intact areas are in the upper watershed, where much of the land is in public ownership and/or there is currently little urban development. Catchments in the poorest hydrologic condition are concentrated in the lower watershed where most of the current development exists. These areas are also downstream of all the reservoirs in the watershed (Figure 5).

Table 7. Distribution of hydrologic alteration scores under current conditions (□A□is least altered, □D□is most altered).

Category	□of catchments	Proportion of catchments
A	25	48□
B	10	19□
C	6	12□
D	11	21□

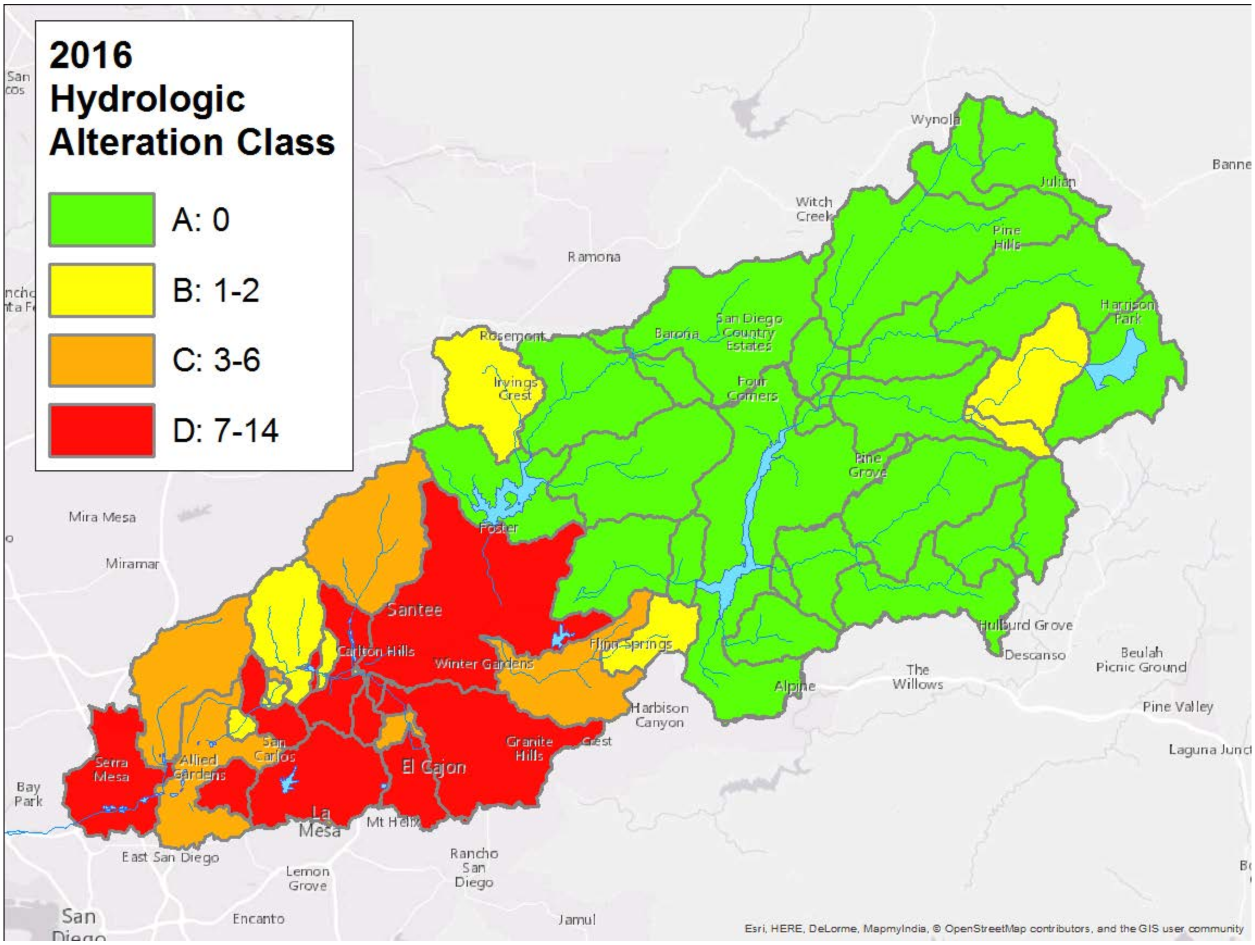

Figure 5. Hydrologic condition of each of the 52 catchments in the watershed. Numbers indicate the number of metrics that failed to meet the designated threshold.

We evaluated all 35 flow metrics in order to provide additional information about the type of hydrologic alteration occurring in each catchment (Figure 6). Catchments that are hydrologically unaltered (Classes A and B in Figure 6) generally “failed” less than 10% of the overall set of 35 metrics. This suggests that the targeted set of metrics used in Figure 5 (based on our screening filters described above) is representative of overall hydrologic condition. The most commonly exceeded metrics range across nearly all categories: duration metrics (e.g. high duration), magnitude metrics (e.g. Q95), frequency metrics (e.g. HighNum), and variability metrics (e.g. RBI). This suggests that when hydrologic alteration occurs, it tends to affect most aspects of runoff hydrographs rather than preferentially influencing certain hydrologic elements.

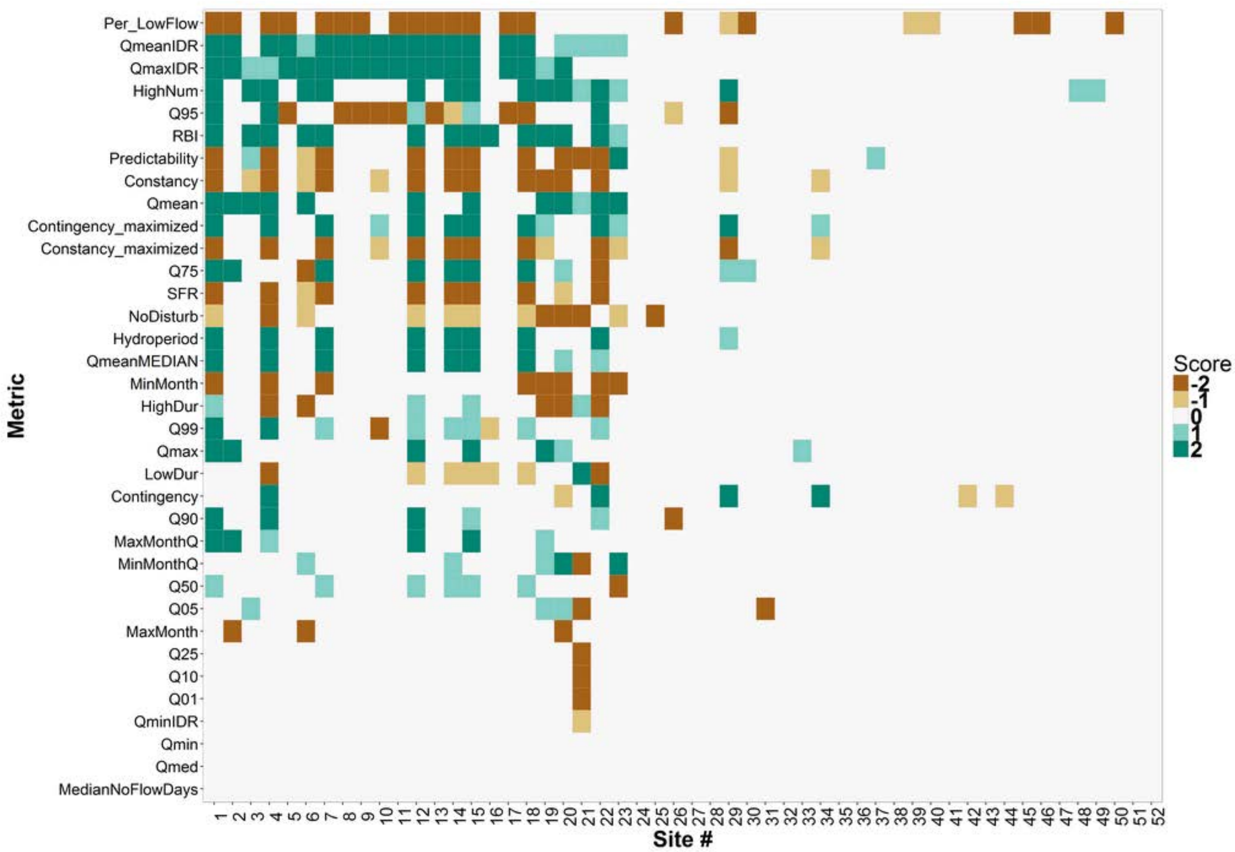

Figure 6. Heatmap showing hydrologic metric scores for all catchments and all metrics. Catchment numbers positions on the x-axis are based on the catchment positions shown in Figure 4.

Hydrologic condition was generally related to catchment imperviousness (Figure 7). In most cases, severe hydrologic alteration was associated with total impervious cover greater than 5%. In all cases, hydrologically unaltered catchments (Classes A and B) had less than 5% total impervious cover, often only 1-2%. This is consistent with past studies that have shown hydrologic and geomorphic responses associated with modest increases in total impervious cover (Hawley and Bledsoe 2011, Vietz et al. 2016).

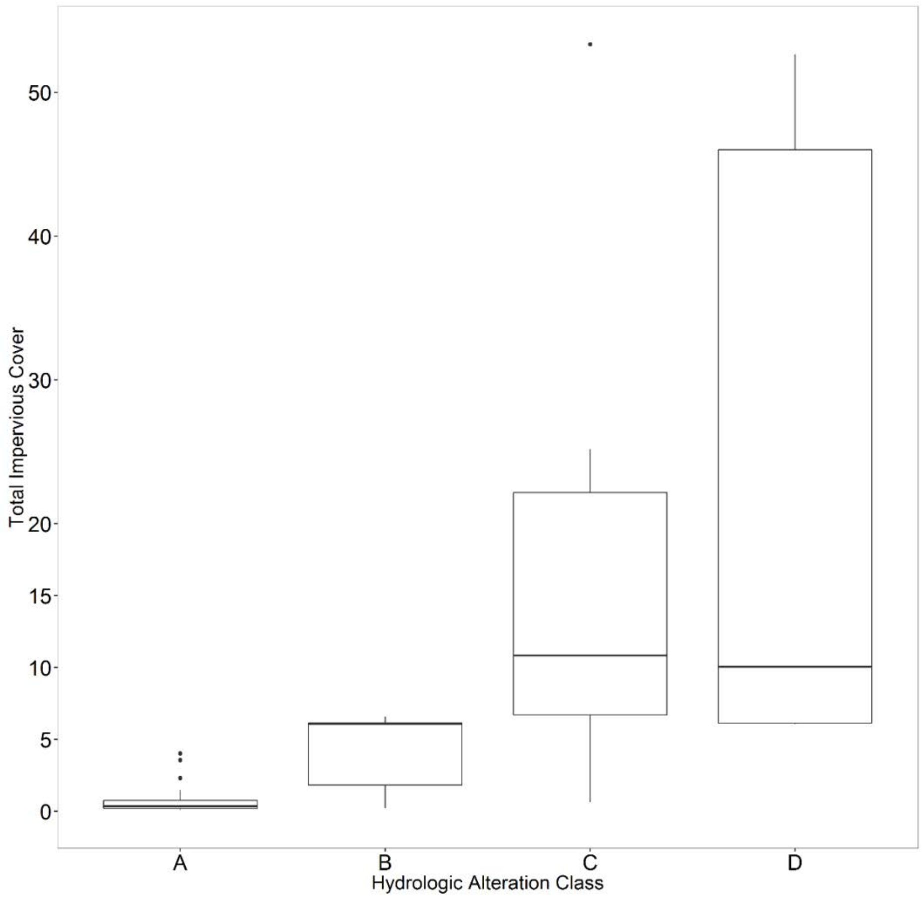

Figure 7. Relationship of hydrologic condition class and percent total impervious cover in the contributing catchment.

Under 2050 land use projections, hydrologic conditions of the watershed are expected to degrade, mainly in the middle portion of the watershed (Figure 8). Mid watershed catchments, around existing reservoirs, are expected to degrade the most in association with future land use changes, with several catchments going from Class A to Class C. Little change is expected in the upper watershed since many of the catchments in the upper watershed are hydrologically unaltered, in public ownership and hydrologic conditions are expected to remain unaltered into the future. Most of the lower watershed is already in poor hydrologic condition and is expected to remain that way in 2050, unless substantial hydrological management and/or remediation measures are implemented. It is important to note that future conditions were modeled using the same precipitation values as the current and historical scenarios since reliable downscaled future precipitation values are not available. Furthermore, the future conditions assumed no stormwater control devices, low impact development or hydromodification management, since we have no information on where/how these will be installed in the future. Therefore, the results of the 2050 analysis should be considered a worst-case scenario.

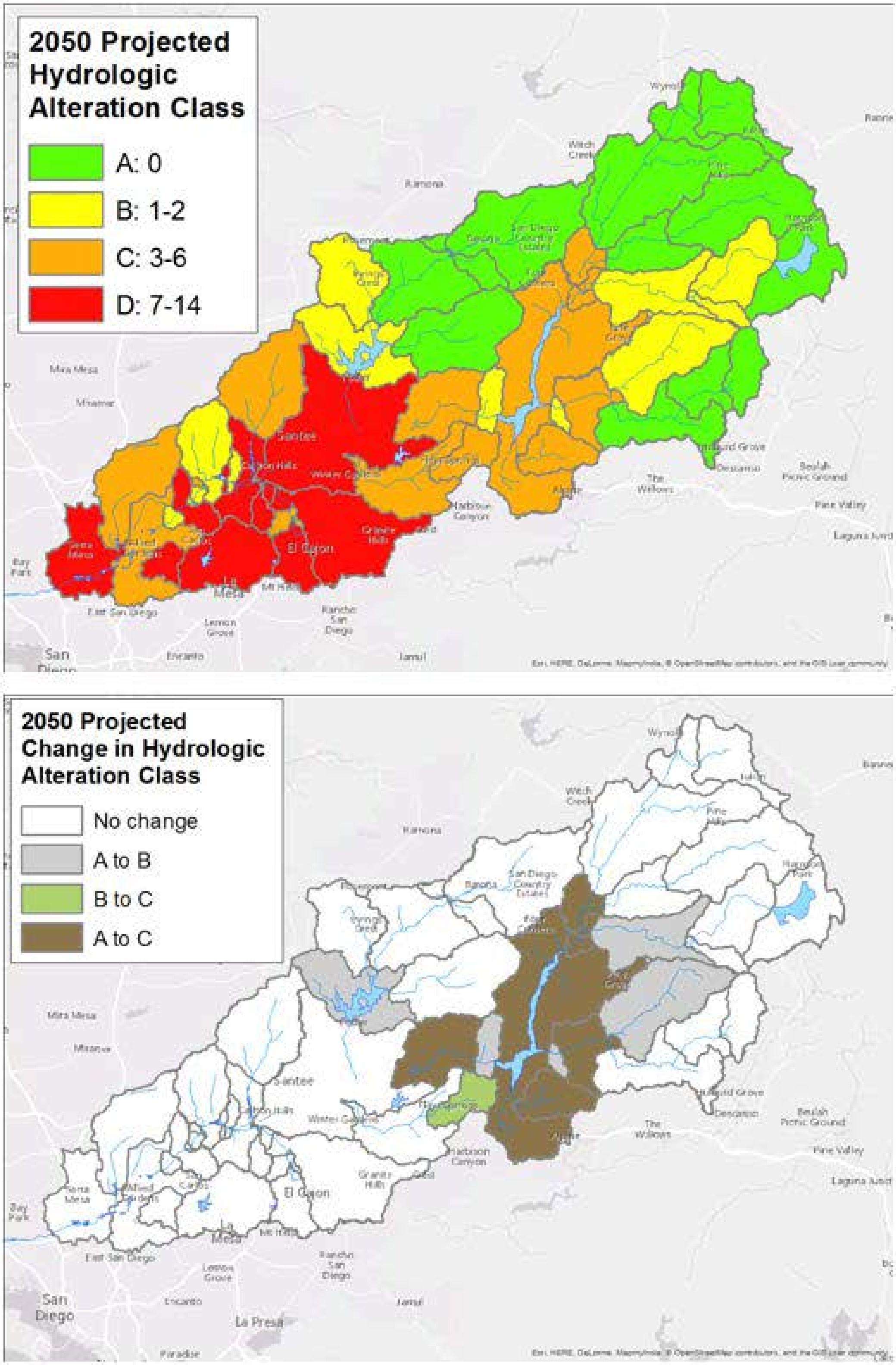

Figure 8. Overall hydrologic condition under 2050 projected land use (top) and change in hydrological condition between 2015 and 2050 (bottom). Categories are defined as in Figure 5.

Future land use changes were associated with sufficient hydrologic alteration to affect all seven metrics that contribute to the overall hydrologic rating. Of the seven metrics, QmaxIDR (a measure of flow variability), Q99 (a measure of high flow magnitude), and HighNum (a measure of the frequency of high flow events) were affected in the greatest number of catchments, and therefore most responsible for the predicted changes in overall hydrologic condition. Changes in these hydrologic metrics are associated with changes in biological condition; this suggests that future hydrologic changes are likely to result in declines in the condition of instream biological communities.

Prioritization of areas for various management actions

To address the question, "***How can flow–ecology relationships be used to prioritize regions of the watershed into various flow management classes that can inform future planning decisions***?" we compared the overall hydrologic condition scores to the CSCI scores at the 29 locations in the watershed where bioassessment has previously occurred.

The majority of upper watershed sites were considered intact, with unaltered hydrology, and therefore a high priority for protection (Figure 9). Candidate areas for flow management were focused in the lower portion of the watershed where both hydrology and biological condition were altered.

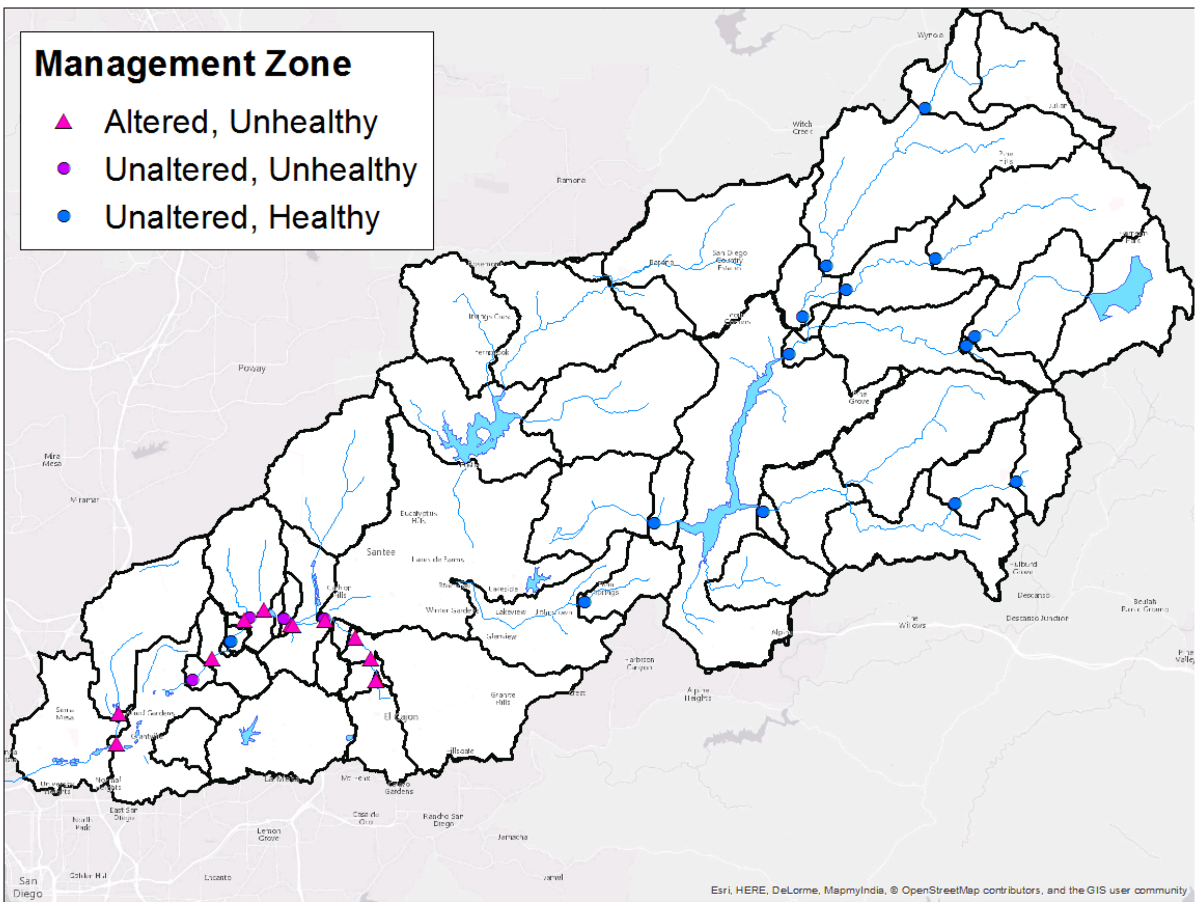

Figure 9. Management categories for bioassessment sites based on combinations of hydrologic and biologic alteration. Only three of the four possible management categories were present in the San Diego River watershed. There were no sites with altered hydrology and healthy biological communities.

Considering both the flow management zones and information available on water quality, habitat, and channel condition from ambient survey data allows us to provide specific management recommendations that can be prioritized for each location (Figure 10). We estimate that flow alteration is the primary factor affecting biology at only 3 of the 13 biologically degraded sites in the lower watershed. At all other sites, flow management should be coupled with habitat or water quality remediation in order to improve biological conditions. The lower watershed was largely in poor biological condition with altered hydrology, making flow management a good option to consider for improving watershed health. However, many of the sites in this category had highly developed floodplains or concrete-lined channels, and all lower watershed sites had poor water quality, as indicated by low scores on the diatom (D18) or soft algae (S2) indices of biotic integrity (Table 8). Therefore, flow management should always be considered in conjunction with other forms of management that address water-quality impacts and alterations to physical habitat. Flow management alone is most likely to improve biological health at sites where habitat is in poor condition, but the channel is unlined and the immediate floodplain is undeveloped. At such sites, the stream form has good capacity to respond to changes in flow, creating the microhabitat structure that supports diverse benthic macroinvertebrate assemblages. In contrast, flow management alone is unlikely to improve sites with armored banks, or where floodplain development limits the capacity of the stream form to respond. In these cases, flow management should be considered in conjunction with habitat restoration efforts that remove these constraints. At lower watershed sites with relatively good condition habitat, other stressors, such as poor water quality, may be responsible for poor biological condition; at these sites, flow management may improve water quality, but care should be taken to maintain good habitat that can support healthy instream biological communities. Finally, in one instance, two sites in close proximity were assigned to different management classes based on different models used to estimate hydrologic alternation. In this instance, we assumed the two sites were in similar condition and assigned the more conservative management class.

Table 8. Relationship of biologically unhealthy sites to water quality and physical habitat stressors.

Recommendation	Sites	Habitat quality	Bank armoring	Response capacity
Manage flows to improve habitat and water quality	3	Poor	Earthen	Moderate or good. Limited development in floodplain.
	13 and 14	Poor	None	Moderate or good. Limited development in floodplain.
Improve water quality	5, 11, 12, and 15	Good	None	Moderate or good. Limited development in floodplain. No channel armoring.
Remove habitat constraints	20, 21, 22	Poor	Concrete	Limited. Stream cut off from floodplain.
	2	Poor	Earthen	Limited. Stream cut off from floodplain.

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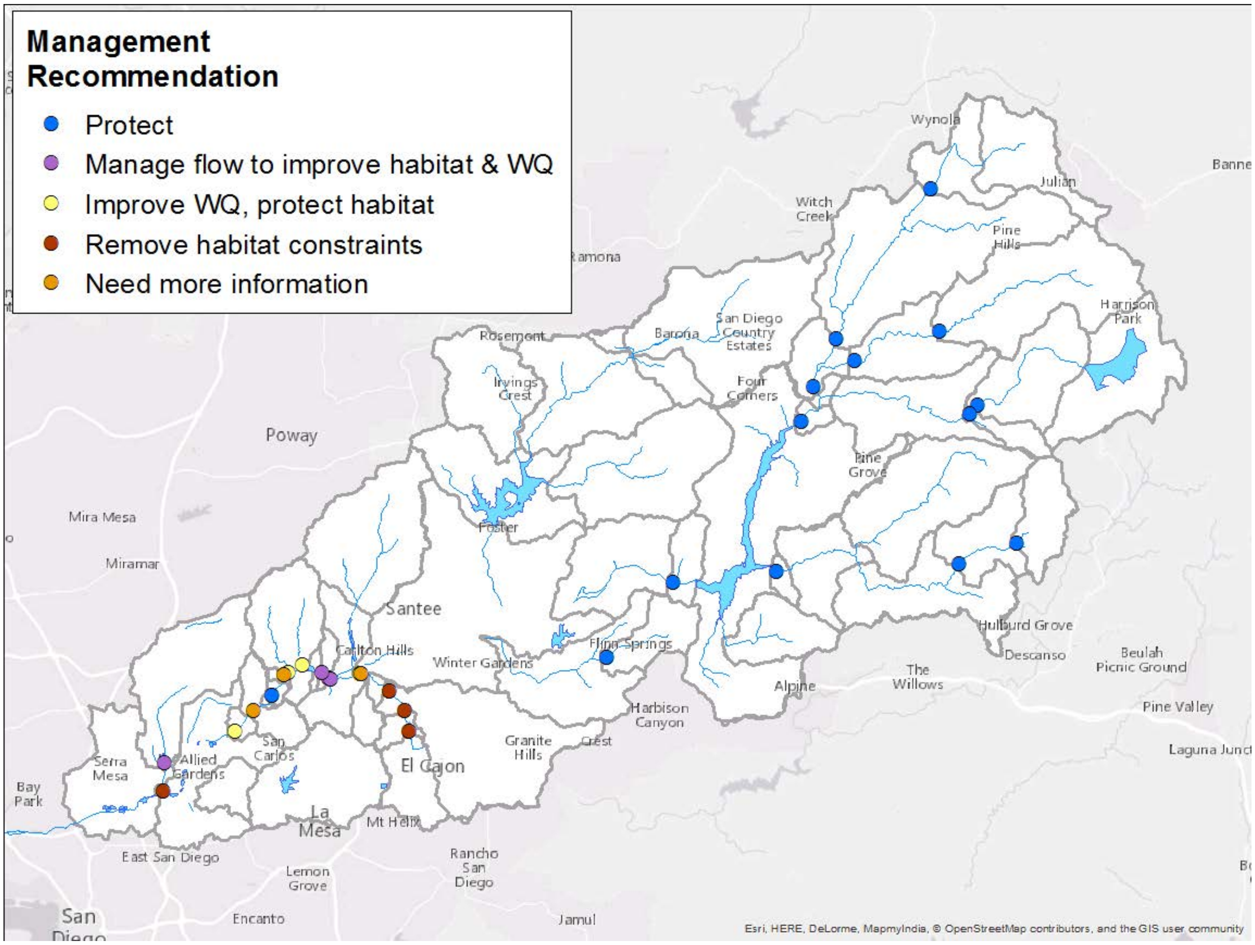

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Figure 10. Recommended management actions for all sites where bioassessment has occurred. Recommendations are based on both flow-ecology information and available data on habitat and water quality obtained through the local regional monitoring program.

Evaluation of management scenarios

The stakeholder workgroup prioritized two future management scenarios for evaluation. Each of them represents potential actions that will affect in-stream flow conditions, and in turn may affect biological condition.

1. lower discharge from Santee Lakes Reservoir due to increased capture and storage to meet demand for reclaimed water
2. disconnecting imperviousness, and implementing stormwater capture strategies in a currently developed portion of the watershed

Results from each of the scenarios are described below:

Scenario 1. Lower discharge from Santee Lakes Reservoir

The Santee Lakes Reservoir receives treated wastewater from Padre Dam Municipal Water District's Ray Stoyer Water Recycling Facility (WRF). The lake releases the treated effluent to Sycamore Creek (which also receives water from a small rain-fed discharge from the lake). Future management scenario involves eliminating discharge of treated wastewater into the lakes and diverting it for reuse to help meet increased demands for recycled water. This will be associated with a proportional decrease in discharge from Santee Lakes Reservoir to Sycamore Creek (because there is less need to create capacity in the lakes); the rain-fed discharge will continue to be released to the creek (Table 9).

Table 9. Inflow into Santee Lakes Reservoir due to wastewater effluent and rainfall runoff. Values are total monthly discharge into the reservoir.

	Average Effluent Flow (Mgal)	Rain-Fed Discharge (Mgal)
January	43.00	2.30
February	33.08	2.73
March	37.60	1.76
April	22.65	1.56
May	12.88	1.31
June	4.91	0.00
July	3.13	2.27
August	2.88	0.00
September	11.25	1.51
October	17.09	0.71
November	28.92	2.79
December	42.24	4.17

Simulations of future scenarios using HEC-HMS indicate that the flow regime will continue to have natural variability, with lower magnitude of flows under the future management scenario relative to current conditions (Figure 11).

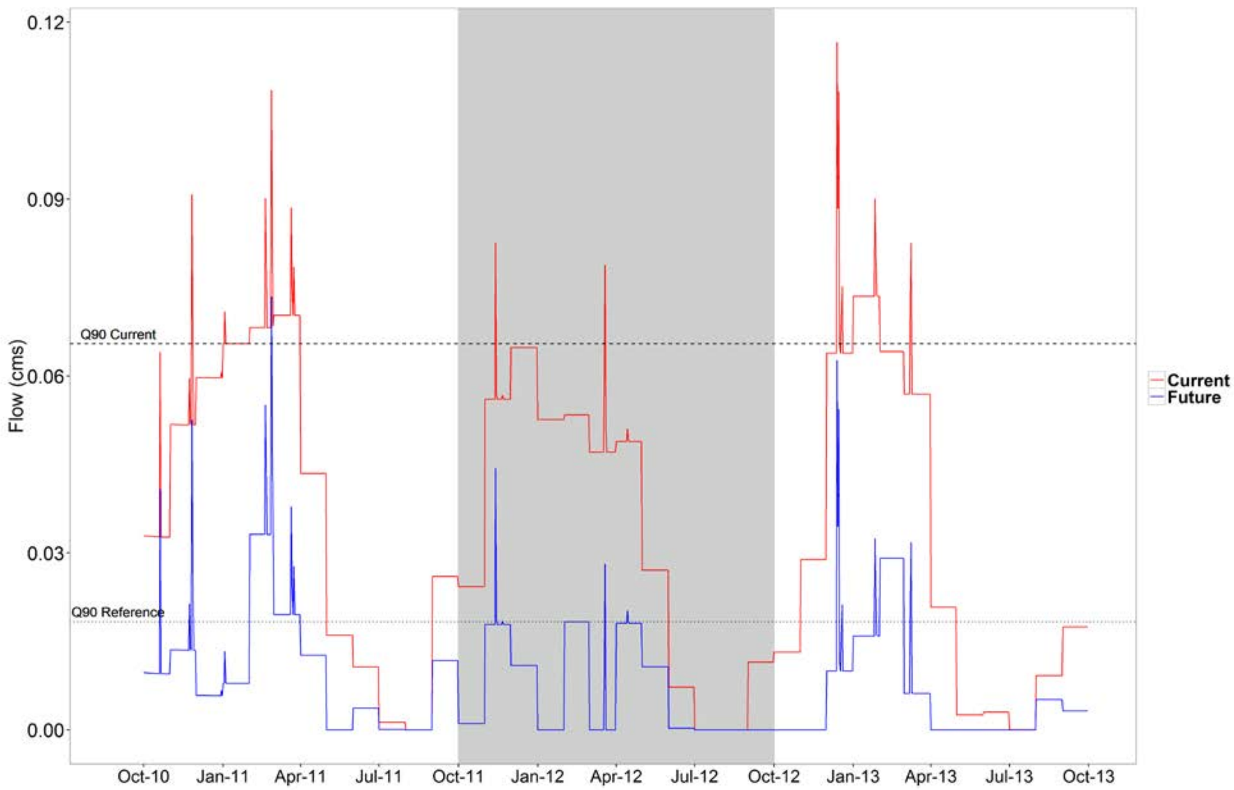

Figure 11: Modeled daily discharge under current and future scenarios at Sycamore Creek. The blue line represents the current scenario (which includes effluent discharge), and the orange line represents a future scenario where effluent is reused and not discharged into the creek.

Current conditions at Sycamore Creek are altered mainly in terms of the duration of high flow conditions (e.g. HighDur and NoDisturb). This reflects discharge from Santee Reservoir that elevates downstream high flow conditions. The balance of the priority flow metrics are currently meeting targets (Table 10). Under future scenarios, many high flow metrics are expected to improve in response to the removal of discharges from the reservoir. In contrast, the remaining metrics will remain at or slightly below the targets associated with healthy biological conditions. Failure to achieve these targets under future conditions likely reflects the effects of ongoing urban runoff, which will not be affected by changes in the reservoir operation. Overall the hydrologic condition in Sycamore Creek will improve under high flow conditions, but is likely to remain in degraded hydrologic and biological condition, even if discharges from Santee Lakes are eliminated following the proposed management scenario.

Providing clear objectives can aid in future desires to manage runoff and reservoir discharge in a manner that promotes healthy downstream biological communities. To assist in future management decisions, we developed the following specific management statements for the Santee Reservoir/Sycamore Creek scenario:

- NoDisturb = Maintain an average low flow between 0 and 0.02 cms (0.7 cfs) for a minimum of 119 days during the dry season

- HighDur = Maintain flow greater than 0.02 cms (0.7 cfs) for between 25 and 52 days per year
- MaxMonthQ = Maintain mean monthly flows below 0.1 cms (3.5 cfs).
- Q99 = Storm flows (or high flow events) should be between 0.03 cms (1 cfs) and 1.1 cms (39 cfs)
- HighNum = Ensure less than 4 high flow events per year with a flow greater than 0.02 cms (0.7 cfs)

Variability metrics do not lend themselves to directed management actions; therefore, we have not provided objectives for RBI or QmaxIDR. Instead these flow metrics should be used to evaluate the effectiveness of actions taken in response to the other metrics.

Table 10. Current and expected future hydrologic metric values in Sycamore Creek (SC) downstream of Santee Reservoir. The table presents site-specific targets that have been calculated based on the regional threshold values. Green cells represent conditions where flow targets would be met; yellow cells represent conditions where flow would be the same as the target value. NT no target assigned.

Metric	Unit	Value		Target	
		Current	Future	Lower	Higher
NoDisturb	days	31	122	119	NT
HighDur	days event	212	28	25.1	52.2
MaxMonthQ	cms	0.1	0.0	NT	0.1
Q99	cms	0.1	0.0	0.0	1.1
HighNum	events year	1	4	NT	4
RBI	unitless	0.0	0.9	NT	0.3

Scenario 2. Impact of disconnecting imperviousness and implementing stormwater retention facilities in an urbanized catchment

Alvarado Creek catchment is located in the downstream portion of the San Diego River watershed. At an area of 14 sq. mi., and 50% total imperviousness cover, it is a heavily urbanized and hydrologically altered reach. We tested **two** scenarios in this sub-catchment: 1) effect of disconnecting imperviousness (modeled as a decrease in total imperviousness in the catchment), and 2) implementing stormwater retention facilities that can capture 85th percentile of a 24-hour rain event.

Disconnecting imperviousness decreases the extent of hydrologic alteration in the creek. However, flow metrics do not drop below levels associated with healthy biological communities until the total imperviousness is at or below 5% (Table 12). Analysis shows that for most metrics, there is a 50%

likelihood of meeting flow targets at 10% impervious cover, 66% likelihood at 5% impervious cover and finally an 80% likelihood of meeting flow targets at 2% impervious cover. Above 10% impervious cover, the likelihood of achieving flow targets declines by 15%. This is consistent with previous results that 5% impervious cover appears to be an important level or maintaining biologically protective levels of flow.

For the 85th percentile of a 24-hour storm event, based on a precipitation isohyetal developed for San Diego River watershed, any storm event with less than or equal to 0.75 inches (1.9 cm) is assumed to be 100 percent captured by the retention structures, resulting in no runoff (Table 11).

Providing clear objectives can aid in future desires to manage runoff and reservoir discharge in a manner that promotes healthy downstream biological communities. To assist in future management decisions, we developed the following specific management statements for the Alvarado Creek scenario.

- NoDisturb = Maintain an average low flow between 0 cms and 0.01 cms (0.4 cfs) for a minimum of 119 days during the dry season
- HighDur = Maintain flow greater than 0.01 cms (0.4 cfs) for between 27 and 56 days per year
- MaxMonthQ = Maintain mean monthly flows below 0.66 cms.(23 cfs)
- Q99 = Storm flows (or high flow events) should be between 0.2 (7 cfs) and 0.66 cms (23 cfs)
- HighNum = Ensure less than 4 high flow events per year with a flow greater than 0.01 cms (4 cfs)

As stated above, variability metrics do not lend themselves to directed management actions. Instead they should be used to evaluate the effectiveness of actions informed by the other metrics.

Table 11. Response of key metrics to changes in total impervious cover and 85□ runoff capture. The table presents site-specific targets that have been calculated based on the regional threshold values. Green cells represent conditions where flow targets would be met. NT □no target assigned

Metric	Unit	Imperviousness					Capture	Target	
		2□	5□	10□	25□	50□	85th □ storm	Lower	Higher
NoDisturb	days	32	32	32	32	31.5	32	119	NT
HighDur	days□event	35.5	34	32.5	24	9	8	27	56
MaxMonthQ	cms	0.31	0.35	0.41	0.59	0.88	0.53	NT	0.66
Q99	cms	0.19	0.45	0.89	2.04	4.04	2.64	0.2	0.67
HighNum	events□year	23.5	22.5	23.5	24	24	24	NT	4
RBI	unitless	0.22	0.47	0.75	1.15	1.4	1.39	NT	0.23

IMPLICATIONS AND RECOMMENDATIONS

The goal of this project was to demonstrate how regional flow-ecology relationships can be used to inform instream environmental flow properties necessary to meet ecological benchmarks as defined by measures of benthic macroinvertebrate community composition and structure. These target flows can be used to help establish goals for use in hydromodification management, nutrient numeric endpoints, and freshwater bioobjectives. They can also be used to develop performance targets for management actions, BMPs, etc. This case study allowed us to develop a framework for implementing regionally derived flow–ecology relationships to inform local management decisions. The stakeholder-focused process allowed us to identify technical and practical benefits and challenges associated with the approach that can inform future implementation efforts.

Utility of the regional flow-ecology approach based on the ELOHA framework

A major objective of this case study was to evaluate the ability to apply the flow–ecology relationships derived from the regional analysis to inform local watershed-scale decisions. Our results illustrate that several of the stated advantages of the ELOHA approach aid in such watershed-scale application. The ability to apply regionally derived flow thresholds to inform local decisions is a major advantage of the ELOHA approach. This eliminates the need to develop local flow–ecology relationships for every stream of interest, as is the case in more traditional instream flow methods (Beecher et al. 2010, McClain et al. 2014). The tools developed through the regional analysis provided readily transferable tools for local stakeholders to produce measures of hydrologic change (i.e., delta H) for any location of interest and to explore how those values would change under different land use or management scenarios. This had the dual benefit of allowing for robust analysis and providing a vehicle for stakeholder engagement in setting management priorities related to instream flow, an important cornerstone of the ELOHA approach.

Use of the predictive CSCI index in our regional flow-ecology analysis took advantage of the available bioassessment data and provided an easy way to provide measures of biological change (delta B), which has been a challenge for past ELOHA applications (e.g., McManamay et al. 2013). Developing the regional flow–ecology relationships and applying them at the local scale would not have been possible without the regional bioassessment data and the existence of the predictive scoring tool (Mazor et al. 2016). Large regional data sets provide sufficient sample size to develop statistically meaningful flow-ecology relationships in spite of the inherent “noise” in the data associated with other co-occurring factors that interact with flow to affect biological community condition (Solans and Jalon 2016). The predictive scoring tool is a measure of biological condition relative to expected reference conditions and thus provides a readily available measure of biological change (delta B) at every site. The availability of similar data and tools should be a major consideration for other efforts interested in developing similar regional approaches.

Other important elements of the ELOHA approach are the inclusion of a broad suite of hydrologic metrics that relate to ecologically relevant biological metrics through hypothesized flow–ecology relationships. Our seven priority flow metrics included two measures of magnitude, two of duration, two measures of variability, and one of frequency. This combination ensures that all elements of the hydrograph will be addressed through flow management. The selected metrics have hypothesized relationships that affect macroinvertebrate communities, allowing us to communicate their ecological relevance to managers and local stakeholders (Table 12). They are also amenable to management and minimize redundancy between metrics (Table 13). Interestingly, our metrics are similar to those identified by DeGasperi et al. (2009) who found that decreases in macroinvertebrate indices in urbanizing watersheds in the Puget Sound area of Washington were associated with changes to the number and duration of high and low flow events, and flow flashiness. It is important to note, however, that hypothesized relationships for both this study and other similar studies were derived through statistical analysis of regional bioassessment data sets. Additional mechanistic studies will be important to validate these relationships and confirm their ecological relevancy. As such studies are completed, they can be used to refine flow management targets based on improved understanding of the flow–ecology relationships.

Table 12. Hypothetical biological responses to alterations in six selected flow metrics

<u>NoDisturb:</u>

- Decrease: Times between spates and droughts are too short to support the expected abundance and diversity of long-lived taxa (e.g., semivoltine insects). Flood-dependent reproducers (e.g., cottonwoods) have fewer opportunities to establish. Good recolonists (drifters, strong fliers, exiters) will flourish.
- Increase: Long-lived taxa are able to out-compete taxa that reproduce quickly or recolonize.

HighDur:

- Decrease: Reduced time with floodplain access, reducing floodplain subsidies to fish and inverts, and diminishing time for riparian seedlings to establish.
- Increase: Desiccation resistance is less useful. More opportunities for aerial colonization (good fliers)

HighNum:

- Decrease: Fewer flushing flows. Allows more clogging of substrate and encroachment of macrophytes. Reduction of spawning gravels for fish. Deposition will fill pools. Greater accumulation of algae may lead to increased grazing.
- Increase: More scouring flows. More incision and bank erosion, leading to mortality of riparian vegetation. Direct mortality of long-lived organisms may eliminate semivoltine taxa.

Q99 and MaxMonthQ:

- Decrease: Reduces size of flushing flows, allowing more clogging of substrate and encroachment of macrophytes. Reduction of spawning gravels for fish. Deposition will fill pools. Greater accumulation of algae may lead to increased grazing. More desiccation-resistant taxa. More predation, and more predation-resistant (armored, or quick reproducers) taxa.
- Increase: Greater scour, leading to incision and bank erosion. Riparian vegetation mortality will increase, both through bank failure and lowering of the water table. Greater flushing of leaf litter will lead to a decline in shredders.

QmaxIDR:

- Decrease: Greater similarity between high and low flows will result in more stable channel morphology, with less bank erosion, leading to a reduction of large woody debris entering the stream. Access to the floodplain will be reduced, limiting growth of fish and amphibians that take advantage of this resource.
- Increase: Increased differences between high and low flows may destabilize channels, leading to greater bank erosion or incision, affecting the growth or survival of riparian vegetation. The consequent loss of riparian vegetation may decrease shading and leaf-litter input to the stream, shifting the trophic structure from an allochthonous system to an autochthonous one.

RBI

- Decrease: Reduced flashiness decreases the frequency of mortality events, allowing the proliferation of long-lived semivoltine taxa.
- Increase: Increased flashiness favors short-lived, multi-voltine taxa and good dispersers that can recover quickly after frequent flooding events.

Table 13. Description and management implications of priority flow metrics

- NoDisturb (days), is the median annual longest number of consecutive days that flow is between the low (Q10) and the high flow (Q90) threshold. Disturbance changes the bed shear stress and effects sediment transport. While an increase in the number of no-disturbance days does not have a high negative impact on the stream health, a decrease in the number of days is significant. Under urbanization scenarios we usually see a decrease in the number of no-disturbance days.

- HighDur, is the median annual longest number of days the flows were greater than upper threshold (Q90). This metric only has a lower threshold and a corresponding lower target. In terms of management, as long as the metric value is higher than the lower target, the stream is not failing the metric. Both the duration metrics require several years of data.

- MaxMonthQ (cms) is the maximum mean of the monthly flows. The MaxMonthQ has an upper threshold and associated target but no lower target. The management goal is to ensure that the metric values are below the upper target value. In cases of urbanization, we see a rapid increase in the MaxMonthQ.

- Q99 (cms) is a high flow threshold, or the top 1□ of the flow and has upper and lower bound targets in cms. The management goal is to maintain the metric values within this range. In cases of urbanization, we see a rapid increase in the Q99 values.

- RBI describes the oscillation in flows (or discharge) relative to the total flows (Baker et al 2004). This flashiness metric usually increases with urbanization which impacts the runoff patterns. However, the flashiness might decrease in case there are dams or steady controlled releases from reservoirs which dampen the natural flashiness of the hydrograph. The metric has an upper target, which implies that an extreme flashy stream is unhealthy for the biological communities, and the management goals should focus on keeping the RBI scores below the upper target value.

- Qmax IDR measures variability as the difference between the high flow threshold (Q90) and low flow threshold (Q10) divided by the 50th percentile flow (Q50). A higher value implies increasing variability, which is typically the case in streams without hydrologic regulation.

- HighNum is the frequency metric which estimates the number of events where the flow is higher than Q90 threshold. This metric has an upper target which implies that the management should focus on maintaining high flow events to a number less than the upper target.

We did not stratify streams in the San Diego case study, as is suggested for the general ELOHA approach. The San Diego watershed includes three stream classes from the statewide classification (Pyne et al. in press), with 60% of the streams being in one class and the remaining 40% being equally divided between two other classes. However, our analysis did not result in substantial differences in the local flow–ecology relationships as result of stream class. Instead climate (wet, dry, average rainfall) was a more important predictor. Therefore, we classified relationships by climatic period vs. stream type.

Challenges of the ELOHA approach

The main challenges associated with local implementation of the regional flow-ecology relationships relate to availability of high-quality input data, applicability of some metrics to site-specific simulation of reference conditions, and limitations on the interpretation of the output relative to other considerations and potentially confounding factors. Quality of rainfall data was one of the most critical factors affecting confidence in the regional flow–ecology relationships (Sengupta et al. in review). Similarly, in the San Diego River watershed the uneven availability of high-quality hourly rainfall data that encompassed all climatic conditions affected our ability to apply the hydrologic models equally across the entire watershed. In some cases, we had to drop data from the nearest gages due to gaps or obvious errors and substitute with less proximate gages, but that provided better or more complete rainfall data. This spatial offset introduced some additional uncertainty that must be accounted for in interpreting the model output.

Application of the regional flow-ecology relationships to local management scenarios revealed several complications associated with the formulations of certain metrics commonly used in applications of the ELOHA framework (e.g., Solans and Jalon 2016). The first complication involves many duration metrics that are calculated based on frequency or duration of flows above or below a benchmark derived from a long-term flow record. For example, the HighNum metric is calculated as the number of flow events over the 90^{th} percentile of daily flow. This formulation may not be suitable for evaluating hydrologic change, because the benchmark may shift along with other parts of the hydrograph, thereby obscuring hydrologic impacts. Figure 12 shows the current and reference hydrographs of a site that has experienced dramatically increased flows. If the current flows are compared to a benchmark derived from the historic hydrograph, it is clear that the site experiences one very extended high flow event every year; in contrast, the historic flows experienced several, short-duration high-flow events each year. However, if the current flows are compared to a benchmark derived from the current hydrograph (as is commonly done), the site appears to experience only a few short high-flow events each year. Thus, the hydrologic alterations from historic conditions are obscured when shifting benchmarks are used to calculate certain metrics. This problem is not easily apparent in regional analyses due to the large sample size, and is most clear when applied to a specific site, as in the present study. We recommend that future analysis use a constant, unshifting benchmark based on historical conditions when estimating thresholds for duration metrics based on thresholds of high- or low-flow events.

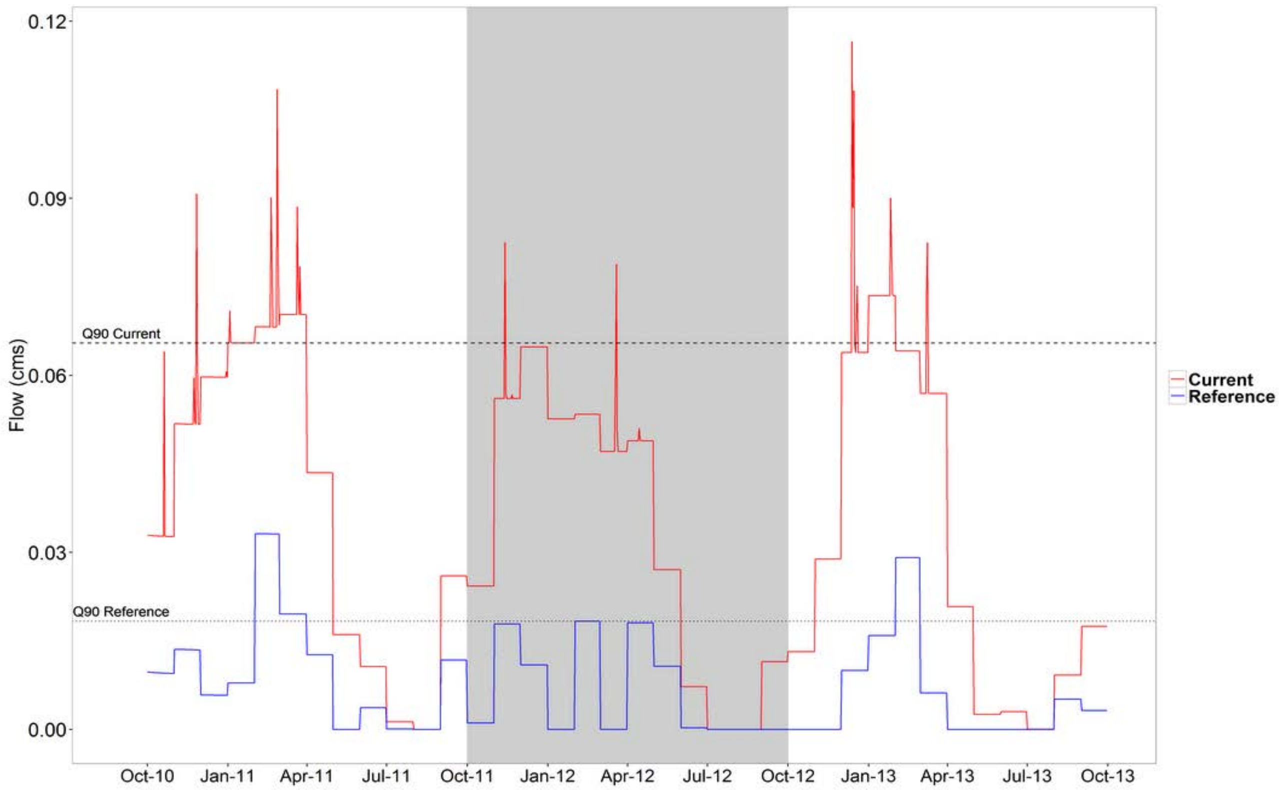

Figure 12. Comparison of current and reference flow for a sample bioassessment site showing the effect of the use of different thresholds. Conclusions about changes in duration of high flow events would vary dramatically if only a single threshold based on reference is issued vs. different thresholds were used for current and reference conditions.

The second issue associated with metric calculation relates to anomalous results that may occur when reference conditions are expected to represent intermittent streams with long periods of zero-flow days. This may result in reference flows for many of the magnitude metrics being extremely low (or zero), making it virtually impossible for management scenarios to achieve targets for certain metrics. This computational issue is confounded by the real challenge that it may not be possible to reduce runoff back to natural conditions, even with full implementation of stormwater runoff controls (DeGasperi et al. 2009). New or modified metrics may need to be developed to accommodate establishing flow management targets appropriate for naturally intermittent or ephemeral streams.

The use of HEC-HMS to produce the delta H values was a tradeoff between ease of use and model precision. HEC-HMS is arguably not optimal for evaluating BMP and other non-point source runoff management measures. We chose this model to develop the regional flow-ecology relationships because of its simplicity, availability, ability to perform long term continuous simulations of streamflow. Its status as an industry standard model developed by the US Army Corps of Engineers makes it practical for application to the hundreds of catchments evaluated during the regional analysis. Similarly, its familiarity and accessibility make it ideal for involving local stakeholders in the analysis and decision-making process. However, other lumped parameter hydrologic models that are also widely used to perform continuous simulations, such as HSPF or SWMM, may be more appropriate. SWMM is more robust in terms of modeling storm sewers and various stormwater control measures including low impact development practices. At the expense of more complexity and model parameters, HSPF includes additional details on soil moisture and subsurface processes that can enhance modeling of baseflow and groundwater behavior. These features would likely provide more precise estimates of how future management interventions could affect runoff and, consequently, stream flow metrics. We did not investigate whether/how use of an alternative or more sophisticated model would affect the output of our scenario analyses, but this should be investigated in the future.

Our reliance on developing flow targets based on the response of a single community assumes that the macroinvertebrate community reflects overall ecological condition. Although this is not a totally unreasonable assumption, we recognize that different components of the stream ecosystem may be affected differently by changes in various components of the hydrograph. Other ELOHA efforts have attempted to address this issue by developing flow–ecology relationships for multiple communities (e.g. fish, vegetation, mussels) and recommending targets around protection of each (DePhilip and Moberg 2013). This approach is more robust, but complicates development of management measures that can address all biological endpoints. Ultimately, such an approach is likely less parsimonious for regulatory applications.

Spatial and temporal factors must also be considered when applying flow–ecology relationships. Our analysis focused on catchment-scale responses. However, benthic invertebrates may also respond to local scale factors such as duration of wetting of bars and localized velocity zones (Kath et al. 2016, Kennedy et al. 2016). Hydrologic change at the local (small) scale may be ecologically important but is likely not affected by managing for the flow metrics we identified, and may be difficult to address through any regionally derived flow management framework. Although our regional flow criteria were developed in consideration of wet, dry and average climatic cycles, they likely do not account for longer term climate patterns and extreme episodic events that may be important for establishing and maintaining resilient instream habitats. This deficiency was highlighted by McManamay et al. (2013), who found that results of ELOHA analysis cannot necessarily be used in a predictive manner because biological communities may respond to other factors not included in the flow–ecology analysis, such as changes in substrate associated with infrequent events, such as catastrophic floods or fires. Moreover, they note that temporal resolution of most case studies does not coincide with the temporal period of data underlying ELOHA relationships. For example, streams may respond to episodic events and patterns operating on decadal time scales. We currently lack flow metrics that capture these interannual and longer term hydrologic patterns. Finally, as we noted in our analysis confounding factors such as changes in water chemistry typically co-occur with hydrologic changes and may contribute to biological community health in ways not captured by flow management.

These issues reinforce the concept that flow-ecology relationships should be used as one line of evidence in coordination with other factors/considerations when establishing stream management prescriptions and targets. In particular, many watersheds are subject to complex regulatory and management systems that involve combinations of new and retrofit facilities aimed at reducing runoff and retaining flows for infiltration and reuse. The regional flow targets established by Mazor et al. (in review) and applied in this case study can be an important consideration in designing and implementing integrated watershed management plans aimed at meeting both short and lon objectives.

Framework for development of local flow targets

We found the case study process to be productive because it provided a framework for considering hydrologic management in the context of watershed planning. It also provided the first opportunity in the region to develop quantitative flow targets that could be used to inform actionable management decisions. The regional flow–ecology relationships provided flexibility in establishing targets based on desired levels of confidence that those targets would be associated with healthy biological communities. Regionally derived targets took advantage of the robust regional monitoring data set and a broad set of hydrologic conditions. This improved relevance to local conditions was an important consideration for the watershed stakeholders. Given the utility of the process, we used the case study to develop a stepwise process that can serve as a framework for future implementation in other watersheds. This stepwise process is based on an adaptation of the ELOHA framework (Figure 13).

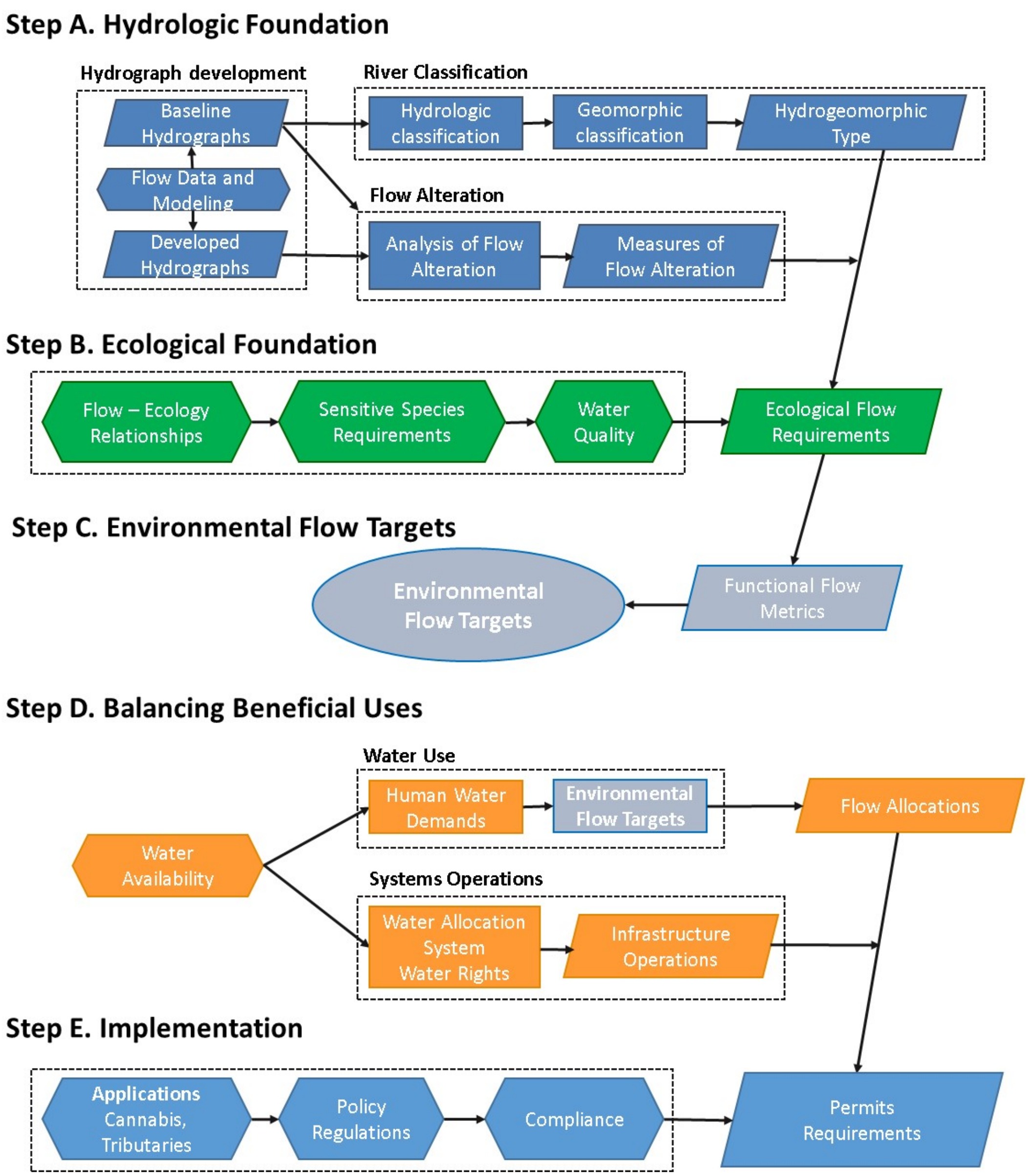

Figure 13. Process for development and implementation of instream flow targets, modified from the ELOHA framework (Poff et al. 2010).

Based on the framework in Figure 13, we identified the following steps that can be followed if other groups wish to pursue similar efforts to develop flow management recommendations:

Step 1: Determine what hydrologic class the stream of interest is in

Step 2: Identify management needs, regulatory objectives, or other targets

Step 3: Compile local data

- Contemporary and proposed future land use
- Information on contemporary and proposed water capture, storage, diversion, discharge, and other water management
- Local rainfall data at hourly time intervals (data must be checked to ensure sufficient quality and duration, at least ten years that encompass wet, dry, average rainfall conditions)

Step 4: Divide watershed in subbasins for analysis based on hydrology and management needs

Step 5: Select appropriate model(s) for catchments of interest using regional model selection tool

Step 6: Model both contemporary and natural hydrology for each catchment

Step 7: Calculate delta H metrics for each reach/node

Step 8: Select priority metrics and targets based on the following:

- Recommendations from the regional ELOHA analysis
- Relevance to local management needs
- Ability to influence through management measures

Step 9: Determine temporal factors associated with the targets

- Seasonality
- Persistence/duration
- Frequency (e.g. always, every X years)

Step 10: Evaluate various management scenarios relative to targets identified in Step 8

Step 11: Explore potential related or confounding factors (e.g. water quality, substrate)

Step 12: Develop recommended actions to achieve flow targets

- Relate actions to specific hydrologic modifications, e.g. diversion rates

Step 13: Relate flow metrics and targets to monitoring design, locations, and indicators

Step 14: Determine adaptive management actions that will be triggered if targets are not met

Informing management decisions

Stakeholder participation was critical in identifying scenarios and interpreting how the results of the analysis can be used to inform management action. Stakeholders identified the following desired applications for flow targets, which helped define our analysis:

- Identify priority management sites based on biological and hydrologic condition
- Use results to inform BMP/LID selection
- Identify areas were flow management has potential to improve CSCI scores
- Explore implication of future management of reservoirs for multiple benefits, e.g. water quality and water supply

These desired uses shaped our ultimate products. For example, we developed the overall composite index of hydrologic alteration in direct response to stakeholder desire to holistically assess the watershed for areas most vulnerable to future hydrologic alteration. Not surprisingly, the degree of hydrologic modification was correlated with impervious cover. We found that hydrologic alteration generally occurred in catchments with greater than 5% total impervious cover, which is similar to other studies that have shown that channel degradation to due to hydromodification occurs at relatively low levels of imperviousness (Hawley et al. 2012, Vietz et al. 2016). Similarly, the map of hydrologic management categories was identified as one of the most useful products for planning purposes because it allows stakeholders to prioritize areas for protection and for flow management.

We were able to demonstrate the utility of applying the flow-ecology relationships to inform management for both point source and non-point source management scenarios. For both the reservoir management scenario and the urban runoff management scenario, we were able to determine a range at which hydrologic management may facilitate recovery of impacted biological communities.

Lessons learned for future implementation

Future efforts can built on the experiences from this case study and continue to refine an iterative process of developing flow targets that are scientifically defensible, practical (i.e., can lead to management actions), and consistent with local stakeholder needs. Key lessons learned from this effort include:

1. Include a broad set of engaged stakeholders, including regulatory agencies, municipalities, water agencies, non-governmental organizations, and researchers. This ensures a broad perspective in the deliberations and increases the likelihood of developing balanced recommendations.
2. Invest in educating the stakeholders early in the process on the underlying science and the rationale behind how regional flow targets were developed. This promotes engagement and fosters creative solutions to the complex challenges of flow management.
3. Invest the time to compile high quality local data sources and show how local data can be used in the evaluation process. Identify the areas were future data collection can most improve outputs of the flow–ecology analysis (e.g., local rainfall data, more refined land use, water quality data). This can inform future monitoring.
4. Develop documentation that clearly illustrates how the products of the flow–ecology analysis can be used in the context of existing regulatory or management programs.

The San Diego River implementation case study also produced several technical recommendations that can improve our ability to apply flow-ecology relationships to manage southern California streams:

1. Several flow metrics, particularly those associated with flow duration, may require modification for use in streams where the natural condition is intermittent or ephemeral.

Natural intermittency poses fewer issues when developing regional flow-ecology relationships based on hundreds of sites. However, application of the resultant thresholds to specific streams that may have been naturally intermittent can lead to erroneous results.

2. Metrics associated with flow durations should be calculated on a single threshold value based on reference conditions. Estimating change in flow durations based on a moving threshold estimated separately for current and reference conditions may produce erroneous results.

3. Need to improve the representation of the drainage system to provide a more accurate hydrologic foundation for analysis. This would ultimately include improved mapping of discharges, diversions, stormwater control facilities, LID, etc. for incorporation into modeling scenarios and effects.

4. Consider expanding the analysis to include additional elements in future case studies

    - Include other stream or water body types
    - Include other indicators (e.g. algae)
    - Explore how consistent/transferable findings are from one watershed to another
    - Explore application in watersheds that cross jurisdictional boundaries

The original authors of the ELOHA framework promote the idea that flow targets derived by statistical analysis are a starting point. Targets should be iteratively refined using additional monitoring data, professional judgement and consideration of all complementary and competing factors necessary to develop flow standards that can address often divergent interests. The San Diego River case study provides an illustration of how watershed stakeholders are critical partners in the process. Resultant flow standards provide a starting point for developing agreed upon, adaptive flow management programs that can protect intact waterbodies and restore those that are currently impacted.

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APPENDIX A DETAILED PROCEDURES FOR HYDROLOGIC ANALYSIS

Directions to run HEC-HMS Modeling packages developed for flow ecology analysis

To be able to run these modules

- Basic idea of catchments, watersheds, and delineated areas
- Moderate skills in R programming (scripts provided)
- Basic understanding of watershed modeling

Software needed:

- Streamstats (online, no download necessary)

  http://streamstatsags.cr.usgs.gov/v3_beta/

- R and Rstudio (installation needed for both, install R before installing R studio)

  https://cran.cnr.berkeley.edu/

  https://www.rstudio.com/products/rstudio2/

- HEC-HMS (install)

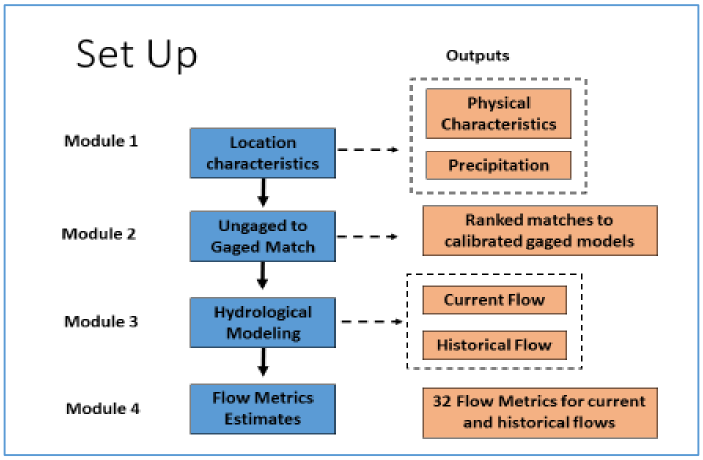
  http://www.hec.usace.army.mil/software/hec-hms/downloads.asp

Notes for running R scripts:

- setwd("../Desktop/") sets up each script to automatically read files in the folder Modeling Workshop, as long it is located on your desktop
- Mac users will need to change the ".." in "../Desktop/" to "~" (tilde)
- Each script must be opened from within R-Studio in order to correctly use setwd("../Desktop/")
- If you get an error that says you cannot change the working directory, then close the script in R-Studio, close R-Studio, re-open R-Studio, then open the script from within R-Studio

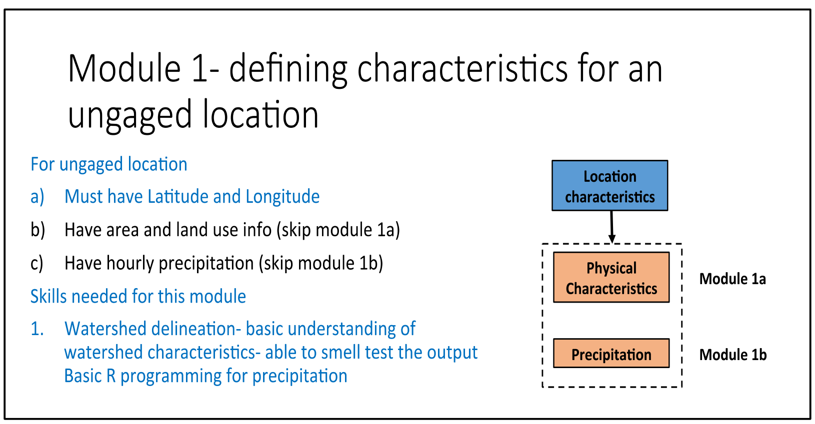
Introduction

The modeling tool has four modules. The modules should be run sequentially to get the flow metrics. Described below are four modules and their outputs.



Module 1.

Module 1 allows the users to delineate the watershed area for an ungaged site, and estimate hourly precipitation (1990-2013).

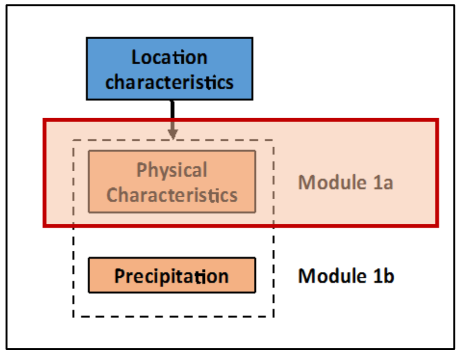


Limitations:

1. For some locations, the Streamstats outputs a square delineated catchment area. Always check the visual output, in case it looks incorrect, move the location slightly to obtain the watershed characteristics.
2. The precipitation raw data from the gages is limited to 1990-2013. The script is enabled for any period, to produce output for periods outside of 1990-2013, hourly gaged precipitation data is required.

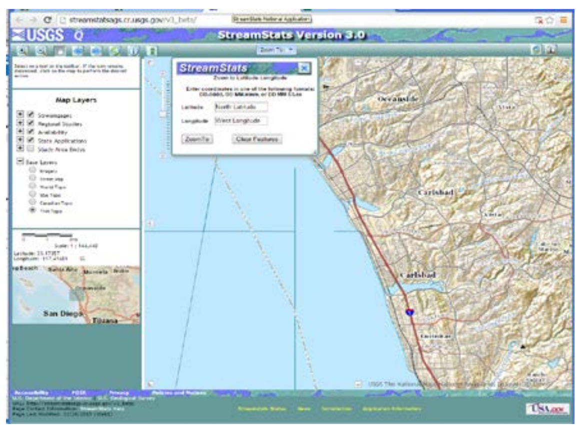
Instructions to run the modules

Delineate the subcatchment/watershed area for ungaged location

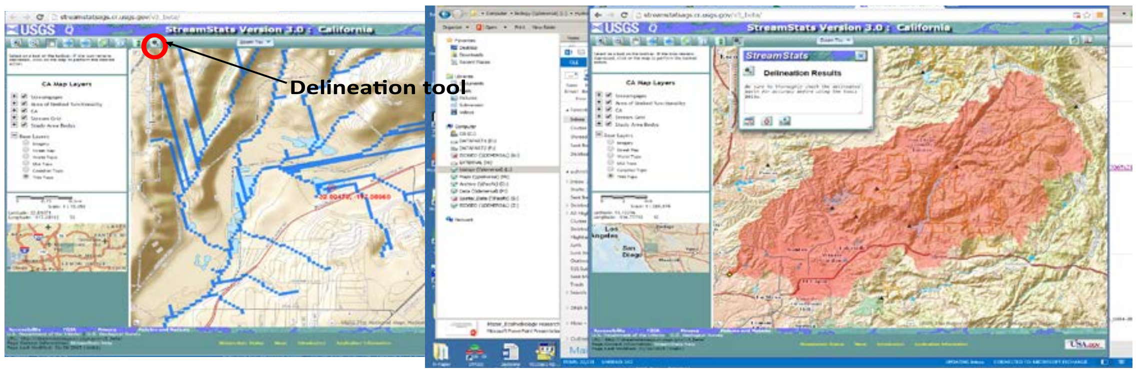


We will use Streamstats to delineate area and land use. URL provided below.

1. http://streamstatsags.cr.usgs.gov/v3_beta/
2. Press the 'zoom to' button highlighted in figure 4, and enter the latitude and longitude.

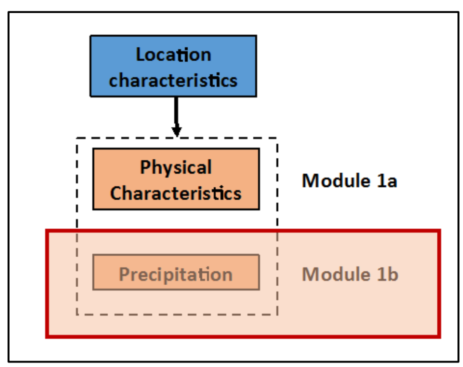


3. Zoom till you see the delineation tool (highlighted below). Select first tab in the pop out window (in figure 5b).



4. Select area and imperviousness, and compute

Module 1b. Estimating hourly precipitation



Input files: Modeling Workshop\Inverse Distance\Data*Precip_(YEAR).csv*, *AssessmentSiteCoord.csv*, *PrecipStationCoord.csv*

Output file: Modeling Workshop\Inverse Distance\Data*Assess_(YEAR).csv*

1. We use R Studio to estimate hourly precipitation.
2. To predict flows at the gages, we need hourly precipitation data
3. Daily data is available on PRISM website
4. For better flow predictions, we estimated hourly flow using precipitation data from >200 sites
5. You can use the script for 1990-2013 (and will require raw precipitation data outside this range)
6. Open the file *AssessmentSiteCoord.csv*, delete the current data in the spreadsheet and enter the data for your site ID, latitude and longitude in the appropriate columns

7. From within RStudio, open Modeling Workshop\Inverse Distance*InvDist_calc_02_SelectYears.R*

8. Run the line install.packages(…), then add a # at the beginning of the line

9. Specify year range on line 23 (default is 1990:2013)

10. Run script by clicking "Source" button at the top right of the script window

11. Look at *Assess_(YEAR).csv* in your working directory for output

Module 2: Matching ungaged sites to gaged sites

Calculates the proximity of the ungaged site to the calibration gages (models).

Input file: Modeling Workshop\Site Assignment*test.csv*

Output file: Modeling Workshop\Site Assignment*top.model.csv*

How to assign an ungauged site to a flow model:

1. Delineate watersheds, and 5-km watershed clips

2. Calculate predictors:

Variable name (CASE SENSITIVE!)	Description	Source file to use
StationCode	Unique site identifier	User
New□Lat	Latitude in decimal-degrees North. Not required for predictions, but useful for plotting.	User
New□Long	Longitude in decimal-degrees West (should be negative). Not required for predictions, but useful for plotting.	User
Imperv□percent	Mean □ imperviousness in the catchment (0-100).	[StreamStats]
URBAN□2000□WS	NLCD urban land use in the catchment (0-100). For NLCD 2000, these codes count towards urban:	NLCD2000 or NLCD2006
KFCT□AVE	Mean soil erodibility in the catchment.	[RAFI]
Ag□2000□WS	NLCD agricultural land use in the catchment (0-100). For NLCD 2000, these codes count towards urban:	NLCD2000 or NLCD2006
CODE□21□2000□WS	NLCDE Code 21 (highly managed vegetation) in the catchment (0-100). For NLCD 2000, only code 21 counts.	NLCD2000 or NLCD2006
Ag□2000□5k	NLCD agricultural land use in the 5-km clip of the catchment (0-100). For NLCD 2000, these codes count towards urban:	NLCD2000 or NLCD2006
RoadDens□5K	Road density (km□km2) in the 5-km clip of the catchment. Dirt roads do not count.	[Rafi]

1. From within R Studio, open Modeling Workshop\Site Assignment*assigning_testsites_020116.R*
2. Currently *test.csv* has dummy site information; use this as a template for your site info
3. Please see handout for GIS information required for this module
4. *top.model.csv* is the output file with top matched gage info

Note: Within a year or two automated tools from the State (SWAMP) will calculate the variables, but for now, use GIS to estimate them.

Module 3: Running hydrological model (HEC-HMS) to predict hourly flow

We run the model for current and reference or historical conditions

Output files: Modeling Workshop\Hourly To Daily Flow Conversion\Hourly Flow*SDR_AssessmentSites_Hourly_Current.csv* and *SDR_AssessmentSites_Hourly_Reference.csv*

First we will estimate current flows

1. Navigate to Modeling Workshop\HEC HMS Models\Current Conditions
2. Copy the model folder that is the top matched to your site
3. Save a copy in a new folder
4. Click on HEC-HMS icon on your desktop
5. Click on open folder tab, navigate to your new folder
6. Open file with the .hms extension
7. We need to change 5 parameters- area, imperviousness, time of concentration, storage coefficient and precipitation
8. From the "Compute" tab, right click on "Run 1" then click "Compute"
9. From the "Results" tab, double click "Run 1", double click "Subbasin-1" then click on "Time-Series Table"
10. A window will appear shortly, from which you will copy all the data in the "Total Flow" column
11. Open the file Modeling Workshop\Hourly To Daily Flow Conversion\Hourly Flow*SDR_AssessmentSites_Hourly_Current.csv*, paste the "Total Flow" data in a new column on the right, starting on row 2
12. Put the site name in the first row of this column
13. Remove all the other columns, EXCEPT for your new column, the "Date_Time" column and one additional column of flow data (the metric calculation requires data from at least 2 sites)

Historical flows

1. Navigate to Modeling Workshop\HEC HMS Models\Reference Conditions

2. Copy the model folder that is the top matched to your site
3. Save a copy in a new folder
4. Click on HEC-HMS icon on your desktop
5. Click on open folder tab, navigate to your new folder
6. Open file with the .hms extension
7. We need to change 4 parameters- area, time of concentration, storage coefficient and precipitation
8. From the “Compute” tab, right click on “Run 1” then click “Compute”
9. From the “Results” tab, double click “Run 1”, double click “Subbasin-1” then click on “Time-Series Table”
10. A window will appear shortly, from which you will copy all the data in the “Total Flow” column
11. Open the file Modeling Workshop\Hourly To Daily Flow Conversion\Hourly Flow*SDR_AssessmentSites_Hourly_Reference.csv*, paste the “Total Flow” data in a new column on the right, starting on row 2
12. Put the site name in the first row of this new column
13. Remove all the other columns, EXCEPT for your new column, the “Date_Time” column and one additional column of flow data (the metric calculation requires data from at least 2 sites)

Module 4. Flow metrics are estimated on daily flow

Convert hourly flow output from HEC-HMS to daily flow

Input files: Modeling Workshop\Hourly To Daily Flow Conversion\Hourly Flow*SDR_AssessmentSites_Hourly_Current.csv* and *SDR_AssessmentSites_Hourly_Reference.csv*

Output files: Modeling Workshop\Hourly To Daily Flow Conversion\Daily Flow*SDR_Assessment_Daily_Current.csv* and *SDR_Assessment_Daily_Reference.csv*

1. From within R Studio, open Metric Workshop\Hourly To Daily Flow Conversion*HourlytoDailyFlow_Current.R*
2. Run install.packages(…) line, then add # to the beginning of the line
3. Run script by clicking “Source” button on the top right of the script window
4. Converted daily flow data will be in Modeling Workshop\Hourly To Daily Flow Conversion\Daily Flow*SDR_Assessment_Daily_Current.csv*
5. Repeat using Metric Workshop\Hourly To Daily Flow Conversion*HourlytoDailyFlow_Reference.R* to produce daily flow data for reference condition hourly flow data

Calculate Metrics for Daily Flow Data

Input files: Modeling Workshop\Hourly To Daily Flow Conversion\Daily Flow*SDR_AssessmentSites_Daily_Current.csv* and *SDR_AssessmentSites_Daily_Reference.csv*

Output files: Modeling Workshop\Metric Calculation \Results\ *Sdr_Current_Metrics.csv* and *Sdr_Reference_Metrics.csv*

1. From within R Studio, open Modeling Workshop\Metric Calculation*KonradMetrics_Current.R*
2. Click “Source” button in upper right corner of script window
3. Metric results will be in Modeling Workshop\Metric Calculation\Results*Sdr_Current_Metrics.csv*
4. Repeat using Modeling Workshop\Metric Calculation*KonradMetrics_Reference.R* to get metric results for reference condition flow data

Description of Metrics in QSUM (typically Median Annual Values)

Qmean [M3/S] - mean streamflow for the period of analysis

QmeanMEDIAN [M3/S] - median annual mean streamflow

QmeanIDR - (90th percentile of annual mean streamflow - 10th percentile of annual mean streamflow)/50th percentile of median annual mean streamflow

Qmed [M3/S] - median daily streamflow

Qmax [M3/S] - median annual maximum daily streamflow

QmaxIDR - (90th percentile of annual maximum streamflow - 10th percentile of annual maximum streamflow)/50th percentile of annual maximum streamflow

HighNum [events/year] - median annual number of events that flow was greater than high flow threshold, an event is a continuous period when daily flow exceeds the threshold

HighDur [days/event] - median annual longest number of consecutive days that flow was greater than the high flow threshold

Qmin [M3/S] - median annual minimum daily streamflow

QminIDR - (90th percentile of annual maximum streamflow - 10th percentile of annual maximum streamflow)/50th percentile of annual maximum streamflow

LowNum [events/year] - median annual number of events that flow was less than or equal to the low flow threshold, an event is a continuous period when daily flow was less than or equal to the threshold

LowDur [days/event]- median annual longest number of consecutive days that flow was less than or equal to the low flow threshold

NoDisturb [days] - median annual longest number of consecutive days that flow between the low and high flow threshold

Hydroperiod [0.01 = 1% of period of analysis] - fraction of period of analysis with flows

FracYearsNoFlow [0.01 = 1% of years] - - fraction of years with at least one no-flow day

MedianNoFlowDays [days/year]- median annual number of no-flow days

PDC50 [0.01=1% change in streamflow] - the median percent daily change in streamflow, no flow days are not included (0.01 = 1%)

SFR [-0.01=-1% change in streamflow]- the 90th percentile of percent daily change in streamflow on days when streamflow is receding (a measure of storm-flow recession)

BFR [-0.01=-1% change in streamflow] - the 50th percentile of percent daily change in streamflow on days when streamflow is receding (a measure of base-flow recession)

MaxMonth [1- Jan, 12-Dec] - month of maximum mean monthly streamflow

MaxMonthQ [M3/S] - maximum mean monthly streamflow

MinMonth [1- Jan, 12-Dec] - month of minimum mean monthly streamflow

MinMonthQ [M3/S] - minimum mean monthly streamflow

Q01, Q05, Q10, ...,Q99 [M3/S] - streamflow exceeded 1%, 5%, 10%, ..., 99% of the time

BugID	ModelMatch	Area	Imperviousness	Lat	Long
907S00577	SantaMaria_11028500	11.64	0.48	33.07609	-116.676
SMC04426	SanMateo_11046300	17.80	0.24	33.00697	-116.67
907S03210	Jamul_11014000	38.43	0.37	33.00313	-116.729
907S01418	SanMateo_11046300	24.87	0.19	32.99246	-116.719
SMC04682	SantaYsabel_11025500	21.04	0.27	32.97115	-116.648
907S46499	SanMateo_11046300	101.73	0.26	32.96269	-116.749
907S03786	SantaYsabel_11025500	11.29	0.26	32.89422	-116.658
SMC32718	Jamul_11014000	190.98	0.59	32.88455	-116.822
SMC11430	Mission_11119750	4.48	6.56	32.84835	-116.86
SMC02006	Poway_11023340	23.29	43.62	32.83115	-116.985
SMC09174	LosAngeles_11092450	346.73	6.08	32.83967	-117.002
SMC08150	Poway_11023340	367.06	6.13	32.83731	-117.02
SMC04134	Jamul_11014000	377.26	6.09	32.82874	-117.052
907P2PBxx	SanLuisRey_11042000	428.14	10.04	32.7675	-117.159
907S05514	SanMateo_11046300	66.73	0.29	32.97974	-116.742
907S01610	SanMateo_11046300	23.07	0.25	32.96676	-116.653
907S01434	SantaYsabel_11025500	5.26	0.10	32.90428	-116.626
907S02774	Poway_11023340	4.45	52.96	32.81182	-116.973
SMC10198	LosAngeles_11092450	5.60	53.24	32.82182	-116.976
907SDFRC2	LosAngeles_11092450	346.67	6.07	32.83945	-117.001
SMC04054	SanLuisRey_11042000	367.06	6.13	32.83697	-117.019
SMC19552	SanLuisRey_11042000	367.90	6.17	32.83965	-117.024
SMC07126	Mission_11119750	368.31	6.18	32.84359	-117.035
SMC12246	Mission_11119750	376.56	6.10	32.83982	-117.043
907SDSDR9	Mission_11119750	376.80	6.09	32.83894	-117.045
907SSDR11	Mission_11119750	380.87	6.12	32.82119	-117.063
SMC03110	Mission_11119750	381.67	6.17	32.81106	-117.073
SMC01990	Poway_11023340	12.19	25.15	32.79577	-117.113
SMC09286	Poway_11023340	405.87	8.53	32.78188	-117.114

APPENDIX B STAKEHOLDER WORKGROUP AND SCHEDULE OF WORKGROUP MEETINGS

The demonstration project workgroup met six times between November 2015 and June 2016 (Table B1). All meetings were held in the San Diego River Watershed

Table B1. Workgroup participants

NAME	ORGANIZATION
Daron Pedroja	State Water Board
Gary Strawn	San Diego Water Board
Shannon Quiquley	San Diego River Park Foundation
Dustin Harrison	San Diego River Conservancy
Tracy Cline	San Diego County
Joanna Wisniewska	San Diego County
Eric Stein	SCCWRP
Raphael Mazor	SCCWRP
Ashmita Sengupta	SCCWRP
Alicia Kinoshita	San Diego State University
Trent Biggs	San Diego State University
Natalie Mladenov	San Diego State University
Charles Morloch	San Diego County
Rob Northcote	Padre Dam Municipal Water District
Arne Sandvik	Padre Dam Municipal Water District
Brian Olney	Helix Water District
Emily Blunt	U.S. Forest Service
Goldy Herbon	City of San Diego
Jeff Pasek	City of San Diego
Vicki Kalkirtz	City of San Diego
Andre Sonsken	City of San Diego
Jim Harry	City of San Diego
Anita Eng	City of San Diego
Doug Thomson	City of San Diego
James Dodd	City of San Diego
Maris Guerro	Army Corps of Engineers
John Rudolph	AMEC Environmental

The dates and goals of each meeting are listed below:

Meeting #1: November 18th, 2015
Meeting Goals:

- Provide an overview of the watershed demonstration project
- Discuss and agree upon portion of the watershed to focus on
- Agree on general roles and contributions of partners
- Develop general schedule for next set of meetings

Meeting #2: January 20th, 2016
Meeting Goals:

- Discuss work plan for priority actions/products from first meeting
- Agree on schedule for obtaining necessary data for analysis
- Compile list of primary contacts for participation in analysis

Meeting #3: February 17th, 2016
Meeting Goals:

- Technology transfer- using models to predict flows, and flow metrics at ungaged locations
- Discuss the process, and usability
- Discussion on final products

Meeting # 4: March 16th, 2016
Meeting Goals:

- Address outstanding issues on the hydrologic modeling tools
- Agree on management scenarios being evaluated

Meeting #5: April 20th, 2016
Meeting Goals:

- Review products and outline for final demo project report

Meeting #6: June 15th, 2016
Meeting Goals:

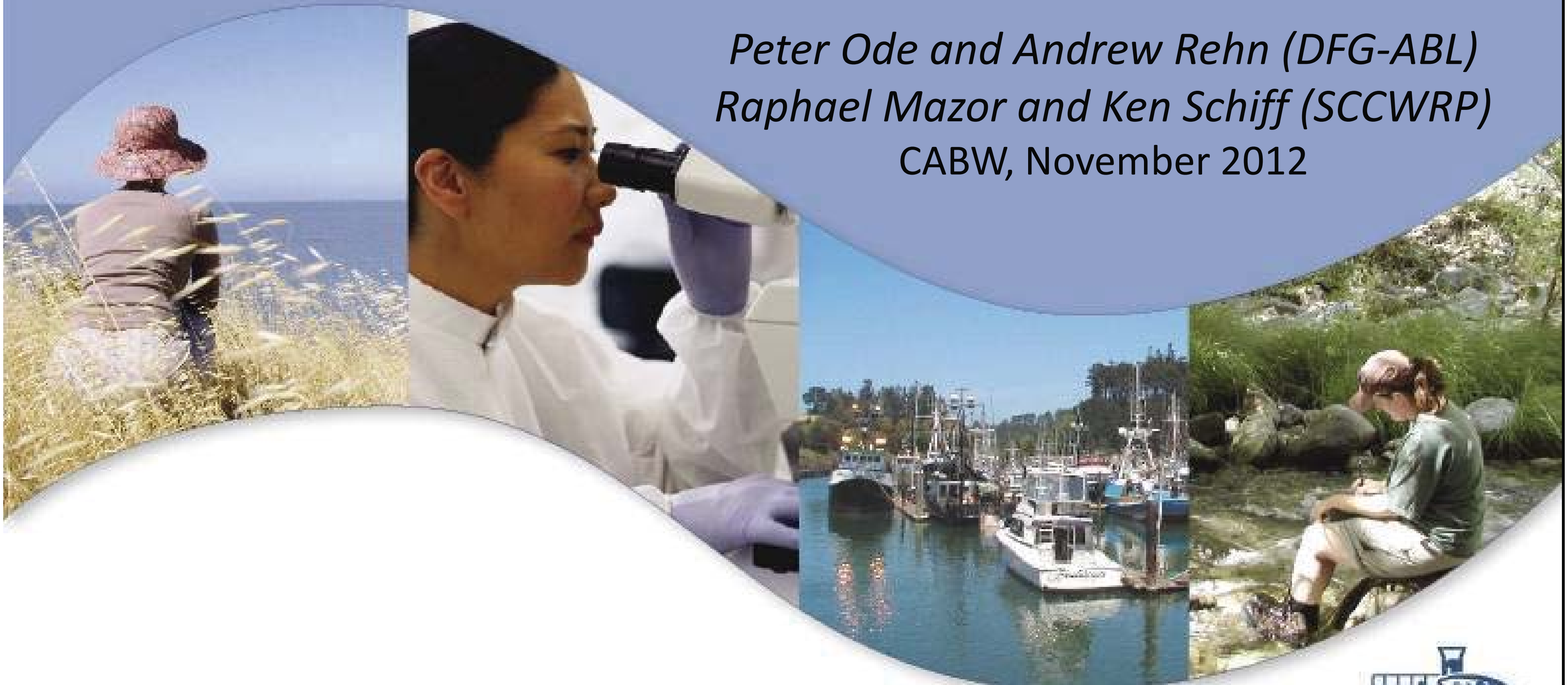
- Review draft demo project report

Appendix 13

Building the Technical Foundation for Biological Objectives

Peter Ode and Andrew Rehn (DFG-ABL)
Raphael Mazor and Ken Schiff (SCCWRP)

CABW, November 2012



CALIFORNIA DEPARTMENT OF FISH&GAME

Aquatic Bioassessment Laboratory

SCCWRP Established 1969

Water Boards

SWAMP Surface Water Ambient Monitoring Program

- **Technical Foundation** (Peter Ode/ Rafi Mazor – DFG, SCCWRP)
- **Regulatory Framework** (Karen Larsen, State Water Board)
- **Causal Analysis** (David Gillett, SCCWRP)
- **Stakeholder Process** (Brock Bernstein)
- **Open Discussion**

- **Measuring Stressor Distributions** (Andy Rehn, DFG)
- **Tools for Assessing Stream/Wetland Condition** (Eric Stein, SCCWRP)
- **SWAMP's Lab SOP for BMIs** (Melinda Woodard, QA Team)

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Technical Foundation

Part I – Laying the groundwork (20)

Part II – Creating the scoring tools (40)

Part III – Supporting Implementation (20)

SWAMP
Surface Water
Ambient Monitoring
Program

Technical Team

***Andy Rehn,** *DFG-ABL*

***Raphael Mazor**, *SCCWRP +DFG-ABL*

Larry Brown, *USGS*

Jason May, *USGS*

David Herbst, *SNARL*

Peter Ode, *DFG-WPCL/ABL*

Ken Schiff, *SCCWRP*

David Gillett, *SCCWRP*

Eric Stein, *SCCWRP*

Betty Fetscher, *SCCWRP*

Kevin Lunde, *SF Water Board*

Why Develop Ecological Indicators?

- Global paradigm shift toward ecological indicators
- Provide direct evidence about resources we are trying to protect
- More relevant measures of impacts and BMP effectiveness
- Links resource protection across multiple agencies by focus on ultimate policy goals

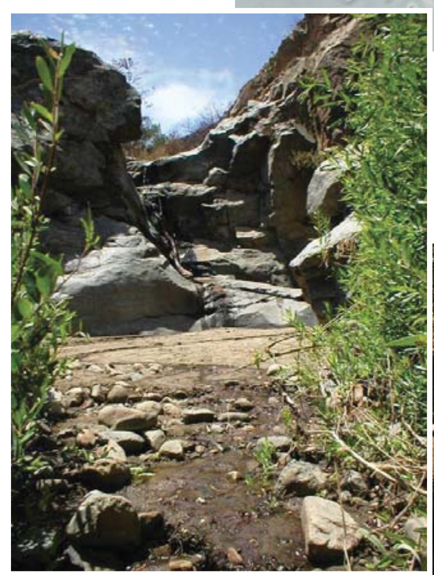
SWAMP Surface Water Ambient Monitoring Program

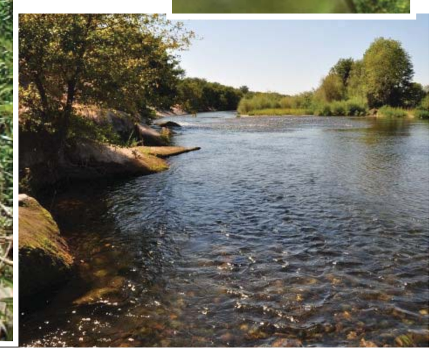
CA's Ecological Indicators

Multiple Indicators – BMIs, algae, (fish), riparian vegetation

Multiple waterbody types – large rivers, non-perennial streams, lakes, wetlands

Start with invertebrates and perennial streams





invertebrates:

the backbone of bioassessment

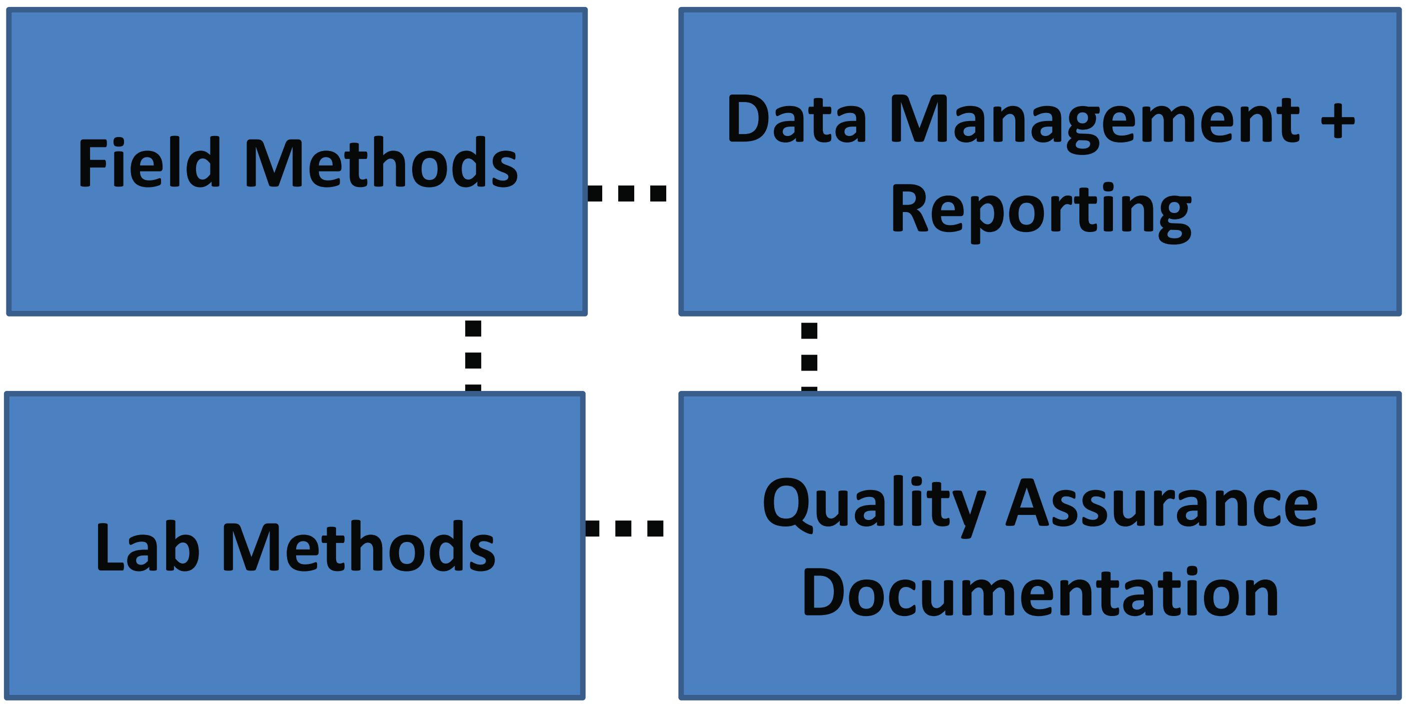
- *Abundant*
- *Diverse*
- *Informative*
- *Adorable*

B448


How do we convert a list of species
into a condition score?
NABS (www.benthos.org)

Standardized Bioassessment Infrastructure Elements

Surface Water Ambient Monitoring Program (SWAMP)



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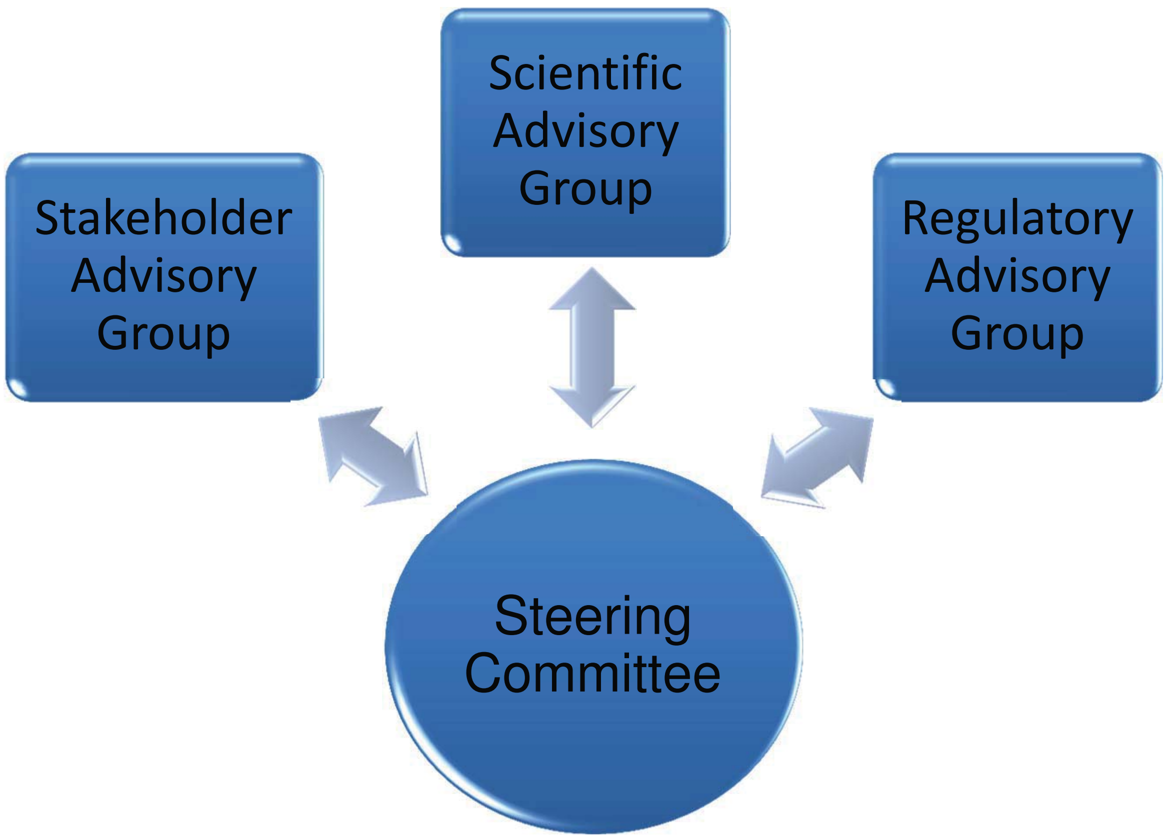
Biological Objectives Workgroups

> 20 meetings, excellent feedback



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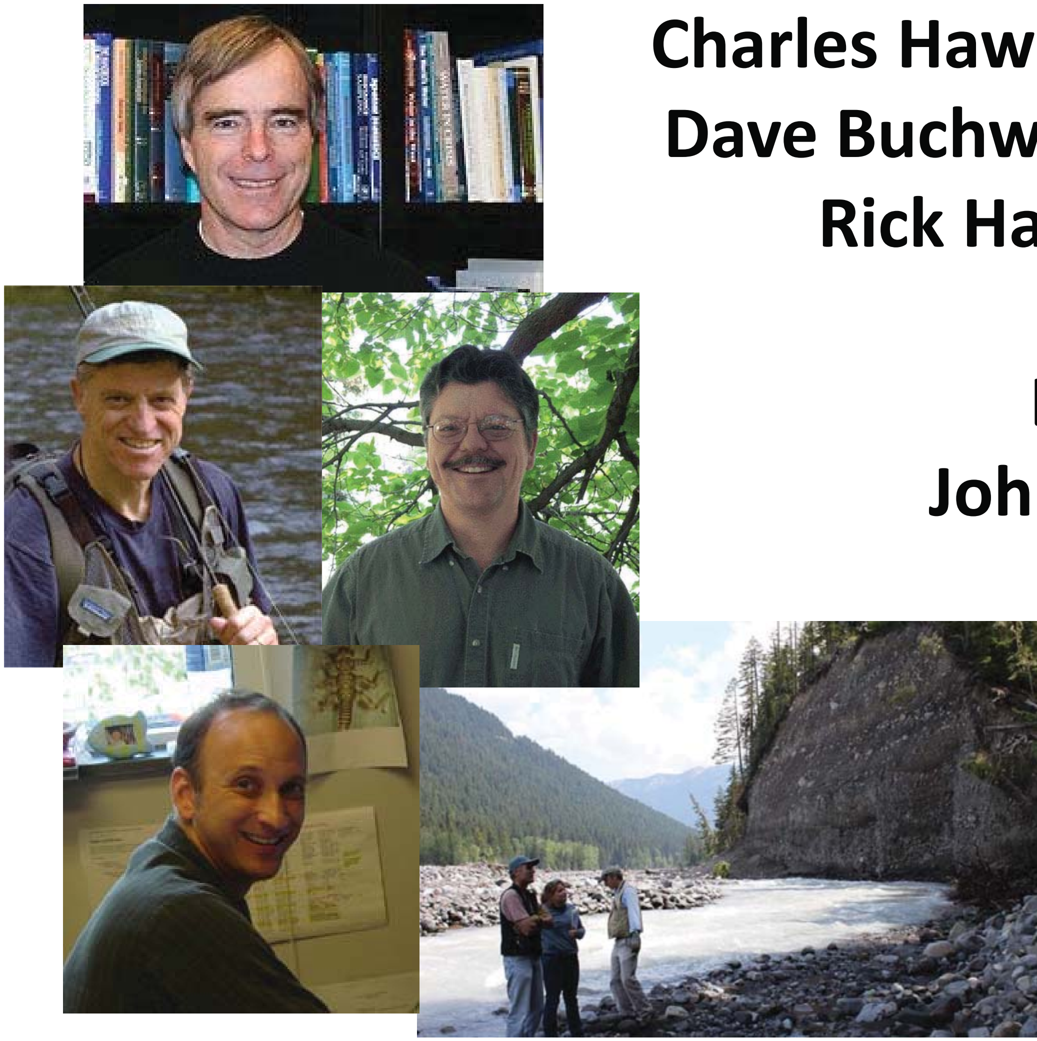
Scientific Advisory Panel



Charles Hawkins, *Utah State University*
Dave Buchwalter, *North Carolina State*
Rick Hafele, *Oregon DEQ (retired)*
Chris Konrad, *USGS*
LeRoy Poff, *Colorado State*
John VanSickle*, *EPA (retired)*
Lester Yuan*, *EPA*

*not pictured

SWAMP Surface Water Ambient Monitoring Program

Scoring Tools Depend on Reference Sites

(sites with low levels of disturbance)

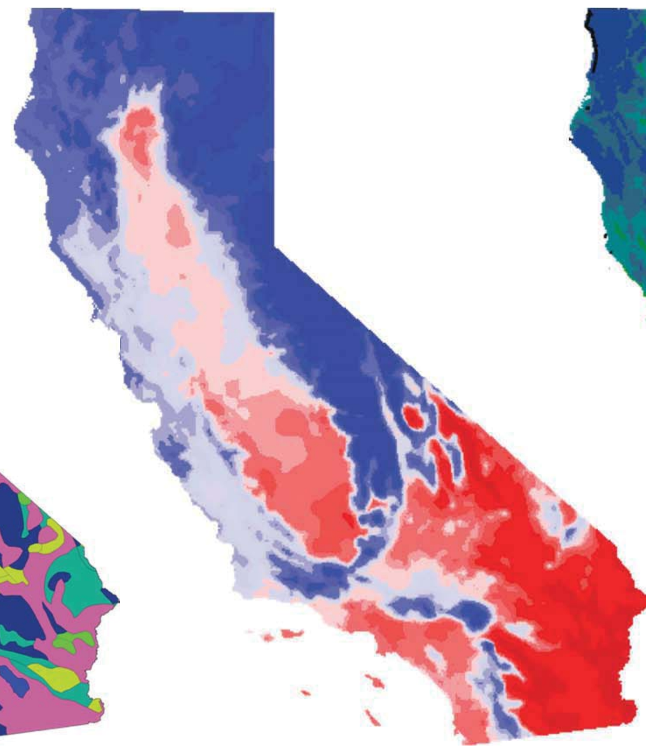
"What should the biology look like at a test site?"

Technical Challenges:

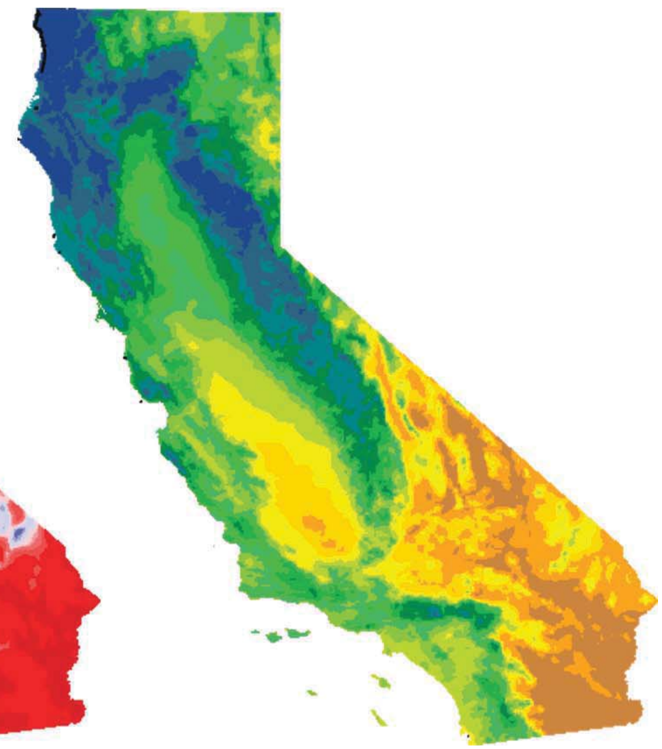
Strong natural gradients result in natural variation in biological expectations

Geology

Temperature

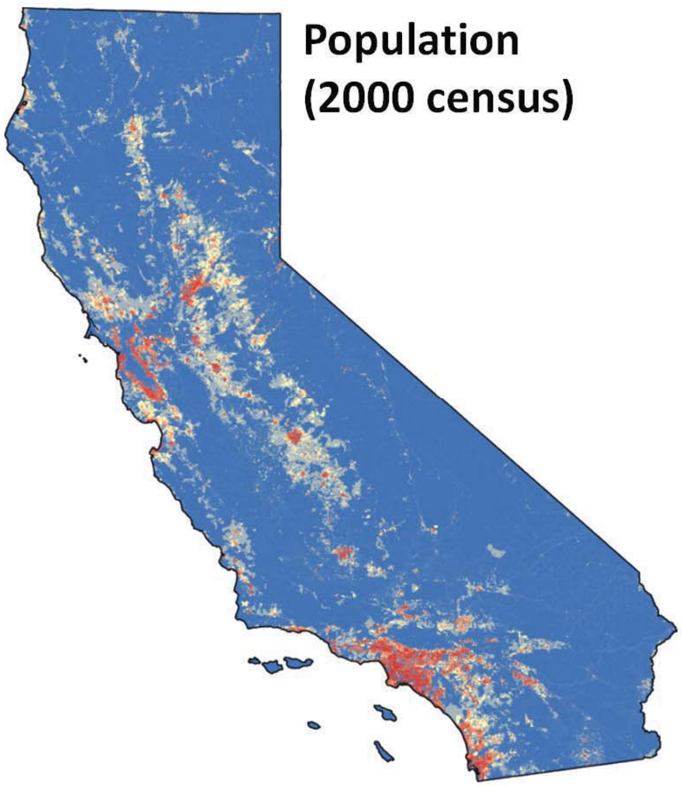


Precipitation



Technical Challenges:

Intense development can create regional gaps



Population
(2000 census)

Agricultural Areas
(2001 NLCD)

Reference Sites for Biocriteria

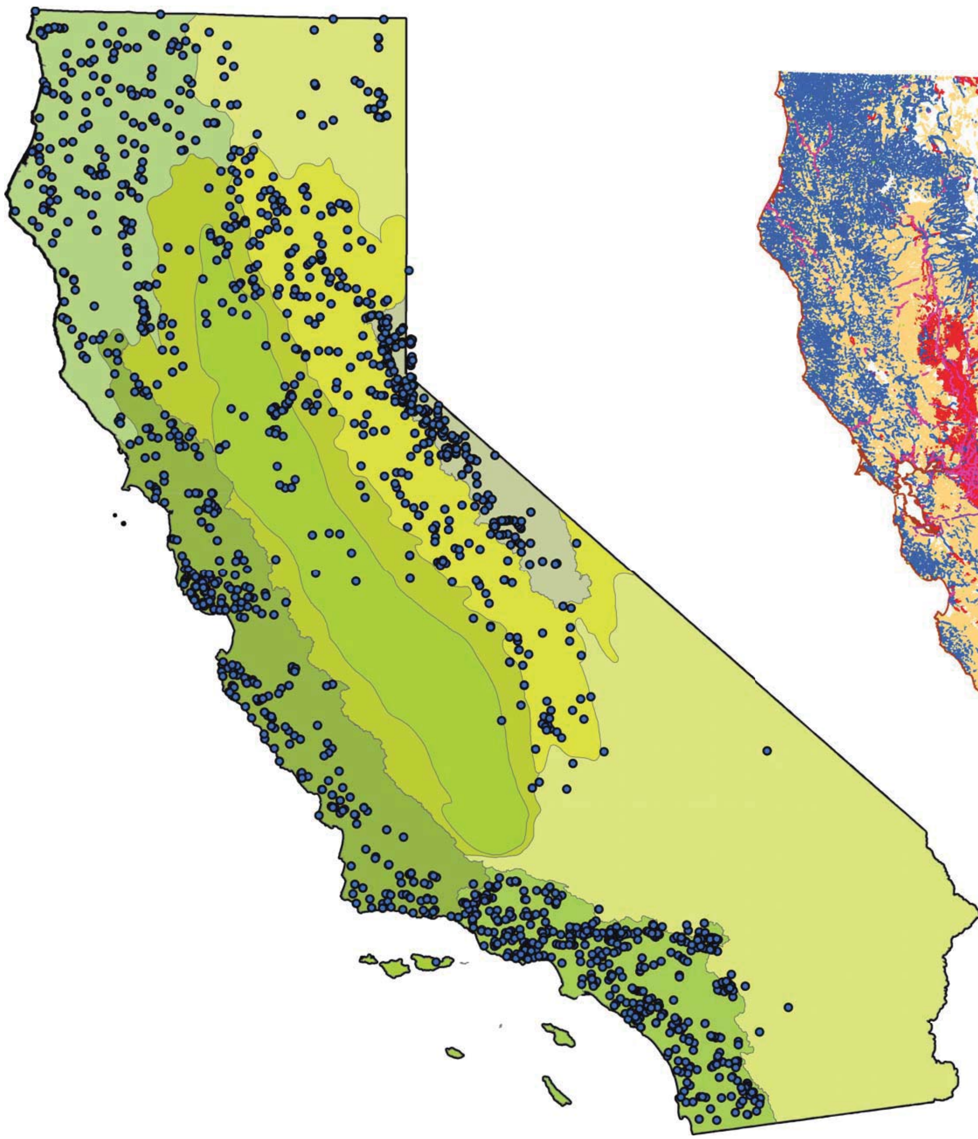
Selecting for site quality and representativeness

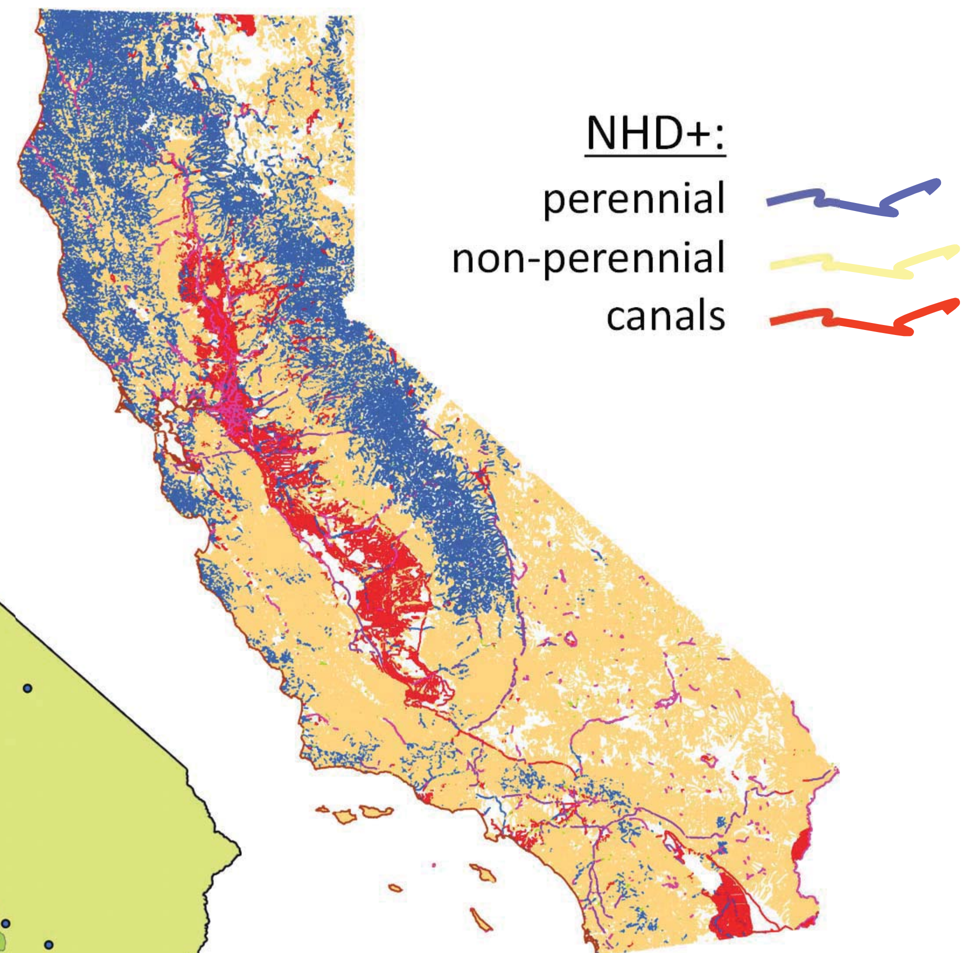
Challenge: Very few (if any) pristine streams exist; site selection process has to maximize representativeness while minimizing amount of disturbance at reference sites

Performance Objectives:

1. Reference pool represents the majority of CA streams
2. Biological "quality" is maintained at reference sites

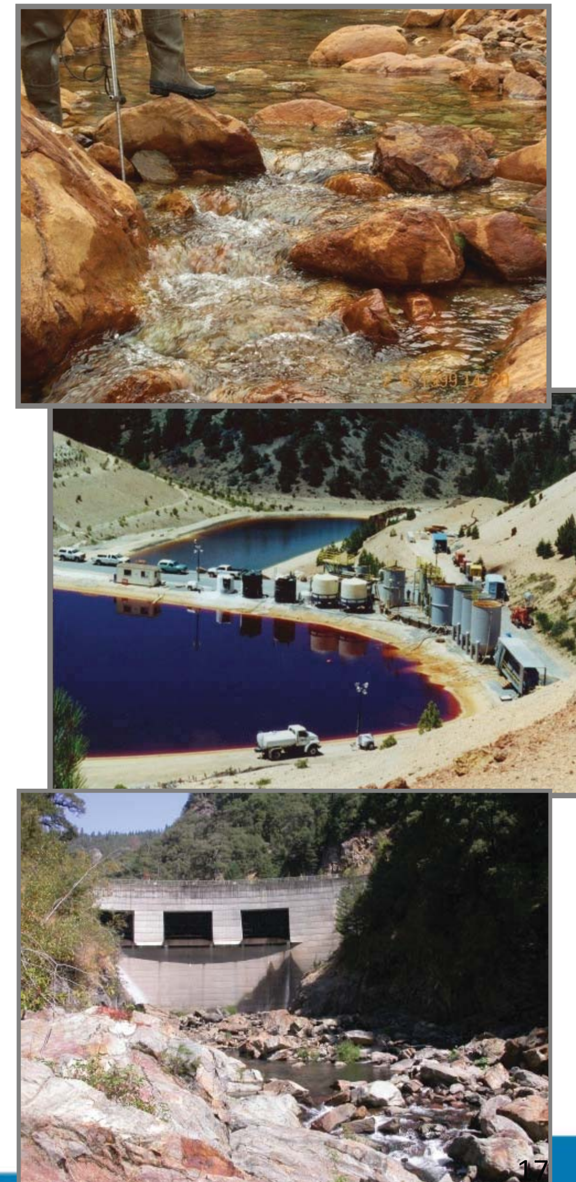
Assemble Data from > 2400 sites





Reference sites have few sources of human stress

- **Infrastructure**: roads, railroads
- **Population**
- **Hydromodification**
  - manmade channels, canals, pipelines
- **Landuse**
  - Ag/Urban development
  - Timber Harvest, Grazing
- Fire history, dams, mines
- 303d list, known discharges
- Invasive invertebrates, plants
- Instream and riparian habitat
- Water chemistry



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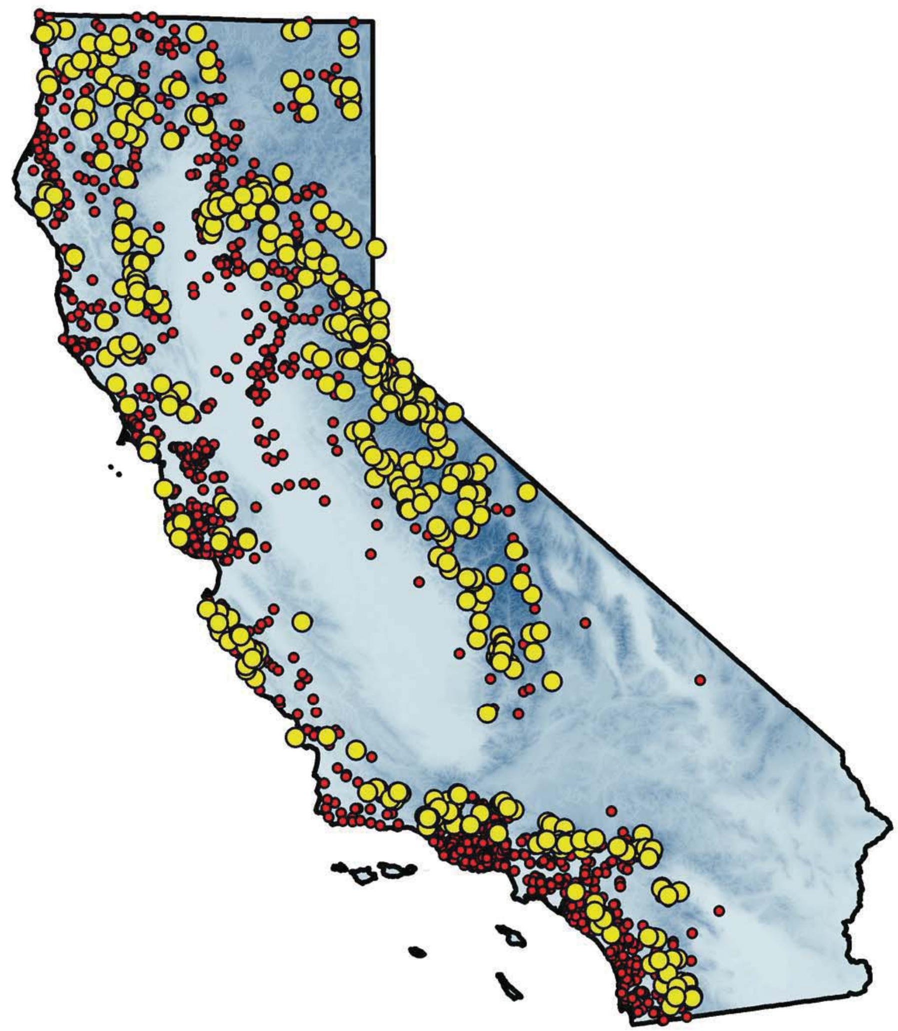
Thresholds are comparable or stricter than other CA indices and include many more criteria

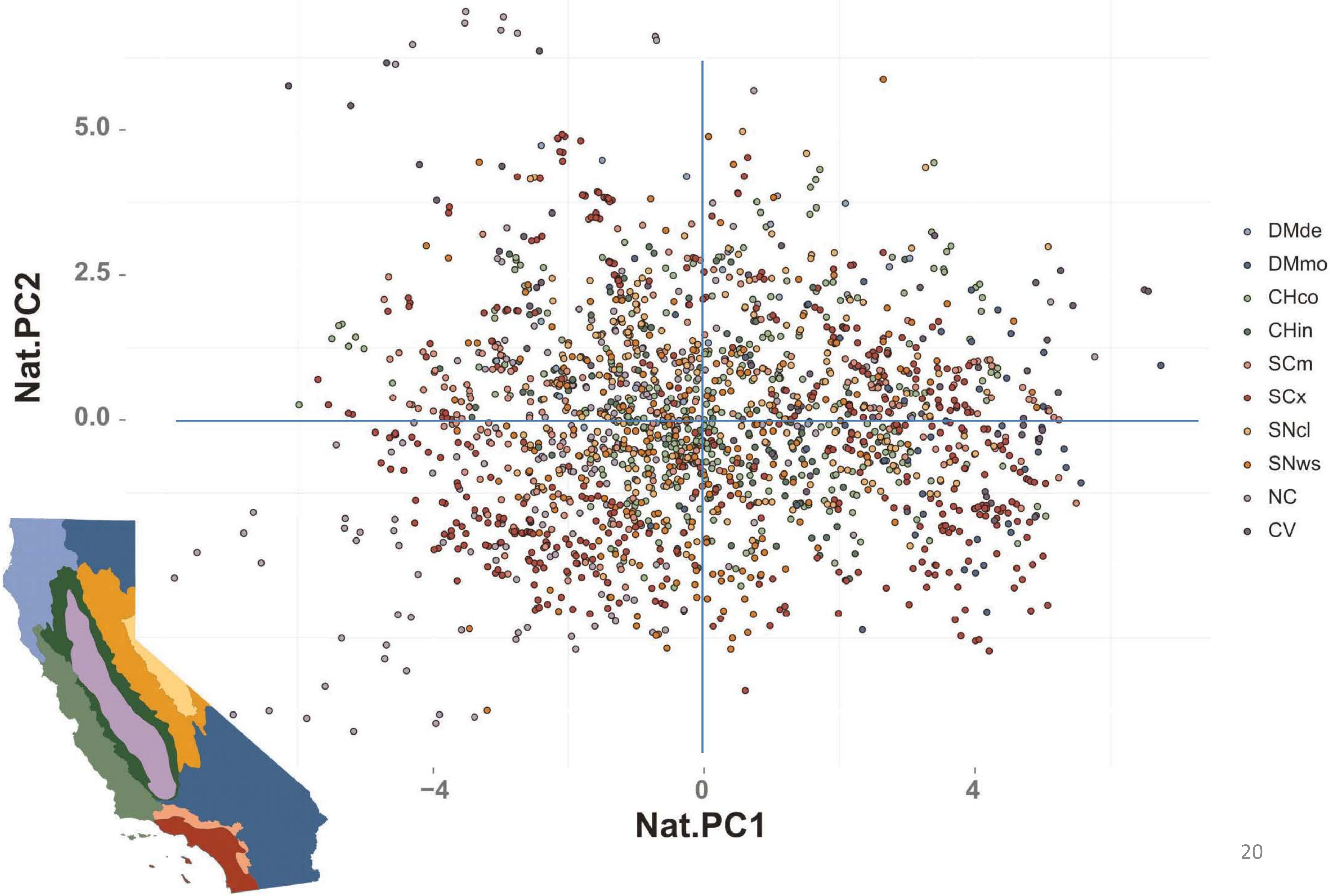
Metric	Bio-Objectives	South Coast IBI	North Coast IBI
Local Disturbance (W1_Hall)	1.5	-	-
% Agricultural	3,3,10	5	5
% Urban	3,3,10	3	3
% Ag + Urban	5,5,10		
% Code 21	7,7,10	in urban	in urban
Road Dens (km/km^2)	1.5	2.0	1.5/ 2.0
Paved Road X-ings (#/ws)	5/10/50		
Nearest Dams	>10 km	-	-
Active Producing Mines	0 (5k)	-	-
% Canals & Pipelines	10	-	-
Gravel Mine Density	0.1 (r5k)		
Conductivity	<2000 uS, + <99%, >1%		
BPJ Screen	X	X	X

Very good geographic coverage

REGION	n
North Coast	75
Central Valley	1
Coastal Chaparral	57
Interior Chaparral	33
South Coast Mountains	85
South Coast Xeric	34
Western Sierra	131
Central Lahontan	114
Deserts + Modoc	27
TOTAL	**586**



Multivariate view of natural diversity



Strong environmental representativeness

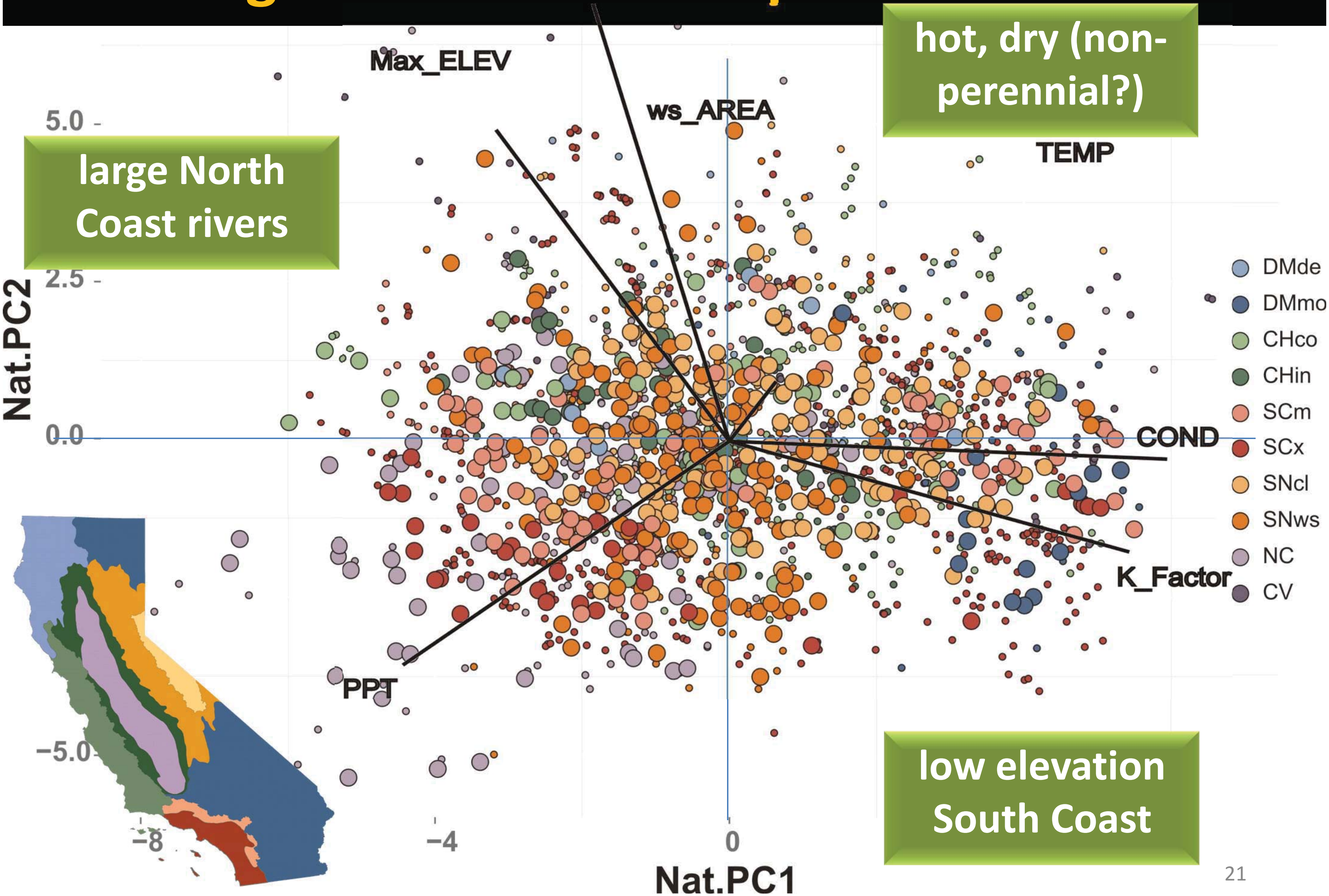



photo courtesy John Sandberg

Part III – Supporting Implementation
(technical support for policy decisions)

- Setting Impairment Thresholds
- Ensuring statewide consistency
- Applicability: Objective approaches for setting limits to the tools
- Summary and What's Next

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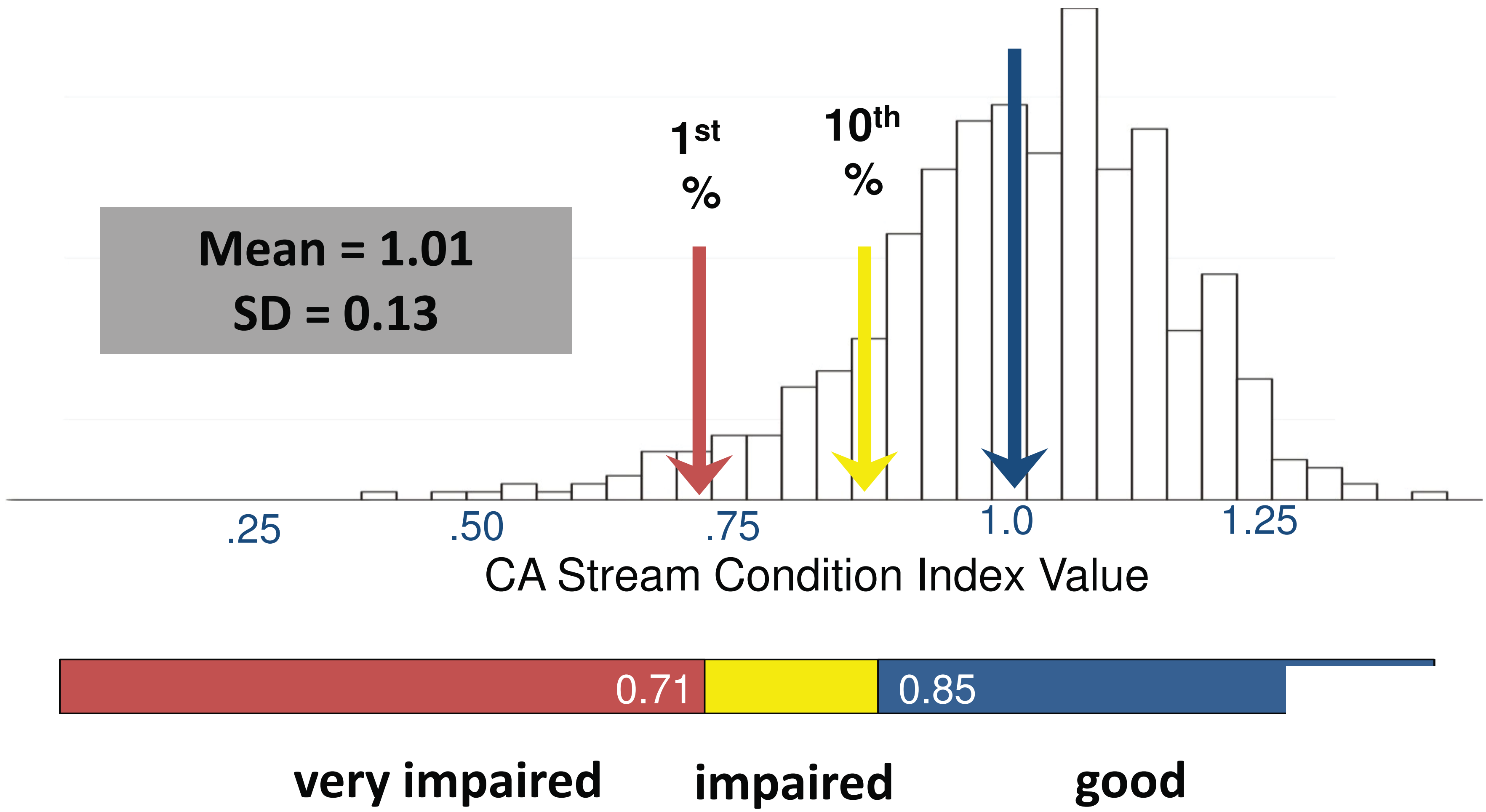
Desirable Qualities of Regulatory Thresholds

- **Objective**
- **Balance false positives and false negatives** – should be protective of resource, but not over-sensitive
- **Incorporate uncertainty of site score**

Distribution based thresholds:



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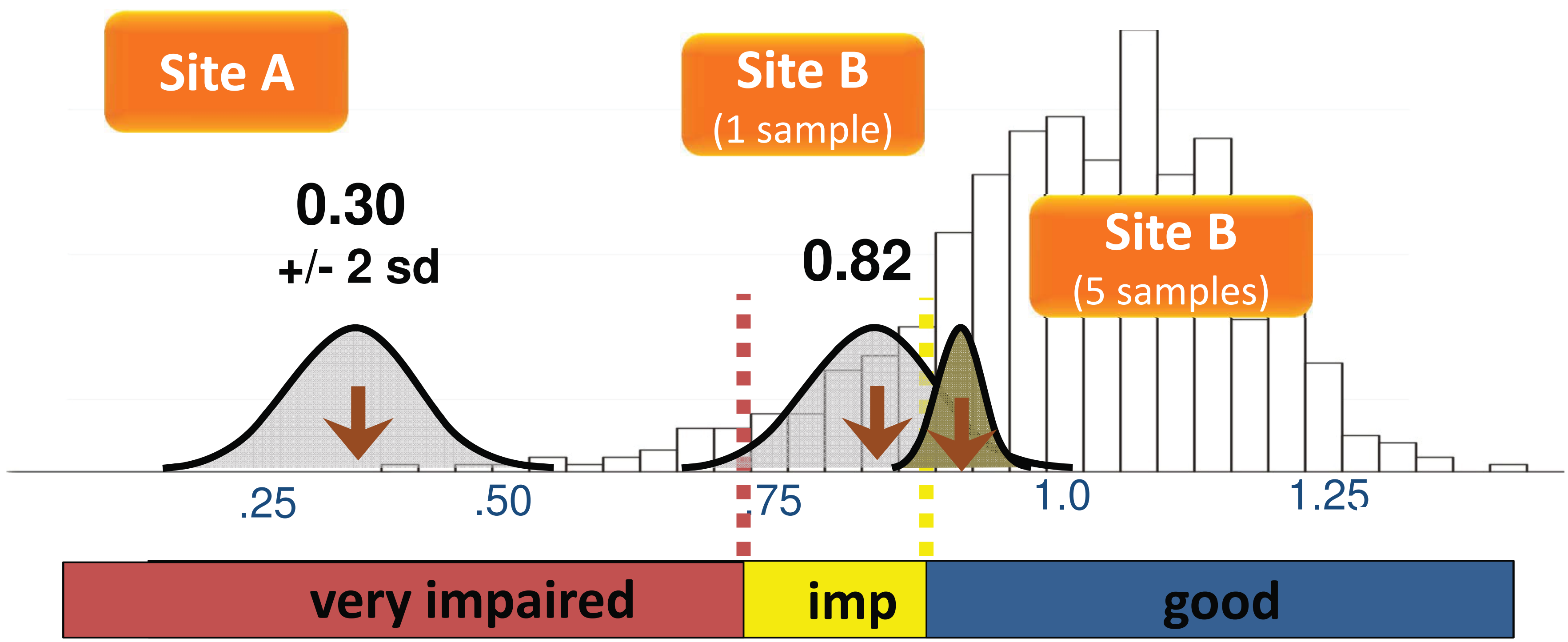
Incorporating Test Site Uncertainty

Use within-site error rate to account for uncertainty around test site score



more certainty with multiple samples

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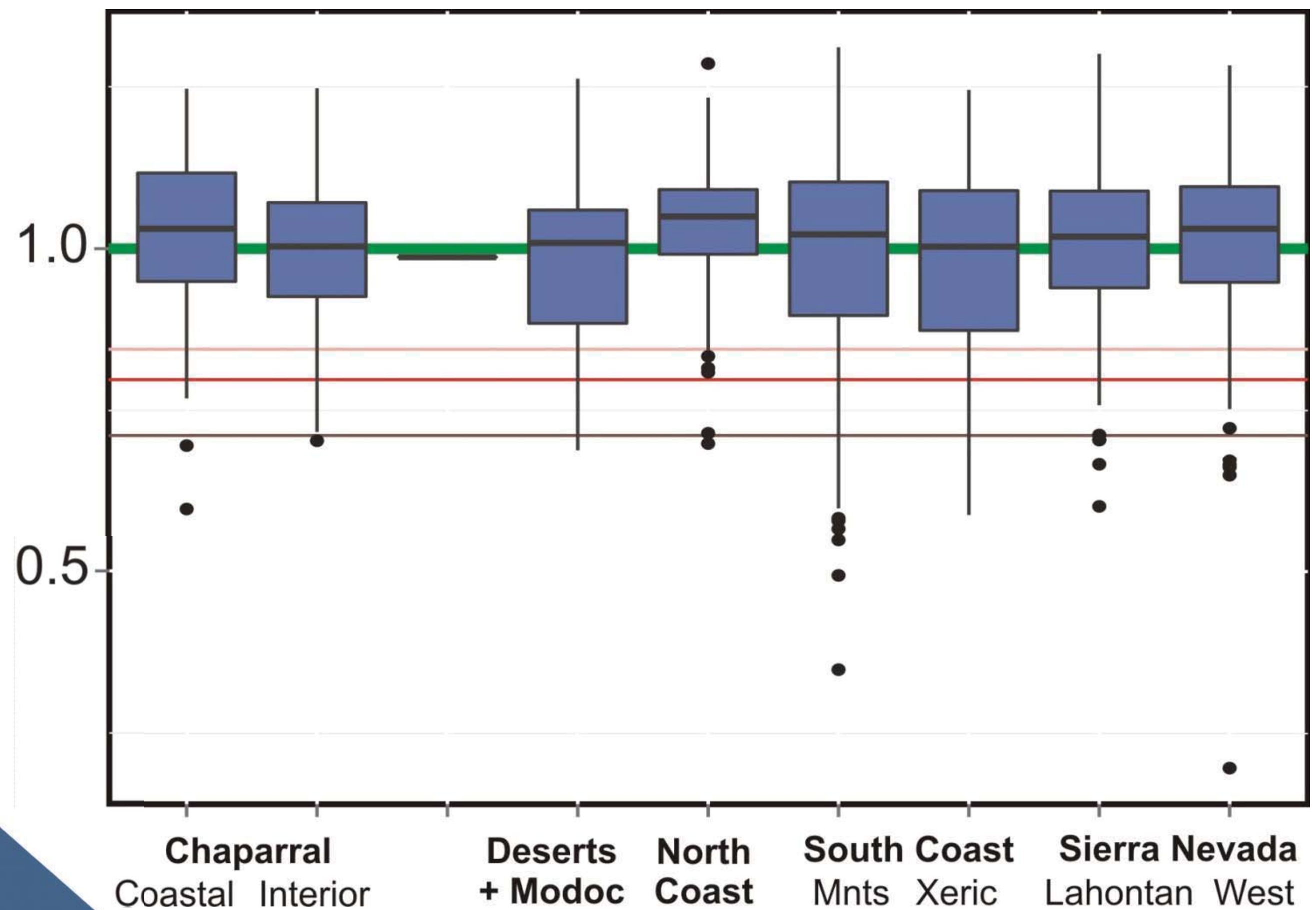
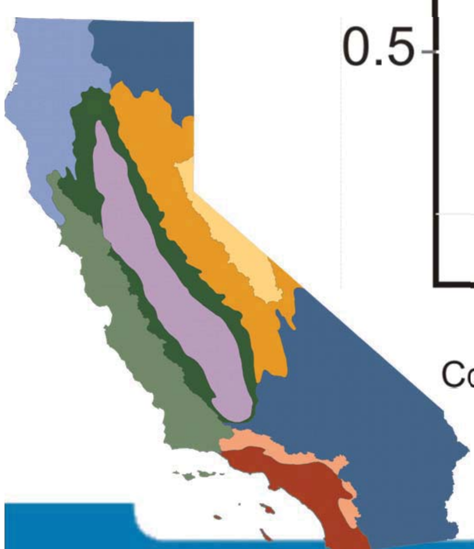
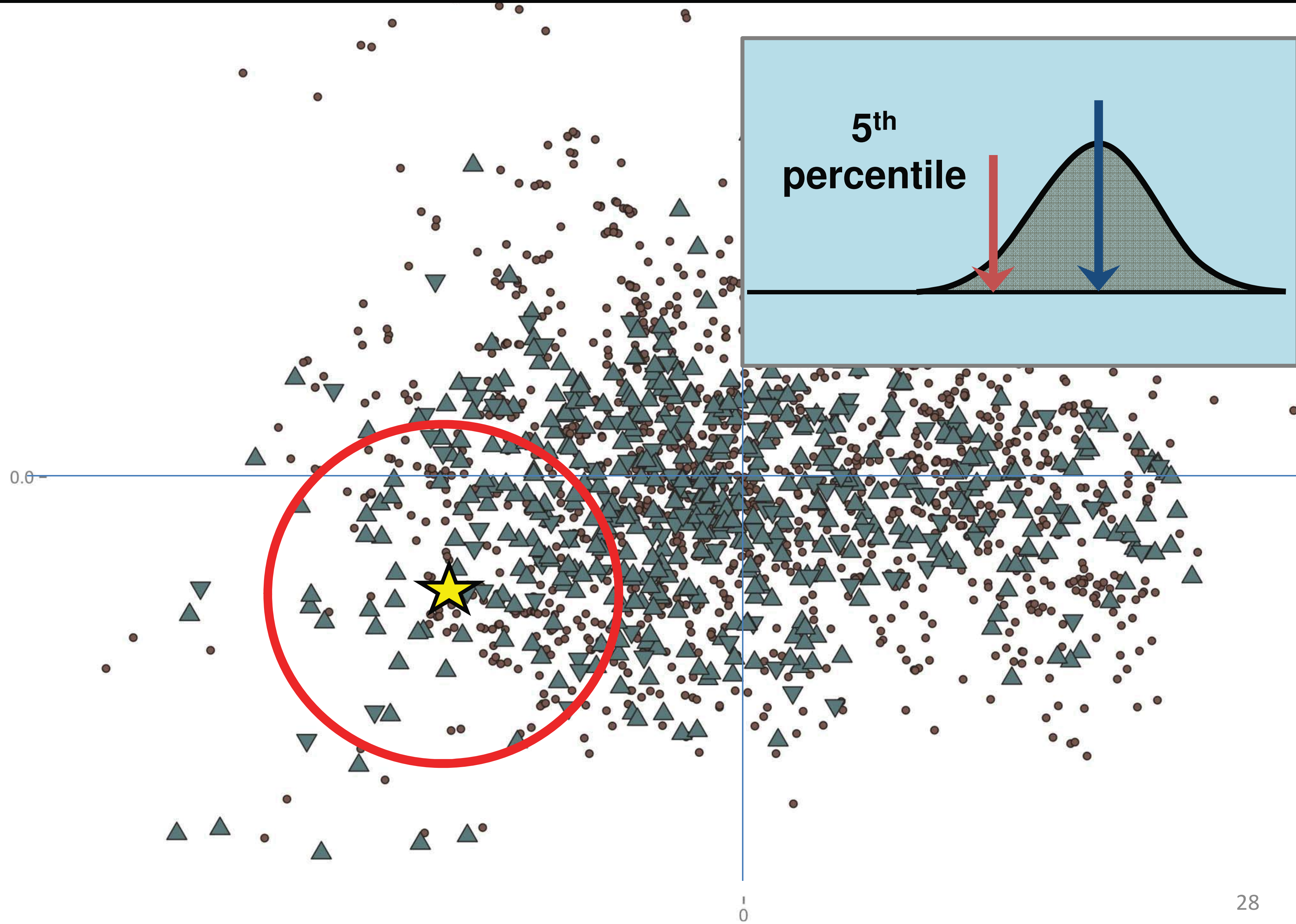
Ensuring Regionally Consistent Thresholds





Enhancing threshold consistency



Where can we apply the CSCI?

- **Categorical** = exception classes in policy
  - Excepted regions (e.g., Central Valley)
  - Excepted waterbody types (e.g., modified channels)
- **Quantitative Approaches**

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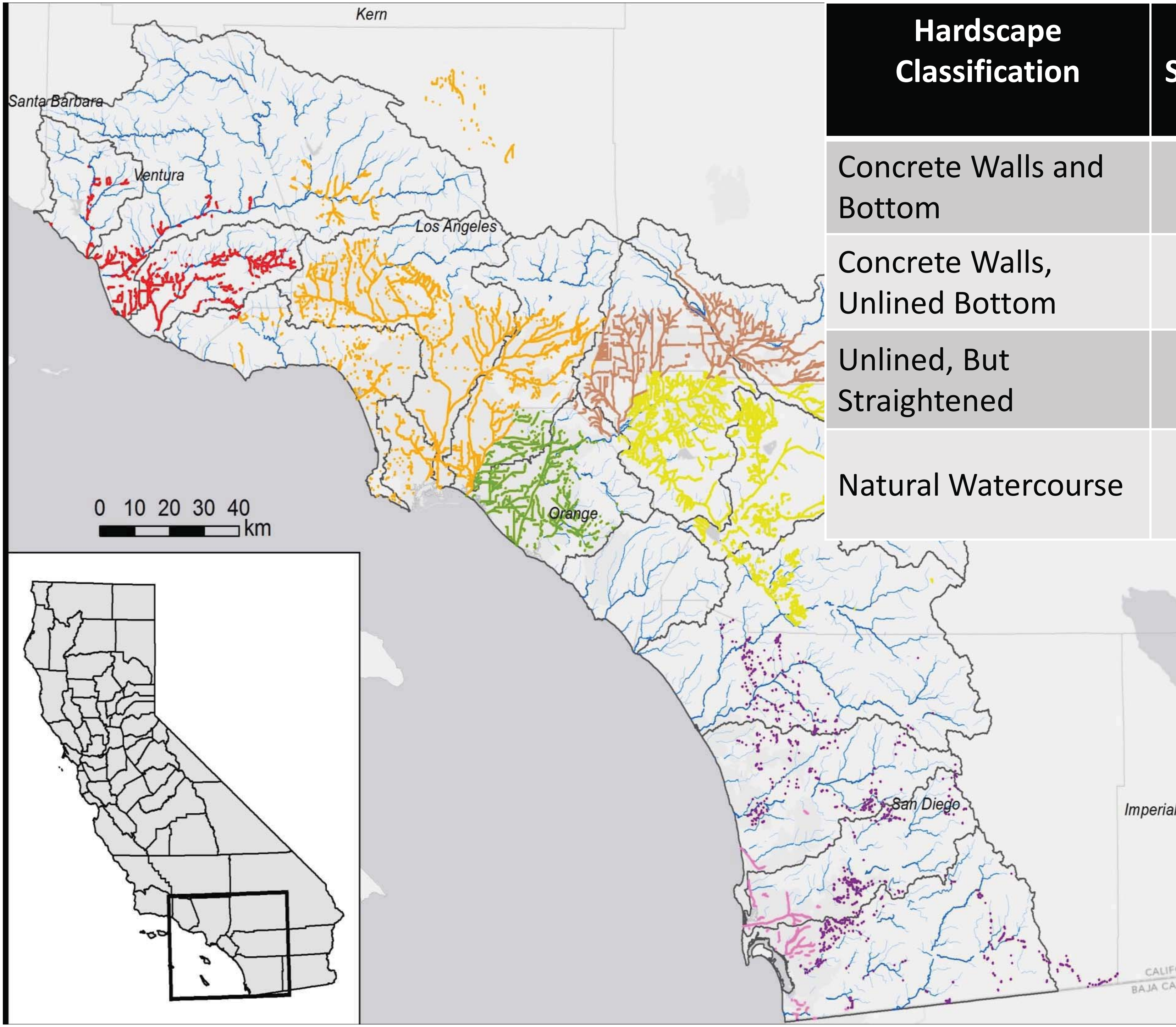
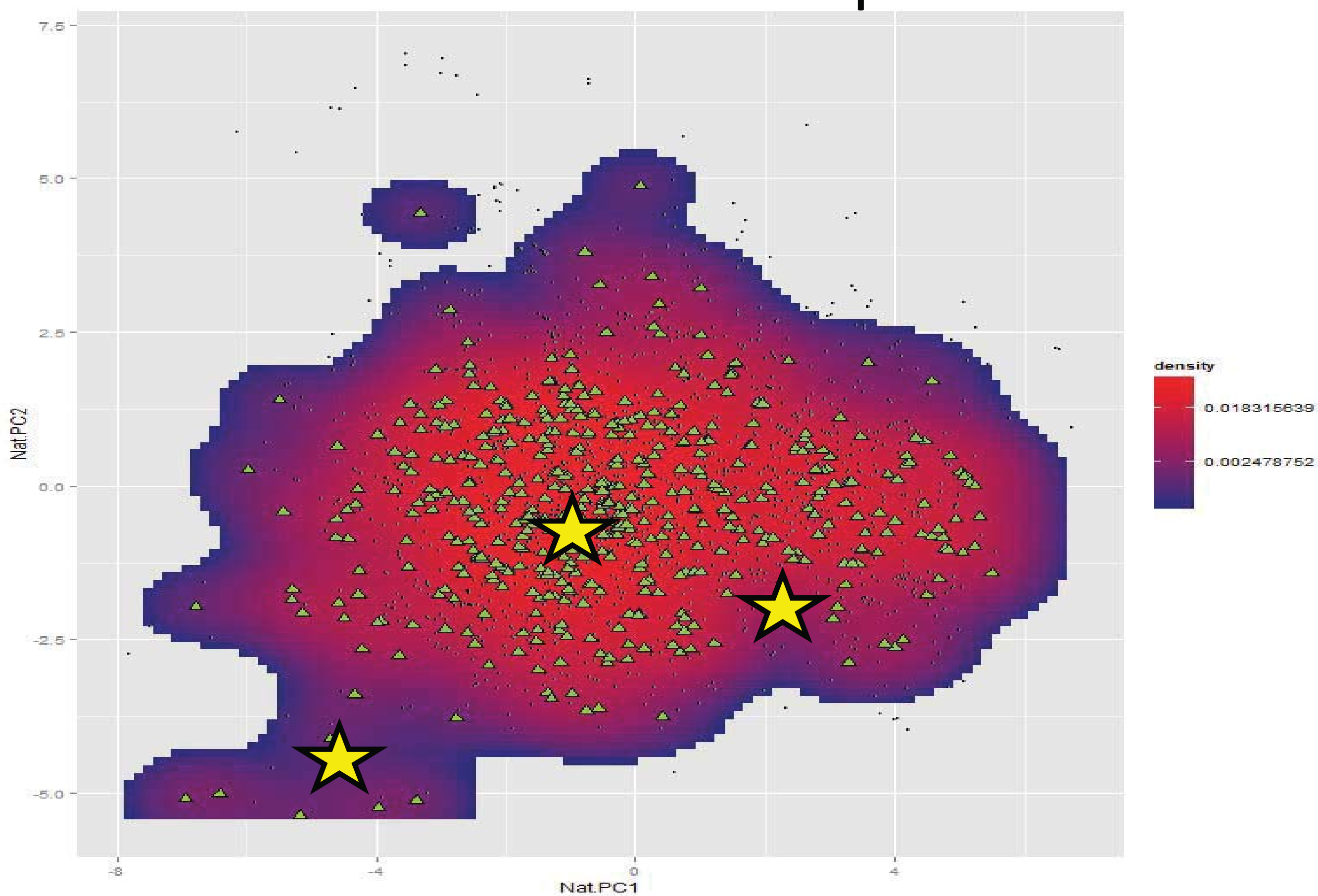
Hardscape Classification	% of So Cal Stream Miles
Concrete Walls and Bottom	3.2%
Concrete Walls, Unlined Bottom	3.6%
Unlined, But Straightened	16.6%
Natural Watercourse	76.3%



Quantitative Approaches:

"is a test site within the experience of the model in environmental space?"



Could be used to establish exceptions for truly unique environmental settings

Applicability of the CSCI in exception class settings

- We can still use the CSCI as a ruler, but we won’t regulate based a reference-based threshold
- Could use “best attainable” approach instead of “reference” to set expectation, or use to compare among sites

SWAMP
Surface Water Ambient Monitoring Program

Automation and Documentation

STANDARD METHODS … available on SWAMP website

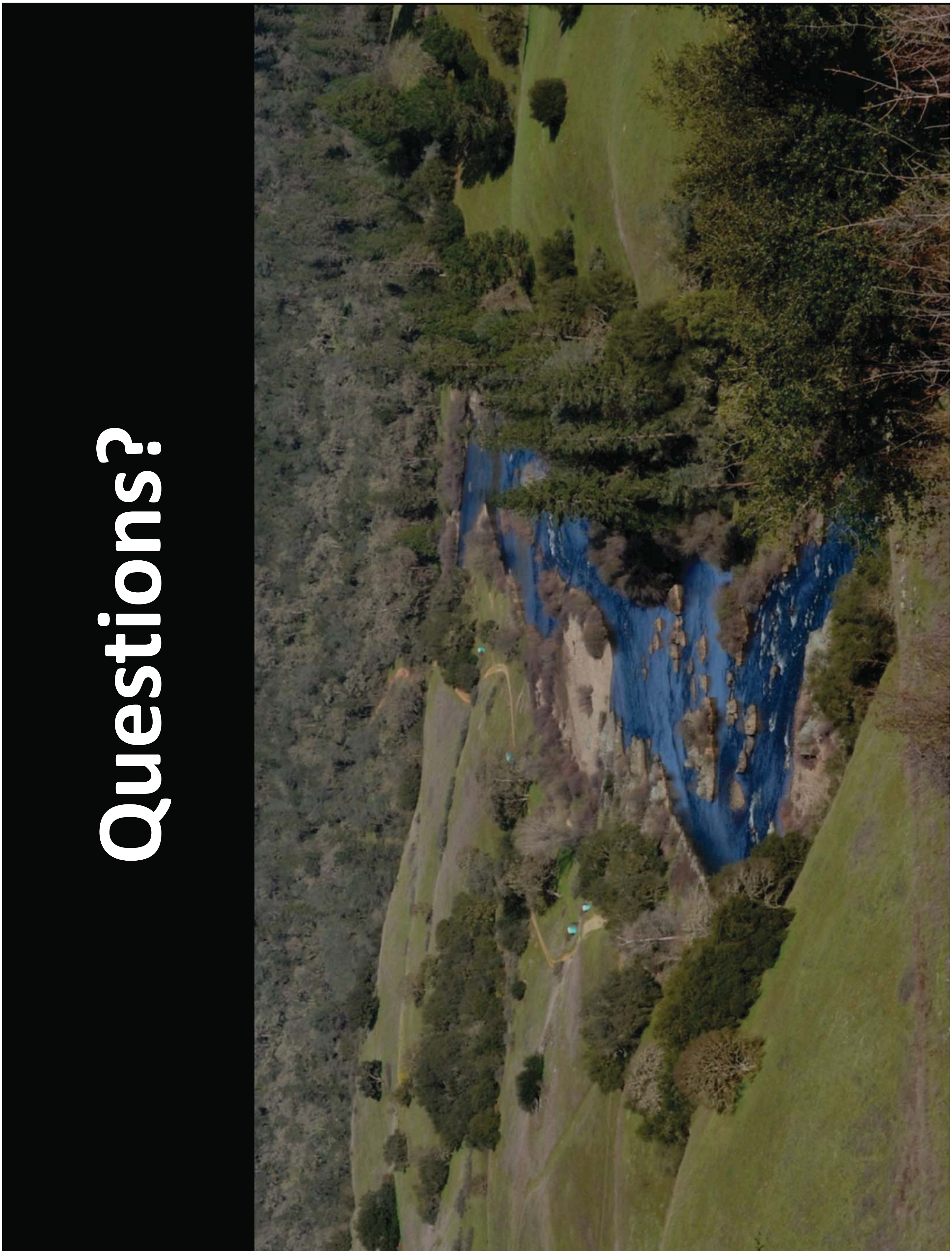
AUTOMATE calculations

- Package GIS layers
- Make standard calculation and reporting tools available via **CEDEN**

Document, document, document

- Journal articles
- Website 101 and FAQ
- Website appendices

Surface Water Ambient Monitoring Program


Questions?

Appendix 14

Science Advisory Panel Response

18 October 2012

Prioritization of Issues

- Scoring Tool
- Determining Scoring Tool Coverage
- Thresholds
- Causal Assessment
- Regulatory Guidance

Scoring Tool

- The Panel supports the use of the hybrid scoring tool
  - Includes both species-specific and biological community responses
  - Science Team will need to work on developing a simple explanation of this tool
- Some additional model evaluation would build confidence
  - Independent validation data sets
  - Simulation of impairment data to test responsiveness
  - What are the actual taxa or metrics that are driving scoring tool disagreement
- The Team will need to automate the calculation of this more complex scoring tool

Determining Scoring Tool Coverage

- A multi-variate approach is preferred
  - Include core dimensions of natural variability that biology responds to
- Guidance should be developed for stakeholders who assert their stream is not covered by this tool
- Even for sites outside the experience of the models, assessment options are still available
  - i.e., upstream-downstream

Thresholds

- Select thresholds based on distributions of reference condition
  - Need to assure some ecological meaningfulness
  - This approach can be used for developing categories of impact
- Test site uncertainty should be included
- Incorporating multiple samples at the test site is preferable: two options
  - Binomial approach (frequency of exceedence)
  - Mean site condition
- Ensure condition is assessed consistently at all sites

Causal Assessment

- Causal Assessment is important for progress in bio-objectives development
  - Panel recognizes that CADDIS is an imperfect tool and needs refinement
- CA needs to take advantage of its large data set to streamline causal assessment
  - This unique opportunity should reduce future costs
- CA needs to improve comparator site selection
  - Incorporate comparators outside the watershed
- CA needs to improve diagnostic tools
  - Regional response models (i.e., Relative risk)
  - Species specific response models
  - Laboratory based species sensitivity distributions

Regulatory Guidance

- CA's working definition of "perennial" and "wadeable" seem appropriate
  - This definition is the foundation of the scoring tools

- Inference of segment-scale biological condition from a single site should be done cautiously
  - Additional samples at multiple locations may be needed

Appendix 15

WORK PLAN

Predicting Biological Integrity of Streams Across a Gradient of Development in California Landscapes

Raphael Mazor, Martha Sutula, Eric Stein (SCCWRP)
Andy Rehn and Pete Ode (CDFW)

Introduction

The California State Water Resources Control Board (State Water Board) is developing a combined Biostimulatory (nutrient) and Biointegrity policy for wadeable streams, hereto referred to as the Biostimulatory-Biointegrity Project. The scientific approach supporting this project is grounded in biological assessments of the health of benthic macroinvertebrate and algal communities. The State is supporting the use of standardized bioassessment indices to quantify the biological integrity and support of aquatic life uses in wadeable streams. The benthic macroinvertebrate index (i.e., the California Stream Condition Index, or CSCI) has previously been developed (Mazor et al. 2016). An algal stream condition index (ASCI) is currently under development, with a provisional ASCI expected fall 2017 (see ASCI work plan).

As natural landscapes are converted to support urban or agricultural uses, the underlying hydrologic, physical, and biogeochemical factors within the stream and its catchment that support healthy stream communities are altered, potentially harming aquatic life. Developed landscapes are associated with an increase of many stressors in streams, such as elevated contaminant and nutrient concentrations, altered flow regimes, sedimentation, and habitat degradation (e.g., Waite et al. 2012). In some streams, direct channel modifications (e.g., bank armoring) may also limit opportunities to sustain high-quality ecological conditions for aquatic life. In these highly developed settings, the large number of linked stressors may prevent a stream from supporting its beneficial uses or attaining high scores on indices of biological condition. Often, these stressors are difficult to mitigate or remove under the traditional mechanisms available to the Water Boards. In these circumstances, the range of CSCI and/or ASCI scores may be constrained, but targeted restoration could improve conditions. Key technical questions underpinning the range of options and prioritization of management actions for wadeable streams along the continuum from undeveloped to highly developed landscapes found within California are: For which streams is biological integrity constrained by development in the catchment? How can they be identified and mapped? What are the ranges of biological conditions these developed landscapes can support?

The State Water Board is seeking to protect biointegrity in streams, including streams where integrity is constrained by development. Identifying landscapes where development has a high likelihood of limiting biointegrity is an important first step to identifying effective management options. This creates a technical need for 1) a simple, reproducible, and easy-to-understand methodology for identifying landscapes where development has a high likelihood of limiting biointegrity and 2) predicting expectations for CSCI and (when available) ASCI indices screening tool or starting point for discussions on appropriate management strategies. These analyses create a technical foundation for the State Water Board and the Regional Boards to protect biological integrity in streams by informing appropriate biological condition expectations or by prioritizing sites long and short term restoration activities in these landscapes.

Geographic information systems (GIS) are commonly used to quantify landscape development within stream catchments. Estimating landscape alteration in catchments has traditionally been time-consuming for large-scale programs that monitor hundreds of sites annually, but recent tools (i.e., STREAMCAT, Hill et al. 2015) have made it possible to rapidly estimate landscape alteration in all streams in California represented by the National Hydrography Dataset Plus (NHD Plus) stream network. STREAMCAT therefore presents an opportunity to model the influence of landscape alterations on stream bioassessment scores on a large scale, and to apply predictions of these models to any stream represented in NHD Plus. These models have the potential to predict a range of likely scores in a stream given a degree of landscape alteration, setting the stage for policy discussions about the level of support that these streams in developed landscapes provide to beneficial uses.

Study Objective, Conceptual Approach to Model Landscape Influences on Stream Bioassessment Index Scores

The purpose of this study is to explore constraints on bioassessment index scores in streams across a continuum of landscape development, using a predictive, GIS approach. Key graphics from this analysis will be used to support discussions between the Water Board and its Regulatory and Stakeholder Advisory Groups on policy options to prioritize and improve the management of streams in developed landscapes.

The GIS approach involves developing models that predict a range of bioassessment index scores based on measures of landscape development. The product of these models is a map of likely CSCI (and when available, ASCI) scores for each segment. The intent of such a map is to identify watersheds where discussions of policy options for undeveloped versus developed landscapes could be productive. This map is intended to be used as a screening tool or starting point for discussions; it is not intended to be a one-off, definitive assessment that is used to set expectations for developed landscapes without further field level investigations of stressors and causal factors.

This approach relies on the following definition of “developed landscapes”:

> *Landscapes where development is likely to limit bioassessment index scores.*

Development of a GIS model and application to predict likely bioassessment index scores in developed landscapes require three types of decisions:

1. *Developed Land Uses*. Developed landscapes can be characterized by variables in the STREAMCAT dataset related to human alterations, such as urban and agricultural land-use types in the National Land Cover Dataset, land cover imperviousness, etc. (Table 1). Other variables could be included or excluded, but must be limited to variables included in or easily added to STREAMCAT.
2. *Likelihood*. The likelihood of achieving the desired biological condition can be calculated by statistical models, but determining if a likelihood is low enough to be considered "unlikely" is a value-based (i.e., non-technical) decision.
3. *Desired biological condition:* The management objective, as defined by bioassessment index scores, here to referred to as "assessment endpoints" (Biostimulatory-Biointegrity Project Science Plan).

Decisions on which developed landscape variables to include must occur during model development, while discussion of values appropriate to set the likelihood and desired CSCI and ASCI assessment endpoints are model application questions, all of which will ultimately be made by the Water Board. In order to foster discussion and provide the regulatory (RG) and stakeholder advisory groups (SAG) an opportunity to provide feedback on these three decisions, the Technical Team will iteratively engage the RG and the SAG in the model development and model application phases to provide ample opportunity for this feedback to occur.

Scope of Work:

The study has three tasks:

1) Develop models to predict a range of CSCI and ASCI scores based on measures of landscape development from the STREAMCAT dataset;
2) Apply the models to the entire NHD Plus stream network represented in the STREAMCAT dataset, classify stream segments based on likelihood of achieving target scores, and create maps illustrating these classifications, in order to engage Water Board staff and advisory groups on decisions on likelihood and CSCI and ASCI assessment endpoints; and
3) Produce a technical memo with key graphics and model output.

Task 1. Develop models to predict a range of CSCI and ASCI scores based on measures of landscape development derived from the STREAMCAT dataset

A dataset representing CSCI scores across a range of site conditions in California will be aggregated. Index scores from each site will be snapped to the corresponding stream segment in NHD Plus. STREAMCAT data characterizing landscape alteration variables (e.g., percent urban land cover, percent cropland, catchment imperviousness; Table 1) will be associated with each bioassessment site. Appropriate statistical models (e.g., quantile random forest) will be calibrated to associate measures of landscape development with bioassessment scores. A models will also be developed for ASCI, though decisions on which land use variables and likelihood values to use will focus on CSCI only, since a provisional ASCI index is anticipated late stage (Fall 2017).

Water Board staff will make provisional decisions on land use variables to include. The initial proposal will be based on consultation with the RG. The proposed land use variables and rationale will be presented to the SAG for feedback.

Deliverable:

1.1 Draft models and related graphics to predict bioassessment scores, in iterative stages of feedback.

1.2 Descriptive summaries of models, including evaluations of model performance, and list of landscape development variables in STREAMCAT selected for use in the models.

Table 1. List of STREAMCAT variables that can be evaluated in landscape modeling exercise. Most of these variables are calculated at multiple spatial scales.

Potential variables	Description
CanalDens	Density of NHDPlus line features classified as canal, ditch, or pipeline (km/ square km)
DamDens	Density of georeferenced dams (dams/ square km)
DamNrmStor	Volume all reservoirs (NORM_STORA in NID) per unit area (cubic meters/square km)
HUDen2010	Mean housing unit density (housing units/square km)
MineDens	Density of mines sites and within 100-m buffer of NHD stream lines (mines/square km)
PctAg2006Slp10	% area classified as ag land cover (NLCD 2006 classes 81-82) occurring on slopes ≥ 10%
PctAg2006Slp20	% area classified as ag land cover (NLCD 2006 classes 81-82) occurring on slopes ≥ 20%
PctCrop2006	% area classified as crop land use (NLCD 2006 class 82)
PctHay2006	% area classified as hay land use (NLCD 2006 class 81)
PctImp2006	Mean imperviousness of anthropogenic surfaces
PctUrbHi2006	% area classified as developed, high-intensity land use (NLCD 2006 class 24)
PctUrbLo2006	% area classified as developed, low-intensity land use (NLCD 2006 class 22)
PctUrbMd2006	% area classified as developed, medium-intensity land use (NLCD 2006 class 23)
PctUrbOp2006	% area classified as developed, open space land use (NLCD 2006 class 21)
PopDen2010	Mean populating density (people/square km)
RdCrs	Density of roads-stream intersections (2010 Census Tiger Lines-NHD stream lines) (crossings/square km)
RdDens	Density of roads (2010 Census Tiger Lines) (km/square km)

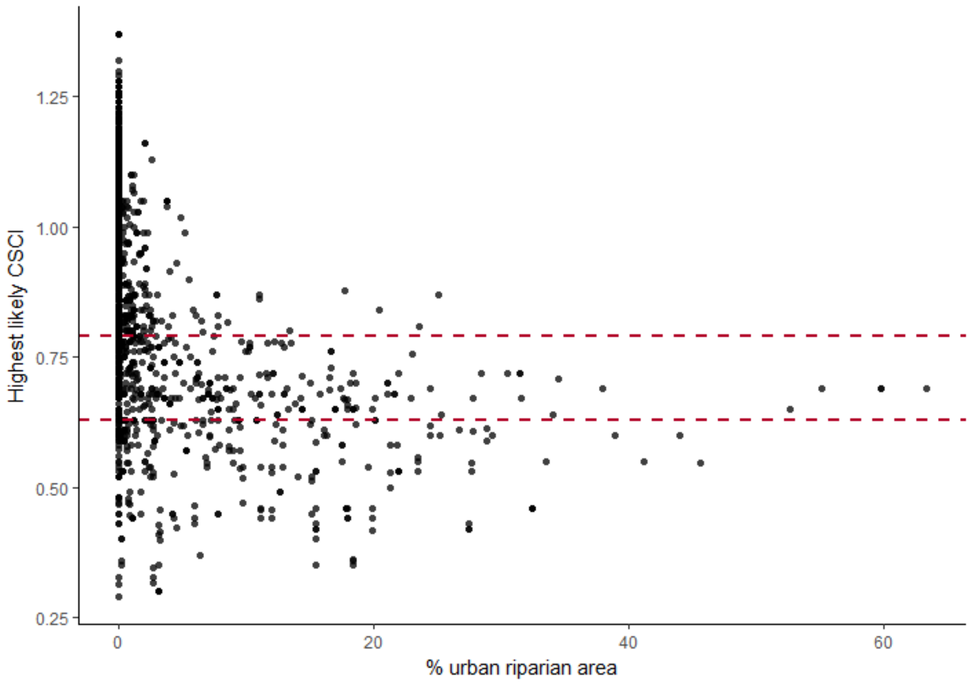


Figure 1. An example of the highest likely CSCI scores predicted by a quantile random forest model relating developed land use variables to biological integrity. The x-axis is percent of high density urban land cover within a 100-m buffer around the NHD stream lines (one of the variables included in example model). Dots above the top red line represent sites that are unconstrained by development (in this example, >10% chance of CSCI scores > 0.79). Dots between the two red lines are moderately constrained by development (<10% chance of CSCI scores > 0.79). Dots below the bottom red line are highly constrained by development (<10% chance of CSCI scores > 0.63). In this example, the 90th percentile of predicted scores represents the highest likely CSCI score.

Task 2. Apply the models to engage Water Board staff and advisory groups on discussions of sensitivity of model output to choice of likelihood and assessment endpoint

The purpose of this task is to help State Water Board staff and advisory groups understand how choice probabilities used to define modeling likelihood and desired assessment endpoint affects mapped categories of streams. The GIS mapping methodology will be applied to entire NHD Plus network of streams in California included in the STREAMCAT database. For selected regions or watersheds, the influence of key decision-points (e.g., minimum thresholds for acceptable bioassessment index scores, or minimum acceptable likelihood for attainment of these thresholds) will be illustrated by showing how the decisions described above influence the percentage and spatial extent of the stream network within the developed category. For example, the Water Board may define constrained channels as those with less than a 10% chance to achieve a CSCI score above 0.63 (e.g., dots below the bottom dashed line in Figure 1); maps will then be generated across the state to highlight which streams are designated as constrained under this definition, thereby helping stakeholders see the implications of this classification for their watersheds (e.g., segments shown as red lines in Figure 2).

Deliverable: 2.1 Interactive maps and oral presentations with maps, graphics, summary tables of the stream drainage network showing model outputs, e.g., maximum score likely to be attained in each stream segment (Figures 2 and 3) as a function of choice of likelihood and assessment endpoint value.

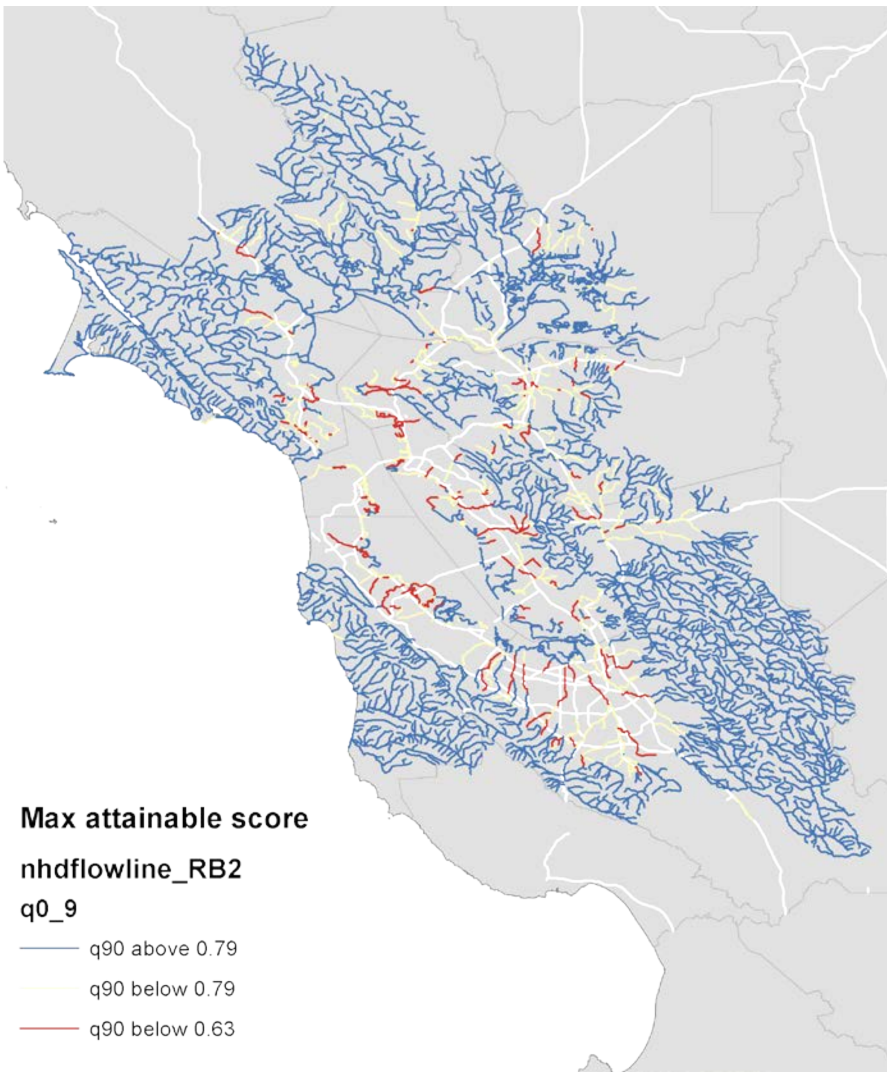


Figure 2. Map showing the classification of stream segments in the San Francisco Bay Area based on landscape development. In this map, attainability is defined as the 90th percentile of model predictions for each segment. Blue segments: Unconstrained by development, as described in Figure 1. Yellow segments: Moderately constrained by development. Red segments: Highly constrained by development.

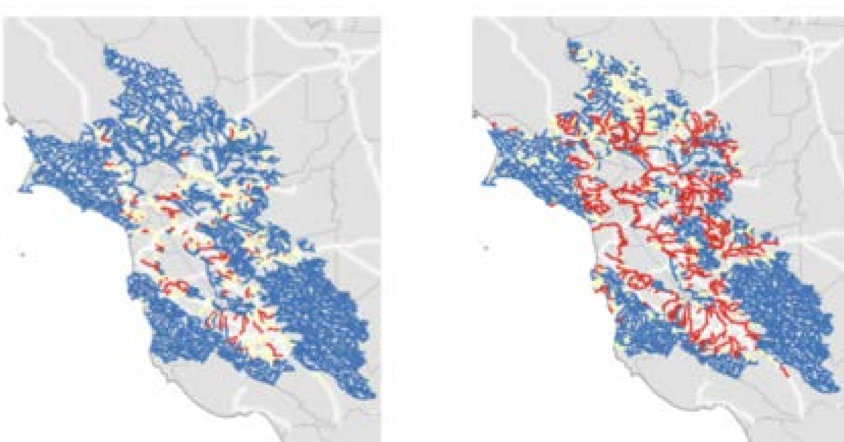


Figure 3: Example of maps generated with two different probabilities to define

likelihood. The map on the left was generated with a 10% probability to define likely scores, whereas the map on the right was generated with a 50% probability.

Task 3. Produce a Technical Memo with Key Graphics and Model Output

Based on feedback from group discussions and Water Board direction from Task 2, a reduced set of interactive maps and graphics can be generated to support this discussion. The purpose of this task is produce a technical memo with this reduced set of key graphics and model output in a format that can be easily shared and used to support discussions among Water Board staff and its advisory groups on policy options for channels in developed versus undeveloped landscapes. The maps and graphics will include ASCI scores and a linkage to Biological Condition Gradient calibration (see BCG workplan), and versions of maps and graphics to demonstrate policy options under consideration, as requested by Water Board staff.

Deliverables: 3.1) technical memo summarizing methodology and results of task 1 and 2, 3.2) model output that can be viewed in an interactive mode (e.g. Google Earth kmz file), 3.3) presentation to RG and SAG of illustrating policy options under consideration, upon request of Water Board staff.

Schedule of Interim Milestones and Deliverables

Task	Description	Estimated Date
1.1	Draft models and related graphics to predict bioassessment scores, in iterative stages of feedback	May 2017 (CSCI) September 2017 (ASCI)
1.2	Descriptive summaries of models, including evaluations of model performance, and list of landscape development variables in STREAMCAT selected for use in the models.	May 2017 and iteratively thereafter
2.1	Interactive maps and oral presentations with maps, graphics, summary tables as a function of choice of likelihood and assessment endpoint value.	May 2017 and iteratively thereafter
3.1	Draft and final technical memo summarizing methodology and results	September 2017 December 2017
3.2	Interactive model output (e.g. google earth .kmz file)	September 2017 December 2017
3.3	Presentation to RG and SAG of illustrating policy options under consideration	Upon request by Water Board staff

Citations

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Appendix 16

B495

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COMPARISON OF STREAM INVERTEBRATE RESPONSE MODELS FOR BIOASSESSMENT METRICS[1]

Ian R. Waite, Jonathan G. Kennen, Jason T. May, Larry R. Brown, Thomas F. Cuffney, Kimberly A. Jones, and James L. Orlando[2]

ABSTRACT: We aggregated invertebrate data from various sources to assemble data for modeling in two ecoregions in Oregon and one in California. Our goal was to compare the performance of models developed using multiple linear regression (MLR) techniques with models developed using three relatively new techniques: classification and regression trees (CART), random forest (RF), and boosted regression trees (BRT). We used tolerance of taxa based on richness (RICHTOL) and ratio of observed to expected taxa (O/E) as response variables and land use/land cover as explanatory variables. Responses were generally linear; therefore, there was little improvement to the MLR models when compared to models using CART and RF. In general, the four modeling techniques (MLR, CART, RF, and BRT) consistently selected the same primary explanatory variables for each region. However, results from the BRT models showed significant improvement over the MLR models for each region; increases in R^2 from 0.09 to 0.20. The O/E metric that was derived from models specifically calibrated for Oregon consistently had lower R^2 values than RICHTOL for the two regions tested. Modeled O/E R^2 values were between 0.06 and 0.10 lower for each of the four modeling methods applied in the Willamette Valley and were between 0.19 and 0.36 points lower for the Blue Mountains. As a result, BRT models may indeed represent a good alternative to MLR for modeling species distribution relative to environmental variables.

(KEY TERMS: modeling; macroinvertebrates; watershed disturbance; land use; prediction; statistical assessment.)

Waite, Ian R., Jonathan G. Kennen, Jason T. May, Larry R. Brown, Thomas F. Cuffney, Kimberly A. Jones, and James L. Orlando, 2012. Comparison of Stream Invertebrate Response Models for Bioassessment Metrics. *Journal of the American Water Resources Association* (JAWRA) 48(3): 570-583. DOI: 10.1111/j.1752-1688.2011.00632.x

INTRODUCTION

Modeling has increased markedly in the past decade in all areas of ecology, and major advances have been made in conceptual models and statistical techniques (Leathwick *et al.*, 2005; Austin, 2007; Cabecinha *et al.*, 2007; Turak *et al.*, 2011), which, in turn, help practitioners derive response models that better support the needs of bioassessment programs. A

[1]Paper No. JAWRA-11-0093-P of the *Journal of the American Water Resources Association* (JAWRA). Received July 26, 2011; accepted December 2, 2011. **Discussions are open until six months from print publication**.

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fundamental goal of bioassessment in stream ecology is a better understanding of the effects of human land use on stream biota and the processes at various scales that cause these effects. However, streams are complex spatial and temporal habitat mosaics that are directly and indirectly influenced by a combination of natural geology, climate, and human disturbance (Stanford *et al.*, 2005). Stream ecologists are trying to understand the spatial scales and processes associated with human and natural disturbances that are affecting the biota. Models provide a useful framework for testing hypotheses, determining potential direct and indirect linkages, and directing where further research is needed. The expansion and application of multivariate models in stream ecology are helping to address these issues and hopefully will lead to a broader understanding of ecological and anthropogenic pathways and responses (Oberdorff *et al.*, 2001; Cabecinha *et al.*, 2007; Turak *et al.*, 2011; Waite *et al.*, 2010).

Much of the research documenting the effects of land-use change on stream biota indicates that as the total watershed area in agricultural and/or urban land use increases, individual biological metrics and multimetric indices (MMIs) (such as an Index of Biotic Integrity, IBI) that reflect compositional changes in sensitive species generally decrease (Paul and Meyer, 2001; Allan, 2004; Van Sickle *et al.*, 2004; Cuffney *et al.*, 2005; Ode *et al.*, 2008; Waite *et al.*, 2010). Though some researchers have found a threshold response (i.e., a nonlinear or step function) of individual or multimetric biological indices to land-use indicators (e.g., Davis and Simon, 1995; Wang *et al.*, 2001; Walsh *et al.*, 2005; Hilderbrand *et al.*, 2010; King and Baker, 2010) much of the literature indicates that the response more often is a simple monotonic response with no initial resistance (Booth, 2005; Cuffney *et al.*, 2005, 2010; Kennen *et al.*, 2005; Morgan and Cushman, 2005; Roy *et al.*, 2005; Stanford *et al.*, 2005; Waite *et al.*, 2008, 2010). The debate about possible threshold responses continues not only because of the interest in determining, from a management perspective, where a threshold might occur along a land-use gradient, but also because of the effect thresholds and the resultant nonlinear responses have on the application of various modeling techniques. If biological responses to landscape measures are indeed complex and nonlinear, then newer modeling techniques such as classification regression trees (CART), random forest (RF) and boosted regression trees (BRT), multilevel hierarchical modeling, structural equation models, or artificial neural networks may be necessary to model these responses (Grace, 2006). However, if various biological responses to human disturbance are commonly simple and linear, then they should be more easily modeled via standard regression techniques, which are typically easier to develop and interpret.

There are three commonly used bioassessment variable types including individual biological metrics (e.g., Ephemeroptera, Plecoptera, and Trichoptera richness or EPT), combining individual metrics into a multimetric index (e.g., IBI) and development of the observed/expected ratio metric (O/E). Each method has its advantages and disadvantages, yet sometimes they can give different results in differ environmental settings (Herbst and Silldorff, 2006; Chessman *et al.*, 2010; Hawkins *et al.*, 2010). It is possible that individual metrics may be more stressor gradient specific and multimetric indices better at more general disturbance gradients, however, detailed comparison of these three methods is beyond the scope of this paper. We focus on two common individual biological metrics, the general tolerance of invertebrates to a multitude of stressors including sediment, temperature, dissolved oxygen, hydrological and habitat changes, nutrients, and contaminants following Barbour *et al.* (1999) and the ratio of the observed/expected taxa based on the RIVSPAC method (River Invertebrate Prediction and Classification System) (Clarke, 2000; Moss, 2000). The number of tolerant taxa is expected to increase while the O/E value is expected to decrease as the amount of disturbance to the stream increases.

Using the same dataset used in this paper, Waite *et al.* (2010) developed macroinvertebrate response models for three regions in the western United States (U.S.) and the best multiple linear regression (MLR) models based on Akaike Information Criterion (AIC) and R^2 from each individual region required only two or three explanatory variables to model macroinvertebrate metrics to explain 41-74% of the variation. In each region, their best model contained some measure of urban and/or agricultural land use, yet often the model was improved by including a natural explanatory variable such as mean annual precipitation or mean watershed slope (for the MLR equations, see Waite *et al.*, 2010). Two macroinvertebrate metrics, the richness of tolerant macroinvertebrates (RICHTOL) and some form of EPT richness, were common response variables in models developed among the three regions (Waite *et al.*, 2010). Models were developed for the same two invertebrate metrics even though the geographic regions they modeled reflect distinct differences in precipitation, geology, elevation, slope, population density, and land use. L. R. Brown, J. T. May, A. C. Rehn, P. R. Ode, I. R. Waite, and J. K. Kennen (personal communication) were also able to develop strong models using linear modeling techniques (MLR), they modeled an invertebrate index of biotic integrity (BIBI) across a gradient of urbanized streams in southern California and were able to explain approximately 48% of the variation based on MLR models including classification accuracy of 69 and 87% for impaired and unimpaired sites, respectively.

One important question that researchers are working to answer is whether the use of newer, more complex modeling techniques such as CART and regression trees improves our ability to predict biological metrics and potentially provide new insights into response patterns and mechanistic pathways. Generalized linear models (GLMs) and generalized additive models (GAMs) were introduced in the 1980s and 1990s as improved methods over MLR for data with non-normally distributed errors (e.g., presence–absence and count data) or nonlinear relations and usually outperform single regression trees (Elith *et al.*, 2008). Regression trees are one type of technique within the commonly used CART or decision tree family (e.g., Breiman *et al.*, 1984; De'ath and Fabricius, 2000; Prasad *et al.*, 2006). Trees attempt to explain variation in one categorical (classification) or continuous (regression) response variable by one or more explanatory variables, the resultant output being a dendogram or tree with varying numbers of branches or nodes. These techniques have a few properties that are highly desirable for ecological data analysis: (1) they can handle numeric, categorical, and censored response variables, (2) they are not affected by explanatory variables that follow non-normal distributions (i.e., skewed, Poisson, or bimodal), and (3) they can model complex interactions simply (De'ath, 2007). Maloney *et al.* (2009) found that CART models of watershed disturbance on BIBI values provided results that were intuitive and easy to interpret but they did not classify sites any better than logistic regression models; however, RF models showed minor improvements in performance over the other models. De'ath (2007) and Elith *et al.* (2008) show that BRTs outperform GLMs and GAMs in variable selection, predictive ability (higher R^2 and lower error), and can handle sharp discontinuities in data that are difficult for the other methods. Aertsena *et al.* (2010) also showed that BRT outperformed most modeling techniques (i.e., MLR, GLM, GAM, and CART), with the exception of artificial neural networks.

Over the past decade the estimate of O/E has become a common measure of biological condition for use in bioassessments (e.g., Hawkins, 2006; Carlisle *et al.*, 2008). The expected taxa for a site are commonly estimated by models (e.g., RIVPACS) (Clarke, 2000; Moss, 2000) of reference sites; this value is then compared to the actual taxa collected at a site. Models based on this approach have been developed in many international regions (e.g., Europe, New Zealand, and Australia) (Davies, 2000; Clarke and Murphy, 2006) and for separate regions within the U.S., including many states (Hubler, 2008). Recently, Hawkins *et al.* (2010) compared the response of three types of O/E models with five versions of MMIs for macroinvertebrates and found that in general, the O/E models were better able to distinguish managed or disturbed sites from reference sites than the MMIs. Due to these results and to its overall national and international popularity, we wanted to evaluate how models developed using O/E as the response variable would compare to models developed using single metrics, such as RICHTOL.

Our goal in this paper is to compare the overall performance (i.e., model fit, or R^2) of models developed using standard MLR techniques with more complex models developed using newer alternative techniques such as CART, RF, and boosted regression for the common macroinvertebrate metrics RICHTOL and O/E as the response variables. Also, we believe that the development of watershed disturbance predictive models such as those presented herein will build upon previous research to help the potential derivation of more complex models to better understand disturbance pathways in the landscape and ultimately the biocomplexity of aquatic systems.

METHODS

Data Aggregation and Landscape Analysis

For this comparative analysis we used the datasets (U.S. Geological Survey, U.S. Environmental Protection Agency, Oregon Department of Environmental Quality, and California Department of Fish and Game) previously aggregated for three regions in the western U.S. by Waite *et al.* (2010). A brief summary of the methods follows. Sites were evaluated based on the following criteria: invertebrate data sampled with comparable methods; upstream watershed area of between 13 and 259 km^2; and watersheds could not be nested (i.e., no spatial autocorrelation). Sites meeting these conservative criteria resulted in three study regions: Coastal Southern California ($n = 55$), the Blue Mountains ecoregion of eastern Oregon ($n = 148$), and the Willamette Valley ecoregion in north-central Oregon ($n = 96$) (Figure 1).

For consistency, watersheds were re-delineated for the selected sampling sites within the three study regions using USGS 7.5 min quadrangle digital raster graphics as base layers. The digital raster graphics were displayed on-screen along with National Hydrography Dataset (NHD) high resolution stream lines for each region (U.S. Geological Survey, 2007).

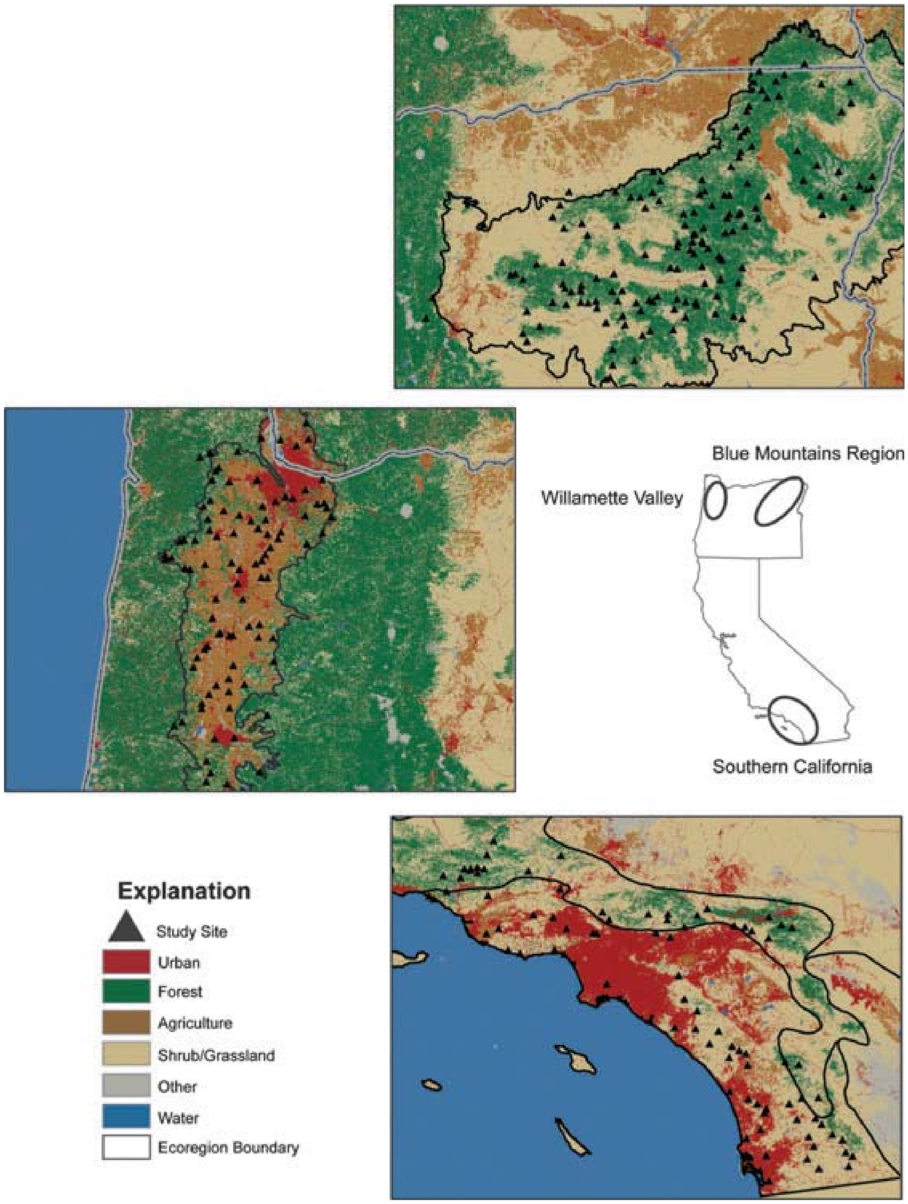

FIGURE 1. Map Showing Land Use and Land Cover for the Three Modeling Regions: Blue Mountains and Willamette Valley, Oregon, and Southern California.

Watershed boundaries were digitized on-screen at a scale of 1:10,000 or larger. Adjacent watershed polygons were edge matched to eliminate all overlaps and gaps. All work was conducted using ArcGIS, ArcMap 9.2 (Environmental Systems Research Institute, Redlands, CA; Table A1) GIS software.

Riparian buffer zone polygons were created within each watershed, extending 2 km upstream from the outlet of each watershed along the main stem and all tributaries and 90 m on either side of the stream centerlines. The buffers were created by selecting the appropriate NHD stream lines within each watershed and creating routes along each main stem and tributary flow path. The routes were then clipped to a distance of 2 km from the basin outlet and buffered. All abbreviations for riparian based explanatory variables begin with the letters “Rip”; otherwise, variables are watershed based (Table 1).

Spatial datasets representing landscape metrics of watershed disturbance were created for each watershed and riparian zone buffer from available national and regional datasets (Table A1) and included elevation, slope, land cover (1992 and 2001), population density, road networks, soil infiltration capacity, hydrography, pollution point sources, dams, and precipitation. Land-use summaries were based on either 1992 or 2001 spatial data (as described in Vogelmann *et al.*, 2001; Homer *et al.*,

TABLE 1. Description, Variable Code and Definition of Explanatory (landscape) and Predictor (invertebrate metrics) Variables Used for Response Model Development.

Explanatory Variables: Landscape		
Description	**Variable Code**	**Definition**
Watershed Scale Variables		
Percent urban land use	Urban	Percent watershed area in urban land use (NLCD 2000 categories 21, 22, 23, and 24)
Percent agricultural land use	Ag	Percent watershed area in agricultural land use (NLCD 2000 category 82)
Sum of percent Ag + Urban	Ag + Urb	Sum of percent watershed area in urban (NLCD 2000 categories 21, 22, 23, and 24) and agricultural (NLCD 82) land use
Percent forest	Forest	Percent watershed area in forest land use (NLCD 2000 categories 41, 42, 43)
Percent pasture	Pasture	Percent watershed area in pasture land use (NLCD 2000 category 81)
Percent shrub/scrub	Shrub	Percent watershed area in shrubland, shrub/scrub (NLCD 2000 category 52)
Road density	RdDens	Road density in watershed = Road length (km)/watershed area (km^2)
Mean population density	PopDen	Watershed mean population density based on 2000 census (persons/km^2)
Minimum elevation	Min-Elev	Elevation (m) at stream site, pour point of watershed
Mean slope percent	Slope	Mean percent watershed slope
Manmade stream density	MmStreams	Manmade stream density in watershed = manmade stream length (km)/ watershed area (km^2)
Mean annual precipitation	MnAnnPrecip	Mean annual precipitation (cm)
Soil infiltration rate	Soil_Mod-Infil	Hydrologic soil group B, moderate infiltration rate (min. infiltration rate 4-8 mm/h)
Riparian Scale Variables		
Percent urban land use	Rip_Urban	Percent buffer area in urban land use (NLCD 2000 categories 21, 22, 23, and 24)
Percent agricultural land use	Rip_Ag	Percent buffer area in agricultural land use (NLCD 2000 category 82)
Sum of percent Ag + Urban	Rip_Ag + Urb	Sum of percent buffer area in urban (NLCD 2000 categories 21, 22, 23, and 24) and agricultural (NLCD 82) land use
Percent forest	Rip_Forest	Percent buffer area in forest land use (NLCD 2000 categories 41, 42, 43)
Percent pasture	Rip_Pasture	Percent buffer area in pasture land use (NLCD 2000 category 81)
Percent shrub/scrub	Rip_Shrub	Percent buffer area in shrubland, shrub/scrub (NLCD 2000 category 52)
Road density	Rip_RdDens	Road density in buffer = Road length (km)/watershed area (km^2)
Mean population density	Rip_PopDens	Buffer area mean population density based on 2000 census (persons/km^2)
Mean slope percent	Rip_Slope	Mean percent buffer slope
Maximum elevation	Rip_Max-Elev	Maximum buffer elevation (m)
Response Variables: Invertebrate Metrics		
Observed/expected	O/E	Ratio of number of observed taxa at a site over the expected taxa based on modeled reference sites
Tolerant richness	RICHTOL	Average USEPA tolerance values for sample based on richness

2004), depending on which data source was closer to the macroinvertebrate sample date for that watershed. Watersheds and riparian zone buffers were used to define zones for analysis and calculate summary statistics. The 1992 and 2001 land cover datasets used slightly different classification schemes. Uniform codes based on the 2001 classification scheme were assigned to all land cover classes in the final summary statistics table (Fry *et al.*, 2009). We did not assess the distribution pattern of land use/land cover within the watershed though this can be important in some situations.

Description of Modeling Regions

The Coastal Southern California (SoCal; Southern and Central California Chaparral and Oak Woodlands Ecoregion) region has a Mediterranean climate of hot, dry summers and cool, moist winters (Ode *et al.*, 2005). Average precipitation at each site ranges from 25 to 50 cm/year. The geology of the ecoregion is dominated by recently uplifted and poorly consolidated marine sediments. Vegetative cover in this region consists mainly of chaparral and oak woodlands, though grasslands occur in some lower elevations and patches of pine are found at higher elevations (open low mountains or foothills). The landscape is currently dominated by urban development; the human population is approximately 19 million and is projected to exceed 28 million by 2025 (Ode *et al.*, 2005). Outside the urban centers, much of this region was historically grazed by domestic livestock or cultivated for fruits and vegetables, but most of this land has since been converted to urban uses.

The Blue Mountains (Blue_Mt) are the westernmost range of the Middle Rocky Mountains and, like the Cascade Range, are largely volcanic, with fertile plateaus and deeply fissured river valleys. Carved by two rivers (the John Day and Grande Ronde Rivers) the landscape has steep hillsides, bluffs and rimrock faces. Temperature and precipitation are highly correlated with elevation. Precipitation ranges from 22 to 45 cm/year along the river valleys and is >150 cm/year in the nearby mountains. This region is dominated by coniferous forests in mid to higher elevations and shrub and grassland in lower elevations, though much of the latter has been displaced by agriculture and grazing. The region has no large cities and urbanization is limited to scattered smaller cities and small towns.

The Willamette Valley (Will_V) ecoregion contains a mixture of rolling prairies, mixed forests, and extensive lowland valley wetlands. With temperate, dry summers and cool, wet winters, the Willamette River basin and surrounding area is characteristic of the Pacific Northwest climate. About 90% of the annual precipitation (100-130 cm/year) occurs during October through May (Uhrich and Wentz, 1999), falling as rain in the valley and snow in the mountains. The land use/land cover in the valley plains and foothills is primarily cultivated crops, pasture, and grasslands. Urbanization ranges from minimal to extensive (Waite *et al*., 2008). Centered on the confluence of the Columbia and Willamette Rivers, Portland is the most populous city in Oregon, with 539,000 people in city limits and nearly 3 million people in the Portland metropolitan area (U.S. Census Bureau, 2000). The population in the metropolitan area increased almost 30% from 1990 to 2000, with some suburban populations increasing more than 80% during the same period (U.S. Census Bureau, 2000). The drainage network in the Willamette Valley combines natural tributaries, complex networks of canals in agricultural areas, and stormwater canals and groundwater infiltration wells in cities.

The three geographic regions modeled in this study have differing natural settings and the extent and type of human disturbance in each respective region. SoCal has the driest climate, intermediate mean stream site elevation (Min-Elev) and percent agriculture, and the highest population density. Blue_Mt has the highest mean site elevation and mean watershed slope, intermediate mean precipitation, and the lowest population density, percent urban, and percent agriculture. Will_V has the greatest precipitation, lowest minimum site elevation, and the highest percent agriculture.

Macroinvertebrate Data

Macroinvertebrate data from 1994 to 2005 assembled for this study were considered to be comparable in terms of sampling protocols (sampled habitat, number of composite samples, and total sampled area) and laboratory procedures, including sorting, subsample count level, and taxonomic resolution (personal communication state agency personnel, 2005; Waite *et al.*, 2010). In general, all macroinvertebrate samples were collected in similar habitats using kick-net techniques from five to eight separate areas and combined for a composite sample (Moulton *et al.*, 2002; Peck *et al.*, 2006; Hubler, 2008). Extensive review of the data was completed to make sure aggregated data from disparate sources included the same taxonomic groups, followed the same nomenclature, and had appropriate taxonomic resolution before data analysis was attempted. The Invertebrate Data Analysis System software (Cuffney, 2003) was used to resolve by region all taxonomic issues (taxonomic identification level and nomenclature), to remove ambiguous taxa (Cuffney *et al.*, 2007), and to randomly subsample raw counts to an equal 300 (Will_V) or 500 specimen count (the highest possible based on the data in each region) across all study regions. In general, data for dominant aquatic insect orders were resolved at genus level. Less common orders were often aggregated to family level. Rare organisms or those with difficult taxonomy were sometimes aggregated to order or higher. The dipteran family Chironomidae is considered an important bioindicator group, yet historically a difficult group to identify to genus or species. As a result, data for this group were assigned to six taxa levels (five subfamilies plus Chironomidae) from the various family to genus level identifications within the original data. Tolerance and functional group metrics were calculated using values from Barbour *et al.* (1999), supplemented with values from Wisseman's tolerances for the Pacific Northwest (Wisseman, 1996, unpublished data). Macroinvertebrate O/E values were estimated using two existing regional models (East and West of the Cascade Mountains) that were developed by Oregon Department of Environmental Quality (Hubler, 2008). O/E models were not ready for the SoCal region at the time of analysis so we were not able to test O/E values for this area.

MODEL DEVELOPMENT

Details of MLR model development procedures are outlined in Waite *et al.* (2010). In brief, model performance was assessed using a variety of statistics, including adjusted mean sum of squares (R^2), root mean squared error, AIC, predicted sum of squares, and regression coefficients in Waite *et al.* (2010). We adopted a model fitting approach for each response variable. We used a step-wise selection based on AIC for all models ranging from 1 to 5 environmental variables, as appropriate by region. If necessary, variables were transformed to improve their distributions to better adhere to assumptions of linearity. Models were developed for each geographic region separately due to the large spatial separation between each region and as described above, because the climatic and disturbance regimes were distinct. Model residuals, potential outliers, and interaction terms were evaluated. A description of variables used in model development is provided in Table 1. A MLR model was developed for the response variable RICHTOL for all three regions; it included two predictor variables (population density and riparian road density) for SoCal, three predictor variables for Blue_Mt (percent shrubs, percent agriculture, and mean annual precipitation in the watershed) and three predictor variables for the Will_V region (percent agriculture plus urban land use in the watershed, mean annual precipitation, and percent agriculture plus urban land use in the riparian zone) (Waite *et al.*, 2010). As a comparison to the MLR models developed by Waite *et al.* (2010) for RICHTOL, new models were developed for O/E for the Blue_Mt and Will_V regions.

To gain additional insight into these data and as a comparison against the MLR models, single regression trees, RF, and BRT models were developed for each region individually. Regression trees are one type of technique within the commonly used CART or decision tree family, and their use and technical details have been described extensively in the literature (e.g., Breiman *et al.*, 1984; De'ath and Fabricius, 2000; Prasad *et al.*, 2006); therefore, we will only provide a brief overview. Trees attempt to explain variation in one categorical (classification) or continuous (regression) response variable by one or more explanatory variables, the resultant output being a dendogram, or tree, with varying numbers of branches or nodes. Trees are developed following a hierarchical binary splitting procedure that attempts to find the best single explanatory variable that minimizes the within group and maximizes the among group dissimilarity in the response variable at each split. It does this for each explanatory variable entered into model development and can thus provide a list of the explanatory or predictive power of the variables. We used R statistics scripts and software (R Development Core Team, 2007, version 2.10.0) following the procedures outlined by Therneau and Atkinson (1997) to determine the proper single regression tree and the appropriate pruning of branches (De'ath and Fabricius, 2000; Prasad *et al.*, 2006). Trees have a few properties that are highly desirable for ecological data analysis: (1) they can handle numeric and categorical variables (2) they are not affected by explanatory variables that follow non-normal distributions (i.e., skewed, Poisson, or bi-modal), and (3) they can model complex interactions simply (De'ath, 2007).

Random forests and BRT are among a family of techniques used to advance single classification or regression trees by averaging the results for each binary split from numerous trees or forests thus reducing the predictive error and improving overall performance (De'ath, 2007; Elith *et al.*, 2008). In BRT, after the initial tree has been generated, successive trees are grown on reweighted versions of the data giving more weight to those cases that are incorrectly classified than those that are correctly classified within each growth sequence. Thus, as more and more trees are grown in BRT, the large number of trees increases the chance that cases that are difficult to classify initially are correctly classified, thus representing an improvement to the basic averaging algorithm used in RF (De'ath, 2007). Boosted trees and RF models retain the positive aspects of single trees seen in CART models, yet have improved predictive performance, nonlinearities and interactions are catered to or easily assessed, and they can provide an ordered list of the importance of the explanatory variables (Cutler *et al.*, 2007; De'ath, 2007). Though RF and BRT offers improved modeling performance over CART, the simple single tree obtained from CART is lost, making it more difficult to visualize the results. Partial dependency plots (PDP) are a way to visualize the effect of a specific explanatory variable on the response variable after accounting for the average effects of all other explanatory variables (De'ath, 2007; Elith *et al.*, 2008); these are presented in this paper for select models as examples (e.g., Figures 2 and 3). Random forest models were developed using the rpart library in R following methods outlined in Cutler *et al*. (2007) and BRT models were run using the gbm library in R and specific code from Elith *et al.* (2008). We used R^2 values for assessing the amount of variation explained among the four modeling techniques since it is a common and well understood measure that allowed us to put each model on the same measurement currency; other model performance measures such as confidence intervals and p-values are not included for simplicity.

RESULTS

In general, the four modeling techniques selected the same primary explanatory variables within each

TABLE 2. Explanatory Variables in Order of Importance in the Models for Four Modeling Methods for Two Macroinvertebrate Metrics for Each of Three Study Regions (SoCal, Southern California; Will_V, Willamette Valley; Blue_Mt, Blue Mountains, Oregon).

	MLR	CART	RF	BRT
SoCal				
RICHTOL	PopDen	PopDen	PopDen	PopDen
	Rip_RdDens	MmStreams	Min-Elev	Rip_Slope
		Min-Elev	Rip_Slope	Min-Elev
Will_V				
RICHTOL	Ag + Urb	Ag + Urb	Ag + Urb	Ag + Urb
	MnAnnPrecip	MnAnnPrecip	MnAnnPrecip	MnAnnPrecip
	Rip_Ag + Urb	Rip_Forest	Rip_Forest	Rip_Max-Elev
			Rip_Max-Elev	Rip_Forest
O/E	Ag + Urb	Forest	Forest	Ag + Urb
	MnAnnPrecip	Rip_Max-Elev	Rip_Max-Elev	Rip_Max-Elev
	Rip_Ag + Urb		Soil_Mod-Infil	MnAnnPrecip
			Rip_Forest	
Blue_Mt				
RICHTOL	Shrub	Shrub	Shrub	Shrub
	Ag	Slope	Slope	MnAnnPrecip
	MnAnnPrecip	MnAnnPrecip	MnAnnPrecip	Slope
O/E	MnAnnPrecip	Slope	Shrub	Slope
	Shrub	MnAnnPrecip	Slope	MnAnnPrecip
	Slope		MnAnnPrecip	Shrub

Notes: MLR, multiple linear regression; CART, classification and regression trees; RF, random forest; BRT, boosted regression trees; RICHTOL, average tolerance value for sample based on richness at a site; O/E, ratio of observed/expected taxa.

region with minor variation among model types (Table 2): (1) SoCal: population density, minimum elevation, and riparian slope, (2) Blue_Mt: percent shrub, mean annual precipitation (MnAnnPrecip), and watershed slope, and (3) Will_V: percent agriculture plus urban, MnAnnPrecip, riparian maximum elevation, and percent riparian forest (see Table 1 for definitions). Generally, the RICHTOL R^2 values for MLR were slightly higher than those for the CART and RF models for all three regions (Table 3); however, this was not the case for the O/E models for Blue_Mt. Nevertheless, these differences are probably not meaningful because the R^2 values for CART and RF models are determined by a cross-validation method that ensures no over-fitting and thus usually gives a lower, more conservative value than the MLR values. Interaction affects were tested for and found to not be significant in the models developed. Conversely, the BRT models showed considerable improvement in the R^2 values over all the other models for both response variables (i.e., RICHTOL and O/E). For example, the SoCal RICHTOL R^2 values for the MLR compared to the BRT model increased from 0.67 to 0.79, Blue_Mt showed an increase from 0.44 to 0.59 for RICHTOL and from 0.08 to 0.28 for O/E, and the Will_V R^2 values increased from 0.74 to 0.83 for RICHTOL and from 0.64 to 0.75 for O/E (Table 3).

TABLE 3. Comparison of R^2 Values for Four Modeling Methods for Two Macroinvertebrate Metrics for Each of Three Study Regions (SoCal, Southern California; Will_V, Willamette Valley; Blue_Mt, Blue Mountains, Oregon).

	MLR	CART	RF	BRT
SoCal				
RICHTOL	0.67 (2)	0.64 (3)	0.65 (3)	**0.79** (3)
Will_V				
RICHTOL	0.74 (3)	0.68 (3)	0.73 (4)	**0.83** (4)
O/E	0.64 (3)	0.62 (2)	0.61 (4)	**0.75** (3)
Blue_Mt				
RICHTOL	0.44 (3)	0.34 (3)	0.41 (3)	**0.59** (3)
O/E	0.08 (3)	0.15 (2)	0.07 (3)	**0.28** (3)

Notes: Number of variables in model in parentheses. MLR, multiple linear regression; CART, classification and regression trees; RF, random forest; BRT, boosted regression trees; RICHTOL, average tolerance value for sample based on richness at a site; O/E, ratio of observed/expected taxa. Highest R^2 value across all models is shown in bold.

The O/E metric derived from RIVPACS type models specifically calibrated for Oregon consistently had lower R^2 values than RICHTOL for the two regions tested (Table 3). Modeled O/E R^2 values were between 0.06 and 0.10 lower than RICHTOL values for each of the four modeling methods applied in the Will_V region and were between 0.19 and 0.36 points lower for the Blue_Mt region.

As mentioned above, all modeling procedures (i.e., MLR, CART, RF, and BRT) generally retained the same subset of explanatory variables. These variables, with some minor exceptions in the Blue_Mt study region, generally accounted for approximately a similar proportion of the variance in the

RICHTOL and O/E response models. R^2 values, however, do not provide a complete picture of the model response pattern, and the overall influence of a specific explanatory variable on the environmental system or process being modeled is typically lost when the model is fit to a linear or nonlinear form. Partial dependency plots, which are provided as a diagnostic tool in the BRT and RF model output, provide a way to more fully examine the relative influence of individual explanatory variables on the response variable given the modeled structure. As explained in De'ath (2007) and Elith *et al.* (2008), PDP provide a way to visualize the effect of a specific explanatory variable on the response variable after accounting for the average effects of all other explanatory variables. For example, PDPs for the four variables retained in the BRT model for Will_V are shown in Figure 2. In general, the plots show a near linear increase in RICHTOL as the amount of agriculture plus urban land use in the watershed increases (Figure 2A) and a decrease in RICHTOL as riparian maximum elevation increases (Figure 2D). However, the response in RICHTOL values flattens out at approximately 60% agriculture plus urban land use, then again increases rapidly from approximately 90 to 100%. Likewise, the PDP graph shows that there is rapid change in RICHTOL

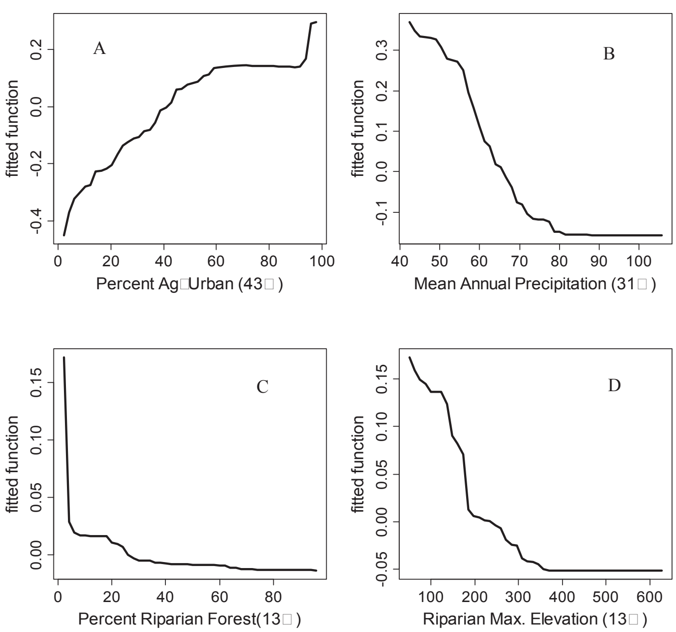

FIGURE 2. Partial Dependency Plots for Ag + Urb (A), MnAnnPrecip (B), Rip_Forest (C), and Rip_Max-Elev (D) in the Boosted Regression Model Developed for RICHTOL in Willamette Valley (Will_V). The *y*-axis fitted function represents the effect of the selected variable on the response variable RICHTOL; the relative contribution of each explanatory variable is reported in parentheses. Refer to Table 1 for variable definitions.

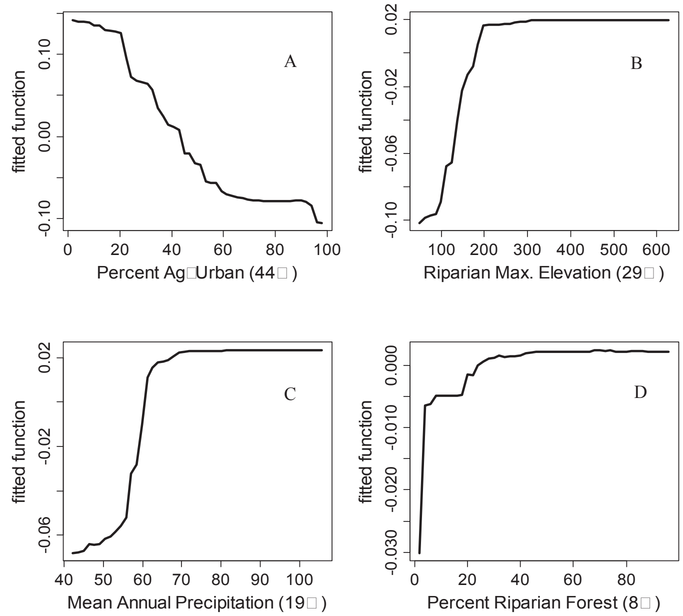

FIGURE 3. Partial Dependency Plots for Ag + Urb (A), Rip_Max-Elev (B), MnAnnPrecip (C), and Rip_Forest (D) in the Boosted Regression Model Developed for Observed/Expected (O/E) in Willamette Valley (Will_V). The *y*-axis represents the effect of the selected variable on the response variable O/E metric, the relative contribution of each explanatory variable is reported in parentheses. Refer to Table 1 for variable definitions.

values from near 0 to 200 m in riparian maximum elevation followed by no response beyond 400 m. The pattern shown for mean annual precipitation (Figure 2B) follows the opposite pattern of the amount of agriculture plus urban land use in the watershed, RICHTOL values decrease rapidly from the lowest precipitation values until approximately 80 cm/year beyond which values show no response. As the amount of riparian forest cover declines (Figure 2C), RICHTOL values increase little until riparian forest values drop to about 30%, where there is a step-wise increase until the point when there is only about 5% riparian forest remaining, whereupon there is a rapid increase in tolerance values. The PDPs for O/E in the Will_V show remarkable similarity to that described above for RICHTOL except that, as one would expect due to the differences in the invertebrate metrics, the curves respond in opposite directions (Figure 3). There is a general linear decrease in O/E values as agriculture plus urban land use increases (Figure 3A), a sharp increase in O/E values as riparian maximum elevation increases to 200 m (Figure 3B) or when mean annual precipitation increases to about 70 cm/year (Figure 3C). As seen for RICHTOL, O/E showed an abrupt threshold-type response at low levels of riparian forest (Figure 3D) followed by a step increase and a plateau above approximately 30% riparian forest cover.

DISCUSSION

It is encouraging that the MLR and the CART and RF (regression tree family) modeling techniques gave similar results selecting in general the same main explanatory variables (Table 2) and explaining similar amounts of variation (Table 3), which may indicate that the MLR methods used in this study are appropriate for these types of ecological data. The BRT models, however, did show notable improvement in model fit with increases in R^2 values ranging from 0.09 through 0.15 for RICHTOL to 0.11 through 0.20 for O/E compared to MLR models (Table 3). L. R. Brown, J. T. May, A. C. Rehn, P. R. Ode, I. R. Waite, and J. K. Kennen (personal communication), using a MMI for macroinvertebrates (i.e., BIBI) sampled across a strong urbanization gradient, also showed a notable improvement in model performance for BRT compared to MLR. De'ath and Fabricius (2000) suggest that for complex or messy data, even single regression trees will often outperform MLR and are preferred for determining variable selection and interaction effects due to the issue that MLR models with complex data are frequently difficult to interpret because they will often include too many variables with high order interactions. It was found that CART and RF models did not outperform the RICHTOL MLR models in this analysis which supports our overarching hypothesis that MLR will generally perform as well as many of the tree modeling techniques when data follows a general linear response or when, in the case of the three regions evaluated, there are few explanatory variables with no high order interactions. Maloney *et al.* (2009) found that CART models of land-use disturbance on macroinvertebrate IBI metrics provided results that were intuitive, but they did not classify sites any better than logistic regression models; however, unlike in this study, their RF models showed minor improvements in performance over CART and logistic regression models.

In general, regression trees allow the inclusion of more variables in the model building phase than MLR, allow for easier testing for interaction affects and produce a list of variables explaining the importance of variation in the response variable. In addition, the PDPs from BRT or RF can offer valuable insights into the pattern or form of the response variable based on select explanatory variables improving model interpretation. For example, the PDPs for Will_V (Figures 2 and 3) revealed that the response rate changed or flattened out and provided additional insight into potential thresholds along the range of the individual explanatory variables that are not easily depicted with MLR models.

The identification of thresholds (i.e., transition points in ecological condition) is of growing interest to the scientific and regulatory community, especially for forecasting the loss of biodiversity (Hilderbrand *et al.*, 2010) or for understanding system recovery (Clements *et al.*, 2010; Qian and Cuffney, 2012). More research is clearly needed to help better detect nonlinear and possible threshold responses (Dodds *et al.*, 2010) and new analytical tools are emerging (i.e., BRT results shown in this study) that can assist with identifying changes in taxa occurrence across an environmental gradient (Qian and Cuffney, 2012).

Even though we were able to successfully develop strong MLR models indicating that the primary responses were linear in nature (Waite *et al.*, 2010), the BRT PDPs reveal potential thresholds in the response variable in at least some of the regions (e.g., the Will_V PDPs shown for RICHTOL and O/E in Figures 2 and 3) that were not seen in the MLR models. It is possible that since MLR models assume linearity that they may sometimes miss nonlinear/thresholds in some explanatory variables. The response of RICHTOL and O/E for watershed agriculture plus urban (Ag + Urb) was primarily linear with a small step function at the end (Figures 2A and 3A). The two riparian variables, riparian maximum elevation (Rip_Max-Elev; Figures 2D and 3B) and riparian forest (Rip_Forest; Figures 2C and 3D) on the other hand showed potential thresholds. The response of the two invertebrate metrics to changes in Rip_Max-Elev showed no response from 600 to 400 m for RICHTOL and to 200 m for O/E, after which there was a steep increase or decrease to the lowest elevation (Figures 2D and 3B). It is likely that riparian elevation is acting as a surrogate for the natural climatic and geologic trend that occurs in the Willamette Valley, trending from the valley floor with low stream gradient and lower elevation and precipitation to higher values for these and other variables as one moves toward the foothills of the Coast or Cascade Ranges on either side of the valley. The response of RICHTOL and O/E to changes in Rip_Forest showed a slow but continuous linear increase or decrease as the amount of Rip_Forest decreased from 100% to approximately 5%, after which there appears to be a rapid change in either of the metric values, which may indicate a strong threshold at or near the 5% level. This suggests that as percent forest in the riparian zone along streams drops below approximately 5-10%

land cover, stream integrity degrades rapidly possible due to the reduction in natural buffering capacity seen in healthy riparian systems. L. R. Brown, J. T. May, A. C. Rehn, P. R. Ode, I. R. Waite, and J. K. Kennen (personal communication) found a similar response in the MMI they modeled (BIBI) against four explanatory variables across a strong urbanization gradient in some California streams. They showed that the amount of agriculture plus urban land use in the riparian zone and mean annual precipitation in the watershed showed approximate linear responses, though in opposite directions. They also found a threshold-type response in the BIBI to low values of population density (approximately 300 persons/km^2) in the watershed. Similar to the findings in this study, L. R. Brown, J. T. May, A. C. Rehn, P. R. Ode, I. R. Waite, and J. K. Kennen (personal communication) found that the BRT method appeared to be more sensitive for detecting nonlinear response patterns such as thresholds, for determining potential surrogate variables, and for model corroboration.

The overall poorer performance of the O/E metric compared to the single metric RICHTOL across all models was notable, yet the especially poor performance in the Blue_Mt region was particularly surprising (Table 3). When comparing the ability of O/E and a multimetric invertebrate IBI to differentiate between reference and degraded sites, Herbst and Silldorff (2006) found that the two methods were in close agreement for sites in eastern Sierra Nevada of California. Hawkins *et al.* (2010) compared the performance of a multimetric index and O/E for 225 sites from five ecoregions in the interior Columbia Basin, including many of the sites used in this study from the Blue_Mt ecoregions. They found that the O/E metric was better at distinguishing among the three disturbance classes, particularly between the intermediate and high disturbance classes than the multimetric index. The discrepancy between the poor performance of O/E in the Blue_Mt region in our study and the strong performance in their study may be due to a larger underlying disturbance gradient within their dataset, which resulted from the inclusion of data from multiple ecoregions. Models derived for the Will_V region, where there was a larger disturbance gradient than that found in the Blue_Mt region, showed relatively little difference in performance between the O/E and RICHTOL metrics. It is also possible that the lower R^2 for the O/E models may be because we are not able to model nor account for the error associated with estimation of the raw O/E metric values. Chessman *et al.* (2010) found that O/E values did not distinguish among site disturbance groups based on hydrologic alteration in Australia even though taxonomic richness and assemblage composition could. However, it is yet unclear why O/E performance would be inhibited in areas with a shorter disturbance gradient than that shown in Hawkins *et al.* (2010). One possibility is that because these O/E models are based on a subset of taxa that occur at 50% of the reference sites and therefore operate with a reduced taxa list, specifically with the relatively rare and arguably with the more sensitive portion of the taxa list removed, the resulting O/E values may be less able to distinguish the small more subtle differences among sites, such as that seen in the Blue_Mt study region. In contrast, the RICHTOL metric uses all the taxa that occur at a site and may be a more sensitive measure of changes in assemblage integrity in areas of low anthropogenic disturbance.

CONCLUSIONS

Waite *et al.* (2010) were able to successfully develop MLR models for the three distinct and separate regional datasets presented in this study for individual macroinvertebrate metrics (e.g., RICHTOL, EPT). This study developed alternate models, CART, RF, BRT, for the same datasets and compared them to the MLR models previously developed. The O/E metric performed nearly as well as RICHTOL in the Will_V region where there was a strong disturbance gradient but performed poorly in Blue_Mt, a region with a relatively weak gradient. Though the data modeled in this study were not particularly noisy or complex, the BRT models, in all cases, outperformed the MLR methods and provided specific information on the form of the response function for each variable giving important insight into potential thresholds in the data. As a result of this ecological modeling comparison, BRT models may indeed represent a good alternative to MLR for modeling species distribution relative to environmental variables. Modeling results indicate that even when the response pattern is simple and strongly linear, BRT models not only markedly improve model fit, but can also help to corroborate results from other methods, provide additional information on potential interactions among variables, and support greater insight into understanding the response profile of a given metric, whether it be a linear, step, or a threshold function, across environmental gradients that may not be easily seen with MLR. Models like these can be used to better understand potential causal linkages between environmental drivers and stream biological attributes or condition and predict expected values of macroinvertebrate metrics at unsampled sites.

APPENDIX

TABLE A1. Sources of Geographical Information System (GIS) and Digital Data Used in Model Development.

Spatial Dataset	Data Source	Source Data Format	Processing Format	Resolution/ Scale	Reference
Hydrography	National Hydrography Dataset (NHD)	Vector	Vector	1:24,000	U.S. Geological Survey, National Hydrography Dataset, Digital data, *accessed* January 2007 at http://nhd.usgs.gov/data.html
Land Cover 1992	National Land Cover Dataset 1992 (NLCD)	Raster	Vector	30 m	U.S. Geological Survey, National Land Cover Dataset 1992, Digital data, *accessed* March 2003 at http://landcover.usgs.gov/natllandcover.php
Land Cover 2001	NLCD 2001	Raster	Vector	30 m	U.S. Geological Survey, National Land Cover Dataset 2001, Digital data, *accessed* January 2007 at http://www.mrlc.gov/
Elevation	National Elevation Dataset (NED)	Raster	Raster	10 m	U.S. Geological Survey, National Elevation Dataset, Digital data, *accessed* May 2007 at http://seamless.usgs.gov/
Slope	NED	Raster	Raster	10 m	U.S. Geological Survey, National Elevation Dataset, Digital data, *accessed* May 2007 at http://seamless.usgs.gov/
Road networks	U.S. Census Bureau Tiger	Vector	Vector	1:100,000	U.S. Census Bureau, TIGER line data, Digital data, *accessed* May 2007 at http://www.census.gov/geo/www/tiger/
	Ground Transportation Roads Publications Arc	Vector	Vector	1:24,000	Oregon BLM, Ground Transportation Roads Publication Arc, Digital data, *accessed* July 2007 at http://www.blm.gov/or/gis/
Soil infiltration capacity	USDA NRCS STATSGO	Vector	Vector	1:250,000	Natural Resource Conservation Service, STATSGO soils data, Digital data, *accessed* May 2007 at http://datagateway.nrcs.usda.gov/
Population density	U.S. Census Bureau Census 2000	Vector	Raster	30 m	U.S. Census Bureau, Census 2000, Digital data, *accessed* May 2007 at http://www.census.gov/main/www/cen2000.html
Precipitation	Oregon State University PRISM	Raster	Raster	30 arc-seconds	PRISM Group, Oregon State University, Precipitation data for the U.S., Digital data, *accessed* May 2007 at http://www.prismclimate.org
Dams	National Inventory of Dams	Vector	Vector	Various	U.S. Army Corps of Engineers, National Inventory of Dams, Digital data, Not publicly available

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March 30, 2017

Jun Zhu
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Los Angeles Regional Water Quality Control Board
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RE: Draft 2016 Section 303(d) and 305(b) Integrated Report

Dear Mr. Zhu,

Please accept the following comments on the Los Angeles Regional Water Quality Control Board's (Regional Board's) 2016 Integrated Report, which are hereby submitted by Santa Barbara Channelkeeper.

Santa Barbara Channelkeeper is a non-profit environmental organization dedicated to protecting and restoring the Santa Barbara Channel and its watersheds through science-based advocacy, education, field work and enforcement. We have been conducting water quality monitoring in watersheds from Gaviota to the Ventura River since 2001. We have engaged more than 1,200 volunteers in our monitoring efforts and represent over 750 members. Our comments address the following concerns:

- Procedural issues related to data solicitation gaps
- Category 4C and Hydrologically Impaired Waterways
- Inappropriate de-listing of the Ventura River Reach 3 Pumping Impairment

Generally, Channelkeeper supports the Regional Board's ongoing efforts to document water quality impairments on the 303(d) List. Specific concerns regarding the Draft 2016 Integrated Report are summarized below.

Procedural Concerns Related to Data Solicitation Gaps

Channelkeeper is troubled that the Regional Board has fallen so far behind on data solicitations and review of 303(d) listings. 40 C.F.R. § 130.7(d)(1) mandates that:

> Each State shall submit ***biennially*** to the Regional Administrator beginning in 1992 the list of waters, pollutants causing impairment, and the priority ranking including waters targeted for TMDL development within the next two years as required under paragraph (b) of this section.

The 2016 Integrated Report is based on data submitted in 2010 and will not be finalized until the middle of 2017. Based on EPA Guidance, the 2016 Integrated

Report was due in April 2016.[1] Clearly, the Regional Board has failed to achieve pertinent milestones and mandates related to the biennial review process.

The lack of any recent data solicitation is particularly troubling as a fully accurate and current depiction of water quality is not available for the 2016 Integrated Report. The Regional Board has a mandate to "assemble and evaluate all existing and readily available water quality-related data and information to develop the list."[2] Accordingly, the Regional Board should base 2016 Integrated Report decisions based on "all existing and readily available" data, which includes data collected since the 2010 data solicitation. Six years of additional data is available to the Board and should be appropriately utilized for the Region's listing, de-listing and planning purposes. Channelkeeper questions how such determinations can reasonably or legally be made without consideration of the last six years of existing and readily available data.

It is additionally concerning that due to the State's new staged approach to 303(d) List review, further data solicitation will be delayed until the Los Angeles Regional Board's 2022 report, which will include data submitted through 2021. This means that the Regional Board will not have reviewed existing water quality data for our region for more than a decade. This is clearly unacceptable from a legal standpoint.

Category 4C and Hydrologically Impaired Waterways

Channelkeeper echoes and supports comments submitted to the Regional Board on March 30, 2017 by *Earth Law Center*[3] regarding the necessity for evaluation and listing for hydrologically impaired waterways to fully comply with Clean Water Act Sections 305(b) and 303(d). Such evaluation and listing is clearly called for under the Clean Water Act, is supported by EPA Guidance, and paves the way for sound public policy and planning. Many other states around the country follow such Guidance to properly identify flow impaired waterways in their Integrated Reports. Recently, the San Diego Regional Water Quality Control Board notably identified 30 waterway segments for listing in Category 4C. Channelkeeper notes with concern that the Los Angeles Region has apparently forgone assessment of Category 4C impairments altogether in the Draft 2016 Integrated Report. We question the legality of such an oversight.

Inappropriate de-listing of the Ventura River Reach 3 Pumping Impairment

The Los Angeles Regional Board currently proposes to delist Reach 3 of the Ventura River for "Pumping" impairment. Channelkeeper strongly opposes this delisting decision. On February 5, 2015 Channelkeeper submitted detailed comments (Attachment 1) and data to the State Water Resources Control Board regarding its stated intent to delist Reaches 3 and 4 of the Ventura River for pumping and diversion impairments. These comments were submitted in response to the State Water Board's Draft Staff Report for the 2012 Integrated Report dated December 31, 2014, which stated that the four listings on the existing 303(d) list due to flow related alterations in the Ballona Creek and Ventura River watersheds "will likely be proposed for delisting as part of the next Listing Cycle."

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[1] Environmental Protection Agency. "Information Concerning 2016 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions." August 13, 2015.
[2] 40 C.F.R. § 130.7(b)(5)
[3] Earth Law Center. "Comment Letter – Revisions to the Los Angeles Region 303(d) List". March 30, 2017

Channelkeeper's submittal outlined in detail why Reaches 3 and 4 of the Ventura River may not be delisted from the 303(d) list as impaired for flow by pumping and diversion. The existing listings for Reaches 3 and 4 of the Ventura River accurately reflect the current diminished flows and resulting impairments to designated beneficial uses in those Reaches. The listings are legally valid, and consistent with the State Water Board's Listing Policy. In contrast, delisting Reaches 3 and 4 from the 303(d) list as impaired for flows due to excessive pumping and diversion is inconsistent with the Listing Policy, the Clean Water Act, and facts on the ground. We refer the Los Angeles Regional Board to our February 5, 2015 letter as its legal and technical merits remain unchanged.

Channelkeeper additionally submitted multiple years of continuous monitoring data (submitted electronically via file "*MasterData_2013-2014.xls*") along with our 2015 comment letter. These data were summarized in tables as well as within an example "Listing Line of Evidence" provided with our 2015 letter. Lacking any formal data solicitation by the Los Angeles Regional Board since 2010, these submittals represent existing and readily available water quality-related data and information, which should have been used to develop the Draft 2016 Integrated Report.

Since the submittal of our 2015 comment letter, Channelkeeper has collected additional water quality data that supports the existing listings for pumping and diversions in Reaches 3 and 4. We are submitting an updated data file ("*MasterData_2013-2016*") electronically along with this comment letter.

Conclusion

When Reaches 3 and 4 of the Ventura River were identified as flow-impaired by pumping and diversions on California's 1998 303(d) list, the State Water Board took an important first step towards restoring the chemical, physical, and biological integrity of these waters. However, there is ongoing documentation that flow alterations from pumping and diversions continue to degrade Reaches 3 and 4 such that these waters cannot support their designated beneficial uses and water quality standards are not attained.

Reaches 3 and 4 of the Ventura River are impaired for pumping and diversions based on the "Numeric Water Quality Objectives for Conventional or Other Pollutants in Water" listing factor, the "Situation-Specific Weight of Evidence" listing factor, as well as the "Degradation of Biological Populations and Communities" listing factor. Removing the pumping impairment listing for Reach 3 is not only illegal but will also impede existing and future efforts to remedy the ongoing flow impairments in the Ventura River. Channelkeeper strongly urges the Los Angeles Regional Board to comply with the Clean Water Act by continuing to identify Reach 3 on the 303(d) list as flow-impaired by pumping.

Thank you for your consideration of our comments.

Sincerely,

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February 5, 2015

Via Electronic Mail
Jeanine Townsend, Clerk to the Board
State Water Resources Control Board
P.O. Box 100, Sacramento, CA 95812-2000
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Re: Comment Letter—303(d) List portion of the 2012 California Integrated Report

Dear State Water Board Members and State Water Board Staff:

Thank you for the opportunity to comment on the proposed federal Clean Water Act ("Clean Water Act" or "CWA") section 303(d) list of water quality limited segments ("303(d) list") portion of the 2012 California Integrated Report as well as the associated supporting draft Staff Report and fact sheets ("2012 Integrated Report").

Santa Barbara Channelkeeper ("Channelkeeper") is a non-profit public benefit corporation whose mission is to protect and restore the Santa Barbara Channel and its tributaries for the benefit of its ecosystems and the surrounding human communities, including the Ventura River. Channelkeeper has served as a lead advocate, community organizer, educator, scientist, and monitor in the Ventura River watershed for 15 years. Based on Channelkeeper's extensive knowledge and experience surrounding the quality and flow in the Ventura River, Channelkeeper submits the following comments on the 2012 Integrated Report for the Board Member's consideration. Channelkeeper also joins and incorporates herein by reference the comments submitted by California Coastkeeper Alliance and Earth Law Center.

In its Draft Staff Report for the 2012 Integrated Report dated December 31, 2014, the State Water Board states that the four listings on the existing 303(d) list due to flow related alterations in the Ballona Creek and Ventura River watersheds "will likely be proposed for delisting as part of the next Listing Cycle." As described in detail below, Reaches 3 and 4 of the Ventura River may not be delisted from the 303(d) list as impaired for flow by pumping and diversion. The existing listings for Reaches 3 and 4 of the Ventura River accurately reflect the current diminished flows and resulting impairments to designated beneficial uses in those Reaches. The listings are legally valid, and consistent with the State Water Board's Listing Policy. In contrast, delisting Reaches 3 and 4 from the 303(d) list as impaired for flows due to excessive pumping and diversion is inconsistent with the Listing Policy, the Clean Water Act, and facts on the ground. Channelkeeper references substantial and significant evidence supporting the existing impairment listings, and submits herewith a draft Line of Evidence. The State Water Board must take all of this information into consideration prior to making any decision – information that renders delisting unsupported and illegal.

I. Consistent with the Existing 303(d) Listing, Reaches 3 and 4 of the Ventura River Are Flow Impaired by Pumping and Diversion.

Since 1998, Reaches 3 and 4 of the Ventura River have been accurately identified on California's 303(d) list as impaired by excessive pumping and diversions. Such pumping and diversions are clearly linked to reduced surface flows. Reduced surface flows and the resulting water quality degradation prevents Reaches 3 and 4 from supporting their designated and potential beneficial uses, which include endangered species habitat. In fact, pumping and diversions in Reaches 3 and 4 continue to result in flows below recommended thresholds needed to protect endangered steelhead trout.

A. The Ventura River Watershed and the Reaches 3 and 4 303(d) Impairment Listings.

The Water Quality Control Plan for the Los Angeles Region ("Basin Plan") describes the Ventura River as consisting of five reaches, which, upstream from the Pacific Ocean, are: Reach 1 (Ventura River Estuary to Main Street), Reach 2 (Main Street to Weldon Canyon), Reach 3 (Weldon Canyon to Casitas Vista Road), Reach 4 (Casitas Vista Road to Camino Cielo Road) and Reach 5 (above Camino Cielo Road). Basin Plan, pp. 2-6. There are two major dams which affect surface flows in reaches 3 and 4, Matilija and Casitas. Two major river diversions are located within these reaches, Robles Diversion Facility and the Foster Park Subsurface Diversion. The City of Ventura operates the Foster Park Subsurface Diversion ("Foster Park"). Three major municipal well fields are located in Reaches 3 and 4. These are operated by Meiners Oaks Water District, the Ventura River Water District, and the City of Ventura. Groundwater from these reaches is also pumped for agricultural and domestic purposes. *See* U.S. EPA Draft Ventura River Reaches 3 and 4 Total Maximum Daily Loads For Pumping & Water Diversion-Related Water Quality Impairments ("EPA Draft TMDL").

The designated potential and existing beneficial uses of Reaches 3 and 4 are municipal and domestic supply, industrial service supply, agricultural supply, ground water recharge, freshwater replenishment, warm freshwater habitat, cold freshwater habitat, wildlife habitat, rare, threatened, or endangered species, migration of aquatic organisms, spawning, reproduction, and/or early development, and wetland habitat. *See* Basin Plan, Table 2-1.

In 1998, the U.S. EPA approved California's list of impaired water bodies identified pursuant to Clean Water Act section 303(d) (33 U.S.C. § 1313(d)), which first listed Reaches 3 and 4 as impaired for pumping and diversion. According to Los Angeles Regional Water Quality Control Board ("Regional Board") staff, the original listing referenced a 1996 Steelhead Restoration and Management Plan for California ("Steelhead Restoration Plan") as one basis for the listing decision. The plan states, "The major obstacle to steelhead restoration in this system is blocked access to headwaters and excessive water diversion." Steelhead Restoration Plan, p. 201. The plan describes several large-scale water diversions in the river including Foster Park and the City of Ventura's wells in the lower River, which, "ha[ve] resulted in dewatering portions of the lower river during summer and fall." Steelhead Restoration Plan, p. 203.

Most recently, on August 4, 2010, the State Water Resources Control Board ("State Water Board") approved California's 2010 303(d) list. Channelkeeper notes that the supporting fact sheets for these listings state that both the Regional Board and State Water Board staff reviewed the existing Ventura River watershed listings for pumping, water diversions, and fish barriers and decided to make no modifications to the list. On October 11, 2011, the U.S. EPA approved the State Water Board's triennial review and update to the 303(d) list, which maintained the pumping and diversion impairments for Reaches 3 and 4 of the Ventura River.

B. There is an Established Relationship Between Surface Flows, Groundwater, and Pumping and Diversions in the Ventura River.

The hydraulic communication between surface and groundwater in the Ventura River has been acknowledged by experts and government agencies for several decades. The significant contribution of groundwater pumping to dewatering of the River has been similarly acknowledged, though its full extent remains undetermined.

A 1978 a Draft Environmental Impact Report on the Conjunctive Use Agreement between Casitas Municipal Water District and the City of Ventura ("Draft EIR") included the following statement:

> *There is a relationship between the groundwater in storage and the presence of year-round springs and surface flows in the live stretch between San Antonio Creek and Foster Park, and also below Foster Park. It is evident from the figure (V-3) that if the groundwater in either of the cells (above San Antonio Creek, or between San Antonio Creek and Foster Park) were to fall to very low levels, then seepage in the form of springs at the surface would stop, and surface flow would also stop.*

Draft EIR, p. V-22. Figure 1 below provides a diagram of the River's surface flows, alluvium, and alluvium with ground water cells. *See also* Draft EIR, p. V-23 (providing an example of when and where the relationship between the groundwater and surface water occurs).

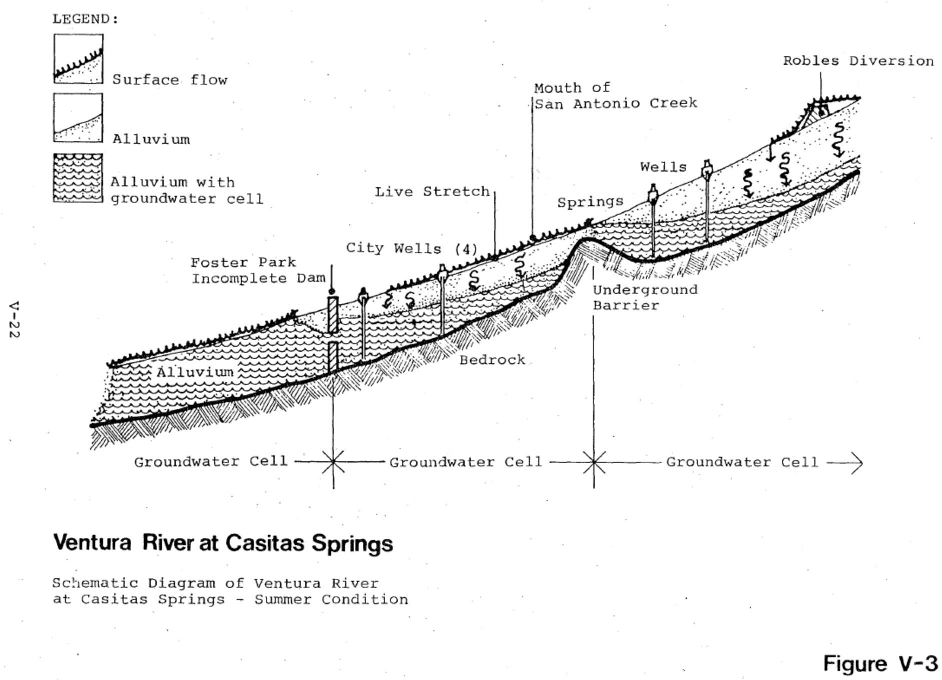

Figure 1: Excerpt figure from Draft Environmental Impact Report Ventura River Conjunctive Use Agreement. June 1978.

More recently, studies and reports continue to acknowledge the strong connection between groundwater pumping and diversions and the resulting loss of flows in the River.

For example, a National Marine Fisheries Service ("NMFS") 2007 Draft Biological Opinion ("Draft Biological Opinion") for the Army Corps of Engineers' permitting of the City of Ventura's proposed Foster Park Well Facility ("FPWF") repairs contains NMFS's summary of information available at the time and its determination that groundwater pumping and diversion at the FPWF detrimentally impacts downstream critical habitat for steelhead trout in Reach 3. On page 16 of the Draft Biological Opinion, NMFS states:

> *Water withdrawals from surface diversions and subsurface pumping have affected the timing and magnitude of the Ventura River flows in the action area* [6 miles downstream of the FPWF including Reaches 1, 2, and 3], *which has resulted in reduced surface flows. This has altered the natural hydrologic processes responsible for recharging the aquifer underlying the lower Ventura River Basin and the lower part of the action area, and has decreased the quantity and quality of critical habitat for steelhead, predominantly in the dry season.*

On page 25 of the Draft Biological Opinion, NMFS states:

> *Consequently, <u>resumed well field operations are expected to substantially reduce, and at times eliminate surface flows in the action area, and could completely</u>*

> *dewater the upper portion of the action area in the vicinity of the FPWF during most years.* (Emphasis added).

A Ventura River Natural Conditions Study further acknowledged loss of flow in the river (Reaches 3 and 4) due to ground water pumping in its model calibrations. TetraTech, 2009, p. A-3. In specific reference to Foster Park, lead authors of the Tetratech study responded to public comments by stating, "It is our understanding that water is withdrawn from pipes buried in the alluvium. Water entering these pipes comes from both flow in the river and from underlying groundwater. We agree that groundwater and surface water appear to be fully connected in this area… ." Jonathan Butcher, July 22, 2009 Memorandum to Scott Holder (VCWPD) Re: Ventura River Model Comment Response.

In December, 2012 the U.S. EPA, Region 9, released the EPA Draft TMDL. The EPA Draft TMDL clearly acknowledges the connection between surface flows, groundwater, and pumping and diversions. The EPA Draft TMDL states:

> *Flow in any particular reach of the* [Ventura] *River is additionally affected by the status of the underlying groundwater basin (whether full, filling, or emptying), the occurrence of natural recharge areas where surface flows will disappear at times, flow between groundwater basins, and the amount of surface or groundwater withdrawals for municipal, domestic, or agricultural uses. …The flow in the river is disrupted at Foster Park (which overlies the Upper Ventura River Groundwater Basin) due to subsurface diversions and groundwater extraction (p. 9).*

In June 2013, the City of Ventura conducted a preliminary hydrogeological and surface water/groundwater interaction study (Hopkins, 2013) for the City's diversions at Foster Park. In its concluding remarks, the study states, "We conclude that groundwater production at Foster Park during the low-flow season is substantially supported by underflow." In other words, the Ventura River itself accounts for a substantial proportion of the water produced by the City's wells during the low-flow season.

In the summer of 2012, using time-lapse video and a deployable pressure transducer sensor Channelkeeper and local citizens documented dramatic and irregular fluctuations in river and pool surface levels in Reach 4 near private wells and wells operated by Meiners Oaks and the Ventura River Water Districts. These observations are compiled in a YouTube video (SBCK, Watchdog Diaries – Episode 6) available at https://www.youtube.com/watch?v=JrGMRITAqH4, and provide strong evidence of surface and groundwater interactions being affected by pumping and/or diversions in Reach 4. The fluctuations captured by camera and sensor data are abrupt, dramatic, and do not resemble any known naturally occurring patterns indicating that pumping and diversions in Reach 4 are directly impacting surface flows.

C. Reduced Surface Flows Impair the Beneficial Uses of Reaches 3 and 4, Including Endangered Species Habitat.

As surface flows, groundwater, and pumping and diversions are connected, excessive pumping and diversions resulting in significantly reduced surface flows degrade critical habitat for endangered steelhead trout and impair additional designated and potential beneficial uses of the River. These impairments are documented by NMFS, U.S. EPA, and the City of Ventura.

NFMS's 2012 Southern California Steelhead Recovery Plan ("Steelhead Recovery Plan") recently affirmed the 1996 Department of Fish and Wildlife Steelhead Restoration Plan findings by describing dams, surface water diversions, and groundwater extraction as a "very high threat" to steelhead recovery in the Ventura River. NMFS found the critical recovery actions to include providing fish passage around dams and diversions, and developing and implementing water management plans for diversion operations such as Foster Park. NMFS also found that diversions from the Ventura River at Foster Park contribute to the present or threatened destruction, modification or curtailment of steelhead habitat or range, and disease and predation of steelhead. *See* Steelhead Recovery Plan, p. 9-42.

In the Draft Biological Opinion, NMFS concluded that summer and fall withdrawals from the Foster Park degrade downstream (Reaches 1, 2, and 3) habitat and water quality and decrease the functional value of these areas as an over-summering area for juvenile steelhead. NMFS states:

> *The reduction in discharge volume resulting from well-field withdrawals is expected to affect water quality within the action area… Reducing discharge and thus depth, is expected to increase water temperatures in the action area because of increased surface area to depth ratio and increased insolation of the river. Decreased flow velocities can reduce water quality by causing stagnant conditions, especially in pools, which will result in low oxygen levels (p. 27).*
>
> *After reviewing the best available scientific and commercial information, the status of the Southern California steelhead DPS, the environmental baseline, expected effects of the proposed action, cumulative effects, and the combined effects of past and present activities, the proposed action, and actions that are reasonably certain to occur, NMFS concludes the proposed action* [resumption of City pumping] *is likely to jeopardize the continued existence of the Southern California DPS, and is <u>likely to destroy or adversely modify critical habitat for this species</u> (p. 33).* (Emphasis added).

After NMFS issued its Draft Biological Opinion, Ventura dropped its permit application submitted to the Corps. However, repairs to water production facilities were completed outside of Corps jurisdiction. Therefore the diversions examined by NMFS – determined to be detrimental to critical habitat and the survival of Southern California steelhead in the River – continue unabated or unmitigated to present time.

NMFS findings were later affirmed by the City of Ventura's hydrological study (Hopkins, 2013), which included a steelhead habitat assessment examining the relationship between low flow conditions caused by pumping and steelhead habitat suitability. Surveys and data collected as part of the assessment generally support NMFS determination that the pumping at the Foster

Park well field results in degradation of downstream critical habitat and water quality. The City's study concludes:

> *The findings of this study indicate a flow threshold exists whereby when flows decrease below the threshold, the steelhead habitat suitability declines significantly…We conclude that the steelhead habitat is generally degraded throughout the low-flow season because the declining river flow results in shallower thalweg depths in pools, runs, and riffles which allows the hotter atmospheric temperatures to increase the surface water temperatures (p. 26).*

The EPA Draft TMDL further supports these findings:

> *Excess nutrients and eutrophic conditions are present in the Ventura River system. Low and intermittent flows exacerbate the nutrient-related problems (too much algae) and lead to low dissolved oxygen concentrations in the River. The cumulative impacts of these conditions result in the failure to attain several beneficial uses, as described throughout the remainder of this section (p. 11).*

Though the U.S. EPA ultimately decided to approve the State Water Board's Ventura River Algae TMDL as an alternative to its own Pumping and Diversions TMDL, a June 28, 2013 approval letter to the State Water Resources Control Board from the Executive Director of the U.S. EPA, states, "EPA found that the effects of pumping and water diversions in these reaches were correlated with the impairment of aquatic life and cold water habitat beneficial uses due to nutrient loading and algae growth."

As described above, both the U.S. EPA and NMFS have established linkages between pumping and diversions in the Ventura River and impairment of water quality standards, as pumping and diversions reduce surface flows such that Reaches 3 and 4 cannot support their beneficial uses. The City of Ventura's hydrological study of the River also confirms that surface flows and pumping and diversions are linked, and that beneficial uses are being degraded by low flows caused by pumping and diversions (Hopkins, 2013).

Channelkeeper has also conducted additional monitoring in 2013 and 2014 that demonstrates that reduced flows caused by pumping and diversion from Reaches 3 and 4 contribute to non-attainment of water quality objectives for water quality parameters indicative of low flows. As detailed in Section II.C., below, Channelkeeper's monitoring data for dissolved oxygen and temperature show that Reaches 3 and 4 are not attaining water quality objectives and/or criteria for these parameters. Specifically, Reach 3 exceeded the 7 mg/L water quality objective for dissolved oxygen on 558 occasions out of 574 samples from 2013-2014. For the 5 mg/L dissolved oxygen water quality objective Reach 3 exceeded on 459 occasions out of 574 samples from 2013-2014. Reach 4 exceeded the 7 mg/L dissolved oxygen water quality objective on 63 occasions out of 174 samples from 2013-2014. For temperature, Reach 3 exceeded the numeric criteria used for temperature by the State Water Board in prior 303(d) listings on 501 occasions out of 649 samples from 2013-2014, and Reach 4 exceeded the temperature criteria on 227 occasions out of 250 samples from 2013-2014. These exceedances of water quality objectives and/or criteria for dissolved oxygen and temperature are well above the minimum number of exceedances warranting 303(d) listing, indicate that reduced flows due to excessive pumping and diversions have and continue to degrade water quality in Reaches 3 and 4, and show that the water quality standards for these segments of the Ventura River are impaired by pumping and diversions.

D. Surface Flows in Reaches 3 and 4 Consistently Fall Below Recommended Flow Thresholds Needed to Protect Beneficial Uses.

To avoid jeopardizing steelhead existence and destruction or adverse modification of critical steelhead habitat, NMFS found that flows in the Ventura River at the Foster Park USGS gauge no. 111185000 should not fall below 11 to 12 cfs. *See* Draft Biological Opinion, p. 33. NMFS states: "This flow rate is based on past studies, which indicate that flows of 12 cfs and above will allow for natural rates of growth and high rates of survival of steelhead within the action area (Moore 1980), and essential features of critical habitat and PCEs within the action area will be preserved." *Id.*, p. 33.

The City of Ventura's hydrology study (Hopkins, 2013) also identified a protective threshold of 2 cfs at the Foster Park USGS gauge based on habitat suitability data. The study further recommended that the City consider reducing its diversion rates during the dry-season when river flows fell below this threshold.

> *We also recommend that during low flow conditions, the City observe streamflows documented by the USGS gage and consider reducing its diversion rates during the dry season as the River flow rate declines to 2 cfs. While the City has no control on how much water will seasonally flow into the Foster Park reach of the River, the reduction and eventual cessation of pumping will serve to maintain the steelhead habitat as long as it will last while the main stem of the River dries out (p. 28).*

Attachment A to Channelkeeper's draft Line of Evidence provides a summary of Foster Park well field production totals in comparison with flow thresholds recommended by NMFS and the City hydrology studies (12 and 2 cfs, respectively). As Attachment A clearly depicts, major withdrawals take place monthly despite the River being well below recommended thresholds at the USGS Foster Park Gage and even dry in many sections.

Figure 2. Dry Ventura River at the Foster Park subsurface dam and diversion on November 22, 2013. Dry conditions at Foster Park were prevalent throughout the 2013 - 2014 dry seasons.

For example, as seen in Figure 2 and as documented at the USGS gage, the River was completely dry at Foster Park throughout much of the 2013-2014 dry seasons.

Data from monitoring stations maintained by Channelkeeper further demonstrate that recommended flow thresholds needed to protect beneficial uses have not been achieved in recent years. Figure 3 identifies SBCK monitoring site locations in relation to water diversion facilities and designated Reaches of the Ventura River, and Table 1 provides the flow data at Channelkeeper's monitoring sites.

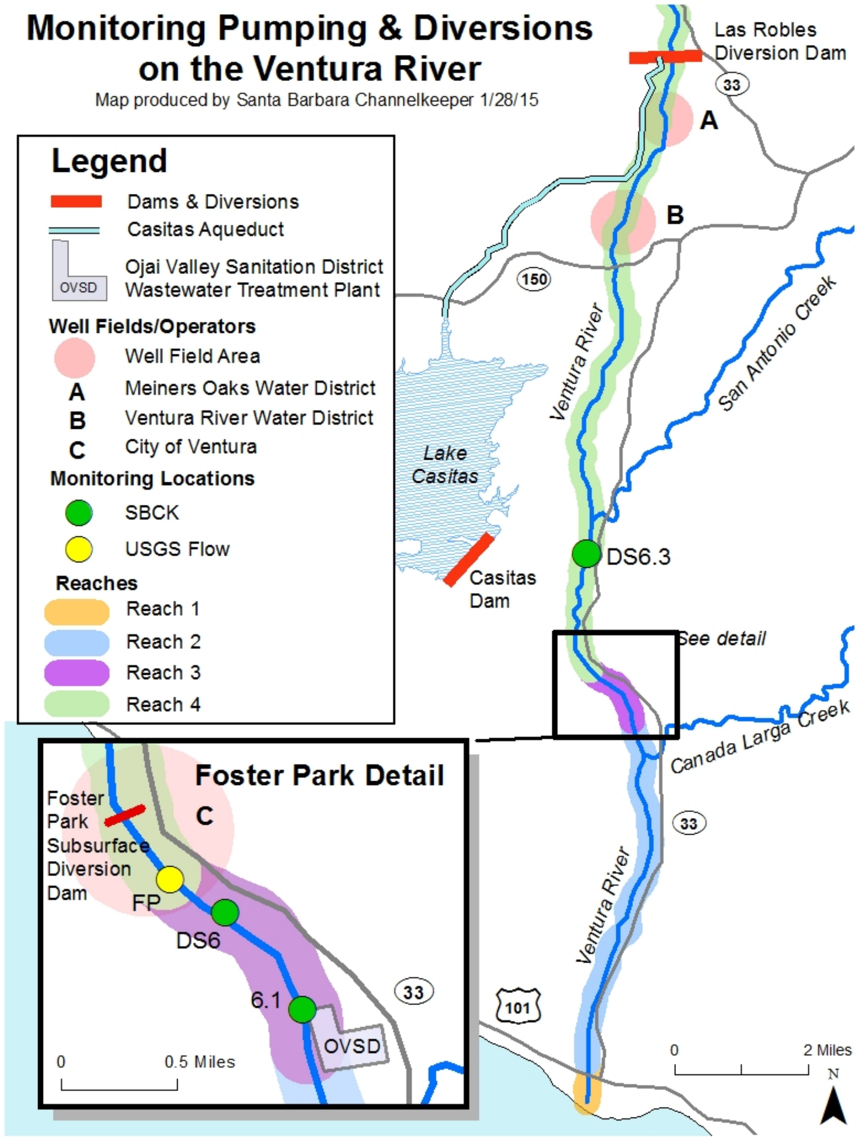

Figure 3. Monitoring sites, pumping and diversion facilities, and designated Reaches of the Ventura River

Most of Reach 4 ran dry through 2013 and 2014 including at Foster Park. Some sections of Reach 4 are known to consistently run dry during the dry season. However, additional sections such as Foster Park characterized as perennial (Beller et al., 2011) also experienced total loss of surface flows in these years. Reach 3 (downstream of Foster Park) is the primary reach for which the recommended thresholds were developed. But as shown in Figure 3 and Table 1, measurements indicate that flow levels of 11 or 2 cfs were not observed at sites in Reach 3 (6.1 and DS6. Attachment B provides a summary of flow rates at the USGS Foster Park gage from 2007 through 2014. As demonstrated in Attachment B to Channelkeeper's Line of Evidence and Table 1, Channelkeeper notes that flows have consistently fallen and remained below the recommended protective thresholds for many years.

Table 1: Flow on the Ventura River (cfs) – SBCK Monitoring

SBCK Monitoring Sites				
Reaches		**Reach 3**		**Reach 4**
Year	**Date**	**6.1**	**DS6**	**DS6.3**
2013	6/6/13		Flow not measured in 2013	
	6/13/13	1.1		
	6/14/13			2.8
	7/10/13	0.6		2.3
	7/11/13			
	7/26/13	0.3		0.6
	8/16/13	0.3		0.3
	9/6/13	0.2		0.1
	9/24/13	0.1		0
	10/17/13	0.1		0
	11/22/13	0.1		0
2014	6/5/14	0.4		3.6
	6/24/14	0.6	0.3	3.3
	7/15/14	0.6	0.3	2.4
	7/31/14	0.5	0.5	1.1
	8/21/14	0.3		0.7
	9/16/14	0.1	0.4	0.3
	10/21/14	0.2	0.3	

* Immediately downstream of OVSD Outfall

II. The Existing 303(d) Listings for Reaches 3 and 4 Are Valid Though the Listings Were Approved Before the Listing Policy Was Adopted.

In reference to the existing 303(d) listings for Reaches 3 and 4 of the Ventura River, the 2012 Integrated Report states:

> California has not considered the direct assessment of flow data since the adoption of the Listing Policy. There are four listings on the existing 303(d) List due to flow related alterations in the Ballona Creek and Ventura River watersheds. These decisions were made prior to adoption of the Listing Policy and before guidance was developed on the method to inventory waters impaired by pollution, and not pollutants. **Those four listings waters [sic] will likely be proposed for delisting as part of the next Listing Cycle**.

2012 Integrated Report, pp. 9-10 (emphasis added). The State Water Board's "likely" proposal to delist Reaches 3 and 4 of the Ventura River as flow impaired by pumping and diversion is improper for at least four reasons. First, the Clean Water Act as well as long-standing U.S. EPA Guidance provide for 303(d) listings for flow-impaired waters such as Reaches 3 and 4. Second, that Reaches 3 and 4 were listed as flow-impaired prior to adoption of a formal listing policy has no bearing on the validity of the listings. Third, the existing 303(d) listings for Reaches 3 and 4 meet the several listing factors in the State Water Board's Water

Quality Control Policy for Developing California's Clean Water act Section 303(d) List in September 2004 ("Listing Policy"). Fourth, Reaches 3 and 4 of the Ventura River must remain 303(d) listed as impaired for flow caused by pumping and diversions because no Listing Policy delisting factors can be met.

A. The Clean Water Act and U.S. EPA Guidance Provide for Flow-Impairment Listings.

Under the Clean Water Act, when effluent limitations are insufficient to ensure compliance with water quality objectives and a water body can no longer be put to its designated beneficial uses (collectively "water quality standards"), that water body's water quality standards have not been attained and its beneficial uses are impaired. The State must identify that water body on the list of impaired waters. 33 U.S.C. § 1313(d)(1). An impairment listing is required whether the impairment is caused by "pollutants" or "pollution." *See* 33 U.S.C. § 1313(d)(1)(A); *see also Pronsolino v. Nastri*, 291 F.3d 1123, 1137-38 (9th Cir. 2002), cert. denied, 123 S. Ct. 2573 (2003) ("Water quality standards reflect a state's designated *uses* for a water body and do not depend in any way upon the source of pollution").

Compliance with the Clean Water Act section 303(d), the Act's "safety net," requirements is a crucial element in achieving the Clean Water Act's goal of restoring the chemical, physical, and biological integrity of the nation's waters so that they are safe for swimming, fishing, drinking, and other "beneficial uses" that citizens enjoy, or used to be able to enjoy. It is the bedrock component of the Clean Water Act; the backstop to ensure that the goals of the Act can be achieved when initial efforts fail. Moreover, section 303(d) requires states to address comprehensively all human activities that affect the chemical, physical, and biological integrity of the nation's waters.

Consistent with the language and the purpose of Clean Water Act section 303(d), the U.S. EPA has found that "pollution" must result in a 303(d) listing if it results in impairment. *See* U.S. EPA, "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act," p. 56 ("2006 Guidance").[1] In describing categories of impairment listings, EPA specifically uses "lack of adequate flow" as an example of a cause an impairment to a water segment. *Id*.

Accordingly, a water body that cannot support its designated beneficial uses due to altered flow must be included on the State Water Board's 303(d) list as impaired. Altered flows in Reaches 3 and 4 of the Ventura River caused by pumping and diversions impair those Reaches' beneficial uses, as described in detail in Section I above. Thus, as provided by the Clean Water Act, in 1998 the State Water Board included Reaches 3 and 4 on the 303(d) list as impaired by pumping and diversion. Not only are these listings valid under the Clean Water Act, they are in line with relevant U.S. EPA Guidance.

[1] Available at: http://www.epa.gov/owow/tmdl/2006IRG/report/2006irg-report.pdf, last visited February 5, 2015.

B. A Formal Listing Policy or Guidance Are Not Prerequisites to an Impairment Listing.

As its reason for the likely proposal to delist Reaches 3 and 4 as flow-impaired, the State Water Board cites the timing of those listing decisions, which came before the adoption of the State Water Board's Listing Policy and "before guidance was developed on the method to inventory waters impaired by pollution, and not pollutants." The State Water Board's stated reason does not support delisting, however. A formal listing policy or guidance are not prerequisites to an impairment listing.

As discussed in Section II.A. above, the Clean Water Act requires that the State Water Board include all impaired water segments on the 303(d) list. The requirement to identify impaired waters on the 303(d) list is not conditioned on the existence of a *formal* listing policy. In fact, the State Water Board has issued multiple California 303(d) lists prior to the adoption of the Listing Policy. For example, in 1998 and 2003 the State Water Board issued 303(d) lists that identified numerous impaired water segments, including the pumping and diversion impairments of Reaches 3 and 4 of the Ventura River, without a formal listing policy. Because a formal listing policy had not been adopted, the State Water Board made listing determinations based on an assessment of all readily available data and facts relating to individual water bodies. *See, e.g.*, Staff Report, Vol. I, Revision of The Clean Water Act Section 303(d) List of Water Quality Limited Segments. U.S. EPA approved each of these 303(d) lists. As such, the State Water Board need not have had a formal listing policy in place to make these valid listing decisions. Channelkeeper further notes that the 2012 Integrated Report does not indicate that water segments other than the segments of the Ventura River and Ballona Creek identified as flow-impaired in 1998 and/or 2003 lists will likely be delisted on the ground that those listings were made prior to adoption of the Listing Policy.

The State Water Board also bases its likely proposal to delist Reaches 3 and 4 on its statement that those listings were made "before guidance was developed on the method to inventory waters impaired by pollution, and not pollutants." Channelkeeper understands the State Water Board to be referring to the U.S. EPA 2006 Guidance. *See* 2012 Integrated Report, pp. 9-10. As with the Listing Policy, formal guidance from U.S. EPA is not a prerequisite to impairment listings and listings issued and approved predating the 2006 Guidance are entirely valid. The State Water Board refers to no authority otherwise. In any event, as explained in Section I.A., U.S. EPA's 2006 Guidance, including the portion cited in the 2012 Integrated Report, supports the listing of Reaches 3 and 4 as flow-impaired due to pumping and diversion. *See* 2012 Integrated Report, p. 10 (explaining that water segments impaired solely by pollution should be included in category 4c of the 303(d) list, and in no way suggesting such waters not be identified as impaired on the 303(d) list).

C. Reaches 3 and 4 of the Ventura River Meet Multiple Listing Policy Factors.

Whether or not a listing policy is some how required for compliance with section 303(d) of the Clean Water Act, the pumping and diversions listings of Reaches 3 and 4 of the Ventura River meet the listing policy factors. The Listing Policy provides several different factors to use to determine whether a water segment should be identified as impaired on the 303(d) list. A water segment that meets any one of the listing factors should be included on the 303(d) list. As discussed below, Reaches 3 and 4 meet Listing Policy factors 3.2 (Numeric Water Quality Objectives for Conventional or Other Pollutants in Water), 3.9 (Degradation of Biological Populations and Communities), and 3.11 (Situation-Specific Weight of Evidence Listing Factor).

1. Reaches 3 and 4 are Impaired for Pumping and Diversions Based on the "Numeric Water Quality Objectives for Conventional or Other Pollutants in Water" Listing Factor.

Section 3.2 of the Listing Policy states that "using a binomial distribution, waters shall be placed on the 303(d) list if the number of measured exceedances supports rejection of the null hypothesis," as provided in Table 3.2 of the Listing Policy. Listing Policy, p. 4. "When continuous monitoring data are available, the seven-day average of daily minimum measurements shall be assessed." *Id*. As explained below, monitoring data for dissolved oxygen and temperature demonstrate that Reaches 3 and 4 meet the listing factor for exceedances of numeric water quality objectives or criteria. Because dissolved oxygen and temperature are parameters indicative of reduced flows, and given the connection between pumping and diversions and reduced surface flows, this listing factor supports the pumping and diversions impairment listings for Reaches 3 and 4.

<u>Dissolved Oxygen</u>

Channelkeeper deployed Onset dissolved oxygen sensors (model U26) and pressure transducers (model U20) at the Channelkeeper monitoring stations listed above from May-November in 2013 and May-October in 2014. Sensors were calibrated to collect measurements every ten minutes, 24 –hours a day, during the 2013 dry season and every 30 minutes, 24-hours a day during the 2014 dry season.

The Basin Plan states:

The dissolved oxygen content of all surface waters designated as WARM shall not be depressed below 5 mg/L as a result of waste discharges.

The dissolved oxygen content of all surface waters designated as COLD shall not be depressed below 6 mg/L as a result of waste discharges.

The dissolved oxygen content of all surface waters designated as both COLD and SPWN shall not be depressed below 7 mg/L as a result of waste discharges.

Tables 2 and Table 3 below evaluate the 2013-2014 dissolved oxygen data using this method based on the 7 mg/L and 5 mg/L dissolved oxygen water quality objectives ("WQO") set forth in the Basin Plan designated to protect Cold Water and Spawning Habitats and Warm Water Habitat beneficial uses, respectively. Based on the Listing Policy, Reach 3 and Reach 4 meet the 303(d) listing criteria for the 7 mg/L dissolved oxygen WQO to protect Cold Water and

Spawning Habitats. Reach 3 meets the listing criteria for the 5 mg/L WQO to protect Warm Water Habitat.

Table 2: Measurements Below the 7 mg/L Dissolved Oxygen Water Quality Objective

7 Day Average of Minimum DO Measurements					
Site	**Year**	**Total n**	**n <7 mg/L**	**Min n for listing**	**Meets Listing Criteria?**
Reach 3					
6.1	2013	173	157		
	2014	155	155		
	Sub Total	328	312		
DS6	2013	140	140		
	2014	106	106		
	Sub Total	246	246		
	Grand Total	574	558	93	**Yes**
Reach 4					
DS6.3	2013	106	8		
	2014	68	55		
	Grand Total	174	63	29	**Yes**

Table 3: Measurements Below the 5 mg/L Dissolved Oxygen Water Quality Objective

7 Day Average of Minimum DO Measurements					
Site	**Year**	**Total n**	**n <5 mg/L**	**Min n for listing**	**Meets Listing Criteria?**
Reach 3					
6.1	2013	173	100		
	2014	155	143		
	Sub Total	328	243		
DS6	2013	140	118		
	2014	106	98		
	Sub Total	246	216		
	Grand Total	574	459	93	**Yes**
Reach 4					
DS6.3	2013	106	0		
	2014	68	2		
	Grand Total	174	2	29	**No**

Temperature

The 2010 Integrated Report (CWA Section 303(d) list) includes listings of temperature water quality impairments for water bodies in Region 3, citing an evaluation guideline of 21°C maximum temperature to protect rainbow trout. This evaluation guideline was applied to Channelkeeper sensor data from 2013 and 2014. Daily maximums were used to evaluate measurements based on a binomial distribution as applied in Section 3.2 and Table 3.2 of the Listing Policy where minimum number of samples needed for listing was calculated based on the total number of seven day averages of the daily minimum dissolved oxygen concentration. Application of this evaluation method indicates that Reach 3 and Reach 4 for meet these 303(d) listing evaluation criteria.

Table 4: Measurements Above the 21° Temperature 303(d) Listing Evaluation Criteria

Daily Maximum Temperature Measurements					
Site	**Year**	**Total n**	**n > 21° *C***	**Min n for listing**	**Meets Listing Criteria?**
Reach 3					
6.1	2013	179	125		
	2014	161	152		
	Sub Total	340	277		
DS6	2013	149	84		
	2014	160	140		
	Sub Total	309	224		
	Grand Total	649	501	108	**Yes**
Reach 4					
DS6.3	2013	124	114		
	2014	126	113		
	Grand Total	250	227	42	**Yes**

2. **Reaches 3 and 4 are Impaired for Pumping and Diversions Based on the "Degradation of Biological Populations and Communities" Listing Factor.**

Section 3.9 of the Listing Policy states that "[a] water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities as compared to reference site(s) and is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." Listing Policy, p. 7. Given the biological populations and communities of steelhead in Reaches 3 and 4 of the Ventura River, this listing factor is met.

Specifically, the Ventura River watershed is home to at least 11 endangered or threatened species, including steelhead trout. *See* U.S. Fish & Wildlife Service, Listing and Occurrence for California.[2] Reaches 3 and 4 of the Ventura River are occupied by steelhead and are rated as

[2] Available at:
http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=CA&s8fid=112761032792&s8fid=112762573902, and http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/TEAnimals.pdf, last visited February 5, 2015.

having high conservation value. *See* Draft Biological Opinion, pp. 355-56; *see also* Section I., above. These reaches of the River provide spawning and rearing habitat and serve as a migratory corridor for steelhead to upstream reaches. Draft Biological Opinion, pp. 356-57. The Ventura River (including Reaches 3 and 4), Ventura River Estuary, San Antonio Creek, Cañada Larga, Matilija Creek and North Fork Matilija Creek, among other tributaries, have been designated as critical habitat for the remaining population of the southern California Steelhead, which is estimated at less than 500 spawning adults. *See* EPA Draft TMDL, p. 104; Draft Biological Opinion, p. 354.

Before dams were constructed in the Ventura River Watershed, during normal to wet years the steelhead run was estimated at 4,000-5,000 individuals. EPA Draft TMDL, p. 100. Following the construction of Matilija Dam (located upstream of Reach 3), which cut off access to about half of the prime spawning habitat, and coincident with a drought in the late 1940s, steelhead runs dropped to about 2,000-2,500 individuals. EPA Draft TMDL, p. 101. By the 1990s there had been a 96% decline in the steelhead population in the Ventura River, prompting its listing as an endangered species in 1997. Draft Biological Opinion, p. 352; *see also* Steelhead Recovery Plan, p. 437 (describing declines in steelhead run sizes of 90% or more).

During dry years, juvenile fish unable to transit back downstream to the ocean due to low flows must survive in pools in the mainstem, i.e., Reaches 3 and 4. EPA Draft TMDL, p. 101. The fish are subjected to elevated temperatures, endure competition with other fish for a decreasing food supply, and are exposed to predators. EPA Draft TMDL, p. 101. Additional evidence of elevated temperatures is shown in Section II.C.1., above.

Since southern California steelhead were listed as endangered in 1997, the impacts leading to the listing remain prevalent and widespread. Steelhead Recovery Plan, p. 447. These impacts include present or threatened destruction, modification or curtailment of habitat or range, over-utilization of the steelhead population for commercial, recreational, scientific, or educational purposes, disease and predation, inadequacy of existing regulatory mechanisms, and other natural or human-made factors affecting continued existence. *Id*. at 448-453. As to the steelhead population in the Ventura River, NMFS found that diversions from the Ventura River at Foster Park contribute to the present or threatened destruction, modification or curtailment of steelhead habitat or range and disease and predation of steelhead. *See id.*, p. 514. The inadequacy of existing regulatory mechanisms for diversions at Foster Park contributed to the listing and continuing impacts to endangered steelhead. *See id.*, p. 514.

3. Reaches 3 and 4 are Impaired for Pumping and Diversions Based on the "Situation-Specific Weight of Evidence" Listing Factor.

The situation-specific weight of evidence listing factor provides that when information indicates non-attainment of applicable water quality standards that water segment is to be evaluated to determine whether the situation-specific weight of the evidence demonstrates that the water quality standard is not attained. *See* Listing Policy, Section 3.11, p. 8. A situation-specific weight of evidence impairment determination is to be justified by: (1) data or information including current conditions supporting the decision, (2) description of how that data or information affords a substantial basis in fact from which the impairment decision can be reasonably inferred, (3) demonstration that the weight of the evidence of the data and information indicate that the water quality standard is not attained, and (4) demonstration that the approach used is scientifically defensible and reproducible. *See id*.

Reaches 3 and 4 each meet the situation-specific weight of evidence listing factor. Current conditions show that Reaches 3 and 4 are impaired for flow, and that the impairment is caused by pumping and diversions. *See* Section I., above; *see also* Attachments A and B. The available information and data supporting impairment listing is scientifically defensible and reproducible. Further, in approving the State Water Board's TMDL for the Ventura River, U.S. EPA recognized need for further action to address flow impairment.

D. Reaches 3 and 4 of the Ventura River Must Remain 303(d) Listed as Impaired for Flow Caused by Pumping and Diversions.

If the Listing Policy applies, then it applies equally for listing and *delisting*. *See* Listing Policy, Section 4, pp. 11-13. In addition to satisfying the delisting factors, which it cannot, to remove Reaches 3 and 4 from the 303(d) list the responsible Regional Water Quality Control Board (here Region 4) must document the list change in a fact sheet and hold a public hearing to approve the change, respond in writing to all public comments, approve a resolution in support of the decision, and submit supporting fact sheets, responses to comments, documentation of the hearing process, and a copy of all data and information considered to the State Water Board. The State Water Board must also assemble supporting fact sheets and provide advance notice and opportunity for public comment on the listing decision. *See* Listing Policy, Section 6.3, p. 26. The 2012 Integrated Report makes no reference to the delisting factor, and Channelkeeper is unaware of any efforts by Region 4 or the State Water Board to comply with these delisting requirements.

Accordingly, unless the delisting factors and additional requirements are met, Reaches 3 and 4 must remain listed as flow-impaired due to pumping and diversions.

Because the existing pumping and diversion impairment listings for Reaches 3 and 4 are entirely consistent with the Clean Water Act, U.S. EPA Guidance, and the State Water Board's Listing Policy, that the impairments were identified on California's 303(d) list before the State Water Board adopted the Listing Policy or U.S. EPA adopted the 2006 Guidance in no way invalidates those listings.

III. The State Board Must Consider All Readily Available Information About Impairments to Reaches 3 and 4 Resulting from Pumping and Diversions Prior to Making a Listing Decision.

The body of regulations and guidance that bear on 303(d) listings are unambiguous about the information that should be considered in making listing decisions: *all of it*. Federal regulations state clearly that "[e]ach State shall assemble and evaluate all existing and readily available water quality-related data and information to develop the [303(d)] list." 40 C.F.R. § 130.7(b)(5). The regulations further mandate that local, state and federal agencies, members of the public, and academic institutions "should be *actively* solicited for research they may be conducting or reporting." 40 C.F.R. § 130.7(b)(5)(iii) (emphasis added). Furthermore, U.S. EPA's 2006 Guidance explicitly states that U.S. EPA's review of California's list will include an "assess[ment of] whether the state conducted an adequate review of all existing and readily available water quality-related information." 2006 Guidance, p. 29. To that end, the 2006 Guidance also requires states to provide "[r]ationales for any decision to not use any existing and readily available data and information." *Id.*, p. 18. Accordingly, any and all existing and readily available data and information must be considered to determine the health of the state's increasingly-degraded water bodies.

To provide the State Water Board with available data and information about the impairments to Reaches 3 and 4 of the Ventura River resulting from pumping and diversions described in Section I., Channelkeeper attaches hereto a draft Line of Evidence as Exhibit A. The Line of Evidence summarizes the existing flow-impairment to Reaches 3 and 4, relies on scientifically defensible and reproducible data and information,[3] and includes analysis of that data and information supporting the decision to identify Reaches 3 and 4 as flow-impaired on California's 303(d) list.

IV. Conclusion.

When Reaches 3 and 4 of the Ventura River were identified as flow-impaired by pumping and diversions on California's 1998 303(d) list, the State Water Board took an important first step towards restoring the chemical, physical, and biological integrity of these waters. However, there is ongoing documentation that flow alterations from pumping and diversions continue to degrade Reaches 3 and 4 such that these waters cannot support their designated beneficial uses and water quality standards are not attained.

Removing the impairment listings for Reaches 3 and 4 as the State Water Board says it will likely propose may impede existing and future efforts to remedy the ongoing flow-impairments of Reaches 3 and 4. Thus Channelkeeper strongly urges the State Water Board to comply with its Clean Water Act duty to continue to identify Reaches 3 and 4 on the 303(d) list as flow-impaired by pumping and diversions.

Respectfully,

[3] Data collected by Channelkeeper followed quality assurance protocols for continuous monitoring and flow measurements. *See* Attachment C. Additional data and findings referenced were produced by and for government agencies including the California Department of Fish and Game, the National Marine Fisheries Service, the City of Ventura, Ventura County, the United States Geologic Survey, the Los Angeles Regional Water Quality Control Board, the State Water Resources Control Board, and the United States Environmental Protection Agency.

Ben Pitterle
Watershed and Marine Program Director

Kira Redmond
Executive Director

Reference List

1. Water Quality Control Plan for the Los Angeles Region ("Basin Plan").
2. California Department of Fish and Wildlife 1996 Steelhead Restoration and Management Plan for California ("Steelhead Restoration Plan").
3. U.S. EPA Draft Ventura River Reaches 3 and 4 Total Maximum Daily Loads For Pumping & Water Diversion-Related Water Quality Impairments ("EPA Draft TMDL").
4. Draft Environmental Impact Report on the Conjunctive Use Agreement between Casitas Municipal Water District and the City of Ventura ("Draft EIR").
5. National Marine Fisheries Service 2007 Draft Biological Opinion ("Draft Biological Opinion").
6. Ventura River Natural Conditions Study, TetraTech, 2009.
7. Jonathan Butcher, July 22, 2009 Memorandum to Scott Holder (VCWPD) Re: Ventura River Model Comment Response.
8. City of Ventura Preliminary Hydrogeological and Surface Water/Groundwater Interaction Study (Hopkins, 2013).
9. NMFS 2012 Southern California Steelhead Recovery Plan ("Steelhead Recovery Plan").
10. Beller, EE et al., Historical Ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: an analysis of terrestrial, riverine, and coastal habitats, San Francisco Estuary Institute, 2011.
11. 2010 California 303(d) List of Water Quality Limited Segments ("2010 Integrated Report").

Ventura River Reaches 3 and 4 Listing Line of Evidence

Pollution: Pumping and Diversions

Beneficial Uses Being Impaired: Cold Freshwater Habitat; Warm Freshwater Habitat; Rare, Threatened, or Endangered Species; Migration of Aquatic Organisms; Spawning, Reproduction, and/or Early Development; Contact and Non-Contact Water Recreation

Conclusion: Available data demonstrates that pumping and diversions are impairing the beneficial uses of Reaches 3 and 4 of the Ventura River, and that conditions in Reaches 3 and 4 meet Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (September 2004) listing factors 3.1, 3.9, and 3.11.

Summary of Evidence: In 1998, the United States Environmental Protection Agency (EPA) approved California's list of impaired water bodies identified pursuant to section 303(d) (303(d) list) of the Federal Water Pollution Control Act (Clean Water Act), 33 U.S.C. § 1313(d), which first listed Reaches 3 and 4 of the Ventura River as impaired for pumping and diversion. The original listing referenced findings in a 1996 Steelhead Restoration and Management Plan for California as one basis for the listing decision. Over the last several decades, additional Lines of Evidence (LOE) have been produced, which verify and support the listing decision.

The hydraulic communication between surface and groundwater in the Ventura River and the contribution of groundwater pumping to dewatering of the river has been acknowledged by experts and government agencies for several decades. These relationships were clearly evaluated and established in numerous studies and reports including: (1) a Draft Environmental Impact Report on the Conjunctive Use Agreement between Casitas Municipal Water District and the City of Ventura (EDAW, Inc. et al. 1978); (2) a National Marine Fisheries Service (NMFS) 2007 Draft Biological Opinion (Draft Biological Opinion) for the Army Corps of Engineers' permitting of the City of Ventura's proposed Foster Park Well Facility repairs; (3) a Ventura River Natural Conditions Study (TetraTech, 2009); (4) the United States Environmental Protection Agency, Region 9, Draft Ventura River Reaches 3 and 4 Total Maximum Daily Loads For Pumping & Water Diversion-Related Water Quality Impairments (EPA Draft TMDL); and (5) the City of Ventura's Preliminary Hydrogeological and Surface Water/Groundwater Interaction Study (Hopkins, 2013).

Linkages have also been established between reduced surface flows caused by pumping and diverting and impairment of designated and potential beneficial uses of the River. The Draft Biological Opinion concluded that summer and fall withdrawals from Foster Park are, "likely to destroy or adversely modify critical habitat" through dewatering, reduction of water depth, and subsequent degradation of water quality (pp. 27, 33). Hopkins, 2013 concludes that pumping at Foster Park results in degradation of downstream critical habitat and water quality (p. 26). The EPA Draft TMDL found that low and intermittent flows result in, "failure to attain several beneficial uses" (p.11). During dry years, juvenile fish unable to transit back downstream to the ocean due to low flows must survive in pools in the mainstem, i.e., Reaches 3 and 4 (EPA Draft TMDL, p.

101). These oversummering fish are subjected to elevated temperatures, endure competition with other fish for a decreasing food supply, and are exposed to predators (EPA Draft TMDL, p.101).

Continuous dissolved oxygen and temperature monitoring conducted by Santa Barbara Channelkeeper through the 2013 and 2014 dry seasons confirms Reaches 3 and 4 consistently fail to meet Water Quality Objectives established in the Basin Plan to protect beneficial uses and/or criteria used in prior 303(d) listings (see Tables 1, 2, and 3 below).

To avoid jeopardizing steelhead existence and destruction or adverse modification of critical steelhead habitat, flow thresholds measured at the USGS Foster Park Gage were established by Hopkins (p. 28) and the National Marine Fisheries Service in the Draft Biological Opinion (p. 33). A comparison of Foster Park Well Field production totals with flow measurements at the USGS Foster Park Gage (Attachments A and B) clearly illustrates that pumping and diversion activities continued despite surface flows in Reaches 3 and 4 consistently falling below recommended flow thresholds. Flow monitoring in Reaches 3 and 4 conducted by Santa Barbara Channelkeeper in 2013 and 2014 further demonstrates that flows consistently fell below recommended protective thresholds through the dry seasons (see Table 4 below).

Finally, degradation of biological populations and communities has occurred and has been documented for southern California steelhead trout. By the 1990s there had been a 96% decline in the steelhead population in the Ventura River observed, prompting its listing as an endangered species in 1997 (Draft Biological Opinion, p. 352; *see also* National Marine Fisheries Service 2012 Southern California Steelhead Recovery Plan, p. 437) (Steelhead Recovery Plan) (describing declines in steelhead run sizes of 90% or more). The Steelhead Recovery Plan describes dams, surface water diversions, and groundwater extraction (including at Foster Park) as contributing to the present or threatened destruction, modification or curtailment of steelhead habitat or range and disease and predation of steelhead and as a "very high threat" to steelhead recovery in the Ventura River (p. 514).

Data Referenced:

1. Water Quality Control Plan for the Los Angeles Region ("Basin Plan").
2. California Department of Fish and Wildlife 1996 Steelhead Restoration and Management Plan for California ("Steelhead Restoration Plan").
3. U.S. EPA Draft Ventura River Reaches 3 and 4 Total Maximum Daily Loads For Pumping & Water Diversion-Related Water Quality Impairments ("EPA Draft TMDL").
4. Draft Environmental Impact Report on the Conjunctive Use Agreement between Casitas Municipal Water District and the City of Ventura ("Draft EIR").
5. National Marine Fisheries Service 2007 Draft Biological Opinion ("Draft Biological Opinion").
6. Ventura River Natural Conditions Study, TetraTech, 2009.
7. Jonathan Butcher, July 22, 2009 Memorandum to Scott Holder (VCWPD) Re:

Ventura River Model Comment Response.
8. City of Ventura Preliminary Hydrogeological and Surface Water/Groundwater Interaction Study (Hopkins, 2013).
9. NMFS 2012 Southern California Steelhead Recovery Plan ("Steelhead Recovery Plan").
10. Beller, EE et al., Historical Ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: an analysis of terrestrial, riverine, and coastal habitats, San Francisco Estuary Institute, 2011.
11. 2010 California 303(d) List of Water Quality Limited Segments ("2010 Integrated Report").
12. Santa Barbara Channelkeeper Continuous Monitoring Data for Dissolved Oxygen, Ventura River Monitoring Program 2013 - 2014.
13. Santa Barbara Channelkeeper Continuous Monitoring Data for Temperature, Ventura River Monitoring Program 2013 - 2014.
14. USGS Foster Park Stream Gage Data, Gage 11118500. Data downloaded from nwis.waterdata.usgs.gov/nwis on August 18, 2014.
15. Ventura Water Calendar Year source Report 2013 – 2014. City of Ventura Water Department.
16. Santa Barbara Channelkeeper Ventura River Monitoring Program; Methods and QAQC Description, March 1, 2013. Santa Barbara Channelkeeper

Table 1: Measurements Below the 7 mg/L Dissolved Oxygen Water Quality Objective – Santa Barbara Channelkeeper Ventura River Monitoring Program

7 Day Average of Minimum DO Measurements					
Site	**Year**	**Total n**	**n <7 mg/L**	**Min n for listing**	**Meets Listing Criteria?**
Reach 3					
6.1	2013	173	157		
	2014	155	155		
	Sub Total	328	312		
DS6	2013	140	140		
	2014	106	106		
	Sub Total	246	246		
	Grand Total	574	558	93	**Yes**
Reach 4					
DS6.3	2013	106	8		
	2014	68	55		
	Grand Total	174	63	29	**Yes**

Table 2: Measurements Below the 5 mg/L Dissolved Oxygen Water Quality Objective - Santa Barbara Channelkeeper Ventura River Monitoring Program

7 Day Average of Minimum DO Measurements					
Site	**Year**	**Total n**	**n <5 mg/L**	**Min n for listing**	**Meets Listing Criteria?**
Reach 3					
6.1	2013	173	100		
	2014	155	143		
	Sub Total	328	243		
DS6	2013	140	118		
	2014	106	98		
	Sub Total	246	216		
	Grand Total	574	459	93	**Yes**
Reach 4					
DS6.3	2013	106	0		
	2014	68	2		
	Grand Total	174	2	29	**No**

Table 3: Measurements Above the 21° Temperature 303(d) Listing Evaluation Criteria - Santa Barbara Channelkeeper Ventura River Monitoring Program

Daily Maximum Temperature Measurements					
Site	**Year**	**Total n**	**n > 21° *C***	**Min n for listing**	**Meets Listing Criteria?**
Reach 3					
6.1	2013	179	125		
	2014	161	152		
	Sub Total	340	277		
DS6	2013	149	84		
	2014	160	140		
	Sub Total	309	224		
	Grand Total	649	501	108	**Yes**
Reach 4					
DS6.3	2013	124	114		
	2014	126	113		
	Grand Total	250	227	42	**Yes**

Table 4: Flow on the Ventura River (cfs) – Santa Barbara Channelkeeper Ventura River Monitoring Program

SBCK Monitoring Sites				
Reaches		**Reach 3**		**Reach 4**
Year	**Date**	**6.1**	**DS6**	**DS6.3**
2013	6/6/13		Flow not measured in 2013	
	6/13/13	1.1		
	6/14/13			2.8
	7/10/13	0.6		2.3
	7/11/13			
	7/26/13	0.3		0.6
	8/16/13	0.3		0.3
	9/6/13	0.2		0.1
	9/24/13	0.1		0
	10/17/13	0.1		0
	11/22/13	0.1		0
2014	6/5/14	0.4		3.6
	6/24/14	0.6	0.3	3.3
	7/15/14	0.6	0.3	2.4
	7/31/14	0.5	0.5	1.1
	8/21/14	0.3		0.7
	9/16/14	0.1	0.4	0.3
	10/21/14	0.2	0.3	

Attachment A

USGS Foster Park Stream Gage Data
Gage 11118500

Data downloaded from nwis.waterdata.usgs.gov/nwis on August 18, 2014

A	Approved for publication -- Processing and review completed.
P	Provisional data subject to revision.
e	Value has been estimated.

Daily Mean Discharge, cubic feet per second 2007

DATE	Jan 2007	Feb 2007	Mar 2007	Apr 2007	May 2007	Jun 2007	Jul 2007	Aug 2007	Sep 2007	Oct 2007	Nov 2007	Dec 2007
1	7.0 [A]	11 [A]	10 [A]	8.3 [A]	8.3 [A]	6.9 [A]	5.4 [A]	3.9 [A]	2.8 [A]	1.7 [A]	0.86 [A]	0.59 [A]
2	7.1 [A]	11 [A]	9.7 [A]	8.3 [A]	8.2 [A]	6.9 [A]	5.0 [A]	3.1 [A]	2.6 [A]	1.8 [A]	0.85 [A]	0.52 [A]
3	7.4 [A]	11 [A]	9.6 [A]	8.6 [A]	8.0 [A]	7.2 [A]	5.0 [A]	3.1 [A]	2.6 [A]	1.8 [A]	0.75 [A]	0.52 [A]
4	7.5 [A]	9.8 [A]	9.8 [A]	9.0 [A]	8.2 [A]	7.2 [A]	5.0 [A]	3.3 [A]	2.3 [A]	1.8 [A]	0.80 [A]	0.48 [A]
5	7.5 [A]	9.7 [A]	9.4 [A]	8.7 [A]	8.1 [A]	7.0 [A]	5.0 [A]	3.3 [A]	2.3 [A]	1.7 [A]	0.85 [A]	0.48 [A]
6	7.6 [A]	9.7 [A]	9.0 [A]	8.6 [A]	7.9 [A]	6.8 [A]	5.0 [A]	3.2 [A]	2.4 [e A]	1.5 [A]	0.86 [A]	0.49 [A]
7	7.6 [A]	9.8 [A]	9.0 [A]	8.7 [A]	7.9 [A]	6.7 [A]	5.1 [A]	3.4 [A]	2.4 [e A]	1.4 [A]	0.84 [A]	0.60 [A]
8	7.5 [A]	9.8 [A]	8.3 [A]	8.3 [A]	7.8 [A]	6.8 [A]	4.9 [A]	3.3 [A]	2.4 [e A]	1.4 [A]	0.78 [A]	0.52 [A]
9	7.5 [A]	9.7 [A]	8.3 [A]	8.3 [A]	8.1 [A]	6.9 [A]	5.1 [A]	3.3 [A]	2.5 [e A]	1.4 [A]	0.73 [A]	0.43 [A]
10	7.6 [A]	9.7 [A]	8.2 [A]	7.6 [A]	8.9 [A]	7.2 [A]	5.8 [A]	3.1 [A]	2.5 [e A]	1.5 [A]	0.73 [A]	0.43 [A]
11	7.6 [A]	10 [A]	7.7 [A]	7.6 [A]	8.2 [A]	7.3 [A]	4.7 [A]	2.8 [A]	2.5 [e A]	1.5 [A]	0.73 [A]	0.43 [A]
12	7.6 [A]	9.2 [A]	7.3 [A]	7.1 [A]	8.1 [A]	7.3 [A]	4.1 [A]	2.7 [A]	2.6 [A]	1.5 [A]	0.67 [A]	0.42 [A]
13	7.6 [A]	8.9 [A]	6.7 [A]	7.4 [A]	8.1 [A]	7.3 [A]	4.1 [A]	2.7 [A]	2.6 [A]	1.5 [A]	0.62 [A]	0.39 [A]
14	7.6 [A]	9.0 [A]	6.6 [A]	7.2 [A]	8.2 [A]	6.8 [A]	3.7 [A]	2.6 [A]	2.6 [A]	1.3 [A]	0.62 [A]	0.39 [A]
15	7.6 [A]	8.9 [A]	6.7 [A]	7.0 [A]	8.3 [A]	6.8 [A]	4.1 [A]	2.6 [A]	2.4 [A]	1.2 [A]	1.0 [A]	0.39 [A]
16	7.6 [A]	8.6 [A]	6.6 [A]	6.8 [A]	8.5 [A]	6.8 [A]	4.5 [A]	2.6 [A]	2.5 [A]	1.2 [A]	0.92 [A]	0.36 [A]
17	7.6 [A]	7.9 [A]	6.8 [A]	6.7 [A]	8.1 [A]	6.8 [A]	4.3 [A]	2.6 [A]	2.5 [A]	1.2 [A]	0.73 [A]	0.31 [A]
18	7.5 [A]	7.5 [A]	6.9 [A]	6.8 [A]	8.0 [A]	6.8 [A]	3.9 [A]	2.5 [A]	2.5 [A]	1.2 [A]	0.62 [A]	1.0 [A]
19	7.4 [A]	10 [A]	7.0 [A]	7.5 [A]	8.0 [A]	6.5 [A]	4.1 [A]	2.5 [A]	2.5 [A]	1.2 [A]	0.61 [A]	1.2 [A]
20	7.0 [A]	8.7 [A]	7.3 [A]	8.3 [A]	8.0 [A]	6.3 [A]	4.2 [A]	2.5 [A]	2.4 [A]	1.0 [A]	0.58 [A]	0.74 [A]
21	6.6 [A]	8.3 [A]	7.6 [A]	8.4 [A]	7.8 [A]	6.3 [A]	4.2 [A]	2.5 [A]	2.3 [A]	0.99 [A]	0.55 [A]	0.66 [A]
22	6.5 [A]	9.6 [A]	7.6 [A]	8.1 [A]	7.5 [A]	6.3 [A]	4.2 [A]	2.6 [A]	1.5 [A]	1.0 [A]	0.52 [A]	0.62 [A]
23	6.5 [A]	11 [A]	7.6 [A]	8.3 [A]	7.4 [A]	5.8 [A]	4.2 [A]	2.7 [A]	1.4 [A]	1.00 [A]	0.54 [A]	0.60 [A]
24	6.7 [A]	10 [A]	7.6 [A]	8.3 [A]	7.3 [A]	5.8 [A]	4.3 [A]	2.7 [A]	1.4 [A]	0.87 [A]	0.54 [A]	0.57 [A]
25	6.8 [A]	9.7 [A]	7.6 [A]	8.3 [A]	7.2 [A]	6.0 [A]	4.7 [A]	2.6 [A]	1.5 [A]	0.86 [A]	0.46 [A]	0.57 [A]
26	6.9 [A]	9.5 [A]	7.6 [A]	8.3 [A]	7.1 [A]	5.8 [A]	4.5 [A]	2.8 [A]	1.8 [A]	0.85 [A]	0.45 [A]	0.52 [A]
27	8.2 [A]	10 [A]	7.6 [A]	8.3 [A]	7.1 [A]	5.7 [A]	4.3 [A]	2.6 [A]	1.9 [A]	0.76 [A]	0.44 [A]	0.52 [A]
28	34 [A]	10 [A]	7.8 [A]	8.3 [A]	7.2 [A]	5.7 [A]	4.3 [A]	2.5 [A]	2.0 [A]	0.80 [A]	0.48 [A]	0.52 [A]
29	16 [A]		7.8 [A]	8.3 [A]	7.0 [A]	5.5 [A]	4.2 [A]	2.6 [A]	1.7 [A]	0.84 [A]	0.52 [A]	0.52 [A]
30	13 [A]		7.9 [A]	8.4 [A]	7.1 [A]	5.5 [A]	4.3 [A]	2.7 [A]	1.7 [A]	0.86 [A]	0.58 [A]	0.52 [A]
31	12 [A]		8.1 [A]		6.9 [A]		4.2 [A]	2.8 [A]		0.88 [A]		0.51 [A]
COUNT	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
MAX	**34**	**11**	**10**	**9**	**8.9**	**7.3**	**5.8**	**3.9**	**2.8**	**1.8**	**1**	**1.2**
MIN	**6.5**	**7.5**	**6.6**	**6.7**	**6.9**	**5.5**	**3.7**	**2.5**	**1.4**	**0.76**	**0.44**	**0.31**

Daily Mean Discharge, cubic feet per second 2008

DATE	Jan 2008	Feb 2008	Mar 2008	Apr 2008	May 2008	Jun 2008	Jul 2008	Aug 2008	Sep 2008	Oct 2008	Nov 2008	Dec 2008
1	0.52 [A]	155 [e A]	85 [A]	40 [A]	25 [A]	16 [A]	14 [A]	10 [A]	6.7 [A]	5.4 [A]	8.2 [A]	5.1 [A]
2	0.51 [A]	130 [A]	82 [A]	40 [A]	23 [A]	16 [A]	15 [A]	9.8 [A]	6.7 [A]	5.4 [A]	7.3 [A]	5.0 [A]
3	0.56 [A]	158 [A]	78 [A]	40 [A]	22 [A]	17 [A]	15 [A]	9.5 [A]	6.9 [A]	5.4 [A]	6.1 [A]	4.7 [A]
4	1,300 [A]	112 [e A]	77 [A]	41 [A]	21 [A]	18 [A]	13 [A]	9.3 [A]	6.8 [A]	5.7 [A]	5.1 [A]	4.7 [A]
5	1,290 [A]	97 [e A]	75 [A]	41 [A]	19 [A]	19 [A]	13 [A]	8.8 [A]	6.8 [A]	5.3 [A]	4.0 [A]	4.7 [A]
6	32 [A]	96 [e A]	71 [A]	41 [A]	20 [A]	20 [A]	12 [A]	9.6 [A]	7.1 [A]	4.9 [A]	4.2 [A]	4.6 [A]
7	63 [A]	91 [e A]	71 [A]	41 [A]	20 [A]	20 [A]	12 [A]	9.5 [A]	7.3 [A]	4.7 [A]	5.4 [A]	4.8 [A]
8	17 [A]	86 [e A]	71 [A]	41 [A]	19 [A]	21 [A]	12 [A]	9.2 [A]	7.3 [A]	4.5 [A]	5.7 [A]	4.9 [A]
9	9.4 [A]	77 [e A]	66 [A]	40 [A]	18 [A]	22 [A]	13 [A]	9.1 [A]	7.6 [A]	4.6 [A]	5.5 [A]	4.8 [A]
10	6.9 [A]	74 [e A]	65 [A]	36 [A]	17 [A]	22 [A]	12 [A]	9.2 [A]	7.3 [A]	4.7 [A]	5.6 [A]	4.6 [A]
11	5.7 [A]	72 [e A]	61 [A]	36 [A]	17 [A]	20 [A]	12 [A]	9.5 [A]	7.3 [A]	4.9 [A]	5.6 [A]	4.4 [A]
12	5.1 [A]	66 [e A]	58 [A]	35 [A]	17 [A]	21 [A]	12 [A]	10 [A]	7.4 [A]	5.3 [A]	5.4 [A]	4.3 [A]
13	4.7 [A]	63 [A]	57 [A]	33 [A]	15 [A]	21 [A]	11 [A]	10 [A]	7.4 [A]	5.5 [A]	5.2 [A]	4.0 [A]
14	4.4 [A]	61 [A]	57 [A]	32 [A]	13 [A]	21 [A]	11 [A]	8.8 [A]	7.2 [A]	5.3 [A]	5.0 [A]	3.9 [A]
15	4.4 [A]	56 [A]	57 [A]	30 [A]	12 [A]	20 [A]	10 [A]	8.5 [A]	6.9 [A]	5.0 [A]	5.3 [A]	12 [A]
16	4.4 [A]	54 [A]	57 [A]	30 [A]	11 [A]	20 [A]	10 [A]	9.2 [A]	6.7 [A]	4.7 [A]	5.6 [A]	8.8 [A]
17	4.4 [A]	54 [A]	55 [A]	30 [A]	10 [A]	19 [A]	10 [A]	9.4 [A]	6.7 [A]	5.5 [A]	5.6 [A]	6.1 [A]
18	4.3 [A]	54 [A]	53 [A]	29 [A]	11 [A]	18 [A]	10 [A]	9.5 [A]	6.8 [A]	6.8 [A]	5.8 [A]	5.1 [A]
19	4.2 [A]	53 [A]	53 [A]	29 [A]	13 [A]	18 [A]	11 [A]	9.8 [A]	6.8 [A]	7.3 [A]	5.6 [A]	5.7 [A]
20	4.4 [A]	56 [A]	51 [A]	28 [A]	12 [A]	17 [A]	11 [A]	8.8 [A]	6.8 [A]	7.4 [A]	5.5 [A]	7.0 [A]
21	4.4 [A]	56 [A]	49 [A]	29 [A]	12 [A]	16 [A]	11 [A]	7.2 [A]	7.0 [A]	7.0 [A]	4.5 [A]	6.9 [A]
22	4.7 [A]	70 [A]	47 [A]	30 [A]	12 [A]	15 [A]	10 [A]	6.7 [A]	7.0 [A]	6.4 [A]	4.6 [A]	7.5 [A]
23	618 [A]	61 [A]	43 [A]	30 [A]	13 [A]	15 [A]	9.7 [A]	7.1 [A]	6.7 [A]	6.0 [A]	4.6 [A]	7.1 [A]
24	1,200 [A]	164 [A]	42 [A]	30 [A]	14 [A]	13 [A]	9.9 [A]	6.8 [A]	6.4 [A]	5.9 [A]	4.8 [A]	6.7 [A]
25	2,740 [A]	101 [A]	41 [A]	30 [A]	14 [A]	12 [A]	9.9 [A]	6.5 [A]	6.5 [A]	5.8 [A]	5.2 [A]	6.8 [A]
26	713 [A]	98 [A]	39 [A]	29 [A]	14 [A]	13 [A]	9.8 [A]	6.5 [A]	6.4 [A]	5.8 [A]	8.0 [A]	6.7 [A]
27	6,340 [e A]	93 [A]	39 [A]	27 [A]	13 [A]	13 [A]	10 [A]	6.8 [A]	6.2 [A]	5.8 [A]	7.1 [A]	7.0 [A]
28	3,630 [e A]	89 [A]	39 [A]	24 [A]	13 [A]	14 [A]	10 [A]	7.0 [A]	6.3 [A]	5.7 [A]	3.9 [A]	7.0 [A]
29	962 [e A]	85 [A]	39 [A]	25 [A]	14 [A]	16 [A]	11 [A]	6.5 [A]	6.3 [A]	6.0 [A]	3.6 [A]	6.8 [A]
30	354 [e A]		39 [A]	24 [A]	14 [A]	14 [A]	10 [A]	6.5 [A]	5.6 [A]	6.2 [A]	3.5 [A]	6.4 [A]
31	240 [e A]		38 [A]		15 [A]		10 [A]	6.6 [A]		6.3 [A]		6.1 [A]
COUNT	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
MAX	**6,340**	**164**	**85**	**41**	**25**	**22**	**15**	**10**	**7.6**	**7.4**	**8.2**	**12**
MIN	**0.51**	**53**	**38**	**24**	**10**	**12**	**9.7**	**6.5**	**5.6**	**4.5**	**3.5**	**3.9**

Daily Mean Discharge, cubic feet per second 2009

DATE	Jan 2009	Feb 2009	Mar 2009	Apr 2009	May 2009	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Oct 2009	Nov 2009	Dec 2009
1	6.1 A	4.8 A	16 A	12 A	9.1 A	8.2 A	7.0 A	2.2 A	3.3 A	2.1 A	2.5 A	2.3 A
2	6.3 A	4.7 A	16 A	12 A	8.7 A	7.2 A	7.1 A	2.4 A	3.3 A	2.0 A	1.6 A	2.3 A
3	6.4 A	4.7 A	15 A	12 A	8.5 A	7.1 A	5.4 A	2.6 A	3.1 A	1.9 A	1.8 A	2.4 A
4	6.6 A	4.6 A	16 A	12 A	8.4 A	6.1 A	5.5 A	2.0 A	3.1 A	2.0 A	2.2 A	2.3 A
5	6.5 A	5.3 A	16 A	11 A	7.8 A	6.6 A	5.5 A	1.8 A	3.3 A	2.3 A	2.6 A	2.3 A
6	6.1 A	8.2 A	16 A	11 A	7.2 A	6.5 A	4.8 A	2.1 A	3.2 A	2.3 A	2.7 A	2.3 A
7	6.0 A	13 A	15 A	11 A	6.7 A	6.0 A	4.7 A	2.4 A	3.2 A	2.2 A	2.7 A	3.1 A
8	6.2 A	12 A	15 A	11 A	6.6 A	6.2 A	4.7 A	2.9 A	3.1 A	2.2 A	2.7 A	3.0 A
9	6.1 A	12 A	15 A	11 A	6.8 A	6.2 A	4.4 A	3.1 A	3.0 A	2.1 A	2.7 A	2.8 A
10	6.1 A	11 A	15 A	11 A	7.0 A	7.2 A	4.3 A	3.3 A	2.8 A	2.0 A	2.6 A	2.7 A
11	5.9 A	10 A	15 A	11 A	7.2 A	6.1 A	4.0 A	3.5 A	2.9 A	2.1 A	2.6 A	3.4 A
12	5.6 A	10 A	14 A	11 A	7.4 e A	9.9 A	3.8 A	3.3 A	3.0 A	2.0 A	2.5 A	7.5 A
13	5.5 A	11 A	14 A	11 A	7.8 e A	11 A	3.8 A	3.0 A	2.9 A	2.5 A	2.7 A	23 A
14	5.3 A	11 A	14 A	10 A	8.2 A	11 A	3.9 A	2.6 A	2.9 A	36 A	2.8 A	5.7 A
15	5.3 A	11 A	14 A	10 A	8.1 A	12 A	3.9 A	2.4 A	2.9 A	6.7 A	2.7 A	4.1 A
16	5.3 A	65 A	14 A	10 A	8.2 A	12 e A	3.5 A	3.3 A	2.7 A	3.0 A	2.9 A	3.5 A
17	5.2 A	64 A	14 A	10 A	8.4 A	12 e A	3.6 A	3.5 A	2.5 A	2.9 A	2.4 A	3.4 A
18	5.1 A	35 A	14 A	10 A	8.8 A	12 e A	3.5 A	4.0 A	2.4 A	3.1 A	2.5 A	3.1 A
19	5.2 A	29 A	14 A	9.6 A	8.6 A	12 A	3.1 A	3.7 A	2.4 A	2.0 A	2.8 A	3.1 A
20	4.8 A	27 A	14 A	9.6 A	8.4 A	9.3 A	3.0 A	3.4 A	2.4 A	1.9 A	3.0 A	3.3 A
21	4.8 A	24 A	14 A	9.4 A	8.1 A	7.4 A	3.1 A	3.2 A	2.4 A	2.7 A	2.9 A	3.4 A
22	5.0 A	23 A	14 A	9.9 A	8.2 A	6.8 A	3.1 A	2.8 A	2.3 A	2.8 A	2.9 A	3.3 A
23	5.0 A	21 A	14 A	10 A	7.8 A	6.4 A	3.1 A	2.7 A	2.1 A	2.7 A	2.4 A	3.4 A
24	4.8 A	20 A	14 A	10 A	8.3 A	6.2 A	3.7 A	2.7 A	2.2 A	2.8 A	2.3 A	3.5 A
25	4.9 A	20 A	14 A	9.8 A	8.7 A	6.1 A	3.1 A	3.0 A	2.3 A	2.5 A	2.3 A	4.5 A
26	5.0 A	19 A	14 A	9.9 A	9.1 A	8.8 A	2.6 A	3.8 A	2.2 A	2.1 A	2.2 A	4.8 A
27	5.0 A	18 A	13 A	10 A	8.5 A	7.5 A	2.8 A	3.8 A	2.2 A	2.3 A	2.2 A	3.8 A
28	4.9 A	17 A	13 A	9.8 A	8.1 A	9.2 A	3.2 A	4.0 A	2.3 A	2.9 A	2.5 A	4.1 A
29	5.0 A		13 A	9.2 A	8.4 A	7.6 A	2.9 A	3.8 A	2.2 A	3.1 A	2.2 A	4.0 A
30	4.7 A		12 A	8.9 A	8.7 A	6.5 A	2.6 A	3.6 A	2.1 A	3.1 A	2.2 A	3.8 A
31	4.8 A		12 A		8.3 A		2.4 A	3.5 A		2.8 A		3.5 A
COUNT	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
MAX	**6.6**	**65**	**16**	**12**	**9.1**	**12**	**7.1**	**4**	**3.3**	**36**	**3**	**23**
MIN	**4.7**	**4.6**	**12**	**8.9**	**6.6**	**6**	**2.4**	**1.8**	**2.1**	**1.9**	**1.6**	**2.3**

Daily Mean Discharge, cubic feet per second 2010

DATE	Jan 2010	Feb 2010	Mar 2010	Apr 2010	May 2010	Jun 2010	Jul 2010	Aug 2010	Sep 2010	Oct 2010	Nov 2010	Dec 2010
1	3.8 A	56 A	98 A	31 A	35 A	20 A	12 A	8.5 A	6.1 A	6.0 A	4.1 A	4.3 A
2	4.1 A	49 A	91 A	29 A	34 A	21 A	12 A	8.0 A	6.0 A	6.6 A	4.2 A	4.2 A
3	3.9 A	40 A	86 A	30 A	34 A	20 A	12 A	7.7 A	6.0 A	6.1 A	5.0 A	3.9 A
4	3.9 A	38 A	85 A	30 A	34 A	18 A	12 A	7.5 A	5.8 A	4.9 A	5.1 A	3.9 A
5	4.3 A	111 A	80 A	39 A	34 A	18 A	11 A	7.5 A	5.8 A	4.6 A	5.2 A	4.0 A
6	4.8 A	110 A	78 A	33 A	37 A	19 A	12 A	7.4 A	5.9 A	6.2 A	5.4 A	4.1 A
7	5.0 A	98 A	76 A	32 A	35 A	17 A	11 A	7.3 A	6.1 A	6.4 A	5.4 A	3.9 A
8	5.1 A	82 A	70 A	30 A	34 A	17 A	12 A	8.3 A	7.1 A	5.1 A	5.4 A	3.9 A
9	5.0 A	105 A	70 A	29 A	34 A	18 A	13 A	8.4 A	7.5 A	4.3 A	5.3 A	3.9 A
10	4.5 A	85 A	67 A	28 A	35 A	18 A	10 A	7.7 A	7.1 A	3.8 A	5.0 A	3.9 A
11	4.7 A	76 A	59 A	34 A	34 A	17 A	10 A	8.5 A	6.8 A	4.0 A	4.8 A	3.8 A
12	4.6 A	73 A	56 A	115 A	33 A	16 A	10 A	9.3 A	6.5 A	4.6 A	4.7 A	3.8 A
13	4.3 A	74 A	55 A	46 A	32 A	17 A	9.6 A	7.8 A	6.4 A	5.7 A	4.7 A	3.8 A
14	4.7 A	73 A	53 A	39 A	31 A	17 A	8.5 A	7.2 A	6.0 A	5.7 A	4.6 A	4.0 A
15	4.7 A	72 A	51 A	36 A	32 A	15 A	8.5 A	7.7 A	5.8 A	5.0 A	4.6 A	4.0 A
16	3.6 A	68 A	50 A	34 A	29 A	15 A	8.5 A	7.2 A	5.7 A	5.1 A	4.6 A	4.0 A
17	4.8 A	59 A	42 A	33 A	26 A	15 A	8.7 A	6.7 A	5.8 A	5.2 A	4.6 A	4.5 A
18	330 A	51 A	42 A	31 A	29 A	15 A	8.2 A	6.9 A	5.8 A	5.0 A	4.6 A	29 A
19	168 A	50 A	42 A	30 A	30 A	15 A	8.3 A	6.5 A	5.5 A	6.2 A	4.6 A	1,090 A
20	901 A	51 A	42 A	34 A	26 A	15 A	8.7 A	6.0 A	5.4 A	5.1 A	5.4 A	253 A
21	730 A	49 A	42 A	34 A	24 A	14 A	8.1 A	5.7 A	5.6 A	4.2 A	5.9 A	76 A
22	524 A	48 A	43 A	33 A	25 A	14 A	7.8 A	5.6 A	5.3 A	4.2 A	4.5 A	1,320 A
23	191 A	50 A	41 A	32 A	26 A	16 A	8.5 A	5.5 A	5.1 A	4.3 A	4.9 A	235 A
24	127 A	48 A	36 A	31 A	24 A	15 A	8.8 A	5.3 A	4.9 A	4.3 A	4.4 A	80 A
25	108 A	46 A	35 A	32 A	23 A	13 A	8.4 A	5.2 A	4.6 A	4.2 A	3.7 A	54 A
26	93 A	46 A	35 A	32 A	22 A	13 A	9.2 A	5.9 A	4.5 A	5.4 A	4.2 A	75 A
27	72 A	310 A	34 A	34 A	20 A	15 A	8.7 A	6.3 A	4.2 A	5.3 A	4.3 A	41 A
28	65 A	134 A	33 A	33 A	21 A	16 A	8.4 A	6.3 A	4.1 A	4.4 A	4.1 A	35 A
29	61 A		33 A	33 A	21 A	16 A	9.0 A	6.4 A	4.4 A	4.2 A	4.4 A	40 A
30	59 A		33 A	33 A	20 A	13 A	8.9 A	6.4 A	5.6 A	4.8 A	4.4 A	34 A
31	57 A		32 A		19 A		8.2 A	6.2 A		4.3 A		30 A
COUNT	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
MAX	**901**	**310**	**98**	**115**	**37**	**21**	**13**	**9.3**	**7.5**	**6.6**	**5.9**	**1,320**
MIN	**3.6**	**38**	**32**	**28**	**19**	**13**	**7.8**	**5.2**	**4.1**	**3.8**	**3.7**	**3.8**

Daily Mean Discharge, cubic feet per second 2011

DATE	Jan 2011	Feb 2011	Mar 2011	Apr 2011	May 2011	Jun 2011	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Nov 2011	Dec 2011
1	28 A	24 A	75 A	130 A	42 A	37 A	27 A	19 A	13 A	11 A	7.7 A	7.9 A
2	32 A	24 A	73 A	112 A	42 A	38 A	25 A	16 A	11 A	9.7 A	7.4 A	6.2 A
3	42 A	24 A	74 A	100 A	43 A	39 A	26 A	16 A	11 A	8.6 A	6.2 A	5.8 A
4	33 A	24 A	71 A	89 A	43 A	41 A	27 A	16 A	12 A	9.1 A	7.1 A	5.7 A
5	29 A	23 A	69 A	80 A	42 A	41 A	27 A	16 A	12 A	14 A	7.6 A	5.6 A
6	29 A	23 A	69 A	77 A	42 A	43 A	24 A	16 A	10 A	16 A	6.9 A	6.4 A
7	30 A	23 A	68 A	75 A	43 A	43 A	23 A	17 A	9.9 A	13 A	7.6 A	6.4 A
8	28 A	22 A	67 A	74 A	42 A	43 A	22 A	17 A	10 A	12 A	7.4 A	5.7 A
9	27 A	24 A	62 A	72 A	43 A	41 A	22 A	16 A	9.6 A	12 A	7.9 A	5.3 A
10	27 A	24 A	56 A	68 A	42 A	40 A	22 A	16 A	9.4 A	11 A	7.2 A	5.3 A
11	27 A	22 A	54 A	66 A	41 A	43 A	24 A	16 A	9.5 A	11 A	7.6 A	5.5 A
12	29 A	20 A	54 A	65 A	41 A	40 A	26 A	16 A	11 A	12 A	8.9 A	5.6 A
13	31 A	21 A	55 A	65 A	40 A	38 A	24 A	15 A	13 A	11 A	8.1 A	7.0 A
14	27 A	21 A	56 A	63 A	39 A	38 A	23 A	14 A	12 A	8.8 A	7.8 A	8.2 A
15	26 A	21 A	56 A	58 A	38 A	36 A	22 A	15 A	11 A	8.0 A	6.4 A	6.8 A
16	27 A	32 A	56 A	57 A	39 A	38 A	21 A	17 A	11 A	7.9 A	7.8 A	6.9 A
17	27 A	30 A	56 A	57 A	48 A	38 A	20 A	18 A	12 A	7.6 A	8.6 A	8.4 A
18	27 A	62 A	58 A	55 A	49 A	36 A	19 A	16 A	9.9 A	7.5 A	8.3 A	9.0 A
19	26 A	118 A	60 A	54 A	40 A	36 A	18 A	14 A	9.7 A	8.5 A	7.0 A	6.8 A
20	25 A	82 A	6,270 A	51 A	40 A	38 A	22 A	13 A	9.1 A	9.3 A	13 A	6.5 A
21	26 A	73 A	2,670 A	51 A	39 A	37 A	22 A	14 A	9.3 A	9.4 A	12 A	7.1 A
22	26 A	69 A	490 A	50 A	40 A	35 A	19 A	15 A	11 A	9.4 A	11 A	8.7 A
23	24 A	67 A	300 A	49 A	39 A	31 A	18 A	13 A	9.5 A	7.4 A	10 A	9.0 A
24	24 A	66 A	277 A	48 A	38 A	33 A	18 A	12 A	10 A	7.4 A	8.5 A	6.6 A
25	25 A	126 A	1,260 A	48 A	38 A	32 A	17 A	11 A	11 A	9.9 A	8.4 A	6.9 A
26	24 A	221 A	430 A	47 A	38 A	31 A	18 A	12 A	11 A	9.7 A	8.1 A	6.9 A
27	23 A	96 A	319 A	45 A	38 A	31 A	21 A	12 A	9.4 A	7.4 A	7.3 A	6.7 A
28	24 A	80 A	257 A	44 A	38 A	31 A	17 A	11 A	9.3 A	6.6 A	6.3 A	6.5 A
29	23 A		212 A	43 A	39 A	29 A	16 A	11 A	9.0 A	7.0 A	5.9 A	7.4 A
30	23 A		180 A	42 A	39 A	29 A	18 A	10 A	9.0 A	7.3 A	7.0 A	7.9 A
31	23 A		158 A		38 A		19 A	11 A		6.3 A		7.6 A
COUNT	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
MAX	**42**	**221**	**6,270**	**130**	**49**	**43**	**27**	**19**	**13**	**16**	**13**	**9**
MIN	**23**	**20**	**54**	**42**	**38**	**29**	**16**	**10**	**9**	**6.3**	**5.9**	**5.3**

Daily Mean Discharge, cubic feet per second 2012

DATE	Jan 2012	Feb 2012	Mar 2012	Apr 2012	May 2012	Jun 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012
1	6.5 [A]	7.0 [A]	7.2 [A]	11 [A]	7.2 [A]	5.1 [A]	3.8 [A]	6.9 [A]	1.0 [A]	0.53 [A]	0.29 [A]	0.28 [A]
2	5.6 [A]	7.9 [A]	7.3 [A]	12 [A]	8.7 [A]	5.1 [A]	4.1 [A]	7.1 [A]	1.0 [A]	0.47 [A]	0.29 [A]	0.25 [A]
3	7.0 [A]	6.8 [A]	5.8 [A]	13 [A]	9.2 [A]	5.2 [A]	3.5 [A]	7.4 [A]	1.1 [A]	0.48 [A]	0.27 [A]	0.29 [A]
4	6.7 [A]	7.5 [A]	5.0 [A]	14 [A]	7.8 [A]	5.4 [A]	3.6 [A]	7.4 [A]	1.1 [A]	0.52 [A]	0.27 [A]	0.31 [A]
5	7.7 [A]	6.8 [A]	4.6 [A]	14 [A]	8.0 [A]	5.1 [A]	3.6 [A]	7.0 [A]	1.2 [A]	0.50 [A]	0.25 [A]	0.27 [A]
6	7.5 [A]	5.8 [A]	5.9 [A]	14 [A]	6.8 [A]	5.0 [A]	3.7 [A]	7.0 [A]	1.1 [A]	0.48 [A]	0.23 [A]	0.31 [A]
7	6.2 [A]	5.3 [A]	6.7 [A]	15 [A]	6.2 [A]	5.0 [A]	3.6 [A]	7.0 [A]	0.98 [A]	0.42 [A]	0.26 [A]	0.32 [A]
8	5.2 [A]	7.0 [A]	7.0 [A]	15 [A]	6.2 [A]	5.0 [A]	4.6 [A]	6.5 [A]	0.92 [A]	0.42 [A]	0.32 [A]	0.35 [A]
9	6.1 [A]	7.2 [A]	5.8 [A]	15 [A]	6.2 [A]	5.2 [A]	4.7 [A]	4.9 [A]	0.96 [A]	0.38 [A]	0.44 [A]	0.32 [A]
10	7.6 [A]	5.8 [A]	6.7 [A]	15 [A]	5.7 [A]	5.4 [A]	5.4 [A]	4.4 [A]	0.87 [A]	0.38 [A]	0.38 [A]	0.25 [A]
11	6.6 [A]	5.0 [A]	7.1 [A]	25 [A]	5.7 [A]	5.3 [A]	4.0 [A]	4.2 [A]	0.89 [A]	0.35 [A]	0.30 [A]	0.24 [A]
12	5.6 [A]	5.9 [A]	6.2 [A]	18 [A]	5.5 [A]	5.3 [A]	3.7 [A]	4.1 [A]	0.88 [A]	0.39 [A]	0.25 [A]	0.27 [A]
13	5.1 [A]	6.7 [A]	7.2 [A]	42 [A]	5.2 [A]	5.4 [A]	3.2 [A]	4.0 [A]	0.90 [A]	0.41 [A]	0.22 [A]	0.28 [A]
14	4.7 [A]	6.4 [A]	7.1 [A]	25 [A]	5.2 [A]	4.6 [A]	3.0 [A]	3.5 [A]	0.80 [A]	0.39 [A]	0.22 [A]	0.26 [A]
15	4.6 [A]	7.4 [A]	5.9 [A]	16 [A]	5.1 [A]	4.3 [A]	3.0 [A]	2.4 [A]	0.76 [A]	0.38 [A]	0.22 [A]	0.20 [A]
16	6.0 [A]	7.9 [A]	7.2 [A]	12 [A]	4.9 [A]	4.2 [A]	3.1 [A]	2.0 [A]	0.81 [A]	0.42 [A]	0.22 [A]	0.25 [A]
17	4.8 [A]	7.0 [A]	22 [A]	12 [A]	5.0 [A]	4.1 [A]	4.7 [A]	1.6 [A]	0.89 [A]	0.38 [A]	0.32 [A]	0.24 [A]
18	5.4 [A]	6.3 [A]	14 [A]	13 [A]	4.8 [A]	4.3 [A]	3.8 [A]	1.4 [A]	0.82 [A]	0.33 [A]	0.29 [A]	0.22 [A]
19	6.7 [A]	6.7 [A]	12 [A]	13 [A]	4.5 [A]	4.4 [A]	3.1 [A]	1.4 [A]	0.86 [A]	0.34 [A]	0.27 [A]	0.20 [A]
20	5.3 [A]	7.7 [A]	10 [A]	11 [A]	4.5 [A]	4.3 [A]	3.1 [A]	1.4 [A]	0.87 [A]	0.40 [A]	0.26 [A]	0.19 [A]
21	7.4 [A]	7.1 [A]	8.2 [A]	12 [A]	4.5 [A]	4.4 [A]	3.0 [A]	1.5 [A]	0.78 [A]	0.32 [A]	0.24 [A]	0.19 [A]
22	8.3 [A]	7.5 [A]	8.8 [A]	11 [A]	4.3 [A]	4.2 [A]	3.1 [A]	2.7 [A]	0.76 [A]	0.26 [A]	0.24 [A]	0.18 [A]
23	8.7 [A]	7.9 [A]	9.2 [A]	10 [A]	4.2 [A]	4.0 [A]	2.9 [A]	3.8 [A]	0.74 [A]	0.24 [A]	0.23 [A]	0.13 [A]
24	7.9 [A]	5.7 [A]	8.6 [A]	9.6 [A]	4.5 [A]	4.0 [A]	2.6 [A]	2.8 [A]	0.73 [A]	0.28 [A]	0.20 [A]	0.43 [A]
25	7.9 [A]	4.7 [A]	15 [A]	11 [A]	4.6 [A]	3.9 [A]	2.4 [A]	2.2 [A]	0.68 [A]	0.27 [A]	0.21 [A]	0.36 [A]
26	7.3 [A]	5.4 [A]	24 [A]	12 [A]	4.8 [A]	3.7 [A]	2.2 [A]	1.9 [A]	0.62 [A]	0.25 [A]	0.21 [A]	0.34 [A]
27	6.8 [A]	6.0 [A]	16 [A]	11 [A]	4.8 [A]	3.7 [A]	3.0 [A]	1.5 [A]	0.63 [A]	0.24 [A]	0.19 [A]	0.35 [A]
28	7.2 [A]	6.7 [A]	13 [A]	8.9 [A]	4.6 [A]	3.7 [A]	5.0 [A]	1.3 [A]	0.59 [A]	0.25 [A]	0.19 [A]	0.37 [A]
29	8.2 [A]	7.2 [A]	14 [A]	7.9 [A]	4.9 [A]	3.7 [A]	5.7 [A]	1.3 [A]	0.61 [A]	0.25 [A]	0.33 [A]	0.37 [A]
30	7.0 [A]		14 [A]	7.4 [A]	4.9 [A]	3.7 [A]	6.5 [A]	1.2 [A]	0.60 [A]	0.23 [A]	0.29 [A]	0.36 [A]
31	6.2 [A]		12 [A]		5.0 [A]		6.9 [A]	1.2 [A]		0.26 [A]		0.29 [A]
COUNT	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
MAX	**8.7**	**7.9**	**24**	**42**	**9.2**	**5.4**	**6.9**	**7.4**	**1.2**	**0.53**	**0.44**	**0.43**
MIN	**4.6**	**4.7**	**4.6**	**7.4**	**4.2**	**3.7**	**2.2**	**1.2**	**0.59**	**0.23**	**0.19**	**0.13**

Daily Mean Discharge, cubic feet per second 2013

DATE	Jan 2013	Feb 2013	Mar 2013	Apr 2013	May 2013	Jun 2013	Jul 2013	Aug 2013	Sep 2013	Oct 2013	Nov 2013	Dec 2013
1	0.21 A	0.15 A	0.50 A	0.77 A	1.4 A	0.73 A	0.46 A	0.32 e A	0.18 A	0.14 A	0.08 A	0.00 A
2	0.21 A	0.21 A	0.55 A	1.5 A	1.5 A	0.59 A	0.54 A	0.24 A	0.23 A	0.14 A	0.04 A	0.00 A
3	0.21 A	0.29 A	0.59 A	3.0 A	1.6 A	0.59 A	0.57 A	0.22 A	0.26 A	0.17 A	0.02 A	0.00 A
4	0.21 A	0.28 A	0.60 A	3.4 A	1.8 A	0.64 A	0.57 A	0.31 A	0.24 A	0.16 A	0.01 A	0.00 A
5	0.21 A	0.30 A	0.64 A	3.7 A	1.9 A	0.66 A	0.62 A	0.30 A	0.25 A	0.14 A	0.00 A	0.00 A
6	0.20 A	0.23 A	0.50 A	3.8 A	1.7 A	0.67 A	0.62 A	0.33 A	0.18 e A	0.12 A	0.00 A	0.00 A
7	0.19 A	0.20 A	0.64 A	3.8 A	1.3 A	0.64 A	0.66 A	0.30 A	0.11 A	0.12 A	0.00 A	0.00 A
8	0.18 A	0.29 A	1.1 A	4.2 A	1.2 A	0.67 A	0.61 A	0.32 A	0.16 A	0.12 A	0.00 A	0.00 A
9	0.18 A	0.34 A	0.91 A	4.4 A	1.3 A	0.74 A	0.50 A	0.43 A	0.20 e A	0.15 A	0.00 A	0.00 A
10	0.16 A	0.30 A	0.92 A	4.4 A	1.5 A	0.67 A	0.52 A	0.40 A	0.21 A	0.13 A	0.00 A	0.00 A
11	0.15 A	0.27 A	0.92 A	3.8 A	1.6 A	0.63 A	0.52 A	0.39 A	0.18 A	0.10 A	0.00 A	0.00 A
12	0.14 A	0.29 A	1.0 A	1.5 A	1.8 A	0.57 A	0.55 A	0.29 A	0.19 A	0.11 A	0.00 A	0.00 A
13	0.13 A	0.29 A	0.71 A	1.1 A	1.7 A	0.53 A	0.50 A	0.33 A	0.17 A	0.12 A	0.00 A	0.00 A
14	0.14 A	0.30 A	1.0 A	0.90 A	1.9 A	0.52 A	0.47 A	0.33 A	0.17 A	0.10 A	0.00 A	0.00 A
15	0.15 A	0.28 A	1.1 A	0.72 A	2.1 A	0.59 A	0.42 A	0.32 e A	0.15 A	0.09 A	0.00 A	0.00 A
16	0.11 A	0.33 A	1.1 A	0.72 A	2.1 A	0.48 A	0.39 A	0.33 e A	0.16 A	0.09 A	0.00 A	0.00 A
17	0.11 A	0.41 A	0.86 A	0.56 A	2.1 A	0.47 A	0.33 A	0.34 e A	0.14 A	0.07 A	0.00 A	0.00 P
18	0.17 A	0.36 A	0.75 A	0.41 A	2.3 A	0.52 A	0.32 A	0.36 A	0.15 e A	0.06 A	0.00 A	0.00 P
19	0.15 A	0.43 A	0.70 A	0.45 A	2.2 A	0.52 A	0.34 A	0.27 A	0.16 A	0.05 A	0.00 A	0.00 P
20	0.16 A	0.47 A	1.0 A	0.44 A	2.3 A	0.49 A	0.38 A	0.35 A	0.15 A	0.07 A	0.00 A	0.00 P
21	0.11 A	0.51 A	1.8 A	0.42 A	2.5 A	0.52 A	0.42 A	0.41 A	0.15 e A	0.08 A	0.00 A	0.00 P
22	0.08 A	0.46 A	2.5 A	0.48 A	2.7 A	0.51 A	0.41 A	0.44 A	0.14 e A	0.11 A	0.00 A	0.00 P
23	0.08 A	0.39 A	0.99 A	0.43 A	2.8 A	0.52 A	0.39 A	0.41 A	0.14 e A	0.12 A	0.00 A	0.00 P
24	0.21 A	0.42 A	0.89 A	0.42 A	2.8 A	0.54 A	0.41 A	0.35 e A	0.14 e A	0.12 A	0.00 A	0.00 P
25	0.19 A	0.49 A	0.70 A	0.45 A	2.5 A	0.51 A	0.36 A	0.33 e A	0.14 e A	0.14 A	0.00 A	0.00 P
26	0.13 A	0.49 A	0.65 A	0.50 A	2.0 A	0.56 A	0.39 A	0.30 e A	0.14 e A	0.14 A	0.00 A	0.00 P
27	0.14 A	0.42 A	0.57 A	0.58 A	1.7 A	0.51 A	0.36 e A	0.30 e A	0.14 e A	0.12 A	0.00 A	0.00 P
28	0.20 A	0.47 A	0.36 A	0.81 A	1.4 A	0.51 A	0.35 e A	0.29 A	0.14 A	0.12 A	0.00 A	0.00 P
29	0.24 A		0.48 A	1.1 A	1.1 A	0.49 A	0.35 e A	0.24 A	0.15 A	0.12 A	0.00 A	0.00 P
30	0.18 A		0.56 A	1.3 A	1.1 A	0.49 A	0.35 e A	0.21 A	0.13 A	0.13 A	0.00 A	0.00 P
31	0.14 A		0.63 A		0.91 A		0.33 e A	0.20 A		0.12 A		0.00 P
COUNT	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	
MAX	**0.24**	**0.51**	**2.5**	**4.4**	**2.8**	**0.74**	**0.66**	**0.44**	**0.26**	**0.17**	**0.08**	
MIN	**0.08**	**0.15**	**0.36**	**0.41**	**0.91**	**0.47**	**0.32**	**0.2**	**0.11**	**0.05**	**0**	

Daily Mean Discharge, cubic feet per second 2014

DATE	Jan 2014	Feb 2014	Mar 2014	Apr 2014	May 2014	Jun 2014	Jul 2014	Aug 2014
1	0.00 P	0.00 P	680 P	0.00 P	0.00 P	0.07 P	0.55 P	0.20 P
2	0.00 P	0.00 P	76 P	0.00 P	0.00 P	0.04 P	0.56 P	0.18 P
3	0.00 P	0.00 P	10 P	0.00 P	0.01 P	0.08 P	0.61 P	0.19 P
4	0.00 P	0.00 P	3.6 P	0.00 P	0.01 P	0.07 P	0.55 P	0.19 P
5	0.00 P	0.00 P	2.0 P	0.00 P	0.02 P	0.08 P	0.53 P	0.16 P
6	0.00 P	0.00 P	1.5 P	0.00 P	0.02 P	0.09 P	0.56 P	0.19 P
7	0.00 P	0.00 P	1.2 P	0.00 P	0.02 P	0.08 P	0.52 P	0.15 P
8	0.00 P	0.00 P	0.85 P	0.00 P	0.03 P	0.14 P	0.54 P	0.23 P
9	0.00 P	0.00 P	0.62 P	0.00 P	0.02 P	0.17 P	0.50 P	0.13 P
10	0.00 P	0.00 P	0.49 P	0.00 P	0.07 P	0.23 P	0.53 P	0.16 P
11	0.00 P	0.00 P	0.36 P	0.00 P	0.02 P	0.12 P	0.51 P	0.22 P
12	0.00 P	0.00 P	0.23 P	0.00 P	0.02 P	0.12 P	0.51 P	0.11 P
13	0.00 P	0.00 P	0.11 P	0.00 P	0.02 P	0.14 P	0.53 P	0.19 P
14	0.00 P	0.00 P	0.07 P	0.00 P	0.03 P	0.17 P	0.48 P	0.17 P
15	0.00 P	0.00 P	0.06 P	0.00 P	0.03 P	0.19 P	0.48 P	0.10 P
16	0.00 P	0.00 P	0.03 P	0.00 P	0.04 P	0.22 P	0.54 P	0.11 P
17	0.00 P	0.00 P	0.03 P	0.00 P	0.05 P	0.30 P	0.51 P	0.05 P
18	0.00 P	0.00 P	0.02 P	0.00 P	0.03 P	0.36 P	0.55 P	
19	0.00 P	0.00 P	0.03 P	0.00 P	0.03 P	0.26 P	0.50 P	
20	0.00 P	0.00 P	0.01 P	0.00 P	0.04 P	0.29 P	0.49 P	
21	0.00 P	0.00 P	0.01 P	0.00 P	0.04 P	0.29 P	0.43 P	
22	0.00 P	0.00 P	0.00 P	0.00 P	0.05 P	0.31 P	0.43 P	
23	0.00 P	0.00 P	0.00 P	0.00 P	0.06 P	0.38 P	0.38 P	
24	0.00 P	0.00 P	0.00 P	0.00 P	0.11 P	0.96 P	0.31 P	
25	0.00 P	0.00 P	0.00 P	0.00 P	0.09 P	1.3 P	0.31 P	
26	0.00 P	0.00 P	0.00 P	0.00 P	0.05 P	0.79 P	0.32 P	
27	0.00 P	0.00 P	0.00 P	0.00 P	0.06 P	0.67 P	0.32 P	
28	0.00 P	2.8 P	0.00 P	0.00 P	0.05 P	0.60 P	0.30 P	
29	0.00 P		0.00 P	0.00 P	0.11 P	0.54 P	0.26 P	
30	0.00 P		0.00 P	0.00 P	0.05 P	0.62 P	0.23 P	
31	0.00 P		0.00 P		0.06 P		0.22 P	
COUNT		**28**	**31**		**31**	**30**	**31**	**17**
MAX		**2.8**	**680**		**0.11**	**1.3**	**0.61**	**0.23**
MIN		**0**	**0**		**0**	**0.04**	**0.22**	**0.05**

Attachment B

Foster Park Production (acre-feet)[1] at 12 CFS and 2 CFS Thresholds (2007 - 2014)

Daily mean flow[2] < or = 12 cfs for entire month

Daily mean flow[2] < or = 2 cfs for entire month

2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
FP Intake Subsurface Flow	155.15	141.6	157.76	153.87	160.67	155.2	155.3	156.01	147.45	146.65	126.5	120.85	1777.01
Nye Well #11	22.62	18.48	20.57	19.77	20.8	19.73	19.51	17.45	16.67	15.03	11.85	10.76	213.24
Nye Well #2	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye Well #7	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye Well#8	0	0	0	0	0	0	0	0.33	9.19	0	0	0	9.52

Total Production 1999.77

2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
FP Intake Subsurface Flow	148.07	105.11	156.51	87.21	113.59	148.88	155.23	152.86	144.71	147.4	141.7	145.13	1646.4
Nye Well #11	17.12	13.23	20.82	19.75	19.54	16.99	19.67	20.88	19.18	15.08	9.33	21.81	213.4
Nye Well #2	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye Well #7	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye Well#8	14.88	38.01	95.74	102.27	100.57	87.48	120.51	96.99	103.79	51.33	25.23	14.76	851.56

Total Production 2711.36

2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
FP Intake Subsurface Flow	143.19	131.02	137.89	143.71	141.04	102.01	147.97	144.75	139.44	142.56	141.67	139.37	1654.62
Nye Well #11	4.97	0	16.9	21.88	20.7	11.24	19.03	6.68	15.12	8.51	9.48	17.36	151.87
Nye Well #2	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye Well #7	0	0	138.05	159.04	186.16	121.61	130.91	56.56	0	5.58	3.29	0.08	801.28
Nye Well#8	0	64.74	56.86	63.38	65.58	37.4	78.04	50.24	0	10.66	1.86	0.05	428.81

Total Production 3036.58

2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
FP Intake Subsurface Flow	86.98	105.5	156.61	148.87	123.67	134.3	148.08	149.75	143.24	138.02	114.66	106.01	1555.69
Nye Well #11	14.62	2.55	21.68	21.23	17.23	18.25	19.56	17.3	4.38	0.91	0	0.12	137.83
Nye Well #2	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye Well #7	0.02	4.2	72.79	127.18	53.71	0.35	118.08	209.25	214.96	55.79	0	42.56	898.89
Nye Well#8	0	28.99	54	83.53	49.74	68.62	93.23	54.35	3.47	69.79	18.4	44.31	568.43

Total Production 3160.84

2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
FP Intake Subsurface Flow	88.3	107.98	125.68	145.83	150.69	110.48	124.22	129.25	128.93	128.86	129.88	129.26	1499.36
Nye Well #11	19.59	12.84	22.63	17.01	10.1	16.9	17.91	17.89	17.67	17.23	17.35	7.61	194.73
Nye Well #2	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye Well #7	90.78	0	106.14	63.55	62.69	29.2	106.1	81.53	75.05	87.32	62.73	94.98	860.07
Nye Well#8	86.56	48.87	51.44	79.92	85.4	42.71	93.05	104.95	83.79	68.83	65.22	63.51	874.25
											Total Production		**3428.41**

2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
FP Intake Subsurface Flow	129.31	120.67	127.29	91.64	134.39	128.63	129.65	129.69	117.67	92.73	73.54	82.76	1357.97
Nye Well #11	0.02	15.63	5.05	12.44	17.66	15.61	9.88	0	0.02	0	0	0	76.31
Nye Well #2	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye Well #7	121.97	74.95	73.4	71.83	164.22	168.8	138.19	85.58	159.65	137.89	19.72	0	1216.2
Nye Well#8	30.29	36.77	0.08	23.54	68.83	78.94	52.44	60.47	71.85	67.95	83.51	91.12	665.79
											Total Production		**3316.27**

2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
FP Intake Subsurface Flow	84.08	93.84	123.96	90.03	137.65	118.48	106.55	97.32	92.24	72.36	37.95	21.26	1075.72
Nye Well #11	0	0	0	0	2.67	2.96	0.08	0	0	0	0	0	5.71
Nye Well #2	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye Well #7	0	0	32.68	72.18	59.9	178.58	161.57	134.3	96.92	61.11	34.79	23.93	855.96
Nye Well#8	65.36	11.33	0	0	0	0	0	0	0.04	21.97	75.52	67.47	241.69
											Total Production		**2179.08**

2014	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
FP Intake Subsurface Flow	16.72	17.65	80.32	79.02	122.03	115.78	106.02	N/A	N/A	N/A	N/A	N/A	537.54
Nye Well #11	0	0	0.28	0.01	0.16	0.67	0.18	N/A	N/A	N/A	N/A	N/A	1.3
Nye Well #2								N/A	N/A	N/A	N/A	N/A	0
Nye Well #7	2.14	0	128.39	165.9	168.55	162.09	163.46	N/A	N/A	N/A	N/A	N/A	790.53
Nye Well#8	65.43	50.19	96.34	98.08	106.06	103.22	106.37	N/A	N/A	N/A	N/A	N/A	625.69
											Total Production		**1955.06**

[1] City of Ventura Water Source Reports 2007 - 2014

[2] USGS Station 11118500 Ventura R NR Ventura nwis.waterdata.usgs.gov/nwis

N/A - Data not presently available

Attachment C

LOGGERS

Continuous monitoring data are collected using Onset dissolved oxygen loggers (model U26). Specifications are found in Figure 1. All calibrations and uses are in accordance with Onset manual directives.[1]

Figure: 1 Dissolved Oxygen U26 Logger Specifications

Specifications

Dissolved Oxygen	
Sensor Type	Optical (dynamic luminescence quenching)
Measurement Range	0 to 30 mg/L
Calibrated Range	0 to 20 mg/L; 0 to 35°C (32 to 95°F)
Accuracy	0.2 mg/L up to 8 mg/L; 0.5 mg/L from 8 to 20 mg/L
Resolution	0.02 mg/L
Response Time	To 90% in less than 2 minutes
DO Sensor Cap Life	6 months (cap expires 7 months after initialization)
Temperature	
Temperature Measurement/ Operating Range	-5 to 40°C (23 to 104°F), non-freezing
Temperature Accuracy	0.2°C (0.36°F)
Temperature Resolution	0.02°C (0.04°F)
Response Time	To 90% in less than 30 minutes

Pre-deployment calibrations are performed for DO loggers using the "Lab Calibration Tool" and 100% saturation method as outlined on page 3 and 4 of the Onset U26 logger manual. Loggers will be deployed during the dry season, approximately May through October to minimize loss of instrument due to high flows.

Copper tape is applied to dissolved oxygen loggers to limit fouling. Additionally, zip ties are used to secure all loggers inside PVC piping with holes drilled at approximate 1" intervals to maintain water flow and limit fouling. The loggers and housing are mounted to the side of a 10-15 pound river rock using steel all-thread and epoxy. Rocks are carefully placed in the thalweg of the river (in flowing water) to collect representative measurements.

Data will be collected from the loggers approximately every 2-3 weeks. SBCK staff will collect dissolved oxygen calibration measurements upon arriving at each site using a Hach HQ3d portable meter, and ensuring that the meter probe is as close as possible to the dissolved oxygen logger sensor. Calibration measurements will be recorded at each site at a precise continuous sensor sampling interval (for comparison), in accordance with Ventura River Stream Team QAQC protocols with the time of calibration noted. After the field calibration is complete, the loggers will be removed from the rock. Data data will be uploaded to an Onset Hobo waterproof shuttle the dissolved oxygen coupler following procedures outlined in the shuttle manual.[2] Specifications for the shuttle are shown in Figure 2.

[1] Onset Dissolved Oxygen Logger Manual. http://www.onsetcomp.com/files/manual_pdfs/15603-E-MAN-U26x.pdf.

Figure 2: Waterproof Shuttle Specifications

Specifications

Compatibility	All HOBO U-Series loggers with optic USB. Not compatible with the HOBO U-Shuttle (U-DT-1).
Data Capacity	63 logger readouts of up to 64K each
Operating Temperature	0° to 50°C (32° to 122°F)
Storage Temperature	-20° to 50°C (-4° to 122°F)
Wetted Materials	Polycarbonate case, EPDM o-rings and retaining loop
Waterproof	To 20 m (66 feet)
Time Accuracy	±1 minute per month at 25°C (77°F); see Plot A
Logger-to-Shuttle Transfer Speed	Reads out one full 64K logger in about 30 seconds
Shuttle-to-Host Transfer Speed	Full shuttle offload (4 MB) to host computer in 10 to 20 minutes, depending on computer
Batteries	2 AA alkaline batteries required for remote operation
Battery Life	One year or at least 50 complete memory fills, typical use
Weight	150 g (4 oz)
Dimensions	15.2 x 4.8 cm (6.0 x 1.9 inches)

After data is transferred to the shuttle any fouling that has accumulated will be removed from the logger and logger housing using hands, water, and/or a toothbrush. Loggers will then be reattached to the PVC housing using zip ties and re-mounted on the rock in the flowing water. Upstream and downstream photos, as well as flow measurements (discussed below) will also be taken at each site.

After data from each site has been transferred to the shuttle, data will be transferred to an SBCK computer using Onset's Hoboware software. Recorded field calibration measurements for dissolved oxygen will be applied to the Hoboware Dissolved Oxygen Assistant for post-processing and calibration purposes. Data will be exported from Hoboware to Microsoft Excel for analysis.

[2] Onset Waterproof Shuttle Manual. http://www.onsetcomp.com/files/manual_pdfs/10264-I-MAN-U-DTW-1.pdf.

FLOW

Flow measurements will be taken by SBCK staff during each logger maintenance trip (approximately every 2-3 weeks) using a Glow Water flow meter. Specifications are shown in Figure 3.

Figure 3: Global Water Flow Meter Specifications

Flow Probe Specifications

Range: 0.3-19.9 FPS (0.1-6.1 MPS)
Accuracy: 0.1 FPS
Averaging: True digital running average. Updated once per second.
Display: LCD, Glare and UV Protected
Control: 4 button
Datalogger: 30 sets, MIN, MAX, and AVG
Features: Timer, Low battery warning
Sensor Type: Protected Turbo-Prop propeller with magnetic pickup.
Weight:
- *Instrument:* 2 lbs. (0.9 kg) (FP111), 3 lbs. (1.4 kg) (FP211), 2.8 lbs. (1.3 kg) (FP311)
- *Shipping:* 13 lbs. (5.9 kg) (FP111), 23 lbs. (10.4 kg) ((FP211), 19 lbs. (8.6 kg) ((FP311)

Expandable Length: 3.7 to 6 ft (1.1 to 1.8 m) (FP111); 5.5 to 15 ft (1.7 to 4.6 m) (FP211); 2.5 to 5.5 ft (0.76 to 1.7 m) (FP311)
Materials:
- *Probe:* PVC and anodized aluminum with stainless steel water bearing
- *Computer:* ABS/Polycarbonate housing with polyester overlay

Power: Internal Lithium Battery, Approx 5 year life with typical use, Non-Replaceable
Auto Shutoff: After 5 minutes of inactivity
Operating Temperature: -4° to 158° F (-20° to 70° C)
Storage Temperature: -22° to 176° F (-30° to 80° C)
Carrying Case: The Flow Probe is shipped in a padded carrying case.
Approvals: CE

Total width from bank to bank of the flowing water is recorded. Depth and velocity is then recorded at several (minimum of 3) equally-spaced intervals along the width. All measurements will be taken in accordance with procedures outlined in the Global Water flow meter manual.[3] Total stream flow will be calculated by adding the volume of water from each equal segment.

[3] Global Water Flow Meter Manual. http://www.globalw.com/downloads/flowprobe/FP111.pdf.

Sherwood Valley
Homeowners Association

March 29, 2017

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

RE: **Comment Letter – Revisions to the Los Angeles Region 303(d) List**

We thank you for this opportunity to comment on the proposed changes to the 303(d) list prior to the upcoming public hearing on May 4, 2017. Representatives from the Lake Sherwood Joint Lake Advisory Committee plan to attend this meeting to discuss these important issues.

We appreciate the proposed removal of the two pollutants, Ammonia and Organic Enrichment/Low Dissolved Oxygen. This is gratifying and recognizes the positive results produced by the time, effort and expense the Association has put forth over many years to mitigate these concerns. Respectfully, however, we are troubled to see that Algae and Eutrophic remain on the list.

To help understand why these are still considered pollutants in Lake Sherwood, we reviewed the Los Angeles Water Board's website of the Draft 2016 303(d) List, and specifically Appendix G – Fact Sheets of the Draft. Here we see that the listing of Algae and Eutrophic are noted as "placeholders" to support decisions made prior to the 2006 Clean Water Act, and further that no evidentiary data samples were collected which could be used to assess these pollutants relative to the 2006 standards. Clearly there are zero measured exceedances of these standards at this point yet they remain on the list. It seems to us somewhat arbitrary to continue to consider these as "pollutants" in Lake Sherwood especially where there is a consistently good dissolved oxygen level, a continuous effort to remove excess plant growth via a special harvester with a full time crew, monthly monitoring of water chemistry, and special attention to and approved treatment of any algae that occurs as needed throughout the year. If sufficient justification does exist to continue to include these on the 303(d) list, we would appreciate having the reasons and rational detailed to us in writing so we may take any necessary actions to remove them in the future.

We are looking forward to the upcoming meeting. Thank you again for the opportunity to respond to the proposed changes.

Sincerely,

Annette Louder, CMCA, AMS, PCAM
General Manager
Sherwood Valley Homeowners Association, Inc.

cc: Jenny Newman, Chief, TMDL Unit 3, CRWQCB
LB Nye, PhD, Senior Environmental Scientist, CRWQCB
Lake Sherwood Joint Lake Advisory Committee, Sherwood Valley Homeowners Association, Inc.
Board of Directors, Sherwood Valley Homeowners Association, Inc.

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CALLEGUAS CREEK

Watershed Management Plan

A COOPERATIVE STRATEGY FOR
RESOURCE MANAGEMENT & PROTECTION

March 30, 2017

Electronic Submission: losangeles@waterboards.ca.gov

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 W 4th Street, Suite 200
Los Angeles, CA 90013

Subject: Comment Letter – Revisions to the Los Angeles Region 303(d) List

Dear Dr. Zhu,

The Stakeholders Implementing Total Maximum Daily Loads (TMDLs) in the Calleguas Creek Watershed (Stakeholders) appreciate the opportunity to provide comments on the proposed revisions to the Clean Water Act Section 303(d) List of impaired waterbodies in the Los Angeles Region [hereinafter referred to as 303(d) List] which was distributed for public review on February 8, 2017.

The development and implementation of TMDLs is a significant investment of resources and it is critical that the 303(d) List be based on sound science and methodologies. The Stakeholders understand that the Los Angeles Regional Water Board (Water Board) is proposing over 200 new waterbody-pollutant segment combination 303(d) listings, of which 95 changes fall within the Calleguas Creek Watershed (CCW). The Stakeholders have developed and implemented six effective TMDLs in the CCW and thus have extensive experience in the area. The Stakeholders have serious concerns with the Region's Proposed 303(d) List and feel that it requires significant review and modification before adoption. The Stakeholders request that the issues identified in this letter be addressed and the proposed 303(d) List be released for another 60-day comment period prior to adoption. Several of the issues identified herein have resulted in the inability of the proposed 303(d) List to be fully vetted and reviewed by the Stakeholders.

The requested modifications fall into four general categories:

1. New Category 5 listings that should not be listed due to incorrect thresholds being applied for the beneficial use and incorrect interpretation of the data (e.g., mismatched units, incorrectly assigned sample locations)
2. Potential delistings that may exist if all watershed data were evaluated (e.g., TMDL monitoring program and all wastewater treatment plant NPDES monitoring).
3. New Category 5A listings that should be categorized as Category 5B because TMDLs already exist to address the pollutants.
4. Errors in the listing information that make it difficult to fully evaluate the listings. Examples include inconsistencies between the Category 5 list (Appendix B) and the Proposed updates to the 303(d) List (Appendix A), incorrect HUC/Calwater designations, incorrect beneficial uses listed for the applicable water quality objectives, and inconsistent use of thresholds for interpreting narrative objectives.

The remaining sections of this letter provide the detailed list of requested changes to the 303(d) List and the rationale for the requests. In summary, the Stakeholders request that all waterbody-pollutant combinations in **Table 1** not be listed on the 303(d) List, the waterbody-pollutant combinations in **Table 3** be considered for delisting through analysis of all available watershed data, waterbody-pollutant combinations in **Table 4** and **Table 5** be designated as being addressed by a TMDL if they remain on the 303(d) List after the reassessment, and the errors and inconsistencies identified in Comment IV be addressed for all waterbodies.

I. REQUESTED MODIFICATIONS TO THE LISTING STATUS

Based on a review of the proposed Category 5 waterbody-pollutant combinations, the Stakeholders have identified a number of waterbodies that we feel should either be delisted based on available data or proposed listings that should not be listed based on errors in the evaluation. The requested modifications are shown in **Table 1**, below, with a summary of the justifications for the requested change. A detailed discussion of each of the justifications follows the table.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody segment	Pollutant	Justification
Calleguas Creek Reach 2 (estuary to Potrero Rd)	DDD	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody segment	**Pollutant**	**Justification**
Calleguas Creek Reach 2 (estuary to Potrero Rd)	DDE	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Dimethoate	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Nitrogen, Nitrate	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Specific Conductivity	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Total Dissolved Solids	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 3 (Potrero Road upstream to Conejo Creek confluence)	Mercury	• Data and objectives have different units (ng/L vs. µg/L); data do not exceed objectives.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Ammonia	• Data from agricultural drain rather than waterbody used as basis for listing decision. • TMDL data demonstrates delisting possible.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Bifenthrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Chloride	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Cyfluthrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Cypermethrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Malathion	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Mercury	• Data and objectives have different units (ng/L vs. µg/L); data do not exceed objectives.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody segment	Pollutant	Justification
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Nitrogen, Nitrate	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Permethrin	• Data from agricultural drain rather than waterbody used as basis for listing decision. • This pollutant is already covered by the Calleguas Toxicity TMDL.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Specific Conductivity	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Sulfates	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Total Dissolved Solids	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Chlorpyrifos	• Data does not appear to be from a station in Reach 12.
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Diazinon	• Data does not appear to be from a station in Reach 12.
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Malathion	• Data does not appear to be from a station in Reach 12.
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Temperature, water	• Inappropriately applied beneficial use criteria (see temperature comment below).
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Sulfate	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody. *
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Specific Conductivity	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*

Table 1. Waterbody-pollutant combinations that should not be listed		
Waterbody segment	**Pollutant**	**Justification**
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Total Dissolved Solids	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No. 2	Toxaphene	• J-flagged data incorrectly used in assessment.
Rio De Santa Clara/Oxnard Drain No. 3	Nitrogen, Nitrate	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Rio De Santa Clara/Oxnard Drain No. 3	Sulfate	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Rio De Santa Clara/Oxnard Drain No. 3	Specific Conductivity	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Rio De Santa Clara/Oxnard Drain No. 3	Total Dissolved Solids	• Maintained as a brackish waterbody therefore criteria do not apply. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.*
Rio De Santa Clara/Oxnard Drain No. 3	Toxicity	• Insufficient exceedances to warrant listing.
La Vista Drain (Ventura County)	Chlordane	• Data from agricultural drain rather than waterbody used as basis for listing decision. • J-flagged data incorrectly used in assessment.
La Vista Drain (Ventura County)	Chlorpyrifos	• Data from agricultural drain rather than waterbody used as basis for listing decision.
La Vista Drain (Ventura County)	Copper	• Data from agricultural drain rather than waterbody used as basis for listing decision.
La Vista Drain (Ventura County)	DDD	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody segment	Pollutant	Justification
La Vista Drain (Ventura County)	DDE	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
La Vista Drain (Ventura County)	DDT	• Data from agricultural drain rather than waterbody used as basis for listing decision.
La Vista Drain (Ventura County)	Indicator Bacteria	• Data from agricultural drain rather than waterbody used as basis for listing decision.
La Vista Drain (Ventura County)	Mercury	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Data and objectives have different units (ng/L vs. µg/L); data do not exceed objectives.
Santa Clara Drain	Chlordane	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara Drain	Chlorpyrifos	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara Drain	Cypermethrin	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara Drain	DDD	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using COMM criteria; public access is prohibited by chain link fencing and locked gates.
Santa Clara Drain	DDE	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using COMM criteria; public access is prohibited by chain link fencing and locked gates.
Santa Clara Drain	DDT	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using COMM criteria; public access is prohibited with chain link fencing and locked gates.
Santa Clara Drain	Nitrogen, Nitrate	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Santa Clara Drain	Specific Conductivity	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.

Table 1. Waterbody-pollutant combinations that should not be listed

Waterbody segment	Pollutant	Justification
Santa Clara Drain	Sulfates	• Data from agricultural drain rather than waterbody used as basis for listing decision.
Santa Clara Drain	Total Dissolved Solids	• Data from agricultural drain rather than waterbody used as basis for listing decision. • Incorrectly listed using guideline for MUN beneficial use that is not applicable to waterbody.
Santa Clara Drain	Toxaphene	• Data from agricultural drain rather than waterbody used as basis for listing decision.

*Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2 and Rio De Santa Clara/Oxnard Drain No. 3 are not listed in the Basin Plan and therefore do not have assigned beneficial uses but they are tributaries to Mugu Lagoon which does not have a MUN beneficial use and are brackish waterbodies that would not support the MUN beneficial use.

1. Agricultural Drain monitoring data incorrectly used as basis for listing decisions. There are multiple instances where listing decisions are based on data from the Ventura County Agricultural Irrigated Lands Group (VCAILG) which include monitoring data from agricultural drains. In several cases, data from agricultural drains that discharge to waterbody reaches were used to list the waterbody reach. The drains are not listed tributaries or waterbodies in the Basin Plan and are not located within the waterbody that is being listed. As a result, the data should not be used for the listing decisions for these waterbodies. Calleguas Creek Reach 2 and Reach 4 were listed using data from the VCAILG monitoring sites 02D_BROOM (Reach 2) and 04D_ETTG (Reach 4), which are the locations of agricultural drains which drain to Reach 2 and 4. These agricultural monitoring sites were selected to be representative of agricultural discharges to Calleguas Creek Reaches 2 and 4 and are not representative of receiving water conditions. Therefore, any data collected from these sites cannot be used to list the downstream Calleguas Creek Reaches. All listings should be evaluated to ensure that the monitoring locations were in receiving waters rather than agricultural drains.

In addition, La Vista Drain and Santa Clara Drain were listed as new waterbodies never before included in the previous 303(d) List even though data have been collected on both agricultural drains by the MS4 program since the early 1990s. These waterbodies are not designated in the Basin Plan or listed as a tributary in the Basin Plan appendices. The La Vista Drain is an agricultural drain designed to convey excess irrigation water from agricultural lands, and as such, it is predominantly an open ditch that flows alongside W. Los Angeles Avenue and then along Santa Clara Avenue where it becomes the Santa Clara Drain. Additionally, inclusion of the COMM beneficial use for the Santa Clara Drain is inappropriate, as public access is prohibited because of fencing and locked gates maintained by the Ventura County Watershed Protection District. Inclusion of the MAR and EST beneficial uses are also inappropriately applied to the Santa Clara Drain because the drain is located upstream of Highway 101 and is not tidally influenced. The monitoring location on each drain was selected to represent agricultural discharges for the Agricultural Waiver and was not designed to characterize receiving waters. Because these are agricultural drains and not tributaries, they should be removed from the Draft Category 5 list.

Requested Action:

- **Remove all listings shown in Table 1 that were based on Ag monitoring data from agricultural drains not representative of the listed waterbody and evaluate remaining listings to ensure no other listings are based on agricultural drain monitoring rather than receiving water monitoring.**
- **Remove the La Vista Drain and the Santa Clara Drain from the List as they are agricultural drains and not waterbodies that fall under the jurisdiction of the 303(d) List.**

2. Remove any pollutant listing based on municipal drinking water objectives where the MUN beneficial use does not apply.

Numerous listings were made using water quality objectives for the protection of the municipal drinking for waterbodies that do not have applicable municipal drinking water beneficial uses. Many of the waterbodies listed are brackish waterbodies for which no beneficial uses are designated or waterbodies designated for the municipal beneficial use with an asterisk (i.e., P*) in the Basin Plan. The asterisked MUN beneficial use should not be used to propose new 303(d) listings. Fact Sheets for previous 303(d) listing cycles have clearly noted that the asterisked MUN beneficial uses should not be used for 303(d) listing purposes.

State Board Resolution No. 88-63 (Sources of Drinking Water) and Regional Board Resolution 89-03 (Incorporation of Sources of Drinking Water Policy into the Water Quality Control Plans (Basin Plans)), state that "All surface and ground waters of the State are considered to be suitable, or potentially suitable, for municipal or domestic waters supply and should be so designated by Regional Boards… [with certain exceptions which must be adopted by the Regional Board]." The Regional Board adopted a Water Quality Control Plan for the Los Angeles Region (Basin Plan) on June 4, 1994, that included provisions to implement State Water Board Resolution 88-63. On May 26, 2000, the USEPA approved the revised Basin Plan except for the implementation plan for potential MUN-designated water bodies. On August 22, 2000, the City of Los Angeles, City of Burbank, City of Simi Valley, and the County Sanitation Districts of Los Angeles County challenged USEPA's water quality standards action in the U.S. District Court. On December 18, 2001, the court issued an order remanding the matter to USEPA to take further action on the 1994 Basin Plan consistent with the court's decision. On February 15, 2002, USEPA revised its decision and approved the 1994 Basin Plan in whole. In its February 15, 2002 letter, USEPA stated:

> *"EPA bases its approval on the court's finding that the Regional Board's identification of waters with an asterisk ("*") in conjunction with the implementation language at page 2-4 of the 1994 Basin Plan, was intended "to only conditionally designate and not finally designate as MUN those water bodies identified by an ("*') for the MUN use in Table 2-1 of the Basin Plan, without further action." Court Order*

> *at p. 4. Thus, the waters identified with an ("*") in Table 2-1 do not have MUN as a designated use until such time as the State undertakes additional study and modifies its Basin Plan. Because this conditional use designation has no legal effect, it does not constitute a new water quality standard subject to EPA review under section 303(c)(3) of the Clean Water Act ("CWA"). 33 U.S.C. § 1313(c)(3)."*[1]

In addition to the above decision, the Basin Plan states that until the additional study is undertaken and the Basin Plan is modified "no new effluent limitations will be placed in Waste Discharge Requirements as a result of these designations". The Regional Board has also determined that water quality objectives applicable to the MUN beneficial use will not be used to assess impairments under the 303(d) listing programs. For constituents that only have objectives that are applicable to the MUN beneficial use, the decision Fact Sheets for the 303(d) listing process state that there are no applicable water quality objectives in waterbodies designated with an asterisk ("*"). In the 2010 listing cycle, a number of 303(d) listings were actually removed based on this determination. Below is an example of the language from a listing decision for Los Angeles River Reach 1:

> *"The listing for aluminum in this water body was originally based on data assessed using the MCL for aluminum. Since MUN is a "potential" beneficial use, it is not appropriate to use the MCL to evaluate aluminum data from this reach. Thus, there is no aluminum objective for this reach and the original listing is faulty."*

Based on this evidence, it is clear that for waterbodies with a MUN designation that includes an asterisk ("*"), water quality objectives specific to the MUN beneficial use are not applicable. As such, water quality data collected in these receiving waters should not be compared to water quality objectives applicable to the MUN beneficial use.

The listings of total dissolved solids, sulfates, and conductivity are all based on secondary maximum contaminant levels applied to protect the MUN beneficial use. In addition, Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2 and Rio De Santa Clara/Oxnard Drain No. 3 are maintained as fresh/brackish water via tide gates on both drains and do not have designated MUN beneficial uses. Therefore, the listing of TDS, sulfate, and specific conductivity is inappropriate as naturally occurring levels of these three constituents in groundwater entering both drains within the footprint of Naval Base Ventura County far exceed the secondary MCLs upon which these listings are based. USEPA validated this reasoning in its "TMDLs for Pesticides, PCBs and Sediment Toxicity for Oxnard Drain 3",[2] where the MUN beneficial use was not considered to be "relevant to the impairments" addressed by the TMDL and so was not included in the TMDL. Additionally, Calleguas Creek Reach 2 and Reach 4 are considered brackish waterbodies according to the California Toxics Rule thresholds and

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[1] Language adapted from the 2014 National Pollutant Discharge Elimination System permit findings for wastewater treatment plants in the Calleguas Creek Watershed.

[2] Total Maximum Daily Loads for Pesticides, PCBs, and Sediment Toxicity in Oxnard Drain 3. Approved by USEPA on October 6, 2011.

are designated with an asterisked MUN beneficial use. Due to the brackish nature of these waterbodies, other Basin Plan objectives for TDS and sulfate are not considered to be applicable to Reach 2 or Reach 4 below Laguna Road. For all of these reasons, these proposed listings summarized in **Table 1** should not be listed.

The proposed Calleguas Creek Reach 2 dimethoate listing was based on three lines of evidence which the Fact Sheet states all show no exceedances (this appears to be a typo). However, it appears that the only line of evidence that shows an exceedance is based on the potential (P*) MUN, which as described above, cannot be used to justify a listing. Furthermore, the Fact Sheet cites a guideline from the California Department of Health Services Notification Levels (1 µg/L) which has not yet gone through the formal MCL regulatory process and it is not clear that this threshold would meet the Listing Policy requirements.

Requested Action:

- **Revise all of the new listings in the Fact Sheets to ensure that none are based on municipal drinking water objectives when the MUN beneficial use does not apply.**
- **Remove the segment-pollutant combinations for total dissolved solids, specific conductivity, sulfates, nitrogen, nitrate, dimethoate, and other MUN-based pollutants listed in Table 1 above from the 303(d) List.**

3. Reassess mercury listings using correct objective and correct units

The data used to assess mercury for Calleguas Creek Reach 3, Reach 4, and La Vista Drain are in ng/L and the objective is µg/L. The data have to be converted to the same units as the objective before an exceedance can be determined. The Stakeholders expect that after this calculation has been performed the waterbodies will no longer meet the listing guidelines for mercury. Additionally, although a California Toxics Rule objective exists for mercury, an EPA nationally recommended criterion was used for the assessment. An explanation for the use of a recommended criterion when an established water quality objective exists should be provided.

Requested Action:

- **Repeat the mercury analysis after correcting the units error.**

4. Incorrect location and data were used for listings in Reach 12

The name of the monitoring site presented in the Fact Sheet for the chlorpyrifos, diazinon and malathion listings in Calleguas Creek Reach 12 is unclear. The University site is in Reach 3, not 12 and TO1 is an MS4 discharge characterization site, not a receiving water monitoring location. Therefore, TO1 should not be used for a 303(d) listing decision and University data is not from Reach 12. A review of the datasets provided in the link on the Fact Sheet only show data from University (ME-CC) and the number of samples appears to match up with the sample numbers shown in the Fact Sheet. As a result, it appears that the chlorpyrifos, diazinon and malathion listings do not apply to Reach 12.

In addition, the Stakeholders request that only data collected *after* the implementation of applicable pesticide use restrictions were in place for these pesticides be considered in the listing decisions. Data from the Calleguas Creek TMDL watershed monitoring program that were not used in the assessment (see Comment II) demonstrates a marked reduction in these pesticides in receiving water since the use restrictions were implemented (approximately 2009 to present), particularly for receiving waters downstream of urban areas (e.g., Reach 12). Given the changed condition resulting from the pesticide use restrictions, monitoring data collected prior to 2009 is not representative of waterbody conditions for these constituents. Therefore, these constituents should not be listed unless data collected after the use restrictions were implemented demonstrates a continued impairment.

Requested Action:

- **Remove listings for Reach 12 that are not based on receiving water data from that reach.**
- **Remove listings for chlorpyrifos, diazinon, and malathion based on historic data that are not representative of conditions after implementation of pesticide use restrictions.**

5. Correct the proposed temperature listing for Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork on 1998 303d list) which is based on incorrect criteria.

The temperature listing for Reach 12 uses an evaluation guideline of 13-21°C as the optimum growth range for rainbow trout. However, the beneficial use listed for Reach 12 is WARM. The rainbow trout growth range threshold used for the listing is only applicable to the COLD beneficial use. This guideline should be removed and the number of exceedances recalculated based on the Basin Plan criteria for WARM. [3]

The basin plan criteria for WARM beneficial uses states the following: "*For waters designated as WARM, water temperature shall not be altered more than 5 degrees F above the natural temperature. At no time shall these WARM designated waters be raised above 80 degrees F as a result of waste discharges.*" The Fact Sheet states that of 567 samples there were 3 instances of the downstream sample exceeding 80°F and in some cases a 30°F difference between upstream and downstream reaches. The Fact Sheet statement is unclear because Reach 12 is the upstream location and is not downstream of a waste discharge. Reach 12 drains a portion of the City of Thousand

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[3] Notwithstanding that the evaluation guideline of 13-21°C is inappropriate for Calleguas Creek Reach 12 given the water body's beneficial uses, the manner in which the evaluation guideline is applied is also inappropriate. Line of Evidence (LOE) 85933 references Moyle 1976 as the source of the evaluation guideline. Moyle 1976 was revised and expanded by Moyle 2002[1]. Moyle 2002 states: "Rainbows are found where daytime temperatures range from nearly 0°C in winter to 26-27°C in summer, although extremely low (<4°C) or extremely high (>23°C) temperatures can be lethal if the fish have not previously been gradually acclimated. Even when acclimation temperatures are high, temperatures of 24-27°C are invariably lethal to trout, except for very short exposures (25, 26)." As such, while temperatures above 21°C may not be optimal according to Moyle 1976, Moyle 2002 clearly states that lethal temperatures are those greater than 23°C which indicates that the evaluation guideline of 21°C is more appropriately applied as a chronic guideline (necessitating the establishment of an averaging period) and 23°C is the more appropriate "not-to-exceed" guideline if used for listing.

Oaks and open space areas and is located upstream of the Thousand Oaks Wastewater Treatment Plant. Therefore, it is unclear if the exceedances discussed in the Fact Sheet actually occur in Reach 12 and if exceedances do occur, whether they are a result of waste discharge or are a natural condition. The data provided for review was not compiled in a way that made it possible to easily review the assessment to determine if the exceedances were observed in Reach 12 (upstream) or Reach 10 (downstream).

Regardless of the location of the samples, if there were 3 instances of temperature above 80°F and if they can be confirmed to be a result of waste discharge and not natural temperature conditions, according to the SWRCB 2015 303(d) Listing Policy[4] three samples out of 567 would not meet the minimum number of measured exceedances needed to place a water segment on the 303(d) List (see Listing Policy table 3.2). According to the binomial test, with a sample size of 500+ there would need to be well over 20 exceedances in order to be added to the 303(d) List, however, the Fact Sheet mentions only three exceedances of the Basin Plan criteria. According to the SWRCB's own guidance, this proposed listing should be removed.

Requested Action:

- **Do not use the 13-21°C rainbow trout evaluation guideline which only applies to COLD beneficial use segments.**
- **Remove the temperature listing for Reach 12 as it does not meet the minimum listing requirements based on the binomial test described above and ensure that the analysis is applied to the correct reach.**

6. Ensure no J-flagged data were used in the assessment.

The Listing Policy specifically prohibits the use of J-flagged ("estimated") data that fall below the quantitation limit but above the water quality standard. Section 6.1.5.5 of the Listing Policy specifically states:

> "*When the sample value is less than the quantitation limit and the quantitation limit is greater than the water quality standard, objective, criterion, or evaluation guideline, the result shall not be used in the analysis. The quantitation limit includes the minimum level, practical quantitation level, or reporting limit.*"

All listings based on the use of J-flagged data should, therefore, be removed from the draft 303(d) List. Specific instances are included in **Table 1** and further explained in **Table 2** below, but this list is by no means inclusive; this significant error will have to be addressed by a thorough review of all listing data to confirm that no J-flagged data were used to justify listings.

[4] State of California State Water Resources Control Board (SWRCB) Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. Amended February 3, 2015.

Table 2. Incorrect use of J-flagged data

Segment	Pollutant	Comment
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No. 2	Toxaphene	The Lines of Evidence (LOE) for Toxaphene lists the number of exceedances incorrectly at two. However, only one of six samples exceeded the indicated criterion. The other sample was reported by the laboratory as "estimated" (J-flagged). Because only one of six samples showed an exceedance this listing should be removed as it does not meet the binomial test limits set forth in the Listing Policy.
Rio de Santa Clara/Oxnard Drain No. 3	Chlordane	The LOE for Chlordane erroneously states that four out of five samples exceed the objectives. A review of the data shows that only 3 out of 5 samples exceed indicated criteria. The remaining 2 results were (1) not detected and (2) "estimated" (J-flagged) by the laboratory because results were below the reporting limit.
La Vista Drain	Chlordane	The LOE for chlordane shows that one of the samples used to justify the listing is based solely on estimated (J-flagged) data because results were below the reporting limit. Because Chlordane has only one detected value for two sampling events, more monitoring data are needed to justify the listing and the proposed listing should be removed.

Requested Action:

- **Review all Fact Sheets and LOEs for the use of J-flagged data and remove any instances where J-flagged data were used.**
- **Delist toxaphene for Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No. 2, chlordane for La Vista Drain, and any other pollutants listed in Tables 1 and 2 that lack the minimum number of exceedances required to justify a listing.**

7. Remove listings where a waterbody assessment does not meet listing thresholds based on data provided.

Finally, the toxicity listing for Rio De Santa Clara/Oxnard Drain No. 3 does not meet the minimum requirements to be listed according to the Listing Policy (pg. 9). According to the Listing Policy, a waterbody can be listed only when the number of exceedances meets the binomial test; in the case of this waterbody, four samples were collected and only one sample showed an exceedance. However, two exceedances would be required for the waterbody to be added to the 303(d) List. Therefore, toxicity was incorrectly listed for this waterbody and should be removed entirely from the 303(d) List.

Requested Action:

- **Remove the toxicity listing for Rio De Santa Clara/Oxnard Drain No. 3 based on meeting listing threshold requirements in the Listing Policy.**

II. REQUESTED REASSESSMENTS USING COMPLETE DATA SET

The assessments for the Calleguas Creek watershed do not appear to include any of the submitted Calleguas Creek Watershed TMDL monitoring data, monitoring data from the Camarillo Sanitary District, or monitoring data from the Simi Valley Wastewater Treatment Plant. All of this monitoring data has been provided to the Regional Board in annual monitoring reports and all data were collected using approved QAPPs. As a result, there is no reason why this data should not be included in the 303(d) listing process.

In 2013, the Stakeholders did an assessment of the watershed using all watershed data through 2012 and found that multiple waterbody-pollutant combinations could potentially be delisted as shown in **Table 3**. A summary of the assessment is included as an attachment to this letter and the datasets used in the analysis as well as all of the TMDL annual monitoring reports are available upon request.

Table 3. Waterbody-Pollutant Combinations to Consider for Delisting

Waterbody segment	Pollutant
Calleguas Creek Reach 1	Copper Dieldrin Endosulfan Mercury Nickel Zinc
Calleguas Creek Reach 2	Ammonia Copper
Calleguas Creek Reach 3	Ammonia Chlordane PCBs
Calleguas Creek Reach 4	Diazinon Dieldrin Endosulfan PCBs
Calleguas Creek Reach 6	Ammonia Chlordane Diazinon Dieldrin
Calleguas Creek Reach 7	Ammonia Diazinon
Calleguas Creek Reach 9A	Chlordane DDT Dieldrin Endosulfan Gamma HCH Nitrate as Nitrate Nitrogen, Nitrate PCBs Toxaphene
Calleguas Creek Reach 9B	Ammonia Chlordane Chlorpyrifos

Waterbody segment	Pollutant
	Diazinon Dieldrin Endosulfan PCBs Sulfates
Calleguas Creek Reach 10	Ammonia Chlordane Chlorpyrifos DDT Diazinon Dieldrin Endosulfan Fecal Coliform/Indicator Bacteria Nitrogen, Nitrite PCBs Sulfates Total Dissolved Solids Toxaphene
Calleguas Creek Reach 12	Ammonia DDT Dieldrin PCBs Toxaphene
Calleguas Creek Reach 13	Ammonia Chlordane DDT Dieldrin Endosulfan PCBs Toxaphene

While we recognize that this assessment uses two additional years of data than the current 303(d) listing analysis, a number of these waterbodies had many more samples than were necessary for delisting. As a result, we feel if all the watershed data were used in the assessment, a number of these waterbodies (particularly for metals) would be delisted. We also feel this assessment would demonstrate that several of the proposed listings, particularly for diazinon and chlorpyrifos and a number of organochlorine pesticides, are not warranted. A large number of new proposed listings are being added that are already covered by a TMDL. While the list acknowledges that a TMDL does not need to be developed by categorizing these new listings in Category 5B, in several cases, the watershed now has sufficient data to delist, whereas the listing is an artifact of old data being used to make the listing decision. These listings should not be added to the current list only to be removed during the next listing cycle as an artifact of the timing of the listing assessments.

Requested Action:

- **Reassess all Calleguas Creek waterbodies using all available data.**

III. REQUESTED CATEGORY ASSIGNMENT CHANGES

8. Correct pollutants listed as Category 5A which should be 5B based on coverage by an existing TMDL.

There are a number of proposed new listings for pollutants that are already covered by an existing TMDL and are incorrectly categorized as 5A. While the Stakeholders maintain that all of these listings should be removed entirely because of the issues detailed in Comment I, if they are not removed they should, at a minimum, be changed from 5A to 5B, as applicable.

A nutrient TMDL addressing nitrogen has been in effect since 2003, including for Reach 9A where a new 5A listing for nitrite is proposed. In 2006, the Toxicity and OC Pesticide and PCBs TMDLs for the Calleguas Creek watershed were established to address chlordane, chlorpyrifos, DDT, DDE, DDD, dieldrin, PCBs, sediment toxicity, and toxaphene. The La Vista Drain and Santa Clara Drain ultimately flow into Calleguas Creek Reach 4 (was Revolon Slough Main Branch), which is already addressed by an OC Pesticides and PCBs TMDL, the Toxicity TMDL, the Salts TMDL, and the Metals TMDL and therefore all of these proposed listings should be Category 5B. Furthermore, two other segments were listed for Chlorpyrifos – Honda Barranca and Duck Pond Agricultural Drains – but were correctly listed as Category 5B, citing the 2006 Toxicity TMDL. The Stakeholders request that any listings in **Table 4** and **Table 5** that are maintained after addressing the issues in Comment I should also be corrected to be designated as Category 5B.

Table 4. 303(d) Category 5A listings which should be changed to 5B listings

Segment	Pollutant	Proposed 303(d) Category	Requested 303(d) Category	Existing CCW TMDL[5,6,7,8,9,10]
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Specific Conductivity	5A	5B	Salts TMDL
	Total Dissolved Solids	5A	5B	Salts TMDL
Calleguas Creek Reach 3 (Potrero Road upstream to Conejo Creek)	Mercury	5A	5B	Metals TMDL
Calleguas Creek Reach 4	Mercury	5A	5B	Metals TMDL
	Specific Conductivity	5A	5B	Salts TMDL
	Total Dissolved solids	5A	5B	Salts TMDL
	Sulfates	5A	5B	Salts TMDL
Calleguas Creek Reach 9A	Nitrogen, Nitrite	5A	5B	Nitrogen TMDL
Calleguas Creek Reach 12	Chlorpyrifos	5A	5B	Toxicity TMDL
	Diazinon	5A	5B	Toxicity TMDL
Honda Barranca	DDT	5A	5B	OC Pesticides and PCBs TMDL
Rio De Santa Clara/Oxnard Drain No. 3	Toxicity	5A	5B	Oxnard Drain #3 Pesticides, PCBs, Sediment Toxicity TMDL
La Vista Drain (Ventura County)	Chlorpyrifos	5A	5B	Toxicity TMDL
	Chlordane	5A	5B	OC Pesticides and PCBs TMDL
	DDT	5A	5B	OC Pesticides and PCBs TMDL
	DDE	5A	5B	OC Pesticides and PCBs TMDL
	DDD	5A	5B	OC Pesticides and PCBs TMDL
	Copper	5A	5B	Metals TMDL
	Mercury	5A	5B	Metals TMDL
Santa Clara Drain	Chlordane	5A	5B	OC Pesticides and PCBs TMDL
	Chlorpyrifos	5A	5B	Toxicity TMDL
	DDD	5A	5B	OC Pesticides and PCBs TMDL
	DDE	5A	5B	OC Pesticides and PCBs TMDL
	DDT	5A	5B	OC Pesticides and PCBs TMDL
	Nitrogen, Nitrate	5A	5B	Nutrients TMDL
	Specific Conductivity	5A	5B	Salts TMDL

[5] The Calleguas Creek Watershed Metals TMDL. RS 2006-012. Approved by USEPA on March 26, 2007.

In addition, we feel that the Toxicity TMDL should cover all new listings in the watershed for pyrethroids and organophosphate pesticides (e.g., malathion) if they are not removed as requested in the first comment. The Toxicity TMDL includes a trigger for additional investigation if ongoing toxicity is identified in the watershed. The toxicity trigger has resulted in the identification of pyrethroids as a potential cause of toxicity and the Stakeholders have already begun actions to address these pesticides in addition to the organophosphate pesticides included in the TMDL. The structure of the TMDL is designed to proactively prevent toxicity and therefore it is not necessary to develop another TMDL for these constituents. There are already sufficient controls in place through the agricultural waiver and MS4 permit. As a result, if the waterbodies are placed on the 303(d) List as new listings, we request that the waterbodies in **Table 5** be changed from 5A to 5B.

Table 5. Pyrethroid and Organophosphate listings which covered by the existing Toxicity TMDL[11]

Segment	Pollutant	Proposed 303(d) Listing Category	Requested 303(d) Listing Category
Calleguas Creek Reach 4 (was Revolon Slough Main Branch)	Bifenthrin	5A	5B
	Cyfluthrin	5A	5B
	Cypermethrin	5A	5B
	Malathion	5A	5B
	Permethrin	5A	5B
Calleguas Creek Reach 12 (was Conejo Creek/Arroyo Conejo North Fork)	Malathion	5A	5B
Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	Bifenthrin	5A	5B
Honda Barranca	Bifenthrin	5A	5B
Santa Clara Drain	Cypermethrin	5A	5B

Requested Action:

- **Change all pollutant-waterbody segment combinations in Table 4 and Table 5 from 5A to 5B or 4A based on coverage by an existing USEPA approved TMDL.**

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6 The Calleguas Creek, Its Tributaries, and Mugu Lagoon Toxicity, Chlorpyrifos and Diazinon TMDL. RS 2005-009. Approved by USEPA on March 24, 2006.
7 The Calleguas Creek Nitrogen TMDL. RS 2002-017. Approved by USEPA on June 20, 2003.
8 Total Maximum Daily Load for Organochlorine Pesticides, Polychlorinated Biphenyls, and Siltation in Calleguas Creek, its Tributaries and Mugu Lagoon. RS 2005-010. Approved by USEPA on March 24, 2006.
9 The Calleguas Creek Watershed Salts TMDL. RS 2007-016. Approved by USEPA on December 2, 2008.
10 Total Maximum Daily Loads for Pesticides, PCBs, and Sediment Toxicity in Oxnard Drain 3. Approved by USEPA on October 6, 2011.
11 The Calleguas Creek, Its Tributaries, and Mugu Lagoon Toxicity, Chlorpyrifos and Diazinon TMDL. RS 2005-009. Approved by USEPA on March 24, 2006.

IV. ADDRESS ALL OTHER INCONSISTENCIES AND ERRORS IN LIST

In reviewing the list the Stakeholders identified a large number of inconsistencies and issues in the list that should all be addressed prior to adoption. The summary below provides examples of issues identified and is not a comprehensive list as in many cases the information provided made it challenging to provide comprehensive comments.

9. Correct Appendix G Fact Sheets. The Appendix G Fact Sheets often include incorrect information and discussion. While most of the identified issues do not appear to impact the listing decisions, they make the review of information difficult. Examples of errors found include:

- Incorrect beneficial uses assigned to a waterbody. For example, MUN beneficial uses assigned to a tidally-influenced waterbody (e.g., Duck Ponds Agricultural Drain).
- Incorrect beneficial uses assigned to objectives. For example, MUN beneficial uses listed when aquatic life objectives are presented in the Fact Sheet.
- Incorrect TMDLs assigned to a pollutant. For example, for chlordane in Calleguas Creek Reach 2, the applicable TMDL is listed as the Calleguas Creek Metals TMDL. It should be the Organochlorine Pesticides, PCBs, and Siltation TMDL.
- Incorrect QAPPs identified. For example, the VCAILG QAPP is often referenced for the Ventura County MS4 monitoring data set.
- Incorrect number of samples evaluated and incorrect number of criteria exceedances. For example, the number of samples evaluated for toxaphene on the Rio de Santa Clara/Oxnard Drain No. 3 is identified as 2 samples, whereas data files obtained from the Regional Board website contain 5 samples for the date range indicated in Fact Sheets, including 3 samples with results of "ND". Stating that a pollutant actually exceeds criteria in only 40% of samples, versus 100% exceedances as presented in Fact Sheets, provides a more accurate picture of the degree of impairment for that pollutant in a waterbody. The inclusion of J-flagged data when enumerating exceedances (e.g., for chlordane in the same waterbodies) further exacerbates these numbering inaccuracies.

  Requested Action:
  Correct the Appendix G Fact Sheets for errors such as incorrectly assigned beneficial uses, existing TMDLs, QAPPs, and number of samples/number of exceedances.

10. Correct the Appendices and Fact Sheet Categories. Appendix A, Appendix B, Appendix C, and Appendix G are inconsistent which makes the analysis of new additions very difficult since it is unclear which segment-pollutant combinations actually are new listings. Following are examples of a number of identified issues that need to be corrected to allow the Stakeholders to fully vet and understand the proposed listings.

A number of proposed "name changes" in Appendix A are not shown in Appendix B and there are not associated Fact Sheets describing the name change (e.g., Reach 4 listings for chlorpyrifos and total DDT). This makes it very challenging to assess the validity or basis for the name change. In other instances, listed name changes are found in Appendix B or C but not supported by an explanation for the name change in Appendix G. The Fact Sheets for the following name changes should provide justification or explanation for the name change as many appear to be switching tissue or sediment listings to water listings. If this is, in fact, the change being made, the justification for the water listing needs to be provided in the Fact Sheet. It is not appropriate to modify the medium that is the basis for the listing as a name change.

Table 6. Listed as Name Changes in Appendix A

CCW Segment	Pollutants
Reach 1	Toxicity
Reach 2	Chlordane, Endosulfan, Toxaphene
Reach 4	Chlorpyrifos (tissue), Fecal Coliform, Total DDT
Reach 12	DDT (tissue), Ammonia
Rio De Santa Clara/Oxnard Drain No. 3	Toxicity
Duck Pond	ChemA

There are a number of inconsistencies where Appendix A does not include all of the new 2014 listings found in Appendix B. Below are a few examples of such inconsistencies.

Table 7. Incorrectly listed waterbody segment-pollutant combinations

Segment	Pollutant	Issue
La Vista Drain	DDT	Not included as a new change in Appendix A but listed as a new 2014 5A listing in Appendix B.
Honda Barranca	Bifenthrin	Not included as a new change in Appendix A but listed as a new 2014 5A listing in Appendix B.
Rio De Santa Clara/Oxnard Drain No. 3	Total Dissolved Solids	Not included as a new change in Appendix A but listed as a new 2014 5A listing in Appendix B.
	Toxicity	Listed only as a "name change" in Appendix A but listed as a new 2014 5A listing in Appendix B.
Calleguas Creek Reach 2 (estuary to Potrero Rd)	Indicator Bacteria	Not included as a change in Appendix A but listed as a new 5A listing in Appendix B. Clarify if this is a new listing or a "coliform bacteria" name change as described for Calleguas Reaches 6, 9A, 10, and 11.
	PCBs	Not included as a new change in Appendix A but listed as a new 2014 5B listing in Appendix B.
	Toxicity	Not included as a new change in Appendix A but listed as a new 2014 5B listing in Appendix B.
	ChemA	Not included as a new change in Appendix A but listed as a new 2014 5B listing in Appendix B despite cited as a historical use of pesticides and lubricants.
Calleguas Creek Reach 4	Cyfluthrin	Not included as a new change in Appendix A but listed as a new 2014 5A listing in Appendix B.

There are also a number of instances where existing waterbody-pollutant listings from the 2010 303(d) List were not stated as delisted in Appendix A and do not appear in Appendix B, C, or G under the waterbodies to delist. The Stakeholders would like clarification if these listings are in fact being delisted as some align with the assessment shown in **Table 3**.

Table 8. Not described as delisted in Appendix A but not found Appendix B or C

CCW Segment	Pollutants
Reach 2	Ammonia
Reach 3	Ammonia
Reach 4	Chlordane (tissue & sediment), DDT (tissue & sediment), PCBs (tissue), Toxaphene (tissue & sediment)
Reach 5	Chlordane (tissue & sediment), Chlorpyrifos (tissue), DDT (tissue & sediment), Dieldrin (tissue), Endosulfan (tissue & sediment), Nitrogen, PCBs (tissue), Toxaphene (tissue & sediment)
Reach 6	DDT (sediment)
Reach 9A	Chlorpyrifos, DDT (tissue), Dieldrin (tissue), Endosulfan (tissue), PCBs (tissue), Toxaphene (tissue & sediment)
Reach 9B	Endosulfan (tissue), Toxaphene (tissue & sediment)
Reach 10	DDT (tissue)
Reach 11	DDT (tissue), Endosulfan (tissue), Toxaphene (tissue & sediment)

Requested Action:
Correct the numerous inconsistencies described above in Table 6, Table 7, and Table 8 and ensure that all of the proposed 303(d) List appendices are internally consistent.

11. Correct the waterbody assigned Hydrologic Unit (HUCs) and Calwater numbers to reflect those listed in the Basin Plan. There are multiple instances of what appear to be incorrectly Hydrologic Unit numbers (HUCs) and Calwater numbers assigned to the various waterways. For instance, a comparison of the 8 digit HUCs listed in Appendix B of the 303(d) List to the 12 digit HUCs listed in Appendix I of the Basin Plan indicate a number of inconsistencies such that waterbodies present in the Santa Clara River Watershed (e.g., Santa Clara River Reach 1, 2, and 3) are listed with a Calleguas watershed HUC (18070103) while the same reaches are listed as 18070102 in the Basin Plan. This makes identifying the location of unknown waterbodies not previously listed or described in the Basin Plan to assess if they are receiving waters that should be assessed especially difficult. A full review of the 303(d) List HUCs should be completed to correct all errors.

Requested Action:
Perform a full review of HUCs and Calwater numbers listed in Appendix B through F and correct any inconsistencies with the Basin Plan.

12. Correct or clarify inconsistencies in the staff report. There is inconsistent discussion in the staff report about some proposed listings that should be clarified to avoid confusion about the listings. For instance, on page 10 of the Staff Report there is a discussion about existing TMDLs covering newly proposed pollutants "*For example, the proposed new listings for DDE and DDD in Calleguas Creek Reach 3 … are being addressed by the Calleguas Creek Organochlorine Pesticides, PCBs and Siltation TMDL … and would then be in Category 4A.*" However, we could find no listings of DDE and DDD for Reach 3 in any Appendix of the report including Appendix C – Category 4A Waterbody Segments. Furthermore, the Fact Sheets in Appendix G state that DDE and DDD should *not* be listed for Reach 3. We ask the RWQCB to either clarify or remove the above referenced statement and clarify any other inconsistencies between the staff report and the list.

Requested Action:
Correct or remove language cited on page 10 of the staff report regarding DDE and DDD listing of Calleguas Creek Reach 3 and clarify any other identified inconsistencies within the staff report.

13. Ensure that all thresholds being used for assessment are consistent and valid under the Listing Policy. In many cases, the same pollutant is assessed using different thresholds without any explanation for the basis of the threshold. Additionally, in several cases, an LC50 or threshold for individual species were used for the assessment, which is inconsistent with the Listing Policy which states that it must be demonstrated that an evaluation guideline is *"applicable to the beneficial use, protective of the beneficial use, scientifically-based and peer reviewed, and well described"*. Because it has not been demonstrated that the individual species response to these pollutants is applicable and protective of the beneficial use these guidelines should not be used to make a listing. The Stakeholders ask that the Board review all assessments for consistency, especially for the pesticides (bifenthrin, cyfluthrin, cypermethrin, malathion, permethrin) as well as applicability to the beneficial use as described in the Listing Policy.

Table 9. 303(d) Pollutants Using Thresholds for Interpreting Narrative Objectives

Pollutant	Segment	Objective Used
Bifenthrin	CCW Reach 4	0.0006µg/L (4-day average) from UC Davis[1]
	Honda Barranca	0.0006µg/L (4-day average) from UC Davis[1]
	Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2	0.00397µg/L mean acute value for mysid from Cal Dep of Fish and Game[2]
Cyfluthrin	CCW Reach 4	LC50: 29000µg/L from the USEPA OPP Pesticide Ecotox database
Cypermethrin	CCW Reach 4	0.002µg/L from the Cal Dep of Fish and Game[2]

Malathion	CCW Reach 4	0.28μg/L (4-day average) from UC Davis[1]
	CCW Reach 12	0.1μg/L USEPA[3]
Permethrin	CCW Reach 4	0.0002μg/L from UC Davis[1]

[1]Aquatic life water quality criteria derived via the UC Davis method: II. Pyrethroid insecticides. Reviews of Environmental Contamination and Toxicology 216:51-103.

[2] Hazard Assessment of the Synthetic Pyrethroid Insecticides Bifenthrin, Cypermethrin, Esfenvalerate, and Permethrin to Aquatic Organisms in the Sacramento-San Joaquin River System; 2000. Cal Dept. of Fish and Game. Report 00-6.

[3] USEPA National Recommended Water Quality Criteria (Red Book). 1976. United States Environmental Protection Agency. Office of Water. Office of Science and Technology.

The 303(d) List includes new listings for bifenthrin, cyfluthrin, cypermethrin, malathion, and permethrin in CCW. Currently, no water quality objectives have been promulgated by USEPA or the State of California for these pollutants and so the criteria listed are from a variety of studies. Some issues with these criteria include the following (this list is by no means inclusive; a thorough review of all listings for these pollutants should be undertaken):

- The criterion used for listing bifenthrin on Duck Pond Agricultural Drains/Mugu Drain/Oxnard Drain No 2 is 0.00397 μg/L based on the CDFG criteria. The selective use of a saltwater genus mean acute value is inappropriate when the CDFG study clearly states in the "Conclusions and Recommendations" section that "insufficient freshwater and saltwater acute toxicity data were available to calculate CMC values for bifenthrin." The same use of a criterion unsupported by the study author(s) applies to cypermethrin on the Santa Clara Drain.
- Use of LC50 for listing of cyfluthrin for CCW Reach 4 is inappropriate. LC50s do not meet the standard set forth in the Listing Policy as stated on page 20 " *the evaluation guideline… identifies a range above which impacts occur and below which no or few impacts are predicted*." By definition, an LC50 is simply the concentration at which half of the population of the tested species has died. The LC50 should not be used as the evaluation guideline.
- The criterion used for listing permethrin for Calleguas Creek Reach 4 is 0.0002μg/L based on the UC Davis[12] criteria. However, upon reviewing the UC Davis source the listed chronic standard for permethrin is 2 ng/L (page 92) which is 0.002μg/L, not 0.0002μg/L as listed in the 303(d) List.
- In many instances the incorrect evaluation guideline and guideline reference are used. For example, the evaluation guideline (i.e., criterion) provided for cyfluthrin (a pyrethroid) in LOEs 84065, 83200, and 88712 is for the chlorinated herbicide 2,4,5-TP. The stated criterion (29 mg/L) was not found in the cited guideline reference. Many additional instances were noted in LOEs for phorate, dimethoate, disulfoton, endosulfan sulfate, and many other LOEs. Because the numeric guidelines (and reference documents from which these are obtained)

[12] Aquatic life water quality criteria derived via the UC Davis method: ll. Pyrethroid insecticides. Reviews of Environmental Contamination and Toxicology 216:51-103.

form the basis for any listing, it is critical that these be carefully reviewed and verified prior to issuing the final Fact Sheets and 303(d) List.

Requested Action:

- **Review the guidelines used for interpreting narrative objectives and ensure that they are consistently applied and use correct unit conversions.**
- **Remove all guidelines that do not comply with the stated Listing Policy as described above.**

The Stakeholders appreciate the opportunity to comment on the 303(d) List and look forward to continuing to work with the Water Board to address these concerns. Thank you for your time and consideration of these comments. If you have questions, please contact Ashli Desai at (310) 394-1036 / AshliD@lwa.com or me at (805) 388-5334.

Sincerely,

Lucia McGovern
Chair of Stakeholders Implementing TMDLs in Calleguas Creek Watershed

Attachment A: Data Tables from CCW Water Quality Priorities Memorandum

Calleguas Creek Watershed Assessment

1. Data Sources

In order to fully evaluate the progress of TMDL implementation, as well as the general state of the watershed, data was collected from a variety of CCW stakeholders. Data sources include NPDES monitoring data from three Publicly Owned Treatment Works (POTWs) in the watershed along with long-term MS4 monitoring data from the County of Ventura. Ventura County Agricultural Irrigated Lands Group (VCAILG) monitoring data and available Navy data was also provided. Water, sediment, fish tissue, and toxicity data from ongoing TMDL and data was also retrieved from the State Water Quality Control Board's California Environmental Data Exchange Network (CEDEN).

Overall, a data set of over 375,000 data points gathered between 2003 and 2014 was compiled. The data set was then refined by focusing the analysis on receiving water samples and removing POTW effluent, MS4 outfalls, and agricultural discharge data.

The aggregation of data spanning the ten year study period revealed varying levels of completeness in the monitoring data; therefore several conservative assumptions were necessary to carry out the analysis. Where appropriate, constituents sampled under unknown wet/dry conditions were assumed to be sampled during dry weather conditions and were thus subject to dry weather criteria. POTW metals data reported without indication whether they were in the dissolved or total fraction were assumed to be reported in their dissolved fraction for constituents with dissolved targets (copper, nickel, and zinc). Mercury and selenium targets are for the total fraction; undesignated data for these constituents was assumed to be total. These assumptions were intended to provide the most conservative analysis of the data in light of the uncertainty related to the incomplete data.

Table 1. Summary of Receiving Water Data Used in Analysis

Monitoring Program/Data Source	Date Range		Number of Samples by Reach														Total
			1	2	3	4	5	6	7	8	9A	9B	10	11	12	13	
Camarillo POTW Monitoring	1/22/2003	11/5/2013									7221	237					7458
CCW Characterization Study DBF	1/1/2003	5/3/2005			125				799			238					1162
CCW Salts TMDL	1/31/2011	12/5/2013			296				154		151	135					736
CCW TMDL DBF	2/6/2002	2/3/2014	2593	120	1221	1237	119	596	726		66	525	494		110	414	8221
CCW TMDL Work Plan Monitoring	8/26/2003	10/27/2004	291	292	371	465	208	209	261	158	231	209	231	6	155	207	3294
Navy Monitoring	5/3/2003	1/7/2005	91	59		59											209
RWB4 So. CA Stormwater Monitoring Coalition	5/5/2008	5/13/2008						15		5	15	15			28		78
Simi Valley POTW Monitoring	1/8/2008	6/3/2014							4808								4808
SWAMP Perennial Stream Surveys	5/21/2008	5/21/2008			5												5
Thousand Oaks POTW Monitoring	1/15/2002	10/9/2013											4200		4250		8450
Ventura County MS4 Monitoring	2/12/2003	4/25/2014			4811	541	541							1			5894
Total:			**2975**	**471**	**6829**	**2302**	**868**	**820**	**6748**	**163**	**7684**	**1359**	**4925**	**7**	**4543**	**621**	**40315**

1.1 METALS AND SELENIUM TMDL

The Los Angeles Regional Water Quality Control Board (RWQCB) adopted Resolution No. R4-2006-012 to address water quality issues related to metals and selenium in Calleguas Creek, its tributaries and Mugu Lagoon.

Table 2 summarizes the analysis of available receiving water data for constituents included in the Metals TMDL, as well as the number of exceedances of the final numeric targets. The table illustrates that in most cases a sufficient number of samples is available and the data supports a delisting of the metals. It is important to note that compliance with metals and selenium targets in reach 2 was assessed using data from CCW TMDL monitoring site 01_RR_BR, which is located at the break between reach 1 and 2. Much of the POTW data did not distinguish between the dissolved and total fraction for metals constituents. For metals with dissolved targets (copper, nickel, and zinc) a conservative approach was used by comparing undistinguished metals samples to the dissolved targets. Mercury and selenium have established targets for total metals, in these instances all total and undistinguished samples were compared to these targets. For conservative analysis, available fish tissue mercury data was compared to the lowest fish tissue target for all samples.

Table 2. Analysis of Metals TMDL Constituents in Receiving Water by Reach

Copper (Dry)		303(d) Listed Reaches			Un-listed Reaches with TMDL Targets and Available Data								
Reach		1	2	4	3	5	6	7	9A	9B	10	11	12
Date Range Available		5/3/2003	6/10/2003	6/10/2003	6/5/2003	NS	5/13/2008	2/5/2003	2/19/2003	2/19/2003	2/6/2002	8/13/2013	2/6/2002
		11/5/2013	11/11/2008	11/5/2013	4/25/2014	NS	5/13/2008	5/6/2014	8/7/2013	5/7/2008	10/9/2013	8/13/2013	10/9/2013
TMDL Targets (ug/L):		4.7	11.4	3.1	25.9	3.1	29.3	29.3	27.9	27.9	27.9	27.9	27.9
Previous 10 Years	N	172	102	43	88	NS	1	71	41	2	127	1	129
	N Detect	166	94	41	88	NS	1	61	28	1	126	1	126
	N Exceed	26	30	13	19	NS	0	5	0	0	0	1	1
Previous 5 Years	N	100	29	28	36	NS	NS	44	18	NS	58	1	58
	N Detect	96	29	28	36	NS	NS	44	18	NS	58	1	58
	N Exceed	0	0	5	0	NS	NS	5	0	NS	0	1	1

Copper (Wet)		303(d) Listed Reaches			Un-listed Reaches with TMDL Targets and Available Data								
Reach		1	2	4	3	5	6	7	9A	9B	10	11	12
Date Range Available		10/27/2004	2/26/2004	2/13/2003	2/12/2003	2/13/2003	NS	NS	NS	NS	NS	NS	NS
		1/25/2013	10/27/2004	1/25/2013	2/28/2014	11/26/2008	NS	NS	NS	NS	NS	NS	NS
TMDL Targets (ug/L):		7.2	17.2	4.8	26.3	4.8	29.8	29.8	41.6	41.6	41.6	41.6	41.6
Previous 10 Years	N	NS	12	18	46	7	NS	NS	NS	NS	NS	NS	NS
	N Detect	NS	12	18	46	7	NS	NS	NS	NS	NS	NS	NS
	N Exceed	NS	0	3	0	7	NS	NS	NS	NS	NS	NS	NS
Previous 5 Years	N	NS	8	8	25	NS	NS	NS	NS	NS	NS	NS	NS
	N Detect	NS	8	8	25	NS	NS	NS	NS	NS	NS	NS	NS
	N Exceed	NS	0	0	0	NS	NS	NS	NS	NS	NS	NS	NS

Copper (Wet and Dry Data)	303(d) Listed Reaches			Un-listed Reaches with TMDL Targets and Available Data							
Reach	1	2	4	3	5	6	7	9A	9B	10	11	12
N (previous 5 years)	100	37	36	61	NS	NS	44	41[1]	NS	58	1	58
N Exceed	0	0	5	0	NS	NS	5	0	NS	0	1	1
	Potential for Delisting?			Achieving Targets per Listing Policy?								
	Yes	**Yes**	No	**Yes**	No[1]	NE[1]	No	**Yes**	NE[1]	**Yes**	ID[1]	**Yes**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detected and the potential for listing may exist.

Nickel (Dry)	303(d) Listed Reaches	Un-listed Reaches with TMDL Targets and Available Data

Reach		1	2	4	3	5	6	7	8	9A	9B	10	12
Date Range Available		5/3/2003	6/10/2003	6/10/2003	6/5/2003	NS	5/13/2008	2/5/2003	NS	2/19/2003	2/19/2003	2/6/2002	2/6/2002
		11/5/2013	11/11/2008	11/5/2013	4/25/2014	NS	5/13/2008	5/6/2014	NS	8/7/2013	5/7/2008	8/7/2013	8/7/2013
TMDL Target (ug/L):		8.2	8.2	8.2	149	8.2	168	168	168	160	160	160	160
Previous 10 Years	N	138	61	43	63	NS	1	71	1	41	2	44	46
	N Detect	138	59	43	63	NS	1	62	1	25	1	43	43
	N Exceed	0	11	9	0	NS	0	0	1	0	0	0	0
Previous 5 Years	N	100	29	28	36	NS	NS	44	NS	18	NS	19	19
	N Detect	100	29	28	36	NS	NS	44	NS	18	NS	19	19
	N Exceed	0	1	3	0	NS	NS	0	NS	0	NS	0	0

Nickel (Wet)		**303(d) Listed Reaches**			**Un-listed Reaches with TMDL Targets and Available Data**								
Reach		**1**	**2**	**4**	**3**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**
Date Range Available		10/27/2004	2/26/2004	2/13/2003	2/12/2003	2/13/2003	NS	NS	NS	NS	NS	NS	NS
		1/25/2013	1/25/2013	1/25/2013	2/28/2014	11/26/2008	NS	NS	NS	NS	NS	NS	NS
TMDL Targets (ug/L):		74	74	74	856	74	958	958	958	1292	1292	1292	1292
Previous 10 Years	N	NS	12	18	46	7	NS	NS	NS	NS	NS	NS	NS
	N Detect	NS	12	18	46	7	NS	NS	NS	NS	NS	NS	NS
	N Exceed	NS	0	0	0	0	NS	NS	NS	NS	NS	NS	NS
Previous 5 Years	N	NS	8	8	25	NS	NS	NS	NS	NS	NS	NS	NS
	N Detect	NS	8	8	25	NS	NS	NS	NS	NS	NS	NS	NS
	N Exceed	NS	0	0	0	NS	NS	NS	NS	NS	NS	NS	NS

Nickel (Wet and Dry Data)	**303(d) Listed Reaches**			**Un-listed Reaches with TMDL Targets and Available Data**							
Reach	**1**	**2**	**4**	**3**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**
N (previous 5 years)	100	37	36	61	NS	NS	44	NS	41[1]	NS	44[1]	46[1]
N Exceed	0	1	3	0	NS	NS	0	NS	0	NS	0	0
	Potential for Delisting?			**Achieving Targets per Listing Policy?**								
	Yes	**Yes**	No[2]	**Yes**	NE	NE	**Yes**	ID	**Yes**	NE	**Yes**	**Yes**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis.
2. Single exceedance over the number of allowable exceedances for the given sample size. Constituent is likely to have potential for delisting.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.
ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist.

Selenium (Dry)		303(d) Listed Reaches					Un-listed Reaches with TMDL Targets and Available Data					
Reach		**1**	**2[3]**	**4**	**3**	**5**	**6**	**7**	**9A**	**9B**	**10**	**12**
Date Range Available		8/26/2003	8/27/2003	8/28/2003	6/5/2003	3/29/2004	5/13/2008	8/5/2003	5/8/2008	5/7/2008	8/12/2003	5/5/2008
		11/5/2013	11/11/2008	11/5/2013	4/25/2014	9/7/2004	5/13/2008	6/3/2014	5/8/2008	5/7/2008	8/7/2013	5/13/2008
TMDL Targets (ug/L):		71	5	5	5	5	5	5	5	5	5	5
Previous 10 Years	N	138	64	55	66	7	1	199	1	1	41	43
	N Detect	113	51	51	63	7	1	190	1	1	32	41
	N Exceed	0	14	49	2	6	1	156	0	0	0	2
Previous 5 Years	N	100	29	29	36	NS	NS	132	NS	NS	19	19
	N Detect	75	25	29	36	NS	NS	132	NS	NS	18	19
	N Exceed	0	5	29	0	NS	NS	111	NS	NS	0	0

Selenium (Wet)		303(d) Listed Reaches					Un-listed Reaches with TMDL Targets and Available Data					
Reach		**1**	**2[3]**	**4**	**3**	**5**	**6**	**7**	**9A**	**9B**	**10**	**12**
Date Range Available		NS	2/26/2004	2/13/2003	2/12/2003	2/13/2003	NS	NS	NS	NS	NS	NS
		NS	1/25/2013	1/25/2013	2/28/2014	11/26/2008	NS	NS	NS	NS	NS	NS
TMDL Targets(ug/L):		290	290	290	--	290	--	--	--	--	--	--
Previous 10 Years	N	NS	12	18	46	7	NS	NS	NS	NS	NS	NS
	N Detect	NS	12	18	46	7	NS	NS	NS	NS	NS	NS
	N Exceed	NS	0	3	--	0	NS	NS	NS	NS	NS	NS
Previous 5 Years	N	NS	8	8	25	NS	NS	NS	NS	NS	NS	NS
	N Detect	NS	8	8	25	NS	NS	NS	NS	NS	NS	NS
	N Exceed	NS	0	3	--	NS	NS	NS	NS	NS	NS	NS

Selenium (Wet and Dry Data)	303(d) Listed Reaches			Un-listed Reaches with TMDL Targets and Available Data							
Reach	**1**	**2[3]**	**4**	**3**	**5**	**6**	**7**	**9A**	**9B**	**10**	**12**
N (previous 5 years)	100	37	37	36	NS[1]	NS[1]	132	NS[1]	NS[1]	41	43[1]
N Exceed	0	5	32	0	NS	NS	111	NS	NS	0	2
	Potential for Delisting?			**Achieving Targets per Listing Policy?**							
	Yes	No	No	**Yes[2]**	NE	ID	No	NE	NE	**Yes[2]**	**Yes**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis.
2. In reaches where wet weather targets were not established, only dry weather data were compared to dry weather targets
3. Data may not be representative of conditions in reach 2 due to the consideration of data that includes the influence of reach 4.

NE – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.
ID – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist.

Zinc (Dry)		303(d) Listed Reaches			Un-listed Reaches with TMDL Targets and Available Data								
Reach		1	2	4	3	5	6	7	9A	9B	10	11	12
Date Range Available		5/3/2003	6/10/2003	6/10/2003	6/5/2003	NS	5/13/2008	2/5/2003	2/19/2003	2/19/2003	2/6/2002	8/13/2013	2/6/2002
		11/5/2013	11/5/2013	11/5/2013	4/25/2014	NS	5/13/2008	5/6/2014	8/7/2013	5/7/2008	8/7/2013	8/13/2013	8/7/2013
TMDL Targets (ug/L):		81	81	81	338	81	382	382	365	365	365	365	365
Previous 10 Years	N	138	61	43	63	NS	1	77	41	2	44	1	46
	N Detect	124	57	35	63	NS	1	70	41	2	44	1	15
	N Exceed	1	0	1	0	NS	0	0	0	0	0	1	0
Previous 5 Years	N	100	29	28	36	NS	NS	48	18	NS	19	1	19
	N Detect	89	26	20	36	NS	NS	48	18	NS	19	1	1
	N Exceed	0	0	1	0	NS	NS	0	0	NS	0	1	0

Zinc (Wet)		303(d) Listed Reaches			Un-listed Reaches with TMDL Targets and Available Data								
Reach		1	2	4	3	5	6	7	9A	9B	10	11	12
Date Range Available		NS	2/26/2004	2/13/2003	2/12/2003	2/13/2003	NS	NS	NS	NS	NS	NS	NS
		NS	1/25/2013	1/25/2013	2/28/2014	11/26/2008	NS	NS	NS	NS	NS	NS	NS
TMDL Targets (ug/L):		90	90	90	214	90	240	240	324	324	324	324	324
Previous 10 Years	N	NS	12	18	46	7	NS	NS	NS	NS	NS	NS	NS
	N Detect	NS	12	18	45	6	NS	NS	NS	NS	NS	NS	NS
	N Exceed	NS	0	0	0	0	NS	NS	NS	NS	NS	NS	NS
Previous 5 Years	N	NS	8	8	25	NS	NS	NS	NS	NS	NS	NS	NS
	N Detect	NS	8	8	25	NS	NS	NS	NS	NS	NS	NS	NS
	N Exceed	NS	0	0	0	NS	NS	NS	NS	NS	NS	NS	NS

Zinc (Wet and Dry Data)	303(d) Listed Reaches			Un-listed Reaches with TMDL Targets and Available Data								
Reach	1	2	4	3	5	6	7	9A	9B	10	11	12
N (previous 5 years)	100	37	36	61	NS	NS	48	41[2]	NS	44[2]	NS	46[2]
N Exceed	0	0	1	0	NS	NS	0	0	NS	0	NS	0
	Potential for Delisting?			Achieving Targets per Listing Policy?								
	Yes	Yes	Yes	Yes	NE	NE	Yes	Yes	NE	Yes	ID	Yes

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis.

NE – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

ID – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist.

Mercury		**303(d) Listed Reaches**			**Un-listed Reaches with TMDL Targets and Available Data**					
Reach		**1**	**2**	**4**	**3**	**5**	**7**	**9A**	**10**	**12**
Date Range Available		8/26/2003	8/27/2003	2/12/2003	2/12/2003	2/12/2003	8/5/2003	8/5/2003	8/15/2003	8/15/2003
		11/5/2013	11/5/2013	11/5/2013	4/25/2014	11/26/2008	5/6/2014	8/7/2013	10/9/2013	10/9/2013
TMDL Targets (ug/L):		0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
Previous 10 Years	N	136	75	61	114	7	66	39	123	123
	N Detect	102	60	55	103	7	59	5	24	23
	N Exceed	0	6	7	18	6	26	5	3	2
Previous 5 Years	N	100	37	37	65	NS	44	18	58	58
	N Detect	68	31	35	55	NS	44	2	12	12
	N Exceed	0	2	3	10	NS	24	2	0	0
		Potential for Delisting?			**Achieving Targets per Listing Policy?**					
		Yes	**Yes**	**Yes**	No	No	No	No	**Yes**	**Yes**

Table 3. Analysis of Metals TMDL Constituents in Sediment by Reach

Reach	Constituent	Date Range Available		TMDL target (ppb)[1]	Previous 10 Years			Previous 5 Years			Potential for Delisting
					N	N Detect	N Exceed	N	N Detect	N Exceed	
1	Copper	5/3/2003	8/18/2011	34,000	18	18	1	5	5	0	PD[2]
	Nickel	5/3/2003	8/18/2011	20,900	18	18	6	5	5	0	PD[2]
	Zinc	5/3/2003	8/18/2011	150,000	18	18	3	5	5	0	PD[2]
2	Copper	2/3/2004	8/22/2013	34,000	11	11	4	3	3	0	PD[2]

1. TMDL target only applies if sediment toxicity occurs.
2. No exceedances in most recent five years with a significant number of samples. Considering the exceedances that occurred more than five years ago would inappropriately categorize this as a higher priority.

PD (Potential Delisting) - Insufficient data to information listing decision, however a significant number of the most recent 5 years of monitoring are non-detect. The potential for delisting the reach may exist.

Table 4. Analysis of Metals TMDL Constituents in Fish Tissue by Reach

Mercury		1	2	3	4	5	6	7	9A	9B	10	12	13
Date Range Available		8/19/2008	5/6/2004	12/19/2003	12/18/2003	NS	12/16/2003	12/16/2003	12/19/2003	12/19/2003	12/18/2003	12/17/2003	12/17/2003
		8/21/2008	8/24/2004	8/24/2004	8/27/2013	NS	8/23/2004	8/23/2004	8/26/2004	8/26/2004	8/25/2004	8/25/2004	8/25/2004
TMDL Target (mg/kg MeHg)[1]:		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Previous 10 Years	N	9	2	10	23	NS	2	7	5	8	6	3	6
	N Detect	9	1	8	21	NS	1	7	5	8	6	3	6
	N Exceed	0	0	2	13	NS	0	6	4	5	6	0	6
Previous 5 Years	N	NS	NS	NS	13	NS	NS	NS	NS	NS	NS	NS	NS
	N Detect	NS	NS	NS	13	NS	NS	NS	NS	NS	NS	NS	NS
	N Exceed	NS	NS	NS	13	NS	NS	NS	NS	NS	NS	NS	NS
Potential for Delisting:		NE	NE	No	No	--	NE	No	No	No	No	NE	NE

1. Mercury was compared against Methyl-Mercury final numeric targets.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data

1.2 NUTRIENT TMDL

The Calleguas Creek Nitrogen Compounds and Related Effects (Nitrogen TMDL) was incorporated into the Water Quality Control Plan for the Los Angeles Region (Basin Plan) through the RWQCB adoption of Resolution No. R4-2002-017. An update to the Nitrogen TMDL has since been adopted (Resolution No. 2008-009) and went into effect on October 15, 2009. **Table 5** summarizes the comparison of available receiving water data to numeric objectives identified in the Nitrogen TMDL. The data supports the delisting of Ammonia-N and Nitrite-N in many of the river reaches where sufficient data is available.

Table 5. Analysis of Nitrogen TMDL Constituents in Receiving Water by Reach

Ammonia-N		**303(d) Listed Reaches**											**Un-listed Reaches with TMDL Targets and Available Data**
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**9A**	**9B**	**10**	**12**	**13**	**7**
Date Range Available		8/26/2003	8/28/2003	2/12/2003	2/12/2003	2/12/2003	8/28/2003	1/22/2003	1/22/2003	1/15/2002	1/15/2002	8/28/2003	1/8/2003
		11/5/2013	11/5/2013	4/25/2014	11/5/2013	11/6/2013	11/5/2013	11/6/2013	11/5/2013	11/6/2013	11/6/2013	11/5/2013	6/3/2014
TMDL Targets (mg/L)		8.1	5.5	8.4	5.7	5.7	8.7	9.5	9.5	8.4	3.2	5.1	4.7
Previous 10 Years	N	53	27	108	49	48	40	252	54	178	171	31	289
	N Detect	43	25	105	47	41	39	214	49	175	53	24	254
	N Exceed	0	0	0	0	0	0	0	0	1	10	0	32
Previous 5 Years	N	28	20	52	28	28	27	114	34	86	78	20	188
	N Detect	28	20	47	27	26	27	72	32	80	74	19	185
	N Exceed	0	0	0	0	0	0	0	0	0	0	0	0
		Potential for Delisting?											**Achieving Targets per Listing Policy?**
		Yes	**Yes[1]**	**Yes**	**Yes**	**Yes**	**Yes[1]**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes[1]**	**Yes**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis.

Nitrate-N		**303(d) Listed Reaches**											**Un-listed Reaches with TMDL Targets and Available Data**
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**9A**	**9B**	**10**	**12**	**13**	**7**
Date Range Available		8/21/2008	8/7/2008	1/1/2003	2/13/2003	2/13/2003	5/13/2008	1/22/2003	1/1/2003	1/15/2002	1/15/2002	8/7/2008	1/8/2003
		11/5/2013	11/5/2013	4/25/2014	11/5/2013	11/6/2013	11/5/2013	11/6/2013	11/5/2013	11/6/2013	11/6/2013	11/5/2013	6/3/2014
TMDL Targets (mg/L):		10	10	10	10	10	10	10	10	10	10	10	10
Previous 10 Years	N	31	22	115	38	38	31	242	93	168	171	22	284
	N Detect	31	22	113	37	38	31	242	93	167	169	22	284
	N Exceed	14	20	36	30	31	14	29	48	1	0	0	13
Previous 5 Years	N	28	20	52	28	28	27	114	34	86	78	20	188
	N Detect	27	19	51	27	27	26	72	31	77	62	20	188
	N Exceed	13	18	5	23	26	12	3	0	1	0	0	10
		Potential for Delisting?											**Achieving Targets per Listing Policy?**
		No	No	No	No	No	No[1]	**Yes**	**Yes**	**Yes**	**Yes**	**Yes[1]**	**Yes**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis.

Nitrite-N		303(d) Listed Reaches												Un-listed Reaches with TMDL Targets and Available Data	
		1	**2**	**3**	**4**	**5**	**6**	**9A**	**9B**	**10**	**11**	**12**	**13**	**7**	**8**
Date Range Available		8/21/2008	8/7/2008	1/1/2003	2/13/2003	2/13/2003	5/13/2008	1/22/2003	1/1/2003	1/15/2002	NS	1/15/2002	8/7/2008	1/8/2003	NS
		11/5/2013	11/5/2013	11/5/2013	11/5/2013	11/6/2013	11/5/2013	11/6/2013	11/5/2013	11/6/2013	NS	11/6/2013	11/5/2013	6/3/2014	NS
TMDL Targets (mg/L):		1	1	1	1	1	1	1	1	1	1	1	1	1	1
Previous 10 Years	N	32	22	96	38	38	31	242	93	168	NS	171	22	284	NS
	N Detect	21	22	79	37	36	31	217	70	65	NS	50	22	276	NS
	N Exceed	0	0	11	1	2	0	4	19	2	NS	2	0	12	NS
Previous 5 Years	N	29	20	32	28	28	27	114	34	86	NS	78	20	188	NS
	N Detect	28	18	30	28	27	26	55	31	69	NS	69	18	186	NS
	N Exceed	0	0	0	0	1	0	0	0	0	NS	0	0	0	NS
		Potential for Delisting?												**Achieving Targets per Listing Policy?**	
		Yes	NE	**Yes**	**Yes**	**Yes**	**Yes**[1]	**Yes**	**Yes**	**Yes**	--	**Yes**	NE	**Yes**	**--**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Nitrite-N + Nitrate-N		303(d) Listed Reaches												Un-listed Reaches with TMDL Targets and Available Data	
		1	**2**	**3**	**4**	**5**	**6**	**9A**	**9B**	**10**	**11**	**12**	**13**	**7**	**8**
Date Range Available		8/12/2008	8/7/2008	2/13/2003	2/13/2003	2/13/2003	5/13/2008	1/22/2003	1/1/2003	1/15/2002	NS	1/15/2002	8/7/2008	1/8/2003	5/7/2008
		11/5/2013	11/5/2013	11/5/2013	11/6/2013	11/6/2013	11/5/2013	11/6/2013	11/5/2013	11/6/2013	NS	11/6/2013	11/5/2013	6/3/2014	5/7/2008
TMDL Targets (mg/L)		10	10	10	10	10	10	10	10	10	10	10	10	10	10
Previous 10 Years	N	31	22	116	38	38	31	242	93	168	NS	166	22	284	1
	N Detect	31	22	115	37	38	31	242	93	167	NS	164	22	284	1
	N Exceed	14	21	37	31	31	14	30	48	0	NS	1	0	18	1
Previous 5 Years	N	28	20	52	28	28	27	114	34	86	NS	78	20	188	NS
	N Detect	28	20	52	28	28	27	114	34	85	NS	76	20	188	NS
	N Exceed	13	19	5	23	26	12	3	0	0	NS	0	0	12	NS
		Potential for Delisting?												**Achieving Targets per Listing Policy?**	
		No	No	No	No	No	No	**Yes**	**Yes**	**Yes**	--	**Yes**	NE	**Yes**	ID[1]

1. Historical monitoring data available; however, no samples in previous 5 years. Insufficient number of samples to inform a listing decision.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist.

1.3 OC PESTICIDES AND PCBS TMDL

The RWQCB adopted Resolution No. R4-2005-010 to incorporate the OC Pesticides and PCBs TMDL in Calleguas Creek, its Tributaries, and Mugu Lagoon into the Basin Plan. The TMDL became effective on March 24, 2006. Final numeric targets are specified for water, fish tissue, and/or sediment depending on the constituent. The TMDL also specifies load reductions for sediment and habitat preservation in Mugu Lagoon. **Table 6** summarizes the evaluation of receiving water concentrations in the watershed to TMDL targets. However, when TMDL numeric targets were found to be greater than the Human Health Consumption Criteria for Organisms Only, as outlined in Table (b)(1) §131.38 of 40 CFR Part 131, the Human Health Criteria were used in the analysis. Overall, constituents covered by the OC Pesticides and PCBs TMDL have not been detected in the previous ten years in water samples. DDT compounds, chlordane, and toxaphene are the exception, with exceedances within the past 5 years.

Table 6. Analysis of OC Pesticides and PCBs TMDL Constituents in Receiving Water by Reach.

4,4'-DDD		Un-listed Reaches with TMDL Targets and Available Data												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		6/10/2003	6/10/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	1/7/2005	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	10/9/2013	5/29/2014
WQO (ng/L):		0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Previous 10 Years	N	41	18	108	68	20	45	80	10	164	48	167	137	35
	N Detect	19	2	22	35	10	9	10	0	10	2	1	0	1
	N Exceed	17	1	22	35	10	9	10	0	10	2	1	0	1
Previous 5 Years	N	29	NS	54	31	NS	28	53	NS	68	30	80	58	19
	N Detect	11	NS	7	19	NS	8	8	NS	2	2	1	0	1
	N Exceed	11	NS	7	19	NS	8	8	NS	2	2	1	0	1
		Achieving Targets per Listing Policy												
		No	ID	No	No	No	No	No	NE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis
NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data
ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist

4,4'-DDE		Un-listed Reaches with TMDL Targets and Available Data												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		6/10/2003	6/10/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	1/7/2005	5/29/2014	5/29/2014	11/26/2008	2/19/2014	6/3/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	10/9/2013	5/29/2014
WQO (ng/L):		0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Previous 10 Years	N	41	18	108	68	20	45	247	10	164	48	167	137	35
	N Detect	30	8	65	57	15	9	178	0	24	11	1	0	4
	N Exceed	30	8	65	57	15	9	178	0	24	11	1	0	4
Previous 5 Years	N	29	NS	54	31	NS	28	162	NS	68	30	80	58	19
	N Detect	18	NS	31	30	NS	8	150	NS	6	7	1	0	4
	N Exceed	18	NS	31	30	NS	8	150	NS	6	7	1	0	4
		Achieving Targets per Listing Policy												
		No	No	No	No	No	No	No	NE	**Yes**	No	**Yes**	**Yes**	No

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data

4,4'-DDT		**303(d) Listed Reach**	**Un-listed Reaches with TMDL Targets and Available Data**											
Reach		**2[2]**	**1**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		6□10□2003	NS	2□12□2003	2□13□2003	2□13□2003	8□28□2003	8□28□2003	12□9□2003	2□19□2003	2□19□2003	2□6□2002	2□6□2002	8□28□2003
		5□13□2014	NS	5□29□2014	5□29□2014	11□26□2008	2□19□2014	5□29□2014	8□23□2004	8□7□2013	5□29□2014	5□29□2014	8□5□2013	5□29□2014
WQO (ng□L):		0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Previous 10 Years	N	59	NS	108	68	20	45	80	10	92	48	62	33	35
	N Detect	19	NS	24	29	8	10	7	0	10	1	2	0	1
	N Exceed	15	NS	24	29	8	10	7	0	10	1	2	0	1
Previous 5 Years	N	29	NS	54	31	NS	28	53	NS	34	30	31	9	19
	N Detect	6	NS	10	13	NS	8	6	NS	2	1	2	0	1
	N Exceed	6	NS	10	13	NS	8	6	NS	2	1	2	0	1
		Potential for Delisting	**Achieving Targets per Listing Policy**											
		No	--	No	No	No	No	No	NE	**Yes**	**Yes**	**Yes**	**Yes[1]**	**Yes[1]**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis
2. Station 01□RR□BR is located immediately downstream of the boundary between Reach 1 and Reach 2. The monitoring station was included in analysis of Reach 2 for this constituent due to its 303(d) listing.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Aldrin		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/7/2013	5/29/2014
WQO (ng/L):		0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	300
Previous 10 Years	N	32	11	108	61	20	45	80	10	92	48	84	55	35
	N Detect	0	0	1	0	0	0	1	0	6	0	0	0	0
	N Exceed	0	0	1	0	0	0	1	0	6	0	0	0	0
Previous 5 Years	N	29	NS	54	31	NS	28	53	NS	34	30	41	19	19
	N Detect	0	NS	0	0	NS	0	1	NS	3	0	0	0	0
	N Exceed	0	NS	0	0	NS	0	1	NS	3	0	0	0	0
		Achieving Targets per Listing Policy												
		Yes	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**	**Yes[1]**	**Yes[1]**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Endosulfan I		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/5/2013	5/29/2014
TMDL Targets (ng/L):		8.7	56	56	56	56	56	56	56	56	56	56	56	56
Previous 10 Years	N	32	11	108	61	20	45	80	10	92	48	62	33	35
	N Detect	0	0	0	0	0	0	0	0	6	0	1	0	0
	N Exceed	0	0	0	0	0	0	0	0	0	0	1	0	0
Previous 5 Years	N	29	NS	54	31	NS	28	53	NS	34	30	31	9	19
	N Detect	0	NS	0	0	NS	0	0	NS	0	0	1	0	0
	N Exceed	0	NS	0	0	NS	0	0	NS	0	0	1	0	0
		Achieving Targets per Listing Policy												
		Yes	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**	**Yes[1]**	**Yes[1]**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Endosulfan II		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/5/2013	5/29/2014
TMDL Targets (ng/L):		8.7	56	56	56	56	56	56	56	56	56	56	56	56
Previous 10 Years	N	32	11	108	61	20	45	80	10	92	48	62	33	35
	N Detect	0	0	0	0	0	0	0	0	0	0	0	0	0
	N Exceed	0	0	0	0	0	0	0	0	0	0	0	0	0
Previous 5 Years	N	29	NS	54	31	NS	28	53	NS	34	30	31	9	19
	N Detect	0	NS	0	0	NS	0	0	NS	0	0	0	0	0
	N Exceed	0	NS	0	0	NS	0	0	NS	0	0	0	0	0
		Achieving Targets per Listing Policy												
		Yes	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**	**Yes**[1]	**Yes**[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Chlordane (Total)		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/23/2004	5/29/2014
WQO (ng/L):		0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Previous 10 Years	N	32	11	108	58	20	45	50	10	92	48	43	14	35
	N Detect	9	0	10	11	5	1	3	0	0	3	3	0	1
	N Exceed	9	0	10	11	5	1	3	0	0	3	3	0	1
Previous 5 Years	N	29	NS	54	31	NS	28	30	NS	34	30	22	NS	19
	N Detect	8	NS	3	6	NS	1	3	NS	0	3	3	NS	1
	N Exceed	5	NS	3	6	NS	1	3	NS	0	3	3	NS	1
		Achieving Targets per Listing Policy												
		No	NE	**Yes**	No	No[1]	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**[1]	NE	**Yes**[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Dacthal		Un-listed Reaches with TMDL Targets and Available Data												
Reach		1	2	3	4	5	6	7	8	9A	9B	10	12	13
Date Range Available		8/21/2008	12/4/2003	12/3/2003	12/3/2003	12/4/2003	12/5/2003	12/5/2003	12/9/2003	12/4/2003	12/19/2003	12/4/2003	12/9/2003	12/5/2003
		8/26/2010	8/24/2004	4/25/2014	8/17/2010	11/26/2008	8/17/2010	8/17/2010	8/23/2004	8/23/2004	8/17/2010	8/17/2010	8/23/2004	8/17/2010
TMDL Targets (ng/L):		--[1]	3500000	3500000	3500000	3500000	3500000	3500000	3500000	3500000	3500000	3500000	3500000	3500000
Previous 10 Years	N	12	11	54	31	12	25	28	10	13	25	24	11	21
	N Detect	8	10	45	18	9	19	21	0	7	9	3	0	5
	N Exceed	--	0	0	0	0	0	0	0	0	0	0	0	0
Previous 5 Years	N	9	NS	34	10	NS	10	10	NS	NS	10	8	NS	7
	N Detect	6	NS	34	6	NS	8	9	NS	NS	4	3	NS	3
	N Exceed	--	NS	0	0	NS	0	0	NS	NS	0	0	NS	0
		Achieving Targets per Listing Policy												
		--	NE	**Yes**	**Yes[2]**	NE	NE	**Yes[2]**	NE	NE	NE	NE	NE	NE

1. TMDL does not establish salt water numeric targets that would apply to this reach.
2. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Dieldrin		Un-listed Reaches with TMDL Targets and Available Data												
Reach		1	2	3	4	5	6	7	8	9A	9B	10	12	13
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/7/2013	5/29/2014
WQO (ng/L):		0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Previous 10 Years	N	32	11	108	61	20	45	80	10	92	48	84	55	35
	N Detect	0	0	0	0	0	0	0	0	1	0	0	0	0
	N Exceed	0	0	0	0	0	0	0	0	1	0	0	0	0
Previous 5 Years	N	29	NS	54	31	NS	28	53	NS	34	30	41	19	19
	N Detect	0	NS	0	0	NS	0	0	NS	0	0	0	0	0
	N Exceed	0	NS	0	0	NS	0	0	NS	0	0	0	0	0
		Achieving Targets per Listing Policy												
		Yes	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**	**Yes[1]**	**Yes[1]**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Endrin		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/5/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/7/2013	5/29/2014
TMDL Targets (ng/L):		2.3	36	36	36	36	36	36	36	36	36	36	36	36s
Previous 10 Years	N	32	11	108	61	20	45	116	10	92	48	84	55	35
	N Detect	0	0	0	0	0	0	52	0	4	0	0	0	0
	N Exceed	0	0	0	0	0	0	1	0	0	0	0	0	0
Previous 5 Years	N	29	NS	54	31	NS	28	74	NS	34	30	41	19	19
	N Detect	0	NS	0	0	NS	0	44	NS	1	0	0	0	0
	N Exceed	0	NS	0	0	NS	0	1	NS	0	0	0	0	0
		Achieving Targets per Listing Policy												
		Yes	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**	**Yes**[1]	**Yes**[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

gamma-BHC (Lindane)		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/5/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	6/3/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/7/2013	5/29/2014
WQO (ng/L):		63	63	63	63	63	63	63	63	63	63	63	63	63
Previous 10 Years	N	32	11	108	61	20	45	247	10	92	48	84	55	35
	N Detect	0	0	1	0	1	0	156	0	4	0	2	1	0
	N Exceed	0	0	0	0	0	0	0	0	0	0	1	1	0
Previous 5 Years	N	29	NS	54	31	NS	28	162	NS	34	30	41	19	19
	N Detect	0	NS	0	0	NS	0	132	NS	1	0	1	0	0
	N Exceed	0	NS	0	0	NS	0	0	NS	0	0	0	0	0
		Achieving Targets per Listing Policy												
		Yes	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**	**Yes**[1]	**Yes**[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Heptachlor		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/7/2013	5/29/2014
WQO (ng/L):		0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Previous 10 Years	N	32	11	108	61	20	45	80	10	92	48	84	55	35
	N Detect	0	0	0	0	0	0	0	0	1	0	0	0	0
	N Exceed	0	0	0	0	0	0	0	0	0	0	0	0	0
Previous 5 Years	N	29	NS	54	31	NS	28	53	NS	34	30	41	19	19
	N Detect	0	NS	0	0	NS	0	0	NS	0	0	0	0	0
	N Exceed	0	NS	0	0	NS	0	0	NS	0	0	0	0	0
		Achieving Targets per Listing Policy												
		Yes	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**	**Yes**[1]	**Yes**[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Heptachlor Epoxide		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/7/2013	5/29/2014
WQO (ng/L):		0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Previous 10 Years	N	32	11	108	61	20	45	80	10	92	48	84	55	35
	N Detect	0	0	0	0	0	0	0	0	2	0	0	0	0
	N Exceed	0	0	0	0	0	0	0	0	1	0	0	0	0
Previous 5 Years	N	29	NS	54	31	NS	28	53	NS	34	30	41	19	19
	N Detect	0	NS	0	0	NS	0	0	NS	0	0	0	0	0
	N Exceed	0	NS	0	0	NS	0	0	NS	0	0	0	0	0
		Achieving Targets per Listing Policy												
		Yes	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**	**Yes**[1]	**Yes**[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Total PCBs		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	8/28/2003	8/28/2003	8/28/2003	8/28/2003	8/28/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/5/2013	5/29/2014
WQO (ng/L):		0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Previous 10 Years	N	32	11	104	58	19	45	80	10	96	49	62	33	35
	N Detect	5	0	2	0	1	0	0	0	1	0	1	0	0
	N Exceed	5	0	2	0	1	0	0	0	0	0	0	0	0
Previous 5 Years	N	29	NS	54	32	NS	28	53	NS	37	31	31	9	19
	N Detect	5	NS	1	0	NS	0	0	NS	0	0	0	0	0
	N Exceed	5	NS	1	0	NS	0	0	NS	0	0	0	0	0
		Achieving Targets per Listing Policy												
		No	NE	**Yes**	**Yes**	ID	**Yes**	**Yes**	NE	**Yes**	**Yes**	**Yes**	**Yes**[1]	**Yes**[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis
NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.
ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist

Toxaphene		**Un-listed Reaches with TMDL Targets and Available Data**												
Reach		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/21/2008	12/4/2003	2/12/2003	2/13/2003	2/13/2003	8/28/2003	8/5/2003	12/9/2003	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		5/13/2014	8/24/2004	5/29/2014	5/29/2014	11/26/2008	2/19/2014	5/29/2014	8/23/2004	8/7/2013	5/29/2014	5/29/2014	8/7/2013	5/29/2014
WQO (ng/L):		0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Previous 10 Years	N	31	11	108	61	20	45	116	10	92	48	84	55	35
	N Detect	15	0	16	23	1	10	59	0	0	4	1	0	1
	N Exceed	15	0	16	23	1	10	59	0	0	4	1	0	1
Previous 5 Years	N	28	NS	54	31	NS	28	74	NS	34	30	41	19	19
	N Detect	13	NS	11	19	NS	9	51	NS	0	3	1	0	1
	N Exceed	13	NS	11	19	NS	9	51	NS	0	3	1	0	1
		Achieving Targets per Listing Policy												
		No	NE[1]	No	No	ID[1]	No	No	NE[1]	**Yes**	No	**Yes**	**Yes**[1]	**Yes**[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis
NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.
ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist

Table 7. Analysis of OC Pesticides and PCBs TMDL Constituents in Sediment by Reach

4,4'-DDD		303(d) listed Reaches					Un-listed Reaches with TMDL Targets and Available Data				
Reach		1	2	4	5	6	3	7	9A	9B	10
Date Range Available		8/19/2008	8/27/2003	8/25/2003	NS	8/28/2003	8/25/2003	8/28/2003	8/27/2003	8/5/2008	8/27/2003
		8/18/2011	8/22/2013	8/21/2013	NS	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/27/2003
TMDLTargets (ng/dry kg):		2000	3500	3500	3500	3500	3500	3500	3500	3500	3500
Previous 10 Years	N	10	7	7	NS	7	7	7	7	6	1
	N Detect	5	2	5	NS	1	0	1	0	0	0
	N Exceed	4	1	4	NS	0	0	0	0	0	0
Previous 5 Years	N	5	5	5	NS	5	5	5	5	5	NS
	N Detect	0	1	4	NS	1	0	0	0	0	NS
	N Exceed	0	0	3	NS	0	0	0	0	0	NS
		Potential for Delisting					Achieving Targets per Listing Policy				
		No	ID	No	--	NE	NE	NE	NE	NE	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.
ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist

4,4'-DDE		303(d) listed Reaches					Un-listed Reaches with TMDL Targets and Available Data				
Reach		1	2	4	5	6	3	7	9A	9B	10
Date Range Available		8/19/2008	8/27/2003	8/25/2003	NS	8/28/2003	8/25/2003	8/28/2003	8/27/2003	8/5/2008	8/27/2003
		8/18/2011	8/22/2013	8/21/2013	NS	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/27/2003
TMDL Targets (ng/dry kg):		2200	1400	1400	1400	1400	1400	1400	1400	1400	1400
Previous 10 Years	N	10	7	7	NS	7	7	7	7	6	1
	N Detect	10	6	7	NS	4	5	3	7	6	0
	N Exceed	9	6	7	NS	4	4	3	7	6	0
Previous 5 Years	N	5	5	5	NS	5	5	5	5	5	NS
	N Detect	5	5	5	NS	4	4	2	5	5	NS
	N Exceed	4	5	5	NS	4	4	2	5	5	NS
		Potential for Delisting					Achieving Targets per Listing Policy				
		No	No	No	--	No	No	No	No	No	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data

4,4'-DDT		303(d) listed Reaches					Un-listed Reaches with TMDL Targets and Available Data				
Reach		1	2	4	5	6	3	7	9A	9B	10
Date Range Available		8/19/2008	8/27/2003	8/25/2003	NS	8/28/2003	8/25/2003	8/28/2003	8/27/2003	8/5/2008	8/27/2003
		8/18/2011	8/22/2013	8/21/2013	NS	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/27/2003
TMDLTargets (ng/dry kg):		1000	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]
Previous 10 Years	N	10	7	7	NS	7	7	7	7	6	1
	N Detect	4	0	2	NS	0	0	1	0	0	0
	N Exceed	4	--	--	--	--	--	--	--	--	--
Previous 5 Years	N	5	5	5	NS	5	5	5	5	5	NS
	N Detect	0	0	1	NS	0	0	0	0	0	NS
	N Exceed	0	--	--	--	--	--	--	--	--	--
		Potential for Delisting					Achieving Targets per Listing Policy				
		No	--	--	--	--	--	--	--	--	--

1. The TMDL does not establish numeric targets for freshwater reaches.

BHC-gamma		303(d) listed Reaches		Un-listed Reaches with TMDL Targets and Available Data							
Reach		4	5	1	2	3	6	7	9A	9B	10
Date Range Available		8/25/2003	NS	8/19/2008	8/27/2003	8/25/2003	8/28/2003	8/28/2003	8/27/2003	8/5/2008	8/27/2003
		8/21/2013	NS	8/18/2011	8/22/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/27/2003
TMDLTargets (ng/dry kg):		940	940	--[1]	940	940	940	940	940	940	940
Previous 10 Years	N	7	NS	10	7	7	7	7	7	6	1
	N Detect	0	NS	0	0	0	0	0	0	0	0
	N Exceed	0	NS	--	0	0	0	0	0	0	0
Previous 5 Years	N	5	NS	5	5	5	5	5	5	5	NS
	N Detect	0	NS	0	0	0	0	0	0	0	NS
	N Exceed	0	NS	--	0	0	0	0	0	0	NS
		Potential for Delisting		Achieving Targets per Listing Policy							
		NE	--		NE	NE	NE	NE	NE	NE	NE

1. The TMDL does not establish numeric targets for saltwater reaches.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data

Chlordane (Total)		303(d) listed Reaches		Un-listed Reaches with TMDL Targets and Available Data							
Reach		**4**	**5**	**1**	**2**	**3**	**6**	**7**	**9A**	**9B**	**10**
Date Range Available		8/25/2003	NS	8/19/2008	8/27/2003	8/25/2003	8/28/2003	8/28/2003	8/27/2003	8/5/2008	8/27/2003
		8/21/2013	NS	8/18/2011	8/22/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/27/2003
TMDLTargets (ng/dry kg):		4500	4500	500	4500	4500	4500	4500	4500	4500	4500
Previous 10 Years	N	7	NS	10	7	7	7	7	7	6	1
	N Detect	2	NS	3	0	0	0	0	0	0	0
	N Exceed	0	NS	3	0	0	0	0	0	0	0
Previous 5 Years	N	5	NS	5	5	5	5	5	5	5	NS
	N Detect	2	NS	0	0	0	0	0	0	0	NS
	N Exceed	0	NS	0	0	0	0	0	0	0	NS
		Potential for Delisting		**Achieving Targets per Listing Policy**							
		NE	--	No	NE	NE	NE	NE	NE	NE	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Dieldrin		Un-listed Reaches with TMDL Targets and Available Data								
Reach		**1**	**2**	**3**	**4**	**6**	**7**	**9A**	**9B**	**10**
Date Range Available		8/19/2008	8/27/2003	8/25/2003	8/25/2003	8/28/2003	8/28/2003	8/27/2003	8/5/2008	8/27/2003
		8/18/2011	8/22/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/27/2003
TMDLTargets (ng/dry kg):		20	2900	2900	2900	2900	2900	2900	2900	2900
Previous 10 Years	N	10	7	7	7	7	7	7	6	1
	N Detect	0	0	0	0	0	0	0	0	0
	N Exceed	0	0	0	0	0	0	0	0	0
Previous 5 Years	N	5	5	5	5	5	5	5	5	NS
	N Detect	0	0	0	0	0	0	0	0	NS
	N Exceed	0	0	0	0	0	0	0	0	NS
		Achieving Targets per Listing Policy								
		NE	NE	NE	NE	NE	NE	NE	NE	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Endrin		**Un-listed Reaches with TMDL Targets and Available Data**								
Reach		**1**	**2**	**3**	**4**	**6**	**7**	**9A**	**9B**	**10**
Date Range Available		8/19/2008	8/27/2003	8/25/2003	8/25/2003	8/28/2003	8/28/2003	8/27/2003	8/5/2008	8/27/2003
		8/18/2011	8/22/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/27/2003
TMDLTargets (ng/dry kg):		--[1]	2700	2700	2700	2700	2700	2700	2700	2700
Previous 10 Years	N	10	7	7	7	7	7	7	6	1
	N Detect	0	0	0	0	0	0	0	0	0
	N Exceed	--	0	0	0	0	0	0	0	0
Previous 5 Years	N	5	5	5	5	5	5	5	5	NS
	N Detect	0	0	0	0	0	0	0	0	NS
	N Exceed	--	0	0	0	0	0	0	0	NS
		Achieving Targets per Listing Policy								
		--	NE	NE	NE	NE	NE	NE	NE	NE

1. The TMDL does not establish numeric targets for saltwater reaches.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Heptachlor Epoxide		**Un-listed Reaches with TMDL Targets and Available Data**								
Reach		**1**	**2**	**3**	**4**	**6**	**7**	**9A**	**9B**	**10**
Date Range Available		8/19/2008	8/27/2003	8/25/2003	8/25/2003	8/28/2003	8/28/2003	8/27/2003	8/5/2008	8/27/2003
		8/18/2011	8/22/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/27/2003
TMDLTargets (ng/dry kg):		--[1]	600	600	600	600	600	600	600	600
Previous 10 Years	N	10	7	7	7	7	7	7	6	1
	N Detect	0	0	0	0	0	0	0	0	0
	N Exceed	--	0	0	0	0	0	0	0	0
Previous 5 Years	N	5	5	5	5	5	5	5	5	NS
	N Detect	0	0	0	0	0	0	0	0	NS
	N Exceed	--	0	0	0	0	0	0	0	NS
		Achieving Targets per Listing Policy								
		--	NE	NE	NE	NE	NE	NE	NE	NE

1. The TMDL does not establish numeric targets for saltwater reaches.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

PCBs (Total)		**Un-listed Reaches with TMDL Targets and Available Data**								
Reach		**1**	**2**	**3**	**4**	**6**	**7**	**9A**	**9B**	**10**
Date Range Available		8/19/2008	8/27/2003	8/25/2003	8/25/2003	8/28/2003	8/28/2003	8/27/2003	8/5/2008	8/27/2003
		8/18/2011	8/22/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/21/2013	8/27/2003
TMDL Targets (ng/dry kg):		23000	34000	34000	34000	34000	34000	34000	34000	34000
Previous 10 Years	N	10	7	7	7	7	7	7	6	1
	N Detect	3	0	0	0	0	0	0	0	0
	N Exceed	0	0	0	0	0	0	0	0	0
Previous 5 Years	N	5	5	5	5	5	5	5	5	NS
	N Detect	0	1	0	1	0	0	0	0	NS
	N Exceed	0	0	0	0	0	0	0	0	NS
		Achieving Targets per Listing Policy								
		NE	NE	NE	NE	NE	NE	NE	NE	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Table 8. Analysis of OC Pesticides and PCBs TMDL Constituents in Fish Tissue by Reach.

4,4'-DDD		**303(d) listed Reaches**										**Un-listed Reaches with TMDL Targets and Available Data**		
Reach		**1**	**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**12**	**13**	**3**	**6**	**7**
Date Range Available		8/19/2008	5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	12/17/2003	12/19/2003	12/16/2003	12/16/2003
		8/27/2008	8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/25/2004	8/27/2013	9/3/2009	8/28/2013
TMDL Targets (ng/kg):		45000	45000	45000	45000	45000	45000	45000	45000	45000	45000	45000	45000	45000
Previous 10 Years	N	9	2	23	NS	5	22	6	NS	3	6	28	9	16
	N Detect	7	2	20	NS	4	17	0	NS	1	0	23	8	10
	N Exceed	1	1	15	NS	0	4	0	NS	0	0	9	6	5
Previous 5 Years	N	NS	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	8
	N Detect	NS	NS	10	NS	NS	11	NS	NS	NS	NS	14	6	7
	N Exceed	NS	NS	10	NS	NS	4	NS	NS	NS	NS	8	6	5
		Potential for Delisting										**Achieving Targets per Listing Policy**		
		ID	ID	No	--	NE	No	NE	--	NE	NE	No	No	No

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.
ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist

4,4'-DDE		**303(d) listed Reaches**										**Un-listed Reaches with TMDL Targets and Available Data**		
Reach		**1**	**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**12**	**13**	**3**	**6**	**7**
Date Range Available		8/19/2008	5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	12/17/2003	12/19/2003	12/16/2003	12/16/2003
		8/21/2008	8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/25/2004	8/27/2013	9/3/2009	8/28/2013
TMDL Targets (ng/kg):		32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000
Previous 10 Years	N	9	2	23	NS	5	22	6	NS	3	6	28	9	16
	N Detect	9	2	23	NS	5	22	4	NS	3	3	28	9	15
	N Exceed	9	2	23	NS	5	20	0	NS	3	0	28	9	11
Previous 5 Years	N	NS	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	8
	N Detect	NS	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	7
	N Exceed	NS	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	7
		Potential for Delisting										**Achieving Targets per Listing Policy**		
		No	No	No	--	No	No	NE	--	No	NE	No	No	No

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

4,4'-DDT		**303(d) listed Reaches**										**Un-listed Reaches with TMDL Targets and Available Data**		
Reach		**1**	**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**12**	**13**	**3**	**6**	**7**
Date Range Available		8/19/2008	5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	12/17/2003	12/19/2003	12/16/2003	12/16/2003
		8/21/2008	8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/25/2004	8/27/2013	9/3/2009	8/28/2013
TMDL Targets (ng/kg):		32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000
Previous 10 Years	N	9	2	23	NS	5	22	6	NS	3	6	28	9	16
	N Detect	4	0	19	NS	2	9	0	NS	0	0	17	0	3
	N Exceed	2	0	10	NS	0	4	0	NS	0	0	11	0	1
Previous 5 Years	N	NS	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	8
	N Detect	NS	NS	11	NS	NS	8	NS	NS	NS	NS	14	0	3
	N Exceed	NS	NS	9	NS	NS	3	NS	NS	NS	NS	9	0	1
		Potential for Delisting										**Achieving Targets per Listing Policy**		
		No	NE	No	--	NE	No	NE	--	NE	NE	No	NE	No[1]

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis
NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.
ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist

Aldrin		**303(d) listed Reaches**								**Un-listed Reaches with TMDL Targets and Available Data**				
Reach		**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**13**	**1**	**3**	**6**	**7**	**12**
Date Range Available		5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	8/19/2008	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/18/2011	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg)		50	50	50	50	50	50	50	50	50	50	50	50	50
Previous 10 Years	N	2	23	NS	5	22	6	NS	6	9	28	9	16	3
	N Detect	0	0	NS	0	0	0	NS	0	0	0	0	0	0
	N Exceed	0	0	NS	0	0	0	NS	0	0	0	0	0	0
Previous 5 Years	N	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	8	NS
	N Detect	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
	N Exceed	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
		Potential for Delisting								**Achieving Targets per Listing Policy**				
		NE	NE	--	NE	NE	NE	--	NE	NE	Yes[1]	NE	NE	NE

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis
NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

BHC-alpha		303(d) listed Reaches									Un-listed Reaches with TMDL Targets and Available Data			
Reach		1	2	4	5	9A	9B	10	11	13	3	6	7	12
Date Range Available		NS	5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		NS	8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Previous 10 Years	N	NS	2	23	NS	5	22	6	NS	6	28	9	16	3
	N Detect	NS	0	0	NS	0	0	0	NS	0	0	0	0	0
	N Exceed	NS	0	0	NS	0	0	0	NS	0	0	0	0	0
Previous 5 Years	N	NS	NS	13	NS	NS	13	NS	NS	NS	17	0	8	NS
	N Detect	NS	NS	0	NS	NS	0	NS	NS	NS	0	0	0	NS
	N Exceed	NS	NS	0	NS	NS	0	NS	NS	NS	0	0	0	NS
		Potential for Delisting									Achieving Targets per Listing Policy			
		--	NE	NE	--	NE	NE	NE	--	NE	NE	NE	NE	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

BHC-beta		303(d) listed Reaches									Un-listed Reaches with TMDL Targets and Available Data			
Reach		1	2	4	5	9A	9B	10	11	13	3	6	7	12
Date Range Available		NS	5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		NS	8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Previous 10 Years	N	NS	2	23	NS	5	22	6	NS	6	28	9	16	3
	N Detect	NS	0	0	NS	0	0	0	NS	0	0	0	0	0
	N Exceed	NS	0	0	NS	0	0	0	NS	0	0	0	0	0
Previous 5 Years	N	NS	NS	13	NS	NS	13	NS	NS	NS	17	6	8	NS
	N Detect	NS	NS	0	NS	NS	0	NS	NS	NS	0	0	0	NS
	N Exceed	NS	NS	0	NS	NS	0	NS	NS	NS	0	0	0	NS
		Potential for Delisting									Achieving Targets per Listing Policy			
		--	NE	NE	--	NE	NE	NE	--	NE	NE	NE	NE	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

BHC-gamma		303(d) listed Reaches									Un-listed Reaches with TMDL Targets and Available Data			
Reach		1	2	4	5	9A	9B	10	11	13	3	6	7	12
Date Range Available		NS	5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		NS	8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		8200	8200	8200	8200	8200	8200	8200	8200	8200	8200	8200	8200	8200
Previous 10 Years	N	NS	2	23	NS	5	22	6	NS	6	28	9	16	3
	N Detect	NS	0	0	NS	0	0	0	NS	0	0	0	0	0
	N Exceed	NS	0	0	NS	0	0	0	NS	0	0	0	0	0
Previous 5 Years	N	NS	NS	13	NS	NS	13	NS	NS	NS	17	6	8	NS
	N Detect	NS	NS	0	NS	NS	0	NS	NS	NS	0	0	0	NS
	N Exceed	NS	NS	0	NS	NS	0	NS	NS	NS	0	0	0	NS
		Potential for Delisting									Achieving Targets per Listing Policy			
		--	NE	NE	--	NE	NE	NE	--	NE	**Yes**[1]	NE	NE	NE

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Chlordane (Total)		303(d) listed Reaches						Un-listed Reaches with TMDL Targets and Available Data					
Reach		1	2	4	5	9A	12	3	6	7	9B	10	13
Date Range Available		8/19/2008	5/6/2004	12/18/2003	NS	12/19/2003	12/17/2003	12/19/2003	12/16/2003	12/16/2003	12/19/2003	12/18/2003	12/17/2003
		8/21/2008	8/24/2004	8/27/2013	NS	8/26/2004	8/25/2004	8/27/2013	9/3/2009	8/28/2013	8/28/2013	8/25/2004	8/25/2004
TMDL Targets (ng/kg):		830	830	830	830	830	830	830	830	830	830	830	830
Previous 10 Years	N	9	2	22	NS	5	3	27	9	16	22	6	6
	N Detect	7	1	15	NS	1	0	17	6	5	13	0	0
	N Exceed	7	1	15	NS	1	0	17	6	5	13	0	0
Previous 5 Years	N	NS	NS	12	NS	NS	NS	17	6	8	13	NS	NS
	N Detect	NS	NS	10	NS	NS	NS	15	6	5	11	NS	NS
	N Exceed	NS	NS	10	NS	NS	NS	15	6	5	11	NS	NS
		Potential for Delisting						Achieving Targets per Listing Policy					
Potential for Delisting:		No	ID	No	--	ID	NE	No	No	No	No	NE	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist

Dieldrin		**303(d) listed Reaches**								**Un-listed Reaches with TMDL Targets and Available Data**				
Reach		**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**13**	**1**	**3**	**6**	**7**	**12**
Date Range Available		5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	8/19/2008	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/21/2008	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		650	650	650	650	650	650	650	650	650	650	650	650	650
Previous 10 Years	N	2	23	NS	5	22	6	NS	6	9	28	9	16	3
	N Detect	0	0	NS	0	0	0	NS	0	0	0	0	0	0
	N Exceed	0	0	NS	0	0	0	NS	0	0	0	0	0	0
Previous 5 Years	N	NS	13	NS	NS	13	NS	NS	NS	3	17	6	8	NS
	N Detect	NS	0	NS	NS	0	NS	NS	NS	0	0	0	0	NS
	N Exceed	NS	0	NS	NS	0	NS	NS	NS	0	0	0	0	NS
		Potential for Delisting								**Achieving Targets per Listing Policy**				
		NE	NE	--	NE	NE	NE	--	NE	NE	**Yes**[1]	NE	NE	NE

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Endosulfan I		**303(d) listed Reaches**								**Un-listed Reaches with TMDL Targets and Available Data**				
Reach		**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**13**	**1**	**3**	**6**	**7**	**12**
Date Range Available		5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	8/19/2008	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/21/2008	8/27/2013	9/3/2009	8/28/2013	8/25/2004
Targets (ng/kg):		65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000
Previous 10 Years	N	2	23	NS	5	22	6	NS	6	9	28	9	16	3
	N Detect	0	0	NS	1	0	0	NS	0	0	0	0	0	0
	N Exceed	0	0	NS	0	0	0	NS	0	0	0	0	0	0
Previous 5 Years	N	NS	13	NS	NS	13	NS	NS	NS	3	17	6	8	NS
	N Detect	NS	0	NS	NS	0	NS	NS	NS	0	0	0	0	NS
	N Exceed	NS	0	NS	NS	0	NS	NS	NS	0	0	0	0	NS
		Potential for Delisting								**Achieving Targets per Listing Policy**				
		NE	NE	--	NE	NE	NE		NE	NE	**Yes**[1]	NE	NE	NE

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Endosulfan II		**303(d) listed Reaches**								**Un-listed Reaches with TMDL Targets and Available Data**				
Reach		**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**13**	**1**	**3**	**6**	**7**	**12**
Date Range Available		5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	8/19/2008	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/21/2008	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000	6500000	6500000	6500000	6500000	6500000
Previous 10 Years	N	2	23	NS	5	22	6	NS	6	9	28	9	16	3
	N Detect	0	0	NS	1	0	0	NS	0	0	0	0	0	0
	N Exceed	0	0	NS	0	0	0	NS	0	0	0	0	0	0
Previous 5 Years	N	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	8	NS
	N Detect	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
	N Exceed	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
		Potential for Delisting								**Achieving Targets per Listing Policy**				
		NE	NE	--	NE	NE	NE	--	NE	NE	**Yes**[1]	NE	NE	NE

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Endrin		**303(d) listed Reaches**								**Un-listed Reaches with TMDL Targets and Available Data**				
Reach		**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**13**	**1**	**3**	**6**	**7**	**12**
Date Range Available		5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	8/19/2008	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/21/2008	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		3200000	3200000	3200000	3200000	3200000	3200000	3200000	3200000	3200000	3200000	3200000	3200000	3200000
Previous 10 Years	N	2	23	NS	5	22	6	NS	6	9	28	9	16	3
	N Detect	0	0	NS	1	0	0	NS	0	0	0	0	0	0
	N Exceed	0	0	NS	0	0	0	NS	0	0	0	0	0	0
Previous 5 Years	N	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	8	NS
	N Detect	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
	N Exceed	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
		Potential for Delisting								**Achieving Targets per Listing Policy**				
		NE	NE	NS	NE	NE	NE	--	NE	NE	**Yes**[1]	NE	NE	NE

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Heptachlor		**303(d) listed Reaches**								**Un-listed Reaches with TMDL Targets and Available Data**				
Reach		**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**13**	**1**	**3**	**6**	**7**	**12**
Date Range Available		5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	8/19/2008	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/21/2008	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
Previous 10 Years	N	2	23	NS	5	22	6	NS	6	9	28	9	16	3
	N Detect	0	0	NS	0	0	0	NS	0	0	0	0	0	0
	N Exceed	0	0	NS	0	0	0	NS	0	0	0	0	0	0
Previous 5 Years	N	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	8	NS
	N Detect	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
	N Exceed	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
		Potential for Delisting								**Achieving Targets per Listing Policy**				
		NE	NE	--	NE	NE	NE	--	NE	NE	**Yes[1]**	NE	NE	NE

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Heptachlor Epoxide		**303(d) listed Reaches**								**Un-listed Reaches with TMDL Targets and Available Data**				
Reach		**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**13**	**1**	**3**	**6**	**7**	**12**
Date Range Available		5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	8/19/2008	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/21/2008	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
Previous 10 Years	N	2	23	NS	5	22	6	NS	6	9	28	9	16	3
	N Detect	0	0	NS	0	0	0	NS	0	0	0	0	0	NS
	N Exceed	0	0	NS	0	0	0	NS	0	0	0	0	0	0
Previous 5 Years	N	NS	13	NS	NS	13	NS	NS	NS	NS	17	6	8	NS
	N Detect	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
	N Exceed	NS	0	NS	NS	0	NS	NS	NS	NS	0	0	0	NS
		Potential for Delisting								**Achieving Targets per Listing Policy**				
		NE	NE	--	NE	NE	NE	--	NE	NE	**Yes[1]**	NE	NE	NE

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

PCBs		**303(d) listed Reaches**									**Un-listed Reaches with TMDL Targets and Available Data**			
Reach		**1**	**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**13**	**3**	**6**	**7**	**12**
Date Range Available		8/19/2008	5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		8/21/2008	8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		5300	5300	5300	5300	5300	5300	5300	5300	5300	5300	5300	5300	5300
Previous 10 Years	N	9	2	22	NS	5	22	6	NS	6	27	9	16	3
	N Detect	9	2	10	NS	2	9	0	NS	0	15	6	2	0
	N Exceed	9	2	9	NS	2	7	0	NS	0	12	6	1	0
Previous 5 Years	N	NS	NS	12	NS	NS	13	NS	NS	NS	17	6	8	NS
	N Detect	NS	NS	9	NS	NS	9	NS	NS	NS	11	6	2	NS
	N Exceed	NS	NS	0	NS	NS	0	NS	NS	NS	0	0	0	NS
		Potential for Delisting									**Achieving Targets per Listing Policy**			
		No	No	PD[1]	--	No	PD[1]	NE	--	NE	PD[1]	PD[1]	PD	NE

1. No exceedances in most recent five years with a significant number of samples. Considering the exceedances that occurred more than five years ago would inappropriately categorize this as a higher priority.

PD (Potential Delisting) – Insufficient data to information listing decision, however a significant number of the most recent 5 years of monitoring are non-detect. The potential for delisting the reach may exist.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist.

Toxaphene		**303(d) listed Reaches**								**Un-listed Reaches with TMDL Targets and Available Data**				
Reach		**2**	**4**	**5**	**9A**	**9B**	**10**	**11**	**13**	**1**	**3**	**6**	**7**	**12**
Date Range Available		5/6/2004	12/18/2003	NS	12/19/2003	12/19/2003	12/18/2003	NS	12/17/2003	8/19/2008	12/19/2003	12/16/2003	12/16/2003	12/17/2003
		8/24/2004	8/27/2013	NS	8/26/2004	8/28/2013	8/25/2004	NS	8/25/2004	8/21/2008	8/27/2013	9/3/2009	8/28/2013	8/25/2004
TMDL Targets (ng/kg):		9800	9800	9800	9800	9800	9800	9800	9800	9800	9800	9800	9800	9800
Previous 10 Years	N	2	22	NS	5	22	6	NS	6	9	27	9	16	3
	N Detect	0	18	NS	0	7	0	NS	0	4	10	3	0	0
	N Exceed	0	18	NS	0	7	0	NS	0	4	10	3	0	0
Previous 5 Years	N	NS	12	NS	NS	13	NS	NS	NS	NS	16	6	8	NS
	N Detect	NS	12	NS	NS	7	NS	NS	NS	NS	10	3	0	NS
	N Exceed	NS	12	NS	NS	7	NS	NS	NS	NS	10	3	0	NS
		Potential for Delisting								**Achieving Targets per Listing Policy**				
		NE	No	--	NE	No	NE	--	NE	No	No	No	NE	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

1.4 TOXICITY TMDL

The RWQCB adopted Resolution No. R4-2005-009 to incorporate the Toxicity, Chlorpyrifos and Diazinon (Toxicity) TMDL in Calleguas Creek, its Tributaries, and Mugu Lagoon into the Basin Plan. The TMDL was effective as of March 25, 2006. Chlorpyrifos and diazinon have been phased out from non-agricultural uses and it was recently announced that additional restrictions on the use of chlorpyrifos on farms may be enacted.

Table 9. Analysis of Toxicity TMDL Constituents in Receiving Water by Reach.

Chlorpyrifos (Dry)		**303(d) listed Reaches**			**Un-listed Reaches with TMDL Targets and Available Data**									
Reach		**4**	**5**	**7**	**1**	**2**	**3**	**6**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/28/2003	8/28/2003	8/28/2003	8/21/2008	3/24/2004	6/5/2003	8/28/2003	3/24/2004	8/28/2003	8/28/2003	2/6/2002	2/6/2002	8/28/2003
		11/5/2013	8/23/2004	11/5/2013	11/5/2013	8/24/2004	4/25/2014	11/5/2013	8/23/2004	8/23/2004	11/5/2013	8/21/2013	8/23/2004	11/5/2013
TMDL Targets (ug/L):		0.014	0.014	0.014	0.009	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Previous 10 Years	N	34	9	30	21	7	54	29	6	9	30	26	9	21
	N Detect	19	6	12	7	0	13	12	0	0	4	0	0	0
	N Exceed	14	6	7	4	0	5	6	0	0	0	0	0	0
Previous 5 Years	N	20	NS	19	19	NS	26	18	NS	NS	19	12	NS	11
	N Detect	13	NS	7	6	NS	6	7	NS	NS	2	0	NS	0
	N Exceed	9	NS	4	3	NS	1	3	NS	NS	0	0	NS	0

Chlorpyrifos (Wet)		**303(d) listed Reaches**			**Un-listed Reaches with TMDL Targets and Available Data**									
Reach		**4**	**5**	**7**	**1**	**2**	**3**	**6**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		2/13/2003	2/13/2003	2/3/2004	12/15/2008	2/3/2004	2/12/2003	2/3/2004	2/3/2004	2/3/2004	2/3/2004	2/3/2004	NS	12/15/2008
		1/25/2013	11/26/2008	1/25/2013	1/25/2013	2/26/2004	2/28/2014	1/25/2013	2/25/2004	2/25/2004	1/25/2013	3/17/2012	NS	3/17/2012
TMDL Targets (ug/L):		0.025	0.025	0.025	0.02	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Previous 10 Years	N	22	9	12	9	3	49	10	3	3	10	11	NS	8
	N Detect	19	7	9	9	2	32	8	0	0	4	0	NS	1
	N Exceed	18	7	9	9	2	24	7	0	0	3	0	NS	0
Previous 5 Years	N	8	NS	8	8	NS	25	8	NS	NS	8	7	NS	7
	N Detect	8	NS	7	8	NS	19	7	NS	NS	3	0	NS	1
	N Exceed	7	NS	7	8	NS	13	6	NS	NS	2	0	NS	0

Chlorpyrifos (Wet and Dry Data)	**303(d) Listed Reaches**			**Un-listed Reaches with TMDL Targets and Available Data**									
Reach	**4**	**5**	**7**	**1**	**2**	**3**	**6**	**8**	**9A**	**9B**	**10**	**12**	**13**
N (previous 5 years)	28	18[1]	42[1]	30[2]	10[1]	51	39[1]	NS	NS	40[1]	37[1]	NS	29[2]
N Exceed	16	13	14	13	3	14	13	NS	NS	3	0	NS	0
	Potential for Delisting?			**Achieving Targets per Listing Policy?**									
	No	No	No	No	No	No	No	NE	NE	**Yes**	**Yes**	NE	**Yes**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis.

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Diazinon (Dry)		**303(d) listed Reaches**	**Un-listed Reaches with TMDL Targets and Available Data**											
Reach		**7**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		8/28/2003	8/21/2008	3/24/2004	6/5/2003	8/28/2003	8/28/2003	8/28/2003	3/24/2004	2/19/2003	2/19/2003	2/6/2002	2/6/2002	8/28/2003
		11/5/2013	11/5/2013	8/24/2004	4/25/2014	11/5/2013	8/23/2004	11/5/2013	8/23/2004	8/23/2004	11/5/2013	8/21/2013	8/23/2004	11/5/2013
TMDL Targets (ug/L):		0.1	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Previous 10 Years	N	30	21	7	55	34	9	29	6	10	31	26	9	21
	N Detect	9	3	6	17	10	2	9	0	5	8	5	2	4
	N Exceed	1	0	3	4	0	1	1	0	2	2	3	0	0
Previous 5 Years	N	19	19	NS	27	20	NS	18	NS	NS	19	12	NS	11
	N Detect	2	3	NS	5	5	NS	2	NS	NS	2	0	NS	0
	N Exceed	0	0	NS	1	0	NS	0	NS	NS	1	0	NS	0

Diazinon (Wet)		**303(d) listed Reaches**	**Un-listed Reaches with TMDL Targets and Available Data**											
Reach		**7**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**9A**	**9B**	**10**	**12**	**13**
Date Range Available		2/3/2004	12/15/2008	2/3/2004	2/12/2003	2/13/2003	2/13/2003	2/3/2004	2/3/2004	2/3/2004	2/3/2004	2/3/2004	NS	12/15/2008
		1/25/2013	1/25/2013	2/26/2004	2/28/2014	1/25/2013	11/26/2008	1/25/2013	2/25/2004	2/25/2004	1/25/2013	3/17/2012	NS	3/17/2012
TMDL Targets (ug/L):		0.1	0.82	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Previous 10 Years	N	12	9	3	51	22	9	10	3	3	10	11	NS	8
	N Detect	5	4	1	25	9	1	3	0	1	1	0	NS	0
	N Exceed	2	0	0	6	3	0	1	0	1	0	0	NS	0
Previous 5 Years	N	8	8	NS	27	8	NS	8	NS	NS	8	7	NS	7
	N Detect	4	4	NS	10	5	NS	3	NS	NS	1	0	NS	0
	N Exceed	1	0	NS	3	2	NS	1	NS	NS	0	0	NS	0

Diazinon (Wet and Dry Data)	**303(d) Listed Reaches**	**Un-listed Reaches with TMDL Targets and Available Data**											
Reach	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**9A**	**9B**	**10**	**12**	**13**
N (previous 5 years)	42[1]	30[1]	10[1]	54	28	18[1]	39[1]	NS	13[1]	41	37	NS	28
N Exceed	3	0	3	4	2	1	2	NS	3	2	3	NS	0
	Potential for Delisting	**Achieving Targets per Listing Policy**											
	Yes	**Yes**	No	**Yes**	**Yes**	ID	**Yes**	NE	No	**Yes**	**Yes**	NE	**Yes**

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist.

1.5 SALTS TMDL

The Boron, Chloride, Sulfate, TDS (Salts) TMDL was incorporated into the Basin Plan through the RWQCB's adoption of Resolution No. R4-2007-016. **Table 10** summarizes the comparison of available receiving water grab sample data to the final numeric targets established in the Salts TMDL. This evaluation does not include consideration of continuous monitoring for salts at the receiving water compliance points, however, grab samples collected at these locations to calibrate and verify the sensors are a part of the dataset. Additionally, reaches 1 and 2 are tidally influenced and salts targets do not apply, therefore, those reaches are not considered.

Table 10. Analysis of Salts TMDL Constituents in Receiving Water by Reach

Boron		303(d) Listed Reaches			Un-listed Reaches with TMDL Targets and Available Data								
Reach		4	7	8	3	5	6	9A	9B	10	11	12	13
Date Range Available		2/25/2004	2/5/2003	NS	2/26/2004	2/25/2004	NS	2/19/2003	2/19/2003	2/15/2002	NS	2/15/2002	NS
		11/5/2013	6/3/2014	NS	11/5/2013	2/25/2004	NS	11/6/2013	11/5/2013	10/9/2013	NS	10/9/2013	NS
TMDL Targets (mg/L):		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Previous 10 Years	N	65	235	NS	27	1	NS	237	25	124	NS	133	NS
	N Detect	65	235	NS	27	1	NS	237	25	124	NS	133	NS
	N Exceed	65	85	NS	0	1	NS	1	0	0	NS	0	NS
Previous 5 Years	N	64	162	NS	26	NS	NS	116	23	58	NS	58	NS
	N Detect	64	162	NS	26	NS	NS	116	23	58	NS	58	NS
	N Exceed	64	55	NS	0	NS	NS	1	0	0	NS	0	NS
		Potential for Delisting			Achieving Targets per Listing Policy								
		No	No	--	NE	ID	--	**Yes**	NE	**Yes**	--	**Yes**	--

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.
ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist.

Chloride		303(d) Listed Reaches						Un-listed Reaches with TMDL Targets and Available Data					
Reach		6	7	8	9B	10	13	3	4	5	9A	11	12
Date Range Available		NS	1/8/2003	NS	1/1/2003	1/15/2002	NS	1/1/2003	2/13/2003	2/13/2003	1/22/2003	NS	1/15/2002
		NS	6/3/2014	NS	12/5/2013	10/9/2013	NS	4/25/2014	12/5/2013	11/26/2008	12/5/2013	NS	10/9/2013
WQOs (mg/L):		150	150	150	150	150	150	150	150	150	150	150	150
Previous 10 Years	N	NS	281	NS	116	126	NS	206	99	7	282	NS	135
	N Detect	NS	278	NS	116	126	NS	206	99	7	282	NS	135
	N Exceed	NS	205	NS	31	40	NS	144	75	0	247	NS	125
Previous 5 Years	N	NS	194	NS	63	58	NS	144	92	NS	156	NS	58
	N Detect	NS	193	NS	63	58	NS	144	92	NS	156	NS	58
	N Exceed	NS	142	NS	16	11	NS	108	73	NS	138	NS	56
		Potential for Delisting						Achieving Targets per Listing Policy					
		--	No	--	No	No	--	No	No	NE[1]	No	--	No

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.

Sulfate		303(d) Listed Reaches										Un-listed Reaches with TMDL Targets and Available Data	
Reach		4	6	7	8	9A	9B	10	11	12	13	3	5
Date Range Available		2/25/2004	5/13/2008	2/5/2003	NS	2/19/2003	1/1/2003	2/15/2002	NS	2/15/2002	NS	1/1/2003	2/25/2004
		11/5/2013	5/13/2008	6/3/2014	NS	11/6/2013	11/5/2013	10/9/2013	NS	10/9/2013	NS	11/5/2013	2/25/2004
WQOs (mg/L):		250	250	250	250	250	250	250	250	250	250	250	250
Previous 10 Years	N	44	1	237	NS	250	86	125	NS	136	NS	103	1
	N Detect	44	1	237	NS	250	86	125	NS	136	NS	103	1
	N Exceed	42	1	233	NS	51	5	0	NS	116	NS	31	0
Previous 5 Years	N	43	NS	164	NS	128	36	58	NS	58	NS	74	NS
	N Detect	43	NS	164	NS	128	36	58	NS	58	NS	74	NS
	N Exceed	42	NS	161	NS	22	1	0	NS	54	NS	27	NS
		Potential for Delisting										Achieving Targets per Listing Policy	
		No	ID	No	--	No	**Yes**	**Yes**	--	No	--	No	NE

NE (No Exceedances) – Insufficient data to inform listing decision, however no exceedances were reported in the available monitoring data.
ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist.

TDS		303(d) Listed Reaches											Un-listed Reaches with TMDL Targets and Available Data
Reach		3	4	6	7	8	9A	9B	10	11	12	13	5
Date Range Available		1/1/2003	2/13/2003	5/13/2008	2/5/2003	NS	2/19/2003	1/1/2003	2/15/2002	NS	2/15/2002	NS	2/13/2003
		4/25/2014	11/5/2013	5/13/2008	11/5/2013	NS	11/6/2013	11/5/2013	10/9/2013	NS	10/9/2013	NS	11/26/2008
WQOs (mg/L):		850	850	850	850	850	850	850	850	850	850	850	850
Previous 10 Years	N	172	70	1	80	NS	244	89	113	NS	124	NS	8
	N Detect	172	70	1	80	NS	244	89	113	NS	112	NS	8
	N Exceed	101	61	1	74	NS	133	26	1	NS	97	NS	2
Previous 5 Years	N	100	44	NS	31	NS	127	37	46	NS	46	NS	NS
	N Detect	100	44	NS	31	NS	127	37	46	NS	34	NS	NS
	N Exceed	61	43	NS	27	NS	77	5	0	NS	33	NS	NS
		Potential for Delisting											Achieving Targets per Listing Policy
		No	No	ID	No	--	No	No	**Yes**	--	No	--	No

ID (Insufficient Data) – Insufficient data to inform listing decision, however a single exceedance was detect and the potential for listing may exist.

1.6 INDICATOR BACTERIA□FECAL COLIFORM

Reaches in the CCW are listed for Indicator Bacteria and Fecal Coliform. The recent revision to bacteria objectives in the Basin Plan replaced limits on Fecal and Total Coliforms in REC1 designated waters with geometric means and instantaneous limits on *E. coli*. This analysis compared available *E. coli* monitoring data to the updated instantaneous objectives of 235 MPN/100mL. Table 11 summarizes the findings of the analysis.

Table 11. Analysis of 303(d) listed Reaches for Bacteria

E. *coli*		1	2	3	4	5	6	7	8	9A	9B	10	11	12
Currently 303(d) Listed:			X		X		X	X		X	X	X	X	
Date Range Available		5/27/2004 1/7/2005	8/28/2003 5/5/2005	2/12/2003 4/25/2014	2/12/2003 11/26/2008	2/12/2003 11/26/2008	8/28/2003 3/29/2006	8/28/2003 5/5/2005	12/2/2003 5/5/2005	8/28/2003 5/5/2005	8/28/2003 1/7/2005	8/15/2003 2/22/2014	2/26/2004 8/13/2013	8/15/2003 10/27/2013
WQOs (MPN/100mL):		235	235	235	235	235	235	235	235	235	235	235	235	235
Previous 10 Years	N	7	24	88	38	21	32	23	22	23	15	180	4	161
	N Detect	7	24	87	38	21	30	23	22	23	15	150	4	158
	N Exceed	3	15	62	24	12	20	9	12	7	6	6	4	62
Previous 5 Years	N	NS	NS	24	NS	NS	NS	NS	NS	NS	NS	92	1	96
	N Detect	NS	NS	24	NS	NS	NS	NS	NS	NS	NS	69	1	94
	N Exceed	NS	NS	16	NS	NS	NS	NS	NS	NS	NS	0	1	38
Potential for Delisting:		LP[1]	No[1]	LP	No[1]	LP[1]	No[1]	No[1]	LP	No[1]	No[1]	**Yes**	No[1]	No

1. Previous 5 years of data was insufficient to inform a listing decision, however historical monitoring data was available and used in analysis

LP (Listing Possible) – Considering current and/or earlier data there is potential for this reach to be listed based on the number of observed exceedance

TECS Environmental Compliance Services
106 South Mentor Avenue – 125 • Pasadena, CA 91106 • Tel: 626.396.9424
Fax: 626.396.1916 email: rtahir tecsenv.com

March 30, 2017

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Email: losangeles waterboards.ca.gov

Subject: Comment Letter – Revisions to the Los Angeles Region 2016 (303(d) List

Dear Mr. Zhu:

TECS Environmental is pleased to comment on the Regional Board's proposed 2016 303(d) list revisions.

Because there are almost 900 listing revisions for water quality segments in the Los Angeles County Basin, it would be impossible to address each one. Therefore, I will restrict my comments to general issues.

To begin with, I am sure that a number of MS4 Permittees and industrial dischargers will be pleased to know that many of the pollutants proposed on the 303(d), which are current TMDLs or are scheduled to become ones, have been placed on the "de-list" or placed on the "do not list" category. Most conspicuous are metals for Reach 2 of the Rio Hondo[1] and Reach 3 of the San Gabriel River[2]. Although the 2010 303(d) list did not list any of these reaches for metals-related impairment, they were nevertheless required to comply with metals TMDLs (Los Angeles River Metals TMDL for Reach 2 of the Rio Hondo and the San Gabriel River Metals TMDL for Reach 3 of the San Gabriel River). The 2016 303(d) list proposes to rectify this mistake by placing both of these reaches under the "do not list" category for copper, lead, selenium and zinc, which form the basis for both of the TMDLs.

[1]Alhambra (partially), Arcadia, Bradbury, Duarte, El Monte, Irwindale (partially), Monrovia, Montebello (partially), Monterey Park, Pasadena (partially), Rosemead, San Gabriel, San Marino, Sierra Madre, South El Monte, South Pasadena (partially) and Temple City.
[2]Azusa, Baldwin Park, Claremont, Covina, Duarte (partially), El Monte, Glendora, Irwindale, La Verne, Pomona, South El Monte, and West Covina.

However, the proposed 2016 303(d) list did not place any of the Arroyo Seco reaches on the "do not list." Like Reach 2 of the Rio Hondo and Reach 3 of the San Gabriel River, Arroyo Seco Reaches 1 and 2 were not on 2010 303(d) list, nor were they on the 2012 303(d) list, which did not make it to Los Angeles Basin Plan as an amendment. Nevertheless, the Los Angeles MS4 Permit subjects MS4 Permittees by extending the Los Angeles River Metals TMDL to Arroyo Seco reaches. The 2016 303(d) list should place these reaches on the "do not list" category for metals.
Recommendation: place Arroyo Seco Reaches 1 and 2 on the "do not list" for any metal.

I. CTR and 303(d) Listing Policy

Nevertheless, additional pollutants should be considered for exclusion because they were not established in accordance with the California Toxics Rule (CTR) adopted in 2000; and/or did comply with the *Water Quality Control Policy for California's Clean Water Act Section 303(d) List* (Listing Policy), which was adopted in 2004.

- *California Toxic Rule*

CTR was adopted to provide a mathematical method for establishing ambient (dry weather) water quality standards for toxics necessary to protect beneficial uses of receiving waters. The LAR-MTMDL, however, along with other TMDLs, does not comply with CTR in two significant respects.

First, the TMDL calculates numeric water quality standards/TMDLs for both wet weather and ambient receiving water conditions instead of only on ambient. The LAR-TMDL misinterprets CTR by claiming EPA did not differentiate between wet and dry weather conditions when establishing metals and toxics limitations. There is nothing in CTR that supports that view. CTR makes it clear that its purpose is to establish ambient water quality standards: *This final rule establishes ambient water quality for priority toxic pollutants.* USEPA defines ambient as:

> *Natural concentration of water quality constituents prior to mixing of either point or nonpoint source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact to human health.*

In other words, ambient is the normal reference condition of a receiving water. This is also the clear understanding of the Regional Board's Surface Water Ambient Monitoring Program (SWAMP). MS4 and other point source stormwater (wet weather) outfall discharges, using sampling and analysis results, are measured against the ambient target for a pollutant established by CTR. For example, suppose a copper limitation is set at 37 micrograms per liter for a given water body. This limit is required to protect fish. Persistent exceedances of the limit based on outfall monitoring would necessitate a revision to the MS4 Permittee's stormwater management program.

Second, CTR requires a hardness parameter (calcium carbonate) to make chemical water quality analysis of metals and toxics more accurate. Generally, the higher the hardness value the higher the toxic/metal pollutant expressed as a numeric limit. And, the higher the limit there less difficult it is to meet. The metals and toxics TMDLs rely on differing hardness values. For the Dominguez Channel/Harbor Toxics TMDL an average hardness value of 50 mg/l is used. For Ballona Creek hardiness values for setting the wet weather TMDLs metals are varied, based on an average or median hardness that ranged from 77 mg/l to 108 mg/l. For dry weather, a median hardness value of 300 mg/l was applied. As mentioned, CTR is expressed exclusively as ambient and not wet weather standards. Thus the77 mg/l to 108 mg/l hardness values relative to wet weather are meaningless. For dry weather, a median value of 300 mg/l was used. For the Los Angeles River Metals TMDL variable hardness values were also used for wet and dry weather. The same is true to the San Gabriel River Metals TMDL. In any case, CTR requires actual hardness value to be determined at the time samples of metals/toxic pollutants are taken.

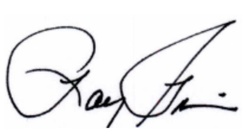
Thus, in the final analysis, each of the metals/toxics pollutants that was placed on the “list” or “do not de-list” category should be placed on the “de-list” or “do not list” category because they were not established in ambient terms only and failed to use an actual hardness value.

- *303(d) Listing Policy*

The Listing Policy was adopted to provide a statistical method to determine how many water quality samples that exceed a water quality standard are required to place a pollutant on the 303(d) list. That method is a binomial distribution based on the rejection of a null hypothesis measured against sample sizes (see attachment #1). A review of the 2016 303(d) list fact sheets reveals that many of the metals and toxics placed on previous 303(d) lists did not conform to the Listing Policy. Those that do not should be placed on the “de-list” or “do not list” category.

This concludes my comments. Should you have any questions or require additional information please let me know.

Sincerely,



Ray Tahir

Attachment 1

TABLE 3.1: MINIMUM NUMBER OF MEASURED EXCEEDANCES NEEDED TO PLACE A WATER SEGMENT ON THE SECTION 303(D) LIST FOR TOXICANTS. *Null Hypothesis: Actual exceedance proportion < 3 percent. Alternate Hypothesis: Actual exceedance proportion > 18 percent. The minimum effect size is 15 percent.*	
Sample Size	List if the number of exceedances equal or is greater than
2 – 24	2□
25– 36	3
37– 47	4
48– 59	5
60– 71	6
72– 82	7
83– 94	8
95– 106	9
107– 117	10
118– 129	11

□Application of the binomial test requires a minimum sample size of 16. The number of exceedances required using the binomial test at a sample size of 16 is extended to smaller sample sizes.

For sample sizes greater than 129, the minimum number of measured exceedances is established where α and f3 < 0.2 and where |α - f3| is minimized.

α = Excel® Function BINOMDIST(n-k, n, 1 – 0.03, TRUE)
f3 = Excel® Function BINOMDIST(k-1, n, 0.18, TRUE)
where n = the number of samples,
k = minimum number of measured exceedances to place a water on the section 303(d) list,
0.03 = acceptable exceedance proportion, and
0.18 = unacceptable exceedance proportion.

Attachment 1

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Ventura Countywide Stormwater Quality Management Program

Participating Agencies

Camarillo

County of Ventura

Fillmore

Moorpark

Ojai

Oxnard

Port Hueneme

San Buenaventura

Santa Paula

Simi Valley

Thousand Oaks

Ventura County Watershed Protection District

March 30, 2017

Electronic Submission: losangeles@waterboards.ca.gov

California Regional Water Quality Control Board
Los Angeles Region
ATTN: Jun Zhu
320 W 4th Street, Suite 200
Los Angeles, CA 90013

Subject: Comment Letter – Revisions to the Los Angeles Region 303(d) List

Dear Dr. Zhu:

On behalf of the Ventura Countywide Stormwater Quality Management Program (Program), which includes the Watershed Protection District, the County of Ventura and the incorporated cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, Ventura, Santa Paula, Simi Valley, and Thousand Oaks, we thank you for the opportunity to provide input on the proposed revisions to the Clean Water Act Section 303(d) list of impaired waterbodies in the Los Angeles Region [hereinafter referred to as 303(d) list] which was distributed for public review on February 8, 2017.

The Program has many concerns with the draft 2016 Los Angeles Water Board's proposed revisions to the 303(d) list of impaired waters. Several errors and inconsistencies hampered our ability to fully vet and review the proposed 303(d) list. It is our opinion that significant review and modifications must be made before adoption and additional public review after modifications will be necessary.

> **Requested Action:**
> **After full consideration of all comments, revise draft 303(D) list, and allow for another 60-day comment period prior to adoption.**

It is critical that the Los Angeles Water Board's proposed revisions to the 303(d) list follow the State Water Resources Control Board (SWRCB) Listing Policy and be based on sound science and methodologies. The development and implementation of Total Maximum Daily Loads (TMDLs) is already a significant investment of resources, and the 303(d) list will drive pollutant waterbody prioritization under the potential Watershed Management Plan option in our next NPDES MS4 Permit.

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Without closely following the Listing Policy, pollutants may be listed where an impairment does not exist leading to misplaced priorities and squandered resources. Focused attention should be paid to identifying beneficial uses, impairments due to natural conditions, and applicability of data.

Data from a single point in time, or which is not representative of the receiving water, should be excluded from this effort as should data with results reported below reporting limits (J-flagged). It appears the Program's outfall data was erroneously included for the Santa Clara River. This sampling location represents the runoff discharging from an MS4, not the receiving water quality, and is mostly from infrequent and short-term rain events. Of special concern is where the beneficial use MUN is driving 303(d) listings even though it should not be applied because it is identified as P* and is a conditionally applicable beneficial use.

> **Requested Action:**
> **Strictly comply with the State Water Resources Control Board (SWRCB) Listing Policy on identifying beneficial uses, impairments due to natural sources, and the appropriate data to support a listing.**

The Program supports the comments from the County of Ventura where a more detailed description of the issues identified here is discussed. The Program also supports the comments from the Calleguas Creek Watershed Stakeholders, as well as the Ventura County Irrigated Lands Group (VCAILG) who will be submitting separate comment letters regarding the proposed listing changes in the Calleguas Creek Watershed and VCAILG-affected waterbody segments.

Significant resources are expended when a pollutant is included on the 303(d) list. Errors in this process, and the challenges of delisting a pollutant, divert our limited funding and staff time away from improving water quality. We greatly appreciate your attention to these requests and look forward to a 303(d) list that appropriately identifies the water quality issues within Ventura County.

If you have questions, please contact me at Arne.Anselm@ventura.org or (805) 654-3942.

Sincerely,

Arne Anselm, Chair
On Behalf of the Ventura Countywide Stormwater Management Committee

Cc: Ventura County Stormwater Quality Management Committee
Glenn Shephard, Director - Ventura County Watershed Protection District

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March 30, 2017

California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

RE: Comment Letter – Proposed Revisions to the Clean Water Act Section 303(d) List for the Los Angeles Region and the 2016 Integrated Report

Attn: Jun Zhu,

Ventura Water, a department of the City of San Buenaventura (City), appreciates the opportunity to comment on the proposed revisions to the Clean Water Act Section 303(d) list for the Los Angeles Region and the 2016 Integrated Report (hereinafter "303(d) list"). The City's Public Works Department is submitting a concurrent letter that discusses the overall proposed listings that impact the City generally. The specific focus of this comment letter by Ventura Water is on the Santa Clara River Estuary (SCRE) proposed listings. New constituents on the list for the SCRE include ammonia and pH. Constituents that are proposed to remain on the list of particular note include nitrate and toxicity.

Ventura Water specifically requests the Los Angeles Regional Water Quality Control Board (Regional Board):

- Reconsider proposed ammonia listing by recalculating the exceedances and using more recent data sets currently available to the Regional Board.
- Reconsider the proposed pH listing based on consideration of reference conditions data, which indicate that substantial fluctuations in estuarine pH values are typical, and consistent pH values that comply with water quality objectives are not biologically attainable within estuaries.
- Delist nitrate based on a recalculation using appropriate data and correct use of averaging periods for the data.
- Reevaluate toxicity listing once the data is appropriately aggregated and averaged.
- Reevaluate ChemA, Taxophene, and Indicator Bacteria listings once more recent data is taken into consideration.
- Address the issues identified in this letter and release a revised, proposed 303(d) list for another 60-day comment period prior to adoption.

Relevant Background Information. It is important to our overall comments on the 303(d) list to understand the context of the Santa Clara River and SCRE. Like many southern California rivers, the Santa Clara River has very minimal flows in the dry months leading to stagnant conditions in the SCRE that encourage algae growth and variations in both dissolved oxygen (DO) and pH due to the algae respiration cycles, as is the case to some extent even in more natural estuaries where conditions have not been modified. The river ends in the SCRE, which experiences both open and closed mouth periods due to beach berm formation and periodic, typically wet weather breaches. The SCRE is wind-mixed and mostly uniform in water quality, especially during closed mouth conditions. The Ventura Water Reclamation Facility (VWRF) discharges approximately 8 million gallons per day (mgd) of disinfected, tertiary effluent first to wildlife/water quality ponds, and then to the SCRE. During dry weather, the tertiary treated flows can be the dominate supply of water to the SCRE to support wildlife species that utilize it. Species that utilize the SCRE include the following state and federally listed species: steelhead trout, tidewater goby, snowy plover, and California least tern.

Ventura Water has spent many years studying the SCRE both independently, and pursuant to requirements of its NPDES permits. Ventura Water has invested more than $21,000,000 dollars in treatment process upgrades of the Ventura Water Reclamation Facility (VWRF) to improve the quality of the tertiary treated flows discharged to the SCRE. Ventura Water also currently recycles approximately 1 mgd for urban irrigation. Ventura Water is also currently working on implementing a potable reuse program that would divert up to 100% of its discharges to water reclamation uses, and identifying how much effluent can be diverted from the SCRE while still protecting its ecology and ecology-related beneficial uses and without "taking" (as that term is defined under the state and federal Endangered Species Acts, as applicable) any of the listed species that use or occupy the SCRE.

General Comments. Of particular concern to Ventura Water with regard to the proposed 303(d) list is that much of the data used to determine water quality impairment for the SCRE is older data that is not representative of current conditions. The Staff report states, "Data used as part of the 2016 Integrated Report were received through August 30, 2010." The report then goes on to later say, "All readily available data and information in the administrative record was considered in the development of the 2016 Integrated Report." These statements are at odds with each other as by choosing to only rely on data collected through 2010; quite clearly the 303(d) list was not developed with all readily available data as required by the Listing Policy. Significant plant improvements have be implemented since 2010. VWRF monitoring data since the plant upgrades are readily available and should be included within the 303(d) list determination analyses.

The SCRE has also been heavily regulated by the VWRF's NPDES permits. Many of those permit requirements have become more stringent since 2010, with the application of technology based limitations. By Ventura Water's estimation, many of constituents on the proposed 303(d) list are not appropriate given recent water quality data.

Lastly, based on current data and the State Water Resources Control Board's "Water Quality Control Policy For Developing California's Clean Water Act Section 303(d) List" ("Listing Policy")[1] requirements to aggregate the data by appropriate reach or area and to use appropriate averaging periods, Ventura Water disagrees with some of the constituent listings and requests recalculation of exceedances. This letter addresses the proposed 303(d) listings and presents current data for each proposed SCRE impairment listing.

Ammonia Comments

The new ammonia listing cites that it is based on 4 exceedances out of 42 samples based on un-ionized ammonia concentrations using data collected from 1997 to 2010. While this meets the technical, formulaic requirements for number of exceedances set forth in the Listing Policy Table 3.1 for placing a waterbody on the 303(d) list, the methods and data used to calculate the exceedances are not clear. To calculate the concentration of un-ionized ammonia, total ammonia must be converted to un-ionized ammonia using site specific pH and temperature conditions within the SCRE at the time of the ammonia sampling. No conversion calculations for total ammonia were provided in the data set provided in the fact sheet; therefore, it is difficult to determine which pH and temperature data were used to correlate to corresponding total ammonia data. An accurate analysis should ideally connect pH, temperature, and ammonia data with a reasonable averaging criteria or statistical determination if multiple data points were used. Ventura Water requests recalculation of the exceedances based on current total ammonia data as well as proper calculations of un-ionized ammonia that take into account temperature and pH conditions that occurred, or should have been expected during the total ammonia sampling events.

More specifically, closer inspection of the 1997 through 2010 data set used to determine the 4 exceedances indicates that the pH data used to calculate un-ionized ammonia was potentially data retrieved from a continuous monitoring, multiparameter Sondes (2009-2010) deployed for the City's Phase 1 Estuary Study (Stillwater Sciences 2011), among other data. The only total ammonia data collected as part of the Phase 1 study were collected on 6 days in 2009 and 2010. Corresponding pH and temperature were collected along with these samples. However, Ventura Water is concerned that these data do not represent the SCRE as a whole, specifically after the improvements to the VWRF (after November 2011). Moreover, only total ammonia is shown in that data set, and the data set does not include the calculation of un-ionized ammonia. Monthly grab sample temperature and pH data for the receiving water exists for some of the monitoring years cited (1997 - 2010), but grab data is not reliable for purposes of determining the one-hour maximum values for temperature and pH.

In light of the aforementioned issues with the methods that appear to have been used to calculate un-ionized ammonia using a 1997 to 2010 data set, Ventura Water requests the Regional Board provide the

[1] California State Water Resources Control Board, "Water Quality Control Policy For Developing California's Clean Water Act Section 303(d) List," Adopted September 30, 2004, Amended February 3, 2015.

calculation for the un-ionized ammonia, and update the calculation as appropriate to include more recent and more valid total ammonia, pH, and temperature assumptions from other data sets readily available to the Regional Board. Based on Ventura Water's more recent monitoring results, all of which constitute data readily available to the Regional Board, it does not appear that the SCRE un-ionized ammonia water quality objective is likely to have been exceeded a sufficient number of times to warrant a listing. Ventura Water requests the Regional Board utilize the data submitted to it by Ventura Water more recently than 2010 to assure that the evaluation of receiving water conditions in the SCRE is reasonably representative of current conditions.

The Regional Board imposed stringent ammonia limits and a time schedule to attain those limits on VWRF discharges of tertiary treated flows in both its 2008 and 2013 NPDES permits. To comply with these limits and to better control nitrates, Ventura Water invested more than $21 million in a VWRF plant improvement project to implement nutrient removal in its biological processes. This treatment upgrade project undertaken to meet the stringent NPDES permit ammonia effluent limits came online in November 2011. Since then, VWRF NPDES permit effluent limits for ammonia, including its water quality based effluent limits, have only been exceeded once, indicating that ammonia conditions in the SCRE have changed since November 2011, and the data relied upon in developing the proposed 303(d) list is not representative of conditions within the SCRE.

The receiving water standards for the SCRE (used to establish the NPDES effluent limitation) are set based on un-ionized ammonia for saltwater criteria. The limits used to determine the 303(d) listing are the same criteria that are used to calculate limits in the NPDES permit (1999 Update of Ambient Water Quality Criteria for Ammonia):

- One Hour Concentration = 0.233 mg/l unionized ammonia, based on fish spawning, and
- 4 day average of 0.035 mg/L of unionized ammonia

The total ammonia NPDES effluent limit calculated to meet this water quality objective is total ammonia of 1.07 mg/l average monthly and 1.17 mg/l max daily in the summer. Limits in the winter months are slightly higher. The limits were determined in accordance with EPA standards by considering the 50th and 90th percentile pH and temperature for considering chronic and acute toxicity.

As shown in Figure 1 below, the total effluent ammonia from 2012 to 2016 only exceeded 1 mg/l once out of 59 samples, thus not exceeding the Listing Policy's binomial distribution null hypothesis Table 3.1 criteria for listing a constituent on the 303(d) list (i.e., would need at least 5 exceedances). Similarly, the receiving water samples from 2012 to 2016 only exceeded 1 mg/l total ammonia twice out of 60 samples, so also not meeting the Table 3.1 criteria for listing a constituent on the 303(d) list.

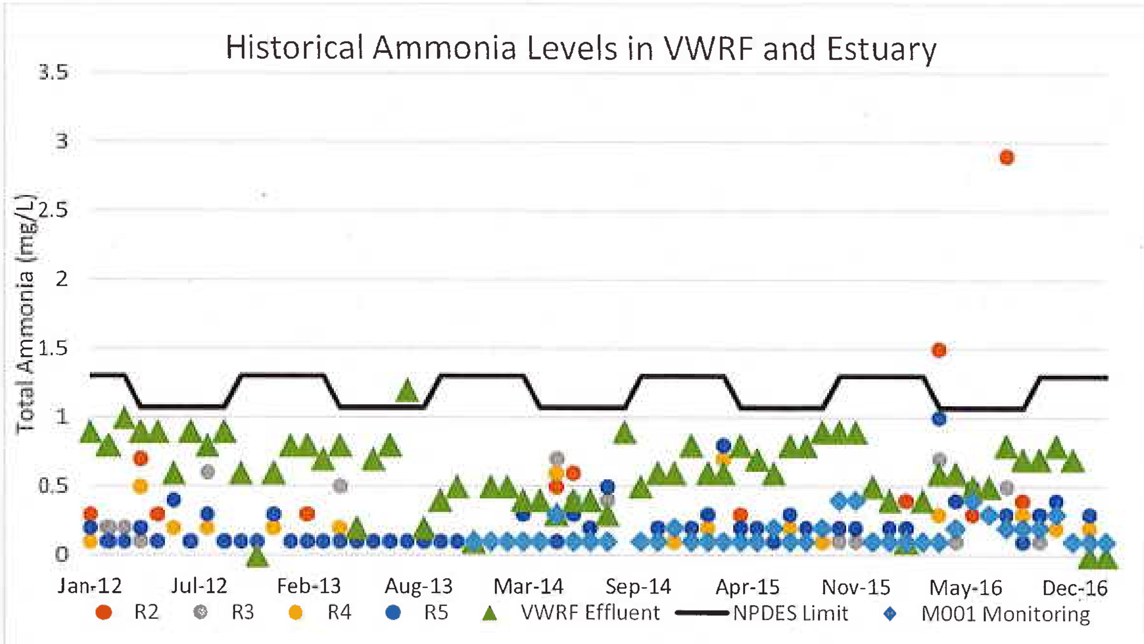

Figure 1 Historical Effluent and Receiving Water Ammonia Monitoring

The effluent compliance point for all constituents except for flow in the 2013 NPDES permit for the VWRF is station M001, which is located at the Effluent Transfer Station (ETS) right before discharge into the wildlife ponds. Station M001A is located downstream of the wildlife ponds. It is only used for compliance with flow, but ammonia levels have been monitored there, starting in December 2013. Total ammonia actually drops from the compliance point to M001A as water passes through the wildlife ponds, likely due to a combination of volatilization and vegetative uptake. Therefore, the ammonia concentrations in the discharges into the SCRE are well below the permit standards that were set up to meet the ammonia receiving water quality objectives for saltwater, which are more stringent than freshwater standards. The comparison of ETS versus M001A data is shown in Figure 2.

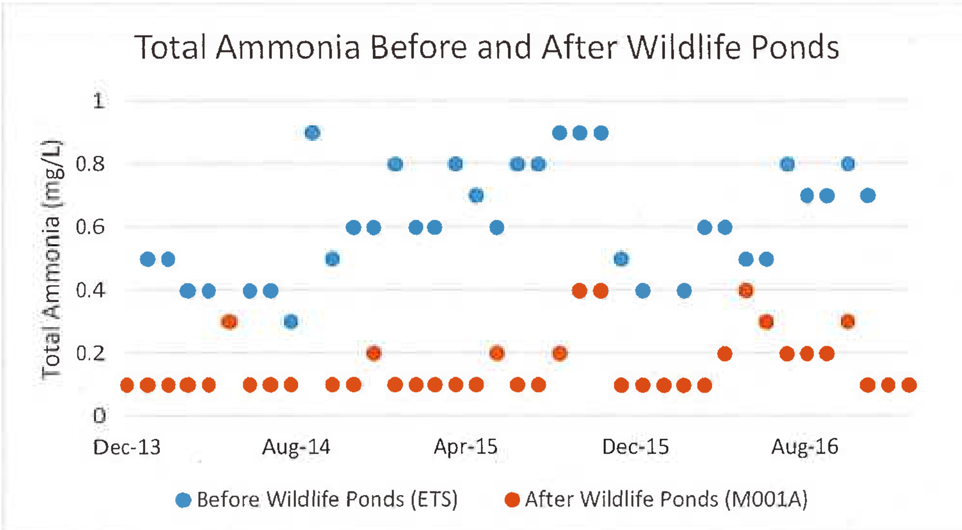

Figure 2 Historical Effluent Ammonia Before and After Wildlife Ponds

In light of the treatment plant upgrades implemented to reduce ammonia, and the fact that more recent data indicates only 1 exceedance in 59 samples, Ventura Water requests recalculation of the exceedances for ammonia and reconsideration of the listing decision based on the more recent data set currently available to the Regional Board.

pH Comments

It is important to understand that many estuaries exhibit wide daily variations in pH mediated by algae as the result of daily photosynthesis and nighttime respiration (Park et al 1958).[2] Beyond potential connections between algal productivity with the multiple nutrient sources to the SCRE (e.g., VWRF, agricultural runoff, groundwater, riverine, VWRF, ocean exchanges), algal growth and pH variations in the SCRE are exacerbated by physical factors as well (e.g., shallow waters, lack of consistent riverine flows, intermittent breaching and limited tidal exchange with the ocean). Consideration of the estuarine conditions likely to induce large pH swings is supported by recent monitoring data fully available to the Regional Board that shows that the VWRF plant tertiary treated flows are always in compliance with pH effluent limits (shown as a black dot on Figure 3). However, despite the very steady and compliant pH values for the tertiary treated flows, the receiving water does experience wide swings in pH as shown in Figure 3 below even when data collected from 2012 through 2016 is analyzed. However, it is important to note that the receiving water pH data is collected by grab samples (via boat) in the SCRE, likely at

[2] Park, K., D.W. Hood, and H.T. Odum. 1958. Diurnal pH variation in Texas bays, and its application to primary production estimation. Publication of the Institute for Marine Sciences, Texas 5: 47–64.

similar times of day and therefore does not necessarily reflect actual conditions in the estuary over the course of the day or the month.

The receiving water data collected could theoretically meet the Listing Policy formulaic criteria. However, the determination whether to list should not be considered in a vacuum, but rather must also take into account the "type of waterbody (Bay and Harbors, Coastal Shoreline, *Estuary*, Lake/reservoir...)" being considered for impairment.[3] One way to take into account the type of waterbody considered for a 303(d) listing is to consider "reference conditions" as defined in Section 7 of the Listing Policy to understand the characteristics of estuarine water bodies that are least impaired by human activities to determine attainable biological conditions for such waterbodies in southern California. As discussed earlier, studies of pH variation in estuaries reveals that wide swings in pH due to the presence of algae constitute reference conditions for typical estuaries.

The proposed listing does not appropriately demonstrate that the high pH was a result of waste discharge as required in the Los Angeles Region Basin Plan (Basin Plan).[4] As stated in the Fact Sheets and according to the Basin Plan, "The pH of inland surface waters shall not be depressed below 6.5 or raised above 8.5 as a result of waste discharges."[5] However, it was not demonstrated for the SCRE that the elevated pH levels were a result of waste discharge as opposed to natural causes. Therefore, the Regional Board should either provide evidence that the elevated pH was a result of waste discharge and detail that in the Fact Sheets or, if not such evidence exists, the Regional Board should remove this proposed listing.

Ventura Water requests reconsideration of the proposed pH listing for the SCRE based on consideration of reference conditions data, which indicate that substantial fluctuations in estuarine pH values are typical, and consistent pH values that comply with water quality objectives are not biologically attainable within estuaries.

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[3] Listing Policy § 6.1.2.2B (emphasis added).

[4] Water Quality Control Plan Los Angeles Region R4 Basin Plan.

[5] Basin Plan at 3-35.

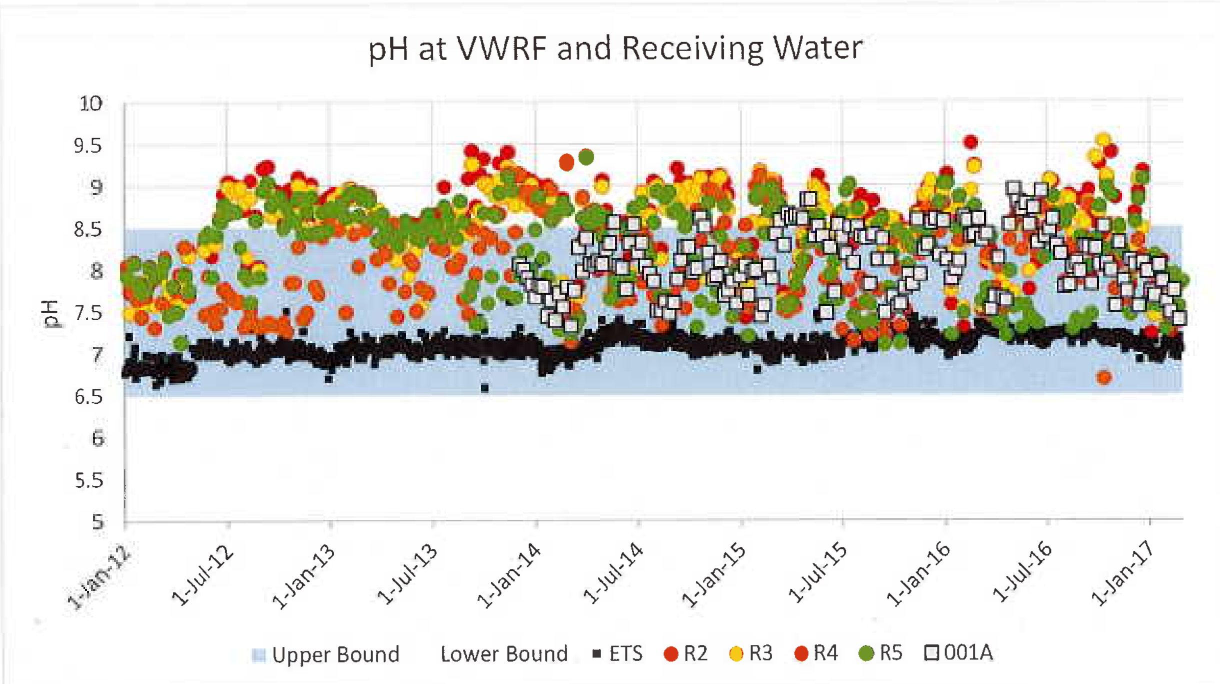

Figure 3 pH at VWRF and Receiving Water Locations

Nitrogen and Nitrate Comments

Nitrogen/nitrate (collectively "nitrate") was originally listed on the 303(d) list adopted in 2012. The nitrate listing is based on receiving water samples collected between 2002 and 2007. Given that Ventura Water implemented a nitrification and denitrification project in November 2011, nitrate data collected before 2011 is no longer representative of SCRE conditions, and is therefore not reliable for determining current SCRE exceedance estimates. In reviewing receiving water data collected monthly from 2012 through 2016 (60 sample dates), which is submitted to the Regional Board as part of NPDES reporting and is therefore readily available data under the Listing Policy, there were only 5 days during which SCRE water quality exceeded the nitrate receiving water quality objective of 10 mg/l . Because the SCRE is wind-mixed and fairly uniform (Phase 1 Estuary Subwatershed Study, Stillwater 2011), we would argue that on any given day, sampling at a given location is strongly influenced by conditions at other nearby locations. The Listing Policy states:

> "Based on these evaluations of the water body setting, the Regional Water Boards should aggregate the data by appropriate reach or area. ... To be considered temporally independent, samples collected during the averaging period shall be combined and considered one sampling

event. ... If the averaging period is not stated for the standard, objective, criterion, or evaluation guideline, then the samples collected less than 7 days apart shall be averaged."[6]

As shown in Figure 4 below, exceedances in multiple locations occurring in the SCRE on the same sampling date should be considered a single event because the multiple sampling results are designed to provide a spatial representation of the estuary during any particular event of exceedance. According to the binomial distribution null hypothesis (Listing Policy Table 3.1), the listing requirement for 60 to 71 data points is 6 exceedances, which is more than the current 5 exceedances demonstrated by the more recent data set developed after Ventura Water's implementation of treatment plant and treatment process upgrades.

Section 4 of the Listing Policy states that a water segment shall be removed from a 303(d) listing if the water meets the water quality standards. Using Policy Table 4.1, the null hypothesis indicates that for 60 to 71 data points, if there are 5 exceedances or less, then the water segment can be delisted. **Based on current data, the number of exceedances (5) meets the delisting criteria, and given that VWRF already has an NPDES permit limit for nitrate, Ventura Water requests recalculation of the exceedances based on current data and correct use of averaging periods for the data (data collected on the same day to be averaged). Ventura Water requests that based on this recalculation, nitrate be removed from the 303(d) list for the SCRE.**

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[6] Listing Policy, pp. 23, 24.

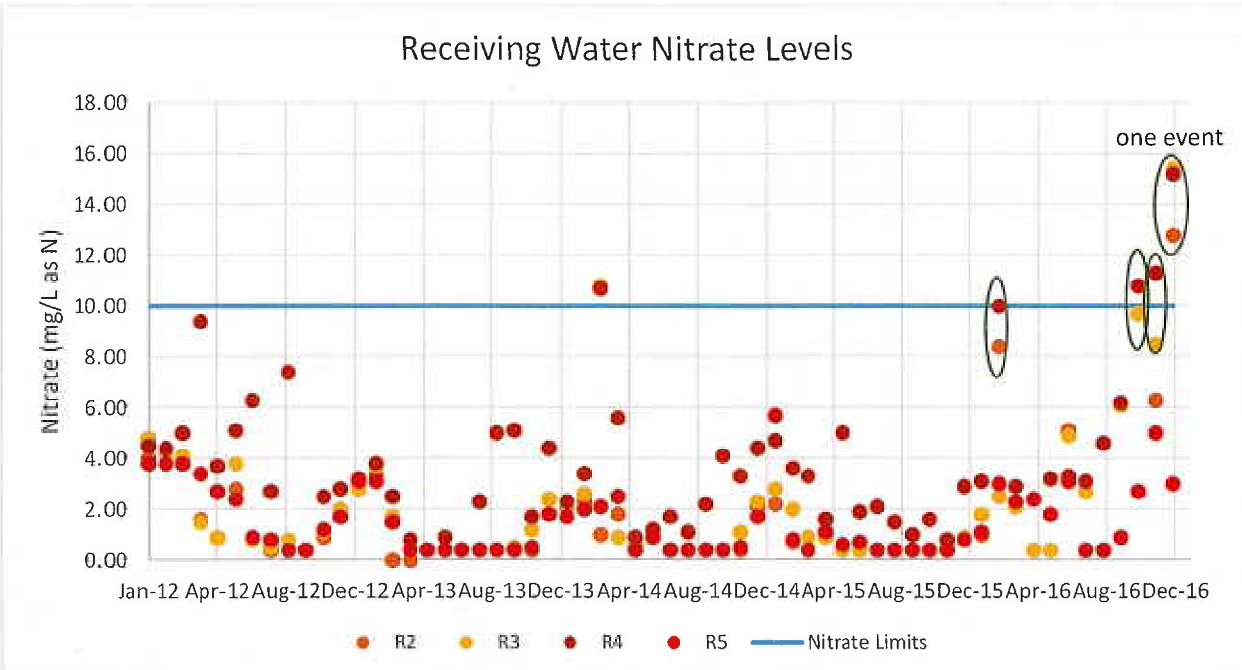

Figure 4 Receiving Water Nitrate Levels

Toxicity Comments

The City monitors chronic toxicity using Selanstrum for both effluent and receiving water. Using readily available data collected by Ventura Water from 2012 – 2016 and submitted to the Regional Board, the VWRF tertiary treated flows consistently met toxicity criteria of 1 TUc for the 60 samples, as shown in Figure 5. However, receiving water monitoring data does not similarly show consistent and full attainment of toxicity criteria. The receiving water monitoring locations have a data set of 25 sample dates. **Using the argument presented above that the data should be aggregated and appropriate averaging should be used, Ventura Water requests that each sampling event (day) be considered separately and the data points be averaged.**

To meet the Listing Policy Table 4.1 requirements for delisting, with 26 data points there would need to be 2 or fewer exceedances of toxicity objectives for the SCRE. Even considered as single events, there have been more than 2 exceedances of a 1 TUc, although those exceedances are unrelated to toxicity of tertiary treated flows, which did not show exceedances. Therefore, it does not appear that delisting the SCRE for toxicity would be appropriate at this time, even though toxicity exceedances are unrelated to VWRF tertiary treated flows. **However, Ventura Water requests this listing be reevaluated once the data is appropriately aggregated and averaged.**

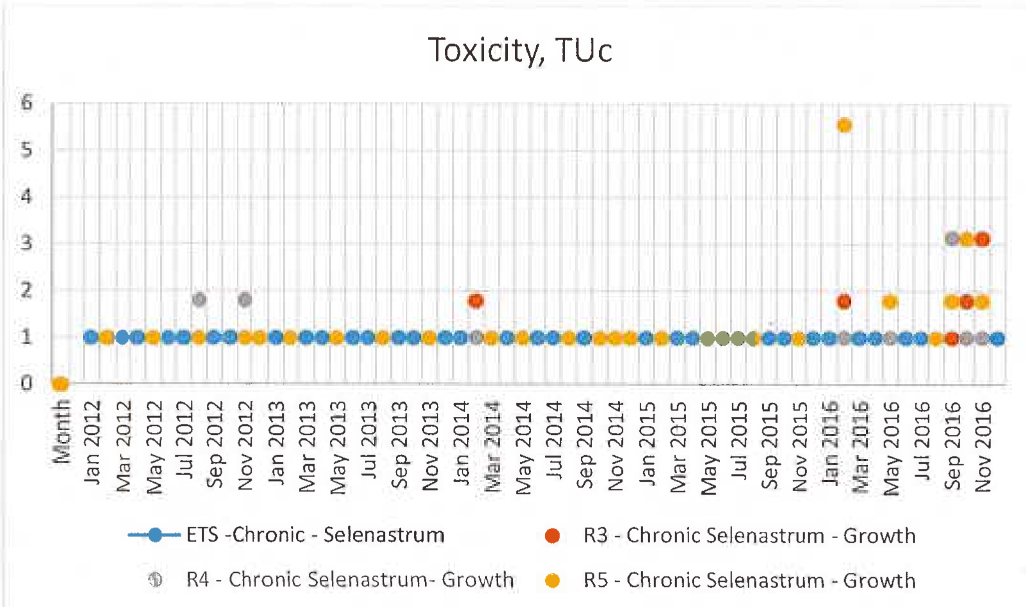

Figure 5 Effluent and Receiving Water Toxicity

ChemA

ChemA is being included on the 303(d) list without any supporting data. The reasons for its listing are that the U.S. EPA approved a TMDL for the estuary in 2011. However, no data, historic or otherwise, were used to support the continued placement on this list. **Ventura Water requests that recent data be taken into consideration when assessing the placement of ChemA on the 303(d) list.**

Toxaphene

Similar to ChemA, toxaphene was included on the 303(d) list due to its TMDL status with the U.S. EPA, circa 2011. No new information or data was brought forward to support the status on the list. Based on data collected semiannually by the VWRF, toxaphene has not even been detected in either the effluent or the receiving water in recent memory. **Ventura Water requests that recent readily available data be taken into consideration when assessing the placement of toxaphene on the 303(d) list.**

Indicator Bacteria

Similar to ChemA and toxaphene, indicator bacteria was included in the 303(d) list due to its TMDL status with the U.S. EPA, circa 2011. No new information or data was brought forward to support the status on the list. **Ventura Water requests that recent data be taken into consideration when assessing the placement of indicator bacteria on the 303(d) list.**

Summary/Conclusion

Ventura Water appreciates the opportunity to comment on the proposed 303(d) list. Based on the analysis presented above using more recently collected, readily available data that properly represents existing conditions in the SCRE (2012 - 2016), our findings include:

- Appropriate ammonia data were not considered in the proposed listing and current data do not meet the Listing Policy criteria for 303(d) listing.
- A listing for pH is not warranted in light of reference conditions for pH within estuaries, which indicates that steady state pH values in compliance with water quality objectives are not biologically attainable even in high functioning estuaries.
- Nitrate should be delisted based on relevant Listing Policy criteria.
- Toxicity is unrelated to VWRF discharges of tertiary treated water to the SCRE, and the listing should be reevaluated once the data is appropriately aggregated and averaged.
- Chem A, Toxaphene, and Indicator Bacteria listings did not include recent data and should be reevaluated based on current data.

It is important to note the City has been conducting studies on the SCRE since 2009 per the special studies requirements in the NPDES permits for the VWRF. These studies analyze the existing discharge impacts/benefits to aquatic habitat, and evaluate alternatives that include a reduction in discharge, improvement in discharge water quality, or a combination of both, for the purpose of improving aquatic habitat. These studies are site specific, taking into account the listed species using or occupying the SCRE, and the associated physical/chemical parameters that contribute to site specific aquatic habitat conditions. The results of the studies will be presented in the Phase 3 Estuary Studies Report (expected January 2018), and will provide a detailed understanding of the SCRE and information relevant to the 303(d) listing process.

Respectfully,

Gina Dorrington
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City of San Buenaventura