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VIA FEDERAL EXPRESS AND ELECTRONIC MAIL

March 13, 2009

Danny McClure
Regional Water Quality Control Board
Central Valley Region
11020 Sun Center Dr., Suite #200
Rancho Cordova, CA 95670

Re: Proposed Revisions to the 303(d) List of Impaired Water Bodies and Consideration of an Integrated Assessment Report for the Central Valley Region

Dear Mr. McClure

The San Joaquin River Group Authority ("SJRGA") appreciates the opportunity to comment on the 2008 proposed revisions to the Clean Water Act §303(d) List for the Central Valley Region. We hope the Central Valley Regional Water Quality Control Board takes its revisions seriously, as the §303(d) List greatly influences planning, resources allocation, and, most importantly, funding. The 2008 §303(d) List is replete with inconsistencies. It also conflicts with the *Water Quality Control Plan for Developing California's Clean Water Act §303(d) List* ("Listing Policy"), the *Water Quality Control Policy for the Sacrament River and San Joaquin River Basin* ("Basin-Plan"), the *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary and Suisun Marsh* ("Bay-Delta Plan"), and the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California* ("Thermal Plan"). Finally, it exceeds the authority granted the water boards under Porter-Cologne and the Clean Water Act.

The SJRGA herein comments on the following 2008 listings:

1. Electrical conductivity for the San Joaquin River from Mendota to the Delta Boundary (Water Body IDs CAR5357000019990126152905, CAR5357000020021002093226, CAR5357000020021002094621, CAR5440000020021002100850, CAR5353000020041020143854, and CAR5440000020041020140348; Decision IDs 7018, 7566, 6960, 6243, 6359, 6232.)

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2. Temperature for the San Joaquin River from the Merced River confluence to the Delta boundary[1] (Decision IDs 15202, 15203, 15204), Lower Stanislaus River (Water Body ID CAR5353000019980817151834, Decision ID 15206), Lower Tuolumne River (Water Body ID CAR5355000019980817143435, Decision ID 15207), and Merced River (Water Body ID CAR5357000019980817154245, Decision ID 15209);

3. Organic enrichment/low dissolved oxygen for the Delta Waterways (Stockton Ship Channel) (Decision ID 7203 for Water Body ID CAE5440000020021115141407);

4. All exotic species listings;

5. Insufficiently specific identification of the "Delta Waterways."

The SJRGA's comments include the attached comments, associated appendices, and referenced materials, all of which the SJRGA submits for the CVRWQCB to incorporate into the administrative record.

In addition, the SJRGA submitted comments for the proposed temperature listings for the San Joaquin River, Stanislaus River, Tuolumne River, and Merced River in response to your invitation at the September 25, 2007 workshop. The comments were submitted, via electronic mail, on November 19, 2007. A compact disc and paper copies followed by US mail. However, the comments were not included in any lines of evidence. The SJRGA therefore includes its November 19, 2007 comments in the appendices herein, also for incorporation into the administrative record.

In addition, the SJRGA is submitting its comments, with appendices and attachments, via electronic mail. A compact disc with all of the referenced documents and Excel spreadsheets with raw data for dissolved oxygen for the Stockton Deep Water Ship Channel will follow and should arrive on March 16, 2009.

Very truly yours,
O'LAUGHLIN & PARIS LLP

By: Kenneth Petruzzelli
KENNETH PETRUZZELLI

[1] The Delta boundary, as defined by Water Code §12220, corresponds to Airport Way Bridge, near the town of Vernalis, and is often referred to as "Vernalis."(U.S. v. St. Water Resources Control Bd. (1986) 182 Cal.App.3d 82, 107.)

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CALIFORNIA WATER QUALITY CONTROL BOARD

CENTRAL VALLEY REGION

IN RE PROPOSED REVISIONS TO THE 303(d) LIST OF IMPAIRED WATER BODIES AND CONSIDERATION OF AN INTEGRATED ASSESSMENT REPORT FOR THE CENTRAL VALLEY REGION	**COMMENTS OF THE SAN JOAQUIN RIVER GROUP AUTHORITY REGARDING PROPOSED REVISIONS TO THE 303(d) LIST OF IMPAIRED WATER BODIES AND CONSIDERATION OF AN INTEGRATED ASSESSMENT REPORT FOR THE CENTRAL VALLEY REGION** DATE; 22-23 April 2009 TIME: To Be Determined

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Appendix D: Bill Loudermilk, *Response to Comments San Joaquin River Group Authority's Written Comments to Proposal by Central Valley Regional Water Quality Control Board to List the San Joaquin, Tuolumne, Merced and Stanislaus Rivers as Impaired Bodies of Water for Temperature Pursuant to Section 303(d)* (Department of Fish & Game, June 6, 2008)

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I. States Can Only Base Water Quality Limited Segment Identification on Non-Compliance with Applicable Water Quality Objectives for Existing Beneficial Uses.[2]

The Clean Water Act directs states to identify waters wherein effluent limitations are insufficient to implement applicable water quality objectives and to rank such waters based on the severity of pollution and uses to be made. (33 U.S.C. §1313(d)(1)(A); 40 C.F.R. §130.2(d).) Waters lacking applicable water quality objectives do not fall under §303(d) and are not identifiable as water quality limited segments.

"Water quality standards," as applied in the Clean Water Act, include both a beneficial use designation and water quality criteria. (40 C.F.R. §130.2(d).) However, the Clean Water Act only requires states to protect and maintain water quality for existing uses. (40 C.F.R. §131.12(a)(1); *see also* PUD No. 1 of Jefferson County v. Wash. Dept. of Ecology (1994) 511 U.S. 700, 705.) Existing uses are those actually achieved on or after November 28, 1975. (40 C.F.R. §130.3(g).) If states choose to degrade water quality, they must only assure water quality sufficient to protect existing uses. (40 C.F.R. §131.12(a)(2).) Consistent with the Clean Water Act direction to protect actual, existing beneficial uses, when states establish TMDLs they must analyze the pollutant loading level necessary to implement water quality standards for *actual* existing, or future beneficial uses of the water body. (33 U.S.C. §1313(d)(1)(C).) Consequently, the Clean Water Act's direction for states to identify water bodies not complying with an applicable "water quality standard" only directs states to identify water bodies not complying with water quality criteria for existing uses. (33 U.S.C. §1313(d)(1)(A).)

Further, the purpose of Porter-Cologne Water Quality Control Act ("Porter Cologne) (Water Code §12000 et seq.) is to achieve the highest water quality that is "*reasonable*, considering all demands made and to be made and the total values involved, beneficial and detrimental, economic and social, tangible and intangible." (Water Code §13000 (emphasis added).) Consistent with Porter-Cologne's quality goal, establishing water quality objectives is

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[2] The *Policy for Developing California's Clean Water Act §303(d) List of Water Quality Limited Segments* ("Listing Policy") does not define the term "impaired water." It appears nowhere in the glossary. Instead, it uses the term "water quality limited segment," just like federal regulations implementing §303(d). (Listing Policy, p. 28; *see also* 33 C.F.R. §130.2(j).) Even the Basin Plan uses the term "water quality limited segment." (Basin Plan, p. IV-7.00.) The CVRWQCB must avoid using dated, casual terms and use the proper term of art established in its regulatory material. For consistency with the Basin Plan, Listing Policy and federal regulations, as well as clarity, any and all uses of the term "impaired water" or "impaired body of water" should be changed to read "water quality limited segment. Similarly, sections using "impairment" either as a noun or an adjective need rewriting to clarify whether the Staff Report and fact sheets specifically refer to water quality factors resulting in water quality limited segment identification or to pollution in general.

therefore more than merely choosing criteria "fully protective" of a single beneficial use. Rather, it represents a policy decision by a RWQCB to ensure *reasonable* protection of beneficial uses in light of past, present, and *probable* beneficial uses, the environmental characteristics of the hydrograph under consideration, including the quality of water available thereto, economic considerations, economic factors, and water quality conditions reasonably achievable through coordinated control of factors affecting water quality. (Water Code §13241.) Fully protecting one beneficial use could preclude fully protecting another use or even prove harmful. Additionally, some beneficial uses may be relatively more important in one water body than in another.

The Basin Plan designates existing and "potential," beneficial uses, but although the Clean Water Act defines "existing use," it does not define "potential use." (40 C.F.R. §130.3(g).) Porter-Cologne and the Basin Plan similarly do not define "potential use."[3]

"Potential uses" are entirely absent from the Water Code. Porter-Cologne's purpose is to achieve the highest water quality "reasonable, considering all demands made and to be made and the total values involved, beneficial and detrimental, economic and social, tangible and intangible." (Water Code §13000.) Uses "made" are present uses. Uses "to be made" are likely future uses. Consistent with the direction to protect existing uses and likely future uses, Water Code §13241 directs the Regional Water Quality Control Boards ("RWQCBs"), when adopting water quality objectives, to consider, among other factors, "past, present, and probable beneficial uses." (Water Code §13241(a).) It does not direct the RWQCBs to consider hypothetical "potential uses." (Id.) Rather, it prohibits such considerations, because considering potential uses

[3] At the March 10, 2009 public meeting for the §303(d) List, when Staff were specifically asked to define "potential use," no Staff member could provide a definition. Then, when asked to explain how much "potential" a "potential use" has of becoming an existing use, Staff could similarly provide no definition. Staff could even provide no answer when posed with the question of whether a "potential use" had more "potential" to become an existing use than Joe Montana returning from retirement to once again play quarterback for the San Francisco 49ers. T the CVRWQCB can treat a "potential use" as equivalent to an "existing use" for the purposes of making applying water quality objectives if it does not know what a "potential use" is.

Z:\611-B CDO, 303(d), Upstream Objectives\303(d) Revisions for 2008\R5 List\McClure (3.16.09) Cover letter, comments.doc would inevitably result in ignoring existing uses and likely future uses.[4] The CVRWQCB therefore can only list waters for non-compliance with water quality objectives applicable to existing uses, not "potential uses."

II. The San Joaquin River Must be Removed from the §303(d) List for Electrical Conductivity.

A. The Electrical Conductivity Listing for the San Joaquin River was Based on Faulty Data.

1. Listings Based on Faulty Data Must be Re-Evaluated.

When the Listing Policy was adopted in 2004, there were already over 1,800 water-body pollutant combinations on the §303(d) List. (SWRCB, Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List Functional Equivalent Document ("Listing Policy FED"), p. 219 (September 2004).) Since the SWRCB concluded the water boards lacked the resources to review all of the existing listings for consistency with the Listing Policy, it decided to review pre-2004 listings as resources allowed with no requirement for new data. (Id.) As a result, under §4 of the Listing Policy:

> All listings of water segments shall be removed from the section 303(d) list if the listing was based on faulty data, and it is demonstrated that the listing would not have occurred in the absence of such faulty data. Faulty data include, but are not limited to, typographical errors, improper quality assurance/quality control procedures, or limitations related to the analytical methods that would lead to improper conclusions regarding the water quality status of the segment.

(Listing Policy, p. 11.)

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[4] The Basin Plan does not define "potential" beneficial use and the difference is not merely one of semantics. "Probable" is defined as "likely to become true or real" or "supported by evidence strong enough to establish presumption." (*Merriam-Webster Online Dictionary*.) By comparison, "potential" merely means "capable of development into actuality." In other words, a potential use is speculative, whereas a probable use is reasonably foreseeable. (Dunham, Tess, *A Review of the Administrative Record for the Central Valley's Water Quality Control Plan: 1975-1994,* Cal. Resource Management Inst., p. 18 (Sept. 2003).) Designating "potential" in a basin plan and protecting such uses through water quality objectives and National Pollutant Discharge and Elimination System permits led a superior court judge to issue a writ of mandate ordering the Los Angeles RWQCB to revise every water quality objective in its basin plan applicable to storm water by eliminating potential use designations for any and all water quality objectives contained therein. (Writ of Mandate, *Cities of Arcadia et al. v. St. Water Resources Control Bd. Et al.* (Super. Ct. Orange County, 2007, Case No. 06CC02974 (July 2, 2008); *see also* Memo. from Michael M. Lauffer, Chief Counsel, St. Water Resources Control Bd., to Dorothy Rice, Exec. Dir., L.A. RWQCB, *Cities of Arcadia, et al. v. St. Water Resources Control Bd., et al., (Super. Ct. Orange County, 2007, No. 06CC02974): Impact of Peremptory Writ of Mandate on Enrollments Under the General Industrial and General Construction Storm Water Permits*, p. 2 (Jul. 16, 2008).)

An interested party may request reassessment of an existing listing whether new data are available or not. (Listing Policy FED, p. 219.) In requesting the reevaluation, the interested party must describe the reason or reasons the listing is inappropriate, state the reason the Listing Policy would lead to a different outcome, and provide the data and information necessary to enable the CVRWQCB and SWRCB to conduct the review. (Id.)

2. The Original Listing for the Lower San Joaquin River Was Based on "Faulty Data," Because it was Based on No Data.

It is unknown what basis, if any, was ever used to list the Lower San Joaquin River ("LSJR"), the segments from Mendota to the Delta boundary, for salinity. The 1996 §303(d) List provided with the agenda for the CVRWQCB meeting adopting the list in January 1996 did not include salinity as a water quality limiting pollutant for LSJR. It suddenly and inexplicably appeared after the meeting.[5] According to an April 3, 1996 memorandum from Sue Yee of the CVRWQCB to Nancy Richards at the Division of Water Quality, obtained pursuant to a request for public records by the SJRGA:

> As we discussed, I have enclosed the newly revised Section 303d list. Two pollutants have been added to the currently listed water bodies. Salt has been added to the Lower San Joaquin River and the Delta, and boron has been added to the lower San Joaquin River. These pollutants are well documented to be impairing the respective water bodies and should have been included on the earlier list. The water body data used for making these changes as well as that used for making the list is on file at our office. We appreciate that Dave Smith, the TMDL coordinator for Region 9 - U.S. EPA, will public notice these changes in the Federal Register. Thank you again for your help.

No supporting data or analysis was provided with the memorandum and none was provided in conjunction with the SJRGA's request for public records. Since there is no public or administrative record for the water quality limited segment identification for the LSJR, it is unknown exactly how or why it was identified. Analytical methods without data certainly fall under analytical methods resulting in "improper conclusions" and "improper quality assurance/quality control procedures" described in §4. Re-evaluation is therefore required.

B. The San Joaquin River from the Merced River Confluence to the Delta Boundary Must Be Removed From the §303(d) List for Electrical Conductivity, Because there is No Non-Compliance With any Applicable Electrical Conductivity Objective for an Existing Beneficial Use.

1. There are No Applicable Numeric Objectives for Salinity for Existing Uses for the San Joaquin River from Mendota to the Delta Boundary.

The Clean Water Act directs states to identify waters wherein effluent limitations are insufficient to implement applicable water quality objectives for existing beneficial uses. (33 U.S.C. §1313(d)(1)(A).) Then, states must rank all identified waters, referred to as "water quality limited segments," in order of priority for TMDLs. (33 U.S.C. §1313(d)(1)(C); 40 C.F.R. §130.2(j).) States cannot list and rank water body-pollutant combinations absent applicable water quality objectives for existing beneficial uses. For waters with applicable water quality objectives with which compliance occurs and is expected to occur, states can establish TMDLs, but only after they have first established TMDLs for all water quality limited segments. (33 U.S.C. §1313(d)(3); 40 C.F.R. §130.7(e).)

The Basin Plan lacks numeric objectives for salinity for the San Joaquin River from Mendota to the Delta Boundary. (Basin Plan, p. III-6.01 to III-7.00.) However, the Chemical Constituent objective prohibits water from containing chemical constituents in concentrations adversely affecting beneficial uses. (Basin Plan, p. 3.00.) The Chemical Constituents objective prohibits MUN-designated waters from containing chemical constituents in excess of secondary maximum contaminant levels ("MCLs") contained in §64449 Table 64449-B in the California Code of Regulations. (Id.) Secondary MCLs, including secondary MCLs for TDS and specific conductivity, apply to water provided to the public by community water systems. (Cal. Code Regs., tit. 22, §64449(a).) A "community water system" is defined as a public water system

[5] The San Joaquin River was initially identified among water quality limited segments in the 1975 Basin Plan, deleted in 1989. The 1996 addition therefore constituted a new listing. The 2008 §303(d) List incorrectly cites the listing history for various segments of the LSJR for salinity and/or EC for the LSJR from Mendota to the Merced River confluence as 1996. As described herein, the entire 130-mile segment from Mendota to the Delta boundary has been listed since 1996. In 1998 the listings for salinity were changed to listings for EC. In 2006, the 130-mile segment from Mendota to the Delta boundary was broken into shorter units. The shorter segments each became separate listings, but otherwise the EC listing for the 130-mile segment of the LSJR did not change. The CVRWQCB §303(d) List fact sheets should therefore be changed to correctly state that the LSJR from Mendota to

serving at least 15 service connections or regularly serving an average of at least 25 individuals daily at least 60 days out of the year. (Cal. Code Regs., tit. 22, §64410.10.) Furthermore, since Secondary MCLs apply to water "supplied to the public," they apply at the tap, not the source.[6] (Cal. Code Regs., tit. 22, §64449(a).)

Between Mendota and the Delta Boundary, MUN beneficial uses are not existing uses. (Basin Plan, p. II-7.00 to II-8.00, III-3.00.) Neither are MUN beneficial uses actual uses, as there are no surface water diversions for any community water systems. (SWRCB Water Quality Order 85-1 Technical Report, p. III-3.) The CVRWQCB conducted the most recent survey of water diversion and discharge points between Mendota and the Delta Boundary from 1985 through 1986 and found no municipal or domestic diversions anywhere. (CVRWQCB, *Water Diversion and Discharge Points Along the San Joaquin River: Mendota Pool to Mossdale Bridge* (April 1989).) There is also no evidence that any municipality plans to, let alone desires, to divert and use surface water from the San Joaquin River between Mendota and the Delta boundary to supply a community water system.[7] No information suggests the existence of a community water system diverting and using water from the San Joaquin River between Mendota and the Delta boundary or that one plans to do so.

Appropriating water from the San Joaquin River is unlikely. The San Joaquin River between Mendota and the Delta boundary is classified as a "fully appropriated stream." (SWRCB Water Rights Order 98-08.) As a fully appropriated stream, the SWRCB must refuse all applications for any further appropriations from the stream for consumptive use, including small use domestic appropriations. (Id., p2-3.) The SWRCB may also cancel all pending applications to appropriate water from the stream. (Id.) Even if a municipality were able to obtain a permit to divert and use water from the San Joaquin River from Mendota to the Delta boundary for MUN beneficial use, the Department of Health Services (now the Department of Public Health) has stated that it will not approve any applications for urban or municipal water

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the Merced River should correctly state that the LSJR from Mendota to the Merced River confluence was listed in 1996, not 2006.

[6] This is consistent with the federal definition, pursuant to which an MCL is the maximum permissible level of a contaminant in water which is delivered to the free flowing outlet of the ultimate user of public water system. (22 C.F.R. §143.2(f); *see also* 44 Fed. Reg. 42197 (Jul. 19, 1979).)

[7] General plans reviewed for the San Joaquin River between Mendota and the Delta boundary included Merced, Lathrop, Turlock, Gustine, Modesto, Tracy, Manteca, Ripon, Escalon, Patterson, Oakdale, and Newman. Municipalities were selected based on a review of topographic maps for municipalities that may divert and use surface water from the San Joaquin River between Mendota and the Delta boundary. For the general planning documents and summaries of the water-supply related aspects of each, *see* Appendix A.

system using water from the San Joaquin River from Mendota to the Delta boundary. (*see* letter from Cindy Forbes at DHS to Brian Kumimoto (April 13, 1996).).

Chemical constituent concentrations cannot adversely affect beneficial uses that are not existing uses. Although MUN beneficial uses encompass both community water systems and domestic water systems, MCLs apply only to community water systems, but no community water systems between Mendota and the Delta Boundary divert surface water from the San Joaquin River. (Cal. Code Regs., tit. 22, §64449(a).) Even if a community water system did divert and use water from the San Joaquin River for MUN uses, Secondary MCLs would apply at the tap, not as water quality standards for surface water. (Cal. Code Regs., tit. 22, §64449(a).)

Even assuming the secondary MCL for specific conductivity can apply to the San Joaquin River from Merced to the Stanislaus, the 900 µS/cm level recommended for tap water served by community water systems should not apply as the surface water standard for the San Joaquin River. MCLs are established based on consumer acceptance levels of aesthetic qualities such as taste and smell, without fixed consumer acceptance contaminant levels for specific conductivity.[8] (Cal. Code Regs., tit. 22, §64449(d).) The regulations therefore recommend a level of 900 µS/cm, an upper level of 1,600 µS/cm, and a short-term level of 2,200 µS/cm. (Cal. Code Regs., tit. 22, §64449(a) Table 64449-B.) Constituent concentrations ranging to the upper contaminant level are acceptable if it is neither reasonable nor feasible to provide more suitable waters. (Cal. Code Regs., tit. 22, §64449(d)(2).) Constituent concentrations ranging to the short-term contaminant level are acceptable for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources.[9] (Cal. Code Regs., tit. 22, §64449(d)(3).) It is unreasonable to provide water any more suitable than 1,600 µS/cm for tap water served by community water systems when there are no identified community water systems diverting surface water from the San Joaquin River between the Merced River confluence and the Stanislaus River confluence. Even the 2,200 µS/cm short-term level is "temporarily" acceptable pending construction of treatment facilities or

[8] Secondary MCLs were initially adopted by the USEPA as guidelines to provide states a realistic frame of reference for the aesthetic water quality goal they should be trying to achieve for consumer acceptance and confidence in public water systems. (40 C.F.R. §143.1; *see also* 44 Fed. Reg. 42195 (Jul. 19, 1979).

[9] A "water source" is an individual water source or individual surface water intake. (Cal. Code Regs., tit. 22, §64402.10.)

development of acceptable new water sources (even if there is no evidence that neither will occur in the foreseeable future).[10]

Finally, although listed as an existing use between Mendota and the Merced River confluence, Irrigated Agriculture is not an actual use.[11] In 1987, the Technical Committee for Water Quality Order 85-1 recommended salinity objectives for the LSJR. (SWRCB Water Quality Order ("WQO") 85-1 Technical Report, p. VIII-1 (August 1987).) In reviewing the agriculture practices in the region, the Technical Committee found few agriculture diversions between Mendota to Hills Ferry (Id.) All of the diversions were used for Stock Watering, a highly salt-tolerant beneficial use. (Id.) As a result, the Technical Committee recommended EC criteria as high as 3,000 µS/cm. (Id.)

Staff cannot identify the San Joaquin River between Mendota and the Delta boundary as a water quality limited segment for salinity, because the segment lacks and applicable salinity objectives for any existing beneficial uses. Municipal beneficial uses are not existing uses are not expected to exist any time in the foreseeable future. Recommending that the CVRWQCB apply any secondary MCL for specific conductivity or TDS becomes absurd, given the absence of any current or anticipated community water systems. However, applying the 2,200 µS/cm standard (or even 1,600 µS/cm standard) is much less absurd than applying the 900 µS/cm standard.

2. The Vernalis Salinity Objective is not an Applicable Salinity/Electrical Conductivity Objective for the San Joaquin River Upstream from the Delta Boundary.

The Vernalis Salinity Objective is contained in the 2006 Bay-Delta Plan as a compliance point for the "Southern Delta Water Quality Objectives for Agricultural Beneficial Uses." (2006 Bay-Delta Plan, p. 13 Table 2.) The Sacramento-San Joaquin Delta boundaries are established in the Water Code with Airport Way Bridge near Vernalis as the farthest upstream boundary. (Water Code §12220.)

The earliest incarnation of the Vernalis Salinity Objective, a 500 mg/L monthly average of TDS, was established in a 1965 agreement between the Sacramento River and Delta Water

[10] Since no community water systems will divert and use surface water from the San Joaquin River between the Merced River confluence and the Stanislaus River confluence any time in the foreseeable future, the "temporary" basis of applying the short-term 2,200 µS/cm level becomes permanent, demonstrating the absurdity of applying objectives to beneficial uses that do not exist and will likely never exist.

[11] The Technical Committee also observed that no municipalities diverted and used surface water from the San Joaquin River between Mendota and the Delta Boundary. (SWRCB WQO 85-1 Technical Report, p. VIII-19.) As a result, they opposed water quality objectives based on Municipal Beneficial uses. (Id.)

Association, the San Joaquin Water Rights Committee, the Department of Water Resources ("DWR"), and the USBR. (D-1641 EIR, Vol. I, p. VIII-11; *see also* USBR, *Water quality criteria agreement among Sacramento River and Delta Water Users Association, San Joaquin Water Rights Committee, Department of Water Resources, and U.S. Bureau of Reclamation*, p. 6 (1965).) Under the agreement, if New Melones Reservoir were ever used for water quality control, the USBR would maintain an average total dissolved solids concentration at Vernalis of 500 part per million ("ppm") TDS or less. (USBR, *Water quality criteria agreement among Sacramento River and Delta Water Users Association, San Joaquin Water Rights Committee, Department of Water Resources, and U.S. Bureau of Reclamation*, p. 6 (1965).) However, the agreement did not obligate the USBR to release more that 70,000 acre-feet in a single calendar year for this purpose. (Id.)

The 500 mg/l TDS, objective subsequently appeared in the 1967 Sacramento-San Joaquin Water Quality Control Policy, requiring a 500 mg/l TDS concentration at Vernalis over any consecutive 30-day period. (CVRWQCB, *Sacramento-San Joaquin Water Quality Control Policy*, p. G-2 (1967).) The CVRWQCB implemented the objective through a Memorandum of Agreement ("MOA") with the USBR. (Basin Plan, p. IV-21.00; *see also* Basin Plan Appendix Item 29, p. 3.) Similar to the 1965 agreement between Sacramento River and Delta Water Association, the San Joaquin Water Rights Committee, the DWR, and the USBR, the MOA required the USBR to maintain a mean monthly TDS concentration of 500 mg/l "immediately below the mouth of the Stanislaus River." (Basin Plan Appendix Item 29, p. 3.) The MOA also limited the USBR's obligation to 70,000 acre-feet in a single calendar year. (Id.) However, it also provided that if hydrologic or other conditions prevented maintaining a mean monthly concentration of 500 mg/l TDS immediate below the mouth of the Stanislaus River, then operational releases of the "water quality reservation" would be restricted to the irrigation season in accordance with the needs of irrigators. (Id.)

The 1978 Sacramento-San Joaquin Delta and Suisun Marsh ("1978 Delta Plan") revised the objective with a 700 µS/cm applying in the irrigation season objective and a 1,000 µS/cm non-irrigation season objective. (D-1641, p. 79-80, 160-163; SWRCB, *D-1641 Environmental Impact Report* ("D-1641 EIR"), Vol. 1, p. IX-3 to IX-5 (November 1999).) The revised objectives adopted in the 1978 Delta Plan were developed and based on thorough consideration of crops representative of those historically grown in the South Delta, in addition to South Delta climate, soils, and cultural practices, its was established specifically for agricultural beneficial uses in the Southern Delta. (*D-1641 Environmental Impact Report*, Vol. 1, p. IX-3 to IX-4; St. Water Resources Control Bd. Cases, (2006) 136 Cal.App.4th 674, 744 ("The southern Delta agricultural salinity objectives in the 1995 Bay-Delta Plan, including the Vernalis salinity objective, were formulated specifically to maintain an adequate level of protection for agriculture in the southern Delta."); *see also* 1978 Delta Plan, p. VI-14 to VI-23.)

Although initially adopted in 1978, the Vernalis Salinity Objective did not become effective until 1995 when the SWRCB adopted the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary ("1995 Bay-Delta Plan"). (D-1641, p. 79-80, 160-163; SWRCB, D-1641 EIR, p.VIII-13 to VIII-14 (November 1999).) Furthermore, since the water right permits for the Central Valley Project ("CVP") had not come before the SWRCB, the Vernalis Salinity Objective had not been implemented through any changes in water right permits. (Id.) The Vernalis Salinity Objective was finally implemented in 1995, in part, when the SWRCB adopted Water Right Order 95-06. (SWRCB, D-1641 EIR, p. VIII-14.) It was fully implemented in 1999 when the SWRCB adopted D-1641. (D-1641, p. 79-80, 160-163.) Nothing in the regulatory history of the Vernalis Salinity Objective indicates it ever applied to the San Joaquin River upstream of the Delta boundary.

Even if the SWRCB had wished to apply the Vernalis Salinity Objective upstream of the Delta boundary, it would have lacked the jurisdiction to do so. The 1978 Delta Plan, the 1991 Salinity Plan, and the 1995 Bay-Delta Plan were all Bay-Delta proceedings specifically limited to the Delta, as defined by Water Code §12220. If the Vernalis Salinity Objective applied upstream of Vernalis, it would have been unnecessary for the SWRCB to direct the CVRWQCB, in D-1641, to "develop and adopt salinity objectives and a program of implementation for the main stem of the San Joaquin River upstream of Vernalis." (D- 1641, p. 85.) It would also be unnecessary for the Salt & Boron TMDL to develop salinity objectives for the LSJR. (Basin Plan, p. IV-32.03.)

From the start, the Vernalis Salinity Objective was not intended to apply to the LSJR, but to mitigate for the impacts of the State Water Project and Central Valley Project on agricultural beneficial uses in the South Delta. It applies only in the Delta. Its specific area of jurisdiction is clear from its regulatory history and on its face. It does not apply upstream of the Delta boundary and therefore cannot operate as a water quality objective to identify a segment of the San Joaquin River upstream of the Delta as a water quality limited segment for electrical conductivity.[12]

3. The Current Electrical Conductivity Listing for the San Joaquin River from Mendota to the Merced River Confluence Must be Removed Because it is Based on Faulty Data.

The 2008 §303(d) electrical conductivity listing for the San Joaquin River from Mendota to the Merced River confluence has no data, no analysis, no citation to any line of evidence, and no citation to any section of the Listing Policy describing the basis for listing. (Decision IDs 7018, 7566, 6960.) The listings merely state:

> 303(d) listing decisions made prior to 2006 were not held in an assessment database. The Regional Boards will update this decision when new data and information become available and are assessed.

The lines of evidence to the prior listing decisions are blank "placeholders," lacking any data, analysis, or citations. (LOEs 4525, 4530, 4536.)

The original salinity/electrical conductivity listing for the San Joaquin River were based on "faulty data," because it was based on no data. The 2008 listing decisions similarly lack any data. Although the decisions state no data was submitted, the RWQCBs are required to consider all "readily available" data. (Listing Policy, p. 17.) "Readily available" data includes data from the Surface Water Ambient Monitoring Program ("SWAMP"), which gathers salinity data from the San Joaquin River. Therefore, data was available, but Staff ignored it.

The issue, however, is whether there is an existing beneficial use with an applicable electrical conductivity objective with which non-compliance has occurred. The primary Agriculture beneficial use on the San Joaquin River from Mendota to Crows Landing is not

[12] If the Vernalis Salinity Objective is an applicable salinity objective for the LSJR upstream of Vernalis, Staff properly recommended removing the San Joaquin River from the Tuolumne River to the Delta boundary for removal from the §303(d) list, although the removal is long overdue. Water Right Decision 1641 conditioned all of the water right permits for the CVP on compliance with the salinity objective at Vernalis by using "flow or other means." (SWRCB Water Right Decision 1641, pp. 160-162.) As a term and condition attached to water right permits, the United States Bureau of Reclamation lacks the discretion to operate the CVP in a manner that would result in any non-compliance with the Vernalis Salinity Objective, let alone a manner resulting in non-compliance sufficient to result in water quality limited segment classification. (C. Delta Water Agency v. U.S. Bureau of Recl. (2006) 452 F.3d 1021, 1026.) If it did not, then the SWRCB would have to use its water right enforcement authority to ensure the CVP fully implements the Vernalis Salinity Objective. (St. Water Resources Control Bd. Cases (2006) 136 Cal.App.4th 674, 734.)

surface water irrigation, but stock watering.[13] (SWRCB WQO 85-1 Technical Report, p. VIII-16.) Furthermore, MUN is not an existing use and likely never will be. The San Joaquin River from Mendota to the Merced River confluence therefore lacks an actual, existing beneficial use with applicable water quality objectives. Since Clean Water Act §303(d)(1)(A) only identifies water bodies with non-compliance with applicable water quality objectives for existing beneficial uses, the San Joaquin River from Mendota to the Merced River confluence cannot fall under Clean Water Act §303(d)(1)(A) and is not subject to water quality limited segment identification. (33 U.S.C. §1313(d)(1)(A).)

III. The San Joaquin River and Major Eastside Tributaries Should Not be Identified as Water Quality Limited Segments for Temperature.

A. The Fact Sheets Do Not Support the Existence of COLD Beneficial Uses.

1. Historic Temperature Data Is Not Relevant in Establishing that COLD is an Existing Use.

"Existing uses," as defined by the Clean Water Act, are those actually achieved since 1975. (40 C.F.R. §131.3(e).) As a result, comparing pre-1975 information about the presence/absence or abundance of sensitive aquatic life species is not relevant for establishing the existence of an existing use. Since the use must have been achieved since 1975, only information after 1975 is relevant. If post-1975 information shows a stable, fully supported cold water fishery, then COLD beneficial uses are existing uses. If post-1975 information does not establish the existence of a thriving, fully supported cold water fishery, then COLD beneficial uses are not existing uses. Uses that are not existing uses are not protected by the Clean Water Act. Since water quality limited segments are identified under the Clean Water Act, non-compliance with an objective for a beneficial use that does not exist does not constitute a valid basis for water quality limited segment identification.

Although the Basin Plan designates the San Joaquin River, Stanislaus River, Tuolumne River, and Merced River with COLD existing beneficial uses, it cannot change the definition of existing use contained in the Clean Water Act for the purposes of developing the §303(d) List. The Clean Water Act directs states to develop the §303(d) List and, as a result, the Clean Water

[13] Since the primary Agriculture beneficial use was specifically stock watering and no public water systems drew water from the San Joaquin River between Mendota and Crows Landing, the technical committee for the Technical Report for SWRCB Water Quality Order 85-1 recommended an EC objective of 3,000 µS/cm as far downstream as Hills Ferry. (SWRCB WQO 85-1 Technical Report, p. VIII-16.)

Act's definitions of existing uses apply in developing the List. Consequently, ff data shows a beneficial use did not exist since 1975, then it is not an existing use, regardless of its designation in the Basin Plan.

The Department of Fish & Game ("DFG") submitted a substantial amount of information, including a substantial amount of anecdotal evidence to support its recommendation to indentify the Stanislaus River, Tuolumne River, Merced River, and San Joaquin River as water quality limited segments for temperature. (Decision IDs 15202, 15203, 15204, 15206, 15207, 15209.) In general, the evidence cites various hearsay statements describing the decline of Chinook salmon and steelhead since at least 1920. Rather than showing that effluent limitations are insufficient to implement temperature objectives for existing COLD beneficial uses, they instead show that such uses are not existing uses, as defined by the Clean Water Act.

For the San Joaquin River, Chinook salmon populations had already declined by 1920. (LOE 26524) By 1950's salmon were extinct in the mainstem San Joaquin River and populations of less than 500 were a common occurrence in the Merced, Tuolumne and Stanislaus Rivers. (LOE 26524) Although there have been several peak escapement trends since 1952, the trend over time to 2006 has been declining escapement, with escapement peaking in 1952 at over 8,000 salmon and declining to 1,000 in 2006. (LOE 26526, 26524, 26519) (Id.)

The Stanislaus River had a good spring and fall-run as late as 1929 and at least until the construction of Tulloch Dam in 1958, when fall-run escapement averaged 10,300 spawners. (LOE 26531) After Tulloch Dam's construction, however, escapement declined to an average of 4,300 spawners. (Id.) With the operation of New Melones Reservoir in the 1970s, annual escapement dropped further to an average of 3,600 spawners. (LOE 26531) Between 1952 and 2006 the fall-run escapement population has oscillated over time and has dropped to levels less than 1,000 on several occasions. (Id.)

On the Tuolumne River, John Marsh noted particular salmon abundance in 1830. (LOE 26536) In 1849 Samuel Ward recalled a "plenteous fish summer of salmon, caught by rifle shot in the lower Tuolumne River." (Id.) The Tuolumne River annual escapement trends from 1940 to 2006 show production steadily decreasing. (Id.)

On the Merced River, residents informed the Fish & Game Commission as early as 1920 that Chinook salmon had declined to only a fiftieth of their former numbers. (LOE 26541) In

1928, the DFG stated there were several hundred Chinook salmon in the fall, but by 1961 the run was "poor," with only about 250 estimated salmon per year (Id.)

To constitute an existing use, as defined by the Clean Water Act, the Chinook salmon and steelhead fisheries must have been stable and thriving since 1975, but the evidence cited by the DFG shows only the contrary. With declining abundance since as early as 1920, beneficial uses for Chinook salmon and steelhead have not been fully supported since 1975. COLD is therefore not an existing use under the Clean Water Act.

2. USEPA Region 10 Criteria and Data from the Department of Fish & Game Show COLD is Not an Existing Beneficial Use.

Due to an alleged lack of data for natural receiving water temperature, the CVRWCB Staff used the "alternative approach focused on beneficial use impacts and likely effects of elevated temperature on sensitive species" by comparing the seven day average daily maximum temperature ("7DADM") to temperature criteria published by Region 10 of the USEPA. (*see* Listing Policy FED, p. 133.) All of the data was collected after 1975. (*see* Table 1, below.)

Table 1. Department of Fish & Game data collection periods of temperature listings.

Water Body	Collection Periods				
	Migration	Spawning	Smoltification	Juvenile Rearing	Steelhead Summer Rearing
San Joaquin R.					
Merced R. to Tuolumne R.	1996-2006		1997-2007		
Tuolumne R. to Stanislaus R.	1996-2006		1997-2007		
Stanislaus R. to Delta boundary	2001-2005		2002-2005		
Stanislaus R.	1991-2007	1999-2007	1999-2007	1999-2007	1999-2007
Tuolumne R.	1996-2007	1996-2007	1997-2008	1997-2008	1998-2007
Merced R.	1991-2007	1991-2007	1992-2007	1992-2007	1992-2007

In addition, a large proportion of samples collected during the period of data collection show a large proportion of samples exceeding the USEPA Region 10 7DADM temperature criteria. (*see* Table 2, below.)

Table 2. Proportion of 7DADM Samples Exceeding USEPA Region 10 Criteria.

Water Body	Proportion				
	Migration	Spawning	Smoltification	Juvenile Rearing	Steelhead Summer Rearing
San Joaquin R.					
Merced R. to Tuolumne R.	19 of 20		5 of 7		
Tuolumne R. to Stanislaus R.	13 of 13		9 of 12		
Stanislaus R. to Delta boundary	13 of 13		5 of 7		
Stanislaus R.	38 of 76	38 of 49	36 of 73	36 of 73	7 of 27
Tuolumne R.	85 of 147	102 of 118	75 of 137	75 of 137	26 of 78
Merced R.	107 of 130	95 of 96	102 of 125	102 of 125	31 of 47

The Listing Policy analyses under §4.2 and §3.2 are quantitative measures of whether a beneficial use, as measured by a water quality objective, has or has not been attained. If DFG's analysis is correct, USEPA Region 10 7DADM temperature constitutes numeric criteria for

COLD beneficial uses, COLD beneficial uses have been attained and are existing uses only if temperature data does no support listing. If, however, all of the data obtained since 1975 supports listing, then COLD beneficial uses have not been attained since 1975 and are not existing uses.

All of the temperature data collected since 1975 and supported by a Quality Assurance Project Plan ("QAPP") supports rejecting the null hypothesis presented in Table 3.2 of the Listing Policy. (Decision IDs 15202, 15203, 15204, 15206, 15207, 15209.) No QAPP-supported temperature data supports rejecting the null hypothesis in Table 4.2 of the Listing Policy. As objectively measured by comparing USEPA Region 10 criteria to 7DADM temperature data obtained by the DFG and analyzed under the Listing Policy, COLD beneficial uses have never been attained since 1975. Consequently, COLD beneficial uses do not exist in the San Joaquin River or the Stanislaus, Tuolumne, and Merced River, precluding water quality limited segment identification due to non-compliance with Basin Plan temperature objectives.

B. Water Quality Objectives for Temperature.

1. The Basin Plan Temperature Objective is Based on Natural Receiving Water Temperature.

The Basin Plan does not provide water body-specific temperature objectives for the LSJR or its east side tributaries. (Basin Plan, p. III-8.00.) In general, "[t]he natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses." (Id.) Further, "At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature." (Id.) The 5°F limitation is not an absolute differential between natural receiving water temperature and effluent temperature, as the Basin Plan allows for mixing zones.[14] (Basin Plan, p. II-2.00.) The San Joaquin River and its major east side tributaries all include COLD existing beneficial uses. (Basin Plan, p. II-7.00 to II-8.00.) Therefore, the objectives for COLD waters apply.

[14] "The objectives are intended to govern the levels of constituents and characteristics in the main water mass unless otherwise designated, and therefore do not apply at or in the immediate vicinity of effluent discharges. Where appropriate, zones of dilution or criteria for diffusion or dispersion will be defined in waste discharge requirements." (Basin Plan, Ch. II p. 2.00.)

Most important, however, the Thermal Plan[15] defines "natural receiving water temperature," which is "[t]he temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated temperature waste discharge or irrigation return waters." (Thermal Plan, p1.) "Elevated temperature waste" is "[1]iquid, solid, or gaseous material including thermal waste discharged at a temperature higher than the natural temperature of receiving water." (Id.) "Thermal waste" is "cooling water and industrial process water used for the purpose of transporting waste heat." (Id.)

The Thermal Plan applies to interstate and coastal waters, enclosed bays, and estuaries. (Thermal Plan, p. 1.) However, the SWRCB has applied the definitions included therein, particularly the definition for "natural receiving water temperature," to intrastate waters. (SWRCB Water Quality Order No. 2002-0015, *In the Matter of Review on Own Motion of Waste Discharge Requirements Order No. 5-01-044 for Vacaville's Easterly Wastewater Treatment Plant Issued by the California Regional Water Quality Control Board, Central Valley Region*, p. 49 (Oct. 3, 2002).) Furthermore, "natural receiving water temperature" is defined nowhere other than the Thermal Plan. The use of the same term in similar regulations is presumed to have the same meaning. (Boise Cascade Corp. v. USEPA, 942 F.2d 1427, 1432 (9th Cir. 1991)). This is especially true when, as here, the agency has given a specific definition for a term. (Urban Renewal Agency v. Calif. Coastal Zone Conservation Co. (1975) 15 Cal.3d 577, 584-585). Since the SWRCB used the term "natural receiving water temperature" in regards to the interstate waters, coastal waters and enclosed bays covered expressly by the Thermal Plan, and in regards to the intrastate waters which are not discussed in the Thermal Plan, in the absence of some other manifestation of a differing intent, the two terms are to be treated as if they have the same meaning.

Natural receiving water temperature is the key component in establishing the naturally occurring background temperature. As the Listing Policy FED acknowledged, "Without natural receiving water temperatures it is impossible to interpret the Basin Plan and Thermal Plan water quality objectives." (Listing Policy FED, p. 133.) Solar radiation, since it is not water or liquid, solid, or gaseous material fits neither the definitions of elevated temperature waste not thermal waste. Reservoir releases that are colder than natural receiving water temperature also fall outside the definition of elevated temperature waste. Since "natural receiving water temperature"

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[15] The Thermal Plan is included as Item 11 in the Basin Plan Appendix.

includes everything except elevated temperature waste, thermal waste, and irrigation return flows, it includes the effects of sunlight, flow, and changes in flow, regardless of whether flow has been increased or decreased.[16]

2. The Listing Policy Revised the Basin Plan Temperature Objective by Incorrectly Defining Natural Receiving Water Temperature.

a. The Listing Policy Illegally Revised the Basin Plan Temperature Objective by Adding Two Commas to the Definition of Natural Receiving Water Temperature.

The Listing Policy did not establish new or revised water quality objectives and the listing process similarly does not revise or establish water quality objectives. (Listing Policy FED, p. 41-42; Listing Policy, p. 1.) As a result, the Listing Policy cannot interpret an objective, whether numeric or narrative, in a manner establishing a new or revised water quality objective. (Fl. Publ. Interest Research Citizen Lobby v. U.S. Envtl. Protection Agency (2004) 386 F.3d 1070, 1088-1089.)

The SWRCB nonetheless fundamentally altered the Basin Plan temperature objective when it developed the Listing Policy by incorrectly defining “natural receiving water temperature.” The Listing Policy FED defined natural receiving water temperature as “The temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated temperature, waste discharge, or irrigation return waters,” adding commas between elevated temperature, waste discharge, and irrigation return water. (Listing Policy FED, p. 132.) Whereas the Thermal Plan definition of natural receiving water temperature includes everything except discharges of “elevated temperature waste,” which is a term of art with a particular meaning, and “irrigation return waters,” the Listing Policy only excludes elevated temperature, waste discharge, or irrigation return waters. By inserting a comma and separating “elevated temperature waste discharge” into “elevated temperature” and “waste discharge,” the Listing Policy fundamentally changed the meaning of natural receiving water temperature.

In excluding elevated temperature waste from the definition of natural receiving water temperature, the SWRCB incorrectly interpreted natural receiving water temperature to mean

[16] If, for example, flows are augmented to achieve a pulse flow objective and have the incidental effect of lowering the water temperature, then the lowered water temperature is the natural receiving water temperature. If flows

historic, unaltered, and/or natural conditions in a water body. (Listing Policy FED, p. 132-133.) Since natural receiving water temperature includes everything except elevated temperature waste discharge and irrigation return water, time and history are only relevant for the purposes of eliminating such factors to determine natural receiving water temperature. The Thermal Plan itself precludes using a natural/historic baseline, providing that:

> "Natural water temperature will be compared with waste discharge temperature by near-simultaneous measurements accurate to within 1ºF. In lieu of near-simultaneous measurements, measurements may be made under calculated conditions of constant waste discharge and receiving water characteristics."

(Thermal Plan, p. 6.)

Given the SWRCB's insistence that temperature comparisons be made using "near-simultaneous measurements," it is clear that the SWRCB was not contemplating the need or use for data reflective of the "historic" or "unaltered" condition of the water body. Rather, the SWRCB viewed elevated temperature waste discharge as a point source discharge. Other than irrigation return water, natural receiving water temperature includes all non-point source discharges, including solar radiation.

b. The Fact Sheets Fail to Consider the Entire Temperature Objective.

In the listing decisions for temperature for the San Joaquin River, Stanislaus River, Tuolumne River, and Merced River, Staff further altered the Basin Plan temperature objective by limiting the narrative to the first sentence, "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses." (CVRWQCB, *Clean Water Act Sections 305(b) and 303(d) Integrated Report for the Central Valley Region Public Review Draft* ("2008 §305(b)/303(d) Staff Report"), p. 8 (January 2009); 2008 §305(b)/303(d) Staff Report, App. E, Decision IDs 15202, 15203, 15204, 15206, 15207, 15209.) As a result, the facts sheets ignore the definition of natural receiving water temperature contained in the Thermal Plan and entirely ignore the Basin Plan COLD water narrative limiting changes in natural receiving water temperature to 5°F. (2008 §305(b)/303(d) Staff Report, App.

consist almost entirely of temperature waste, thermal waste, and irrigation return flows, then there is no "natural" receiving water.

E, Decision IDs 15202, 15203, 15204, 15206, 15207, 15209.) This interpretation has even less basis in the water quality control plans. While the quoted language is contained in the Basin Plan (*see* Chapter III, p. 8.00), it does not constitute a "water quality objective" as defined by the Water Code.

A water quality objective is a standard that limits the levels of water quality constituents or characteristics. Specifically, the Water Code defines a "water quality objective" as "*the limits or levels* of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area."(*See* Water Code 13050(h)(emphasis added)). The language cited by the CVRWQCB as a "narrative objective" does not qualify as a water quality objective as defined by the Water Code as it does not contain any level, criteria, characteristic or other description or limitation regarding the temperature of intrastate water. Rather, the language relied upon by the CVRWQCB merely provides that no alteration of temperature will be allowed unless expressly approved by the CVRWQCB. Although, the language relied upon by the CVRWQCB establishes that alterations of temperature are allowed, it provides for no such alterations unless prior approval is obtained from the CVRWQCB. The need to obtain prior CVRWQCB approval is not a description or identification of a limit or level of water quality constituents as required by Water Code §13050(h).

The language relied upon by Staff similarly does not comply with federal requirements under the Clean Water Act. Pursuant to federal regulation, a water quality standard is comprised of both the designation of use to be made of the water, and the criteria necessary to protect such use. (40 C.F.R. §131.2). In addition to not identifying any criteria, the language relied upon by the CVRWQCB fails to identify any beneficial use or uses which are to be protected. All that the language relied upon by the CVRWQCB says is that temperature cannot be altered, absent the permission of the CVRWQCB, if it will harm "beneficial uses." The Water Code and Clean Water Act both require the CVRWQCB to evaluate, weigh and balance a host of factors before identifying the beneficial use or uses for a particular water (not to mention the criteria necessary to reasonably protect such beneficial use). (Water Code § 13241; 33 U.S.C. §1313(c)(2)(A); *see also* 40 C.F.R. §§131.10-131.13). There is no evidence that the weighing and balancing the CVRWQCB must have engaged in ever occurred, as the language does not identify any specific beneficial use or uses which are to be protected.

Staff's interpretation of the objective is inconsistent with prior interpretations by the CVRWCB, which has treated the language "natural receiving water temperature… shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses" as an exception to the objective rather than the objective itself. In granting an exception to the Thermal Plan for the Antioch Paper and Pulp Mill, the CVRWQCB noted, using similar language to that contained in the Basin Plan, that federal regulations allow the CVRWQCB to establish effluent limitations in permits less stringent than those contained in applicable standards if the discharger demonstrates to the satisfaction of the CVRWQCB that the effluent limitations are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge is made.[17] (Central Valley Regional Water Quality Control Board, *Granting an Exception to the Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California for the Gaylord Container Corporation Antioch Paper And Pulp Mill (Discharger) Wastewater Discharge into the San Joaquin River*, p. 1 (Resolution R5-2003-0069, April 25, 2003).

The Antioch Paper and Pulp Mill subsequently conducted a study in 1976, 27 years prior, determining that the thermal waste discharge was 45 °F hotter than the maximum temperatures of the receiving water. (Id. at 2.) However, the studies also concluded that the thermal waste discharge would not "adversely affect beneficial uses and the propagation of a typical community of fish and macroinvertebrates in the receiving waters." (Id.) Finally, the study

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[17] Specifically, Clean Water Act §316(a) provides that:

> "…with respect to any point source otherwise subject to the provisions of section 1311 of this title or section 1316 of this title, whenever the owner or operator of any such source, after opportunity for public hearing, can demonstrate to the satisfaction of the Administrator (or, if appropriate, the State) that any effluent limitation proposed for the control of the thermal component of any discharge from such source will require effluent limitations more stringent than necessary to assure the projection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made, the Administrator (or, if appropriate, the State) may impose an effluent limitation under such sections for such plant, with respect to the thermal component of such discharge (taking into account the interaction of such thermal component with other pollutants), that will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on that body of water."

(33 U.S.C. §1326(a); *see also* 40 C.F.R. §125.73.)

concluded that a zone defined by water temperatures of no more than 1 °F across 25% of the main river channel and not elevating water temperature more than 4 °F above natural receiving water temperatures could not be met for any foreseeable tidal or river conditions. (Id.) Even though the studies were 23 years old, the Antioch Paper and Pulp Mill nonetheless satisfied the CVRWQCB that natural receiving water temperature could be altered without harming beneficial uses and the CVRWQCB granted an exception to the Thermal Plan. The exception granted to the Antioch Paper and Pulp Mill therefore demonstrates that the language relied upon by Staff as a temperature objective is not a temperature objective, merely authorization for the CVRWQCB to grant exceptions to temperature objectives contained elsewhere.

The Staff interpretation is also inconsistent with that of the SWRCB, which, in reviewing the waste discharge permit for the City of Vacaville's Easterly Wastewater Treatment Plant issued by the CVRWQCB for waste discharges into Old Alamo Creek, stated:

> The Vacaville permit… implements a Current Basin Plan objective that states that "[a]t no time shall the temperature of COLD or WARM interstate waters be increased more than 5° F above natural receiving water temperature." "Natural receiving water temperature" is defined in the [Thermal Plan]. It means "[t]he temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated temperature waste discharge or irrigation return waters."

(SWRCB Water Quality Order No. 2002-0015, *In the Matter of Review on Own Motion of Waste Discharge Requirements Order No. 5-01-044 for Vacaville's Easterly Wastewater Treatment Plant Issued by the California Regional Water Quality Control Board, Central Valley Region*, p. 49 (Oct. 3, 2002).)

Similarly, in amending the Basin Plan to adopt temperature objectives for Deer Creek, the CVRWQCB stated the temperature objective as much more than just the first sentence:

> "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alternation in temperature does not adversely affect beneficial uses.
>
> …At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5ºF above natural receiving water temperature. Temperature changes due to controllable factors shall be limited for the water bodies specified as described in Table III-4. To the extent of any conflict with the above, the more stringent objective applies.

> In determining compliance with the water quality objectives for temperature, appropriate averaging periods may be applied provided that beneficial uses will be fully protected."

(CVRWQCB, *Amendments To The Water Quality Control Plan For The Sacramento River And San Joaquin River Basins For Temperature At Deer Creek El Dorado & Sacramento Counties Staff Report Functional Equivalent Document - Final Staff Report*, p. 4-1 (January 2003).)

Staff's present interpretation of the Basin Plan temperature objective is also inconsistent with previous listing determinations. In responding to recommendations to list certain water bodies for temperature, the CVRWQCB Staff acknowledged the need to determine "natural receiving water temperature" before determining whether temperatures had increased more than 5°F above natural receiving water temperature. (CVRWQCB, *Final Staff Report on Recommended Changes to California's Clean Water Act section 303(d) List*, p. 28 (December 14, 2001).) In responding to requests to list various streams for temperature on the 2002 §303(d) List, the CVRWQCB Staff summarized the objective as:

> "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses. ….At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature. Temperature changes due to controllable factors shall be limited for the water bodies specified as described in Table III-4. To the extent of any conflict with the above, the more stringent objective applies. In determining compliance with the water quality objectives for temperature, appropriate averaging periods may be applied provided that beneficial uses will be fully protected."

(CVRWQCB, Final Staff Report on Recommended Changes to California's Clean Water Act section 303(d) List, p. 28 (December 14, 2001).)

Even in 2006, the CVRQWCB used the "entire" temperature objective prohibiting increases of more than 5 °F above natural receiving water temperature for making listing determinations for Butt Valley Reservoir (LOE 726), Butte Creek (LOE 2677), and the Middle Fork of the Feather River (LOE 2629). Staff, however, at the March 10, 2009 public meeting, admitted they did not consult the Thermal Plan for the definition of "natural receiving water temperature," did not know what "natural receiving water temperature" was, did not try to determine what "natural receiving water temperature" was, and did not even know that "natural receiving water temperature" has a specific definition. As a result, even if Staff's "objective" were correct, which it is not, Staff cannot determine whether compliance has occurred, because if it does not know what "natural receiving water temperature" is, if cannot determine whether natural receiving water temperature changes have adversely affected beneficial uses.

Nonetheless, the objective used for temperature listing determinations for the San Joaquin River, Stanislaus River, Tuolumne River, and Merced River is facially inconsistent with a plain, full reading of the Basin Plan's section regarding surface water temperature. It is also inconsistent with previous interpretations and applications of the objective by the SWRCB and the CVRWQCB. The applicable objective for surface water temperature is more than just the first sentence in the surface water section of the Basin Plan.

3. Even Assuming the Alternative Approach Focused on Beneficial Use Impacts and Likely Effects of Elevated Temperature on Sensitive Species Were Legally Supportable, the Listing Policy Does Not Permit its Application.

Under the Listing Policy, the alternative approach focused on beneficial use impacts and likely effects of elevated temperature on sensitive species only applies if and when information regarding natural receiving water temperature is unavailable. (Listing Policy, p. 25.) Therefore, even assuming the "alternative approach" was legally supportable, which it is not, the RWQCB would first have to show that natural receiving water temperature is unavailable or impossible to determine.

The fact sheets, however, do not establish that such information is unavailable or indeterminate. (Decision IDs 15202, 15203, 15204, 15206, 15207, 15209.) They entirely ignore the need to consider elevated temperature waste discharge and agriculture return flows and any evidence of such.[18] As a result, even if the Listing Policy had properly included elevated temperature waste discharge and agriculture return flows in the definition of natural receiving water temperature, which it did not, the fact sheets ignored the factors necessary to determine natural receiving water temperature. (Id.) There is no assertion that the San Joaquin River from the Merced River confluence to the Delta boundary, the Stanislaus River, Tuolumne River, or Merced River lack elevated temperature waste discharge or agriculture return flows. To the contrary, agriculture return flows are substantial, considering the 2008 §303(d) List cites

[18] Furthermore, since Staff admitted at the March 10, 2009 public meeting that they did not know what the term "natural receiving water temperature" meant, they would not have known what to look for or what to determine.

agriculture as the pollution source for Chlorpyrifos, Diazinon, and Group A Pesticides for all of the aforementioned streams, as well as Boron, DDT, and Electrical Conductivity for the San Joaquin River. (2008 California §303(d) List of Water Quality Limited Segments, Category 5.) Therefore, even assuming the alternative approach focused on beneficial use impacts and likely effects of elevated temperature on sensitive species were legally supportable, the fact sheets fail to meet the Listing Policy's threshold requirement of first showing that information regarding natural receiving water temperature is unavailable.

If the "alternative approach" is used loss of habitat, diversions, toxic spills, and other factors are also considered must also be considered. (Listing Policy, p. 26.) However the facts sheets and lines of evidence similarly lack any such considerations.

4. Information Regarding Natural Receiving Water Temperature is Available.

"Historic" or "natural" temperature data need not be generated solely from actual measurements taken. Since actual measurements of "historic" or "natural" temperatures are rarely available, computer modeling is generally required to determine what such temperatures were. (CVRWQCB, Final Staff Report on Recommended Changes to California's Clean Water Act section 303(d) List, p. 28 (December 14, 2001).) For example, in the Eel River TMDL, the United States Environmental Protection Agency ("USEPA") used a computer model to calculate "natural stream temperatures" and also to evaluate the temperature affects of four additional riparian management scenarios. (USEPA Region 9, *2004 Final Upper Main Eel River and Tributaries Total Maximum Daily Loads for Temperature and Sediment*, p. 20-24, 28-32 (Dec. 29, 2004).). In so doing, USEPA noted that "Modeling of stream temperature is a well developed area of inquiry and many models are available to assist policymakers in understanding the factors controlling stream temperatures." (Id., p. 20.)

A San Joaquin River Basin-Wide Water Temperature Modeling Project ("SJR Basin Temperature Model") began in 2005 as an extension of the HEC-5Q Stanislaus–Lower San Joaquin River Water Temperature Modeling and Analysis Project ("Stanislaus Temperature Model"). The geographic boundaries of the model are the San Joaquin River from the Stevinson Bridge downstream to the Mossdale Bridge, the Merced River from New Exchequer Reservoir downstream to the San Joaquin River confluence, the Tuolumne River from New Don Pedro downstream to the San Joaquin River confluence, and the Stanislaus River from New Melones

Reservoir downstream to the San Joaquin River confluence. (*see* Appendix B, Cal. Dept. of Fish & Game ("DFG") *Lower San Joaquin River Basin-Wide Temperature Modeling Project Data Collection Protocol*, p. 4 (Mar. 22, 2006)[19].) The primary purpose of the SJR Temperature Model is to identify a suite of restoration actions that would, if implemented, assist in developing management strategies for maintaining suitable water temperatures for fall-run Chinook salmon (salmon) and Steelhead rainbow trout (steelhead) in the lower San Joaquin River Basin. (Id.)

Just as the SJR Basin Temperature Model is capable of predicting future water temperatures given a range of operation scenarios, it is likewise capable of accurately identifying "natural" or "historic" temperatures using the same principles. (*see* Appendix C, Item 5, San Joaquin River Group Authority's Written Comments to Proposal By Central Valley Regional Water Quality Control Board to List the San Joaquin, Tuolumne, Merced and Stanislaus Rivers as Impaired Bodies of Water For Temperature Pursuant to Section 303(d), Exhibit B p. 3-4 (Nov. 19, 2007).) As an example, in the Case 1 run done for the SJRGA by AD Consultants, the SJR Basin Temperature Model identified and compared "actual" temperatures with "historic" temperatures at varying locations in the Stanislaus River for the period 1967-1982. (Id., p. 6-7.) The "historic" temperatures were derived solely from the model by removing New Melones Dam and reservoir, installing the original Melones Dam and reservoir, and using historical flow and operation criteria for Melones Dam and reservoir. (Id.) Similarly, the "actual" temperatures, which assumed the existence of New Melones Dam and reservoir and the Interim Plan of Operation as the operating criteria for the period 1967-1982, were derived solely from the model. (Id.) Once the simulation was completed, the results were compared with temperature data collected at Vernalis and downstream of Goodwin Dam. (Id.) The comparison indicated that the model under-predicted the observed temperatures slightly, indicating that the model results are conservative from a temperature increment standpoint. (Id., p. 6, p. 10 [Figure 7].)

In another simulation, the SJR Basin Temperature Model compared historic conditions on the Stanislaus River with and without New Melones, replacing New Melones Reservoir with Old Melones Reservoir. (Id., p. 3.) Simulated historic temperatures were higher than actual historic

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[19] The CDFG's *Lower San Joaquin River Basin-Wide Temperature Modeling Project Data Collection Protocol* ("*San Joaquin River Basin Temperature Modeling Project*") was attached to its February 28, 2007 submittal as Exhibit E, but not included in the data, references, and other materials for Decision IDs 15202, 15203, 15204, 15206, 15207, and 15209. The *San Joaquin River Basin Temperature Modeling Project* is attached herein as Exhibit B.

temperatures, which failed to meet numeric temperature criteria recommended by the DFG in the Stanislaus River and the San Joaquin River.[20] (Id., p. 6.)

Table 3. DFG recommended temperatures in letter to CVRWCB, February 28, 2007.

River	Location	River Mile	Season	Life Phase	Threshold (ºF)	Affected River Miles	Threshold (ºC)
San Joaquin	Vernalis	72	9/1 - 10/31	Adult/Egg	64.4	118	18
	Vernalis	72	3/15 - 6/15	Smolt	59.0	118	15
Stanislaus	Mouth	0	9/1 - 10/31	Adult/Egg	64.4	58	18
	Riverbank	33	10/1 - 12/15	Egg	55.4	33	13
	Mouth	0	3/15 - 6/15	Smolt	59.0	58	15
Tuolumne	Mouth	0	9/1 - 10/31	Adult/Egg	64.4	52	18
	Waterford	28	10/1 - 12/15	Egg	55.4	24	13
	Mouth	0	3/15 - 6/15	Smolt	59.0	52	15
Merced	Mouth	0	9/1 - 10/31	Adult/Egg	64.4	52	18
	River Mile 28	28	10/1 - 12/15	Egg	55.4	24	13
	Mouth	0	3/15 - 6/15	Smolt	59.0	52	15

Table 4. Number and percent of days historic simulated temperatures were higher than actual historic temperatures.[21]

Location	Average Temperatures		Maximum Temperatures	
	# of Days	% of Time	# of Days	% of Time
Goodwin	248	68	340	93
Knights Ferry	241	66	287	79
Orange Blossom	243	67	278	76
Riverbank	247	68	318	87
Ripon	251	69	328	90
Confluence	221	61	303	83
Vernalis	205	56	279	76

The primary reason for the cooling effect under actual historic conditions is the increased storage in New Melones. (App. C, Exh. B p. 7.) Whereas the Old Melones Reservoir storage capacity was approximately 110 thousand acre-feet, New Melones Reservoir storage capacity is approximately 2.4 million acre-ft. (Id.) Additionally, Old Melones Reservoir cycled from full to empty on a yearly basis, either spilling large quantities of water during the flood control season or passing through low flows when the reservoir was empty. (Id.) By comparison, New Melones Reservoir has significantly greater carry-over storage capacity, allowing it to release water for flood control while maintaining cold water storage. (Id.)

The SJR Basin Temperature Model is capable of accurately depicting actual historic temperatures for the San Joaquin, Tuolumne, Merced and Stanislaus Rivers, as well as simulated

[20] The SJR Basin Temperature Model simulations assessed temperature compliance for the San Joaquin River at Vernalis.

a multitude of other conditions. Information regarding natural/historic conditions is available. As a result, the CVRWQCB should not rely on the "alternative approach," set forth in §6.1.5.9 of the Listing Policy, focusing on beneficial use impacts and likely effects of elevated temperature on sensitive species. Instead, it can use the SJR Basin Temperature Model to simulate such conditions.

More importantly, in the context of the Basin Plan Temperature Objective, the impact of New Melones, Old Melones, and other reservoirs is only relevant if they release water warmer than the natural temperature of receiving water. (Basin Plan, p. III-8.00; Thermal Plan, p1.) Such releases would constitute a discharge elevated temperature waste. (Thermal Plan, p1.) Every other impact of dams and reservoirs falls within the scope and definition of natural receiving water temperature. (Id.) The "alternative approach" set forth in §6.1.5.9 of the Listing Policy only becomes possible by misreading or outright ignoring the Basin Plan and Thermal Plan by making commas disappear or pretending they do not exist.

5. Controllable Factors Cannot Achieve the Recommended Temperatures.

Achieving water quality objectives depends on controllable factors. (Basin Plan, p. III-1.00.) Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of waters of the state and that may be reasonably controlled. (Id.) When a RWQCB establishes new or revised water quality objectives, it must consider the water quality conditions reasonably achievable through coordinated control of all factors affecting water quality in an area is a required consideration. (Water Code §13241(c).) Although many numeric water quality objectives have been adopted, in many instances RWQCBs have been unable to adopt numerical water quality objectives for constituents or parameters. (Basin Plan, p. IV-17.00.) Instead, they adopt narrative water quality objectives such as the Basin Plan Temperature Objective. (Id.; *see also* p. III-8.00.) When evaluating compliance with narrative water quality objectives, such as where narratives apply to protect specified beneficial uses, the CVRWQCB must adopt, in each circumstance, numeric limitations. (Basin Plan, p. IV-17.00.) When adopting numeric limitations, the CVRWQCB considers direct evidence of beneficial use impacts, all material and relevant information submitted by the discharger and other interested parties, and relevant numerical criteria and

[21] *See* App. C, Item 5, p. 7 [Table 1].)

guidelines developed and/or published by other agencies and organizations. (Id.) In considering such criteria, the CVRWQCB evaluates whether the specific numerical criteria are relevant and appropriate to the situation at hand and, therefore, should be used in determining compliance with the narrative objective. (Id.)

The requirement to achieve water quality objective compliance through controllable factors was a significant consideration when the SWRCB, in adopting the 1991 Salinity Plan, decided that temperature no greater than 68°F should be achieved though waste discharge controls, increasing riparian canopy, and bypassing warming areas. (SWRCB, *Water Quality Control Plan for Salinity San Francisco Bay/Sacramento San Joaquin Delta Estuary* (adopted pursuant to SWRCB Resolution No. 91-34, May 1, 1991) ("1991 Salinity Plan"), p. 1-13, Table 1-1 fn 4.) Reservoir releases were ruled out as an unreasonable use of water under Article X, §2 of the Constitution, because travel time from reservoirs and ambient air temperatures eliminated any significant benefits in the Delta. (Id.)

The need to achieve water quality objective compliance through controllable factors was also the basis for Decision ID 4323, which recommends against listing Lake Almanor for temperature. (Decision ID 4323, Water Body ID CAL5184100020020418094956.) Of five temperature samples, three exceeded the temperature criteria for steelhead. (Water Body ID CAL5184100020020418094956, LOE 724.) However, Staff decided not to list Lake Almanor for temperature, because there was no evidence that human activities (i.e. controllable factors) were responsible for modifying the temperature regime and adversely impacting cold water species. (Water Body ID CAL5184100020020418094956, LOE 723.) Rather, Lake Almanor, being a reservoir, took on its own temperature regime, which included seasonal development of warm and cold water layers, something unrelated to human induced impacts.[22] (Id.)

For similar reasons, non-compliance with Basin Plan Temperature Objectives only occurs through failure to implement controllable factors. The listing determinations for the San Joaquin River, Stanislaus River Tuolumne River, and Merced River do not address controllable factors such as flow. (Decision IDs 15202, 15203, 15204, 15206, 15207, 15209.) However, in

[22] Staff also used a different methodology than it did for the San Joaquin River, Stanislaus River, Tuolumne River, and Merced River. It used maximum annual temperature instead of seven day average daily maximum temperature and it used Sullivan et al. (2000) Published Temperature Thresholds-Peer Reviewed Literature instead of USEPA Region 10 criteria. Sullivan et al. calculated the Annual Maximum (instantaneous maximum observed during the summer) upper threshold criterion for steelhead trout as 21.0°C and not the <18 °C 7DADM.

responding to the SJRGA's comments at the September 25 2006 staff workshop, the DFG clearly stated their belief that flow was the key factor affecting temperature:

> While the critically dry conditions have not been assessed for the east-side tributaries it is anticipated that water temperatures would exceed those values observed during Dry year type conditions by virtue of 1) lower instream flow levels and 2) the strong relationship between instream flow levels and water temperature.

(*see* Appendix D, p. 10.)

To the contrary, the water quality limited segment identification has not occurred as a result of flow alterations. In the final simulation, Case 5, the SJR Basin Temperature Model simulated temperature conditions if all of the water in the basin were used for fishery flows. (App. C, Exh. B p. 5.) The simulation used the 1995 through 2005 hydrology, but maintained historical storage and eliminated diversions by rerouting them back to the reservoirs. (Id.) Even if New Melones, Don Pedro, McClure Reservoir, and Millerton Lake were emptied immediately, the enhanced flow would still fail to achieve the DFG's recommended temperature criteria sufficiently often to avoid water quality limited segment identification. (App. C, Item 5, Exh. B p. 21-22.) If committing every ounce of water in the basin to fishery flows fails to achieve the DFG's recommended temperature criteria sufficiently often to avoid water quality limited segment identification, then flow alterations are not a controllable factor capable of achieving water quality objectives. [23] Regardless of how many salmon and steelhead once occupied the San Joaquin River, Stanislaus River, Tuolumne River, and Merced River, the temperature regime advocated by the DFG never could have existed and the listing determinations have used the wrong baseline in evaluating compliance with the Basin Plan Temperature Objective.

6. Porter-Cologne, the Clean Water Act, and the Basin Plan do Not Support Using the USEPA Region 10 Criteria for Water Quality Limited Segment Identification.

Without natural receiving water temperature, interpreting the Basin Plan and Thermal Plan temperature objectives is impossible. (Listing Policy FED, p. 133.) Unfortunately, since historic, unaltered, and/or natural conditions in a water body are so site specific, stream segments rarely have any available and useable natural receiving water temperature data sets. (Listing

Policy FED, p. 133.) In developing the 2002 §303(d) List, the CVRWQCB chose not to identify certain streams precisely because they lacked sufficient data and modeling capability to determine natural receiving water temperature. (CVRWQCB, *Final Staff Report on Recommended Changes to California's Clean Water Act section 303(d) List*, p. 28 (December 14, 2001).) In any event, since natural receiving water temperature includes all factors except elevated temperature waste discharges and irrigation return flows, historic data is only relevant for the purposes of using data lacking elevated temperature waste discharges and irrigation return flows for use in determining natural receiving water temperature. (*see* The Basin Plan Temperature Objective is Based on Natural Receiving Water Temperature., *supra*.) However, difficulty interpreting an applicable water quality objective does not negate an objective's applicability.

Instead of finding ways to determine natural receiving water temperature, the SWRCB adopted "an alternative approach focused on beneficial use impacts and likely effects of elevated temperature on sensitive species." (Listing Policy FED, p. 133.) Instead of using natural receiving water temperature, the "alternative approach" compares recent temperature monitoring data for a specific water body to the temperature requirements of resident aquatic life. (Listing Policy FED, p. 134.) There is no evidence in the Listing Policy FED, fact sheets, or elsewhere that the temperature criteria for resident aquatic life, such as those recommended by USEPA Region 10 or by the DFG, are equivalent to the Basin Plan's temperature objective of natural receiving water temperature plus 5 °F. As a result, since the Listing Policy did not change any established water quality objectives and therefore could not have adopted a method of interpretation constituting a revision to the Basin Plan temperature objective, the alternative approach focused on beneficial use impacts and likely effects of elevated temperature on sensitive species violates the Clean Water Act and Porter-Cologne. It cannot serve as a basis for identifying water quality limited segments.

IV. The Delta Should Not Be Listed for Temperature.

The Basin Plan designates the Delta as having existing COLD beneficial uses for freshwater habitat and migration, but not for spawning. (Basin Plan, p. II-8.00.)

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[23] Releasing stored water to regulate temperatures in the San Joaquin River, Stanislaus River, Tuolumne River, and Merced River would still fail to achieve objectives, provide no discernible temperature benefit, and, like the use using stored water for temperature control in the Delta, constitute an illegal waste and unreasonable use of water under Article X, §2 of the Constitution.

For estuaries such as the Delta, the Thermal Plan contains objectives for both existing discharges and new discharges.[24] (Thermal Plan, p. 5.) Existing elevated temperature waste discharges shall not exceed natural receiving water temperature by more than 20 °C. (Id.) Further, elevated temperature waste discharges either individually or combined with other discharges shall not create a zone, defined by water temperatures of more than 1 °F above natural receiving water temperature, exceeding 25 percent of the cross-sectional area of a main river channel at any point. (Id.) Finally, no discharge shall cause surface water temperature rise greater than 4 °F above the natural receiving water temperature of the receiving waters at any time or place. (Id.)

The Basin Plan also adopted temperature objectives for the Delta contained in the SWRCB 1991 Water Quality Control Plan for Salinity ("1991 Salinity Plan"). For Chinook salmon, temperatures at Vernalis would be no more than 68°F from April through June and September through November. (1991 Salinity Plan, p. 1-13.) The temperature objective should be achieved through "controllable factors" such as "waste discharge controls, increases in thermal canopy, and bypass of warming areas." (Id.) With the exception of establishing a 66°F objective for winter-run Chinook salmon on the Sacramento River, no temperature objective specific to any particular run of Chinook salmon was adopted. Furthermore, according to the footnotes to the table establishing various water quality objectives:

> Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable due to the distance of the Delta downstream of reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.

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[24] The CVRWQCB acknowledged that the temperature objectives in the Thermal Plan apply in the Delta when it granted the Antioch Paper and Pulp Mill an exception to the Thermal Plan, stating that the "discharger had an existing discharge of thermal waste into the San Joaquin River at a location in the [Delta]." (CVRWQCB, *Granting an Exception to the Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California for the Gaylord Container Corporation Antioch Paper And Pulp Mill (Discharger) Wastewater Discharge into the San Joaquin River*, p. 1 (Resolution R5-2003-0069, April 25, 2003).) Consistent with the Thermal Plan, the CVRWQCB applied the objective for existing discharges in estuaries. (Id.)

(1991 Salinity Plan, p. 1-13, Table 1-1 fn 4.)

This language no longer exists in the Bay-Delta Plan. However, the Final EIR for D-1641 stated that "The effects of the flow alternatives on water temperature in the Delta are difficult to assess. In general, water temperatures in the Delta are affected primarily by ambient air temperatures." (D-1641 EIR, Vol. 1, p. IV-43.) None of the project alternatives would have resulted in detectable temperature changes in the Delta. (Id.)

The Delta temperature objectives were deleted from the 1995 Bay-Delta Plan and replaced with the San Joaquin River Spring Flow Objectives, which established minimum flow requirements from February through June and a pulse flow from mid-April through mid-May. (SWRCB Resolution No. 95-24, *Adoption of the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (May 22, 1995), p2.) The Spring Flow Objective would provide habitat, water quality, and temperature benefits to fall-run Chinook salmon, migrating steelhead, spawning, larval, and juvenile Delta smelt. (2006 Bay-Delta Plan Appendix I, p. 50.)

Since the SWRCB replaced the temperature objective with the flow objectives, flow, not temperature, is the measure of whether the beneficial use is achieved. No data showing flow objective non-compliance has been submitted. Even if there were flow-objective non-compliance, it is unclear how a TMDL would be established for flow. As a result, even if there were flow objective non-compliance, the Delta should no be listed for insufficient flow. Other forums exist for addressing adequate flow for the Delta.

V. The Delta Waterways (Stockton Ship Channel) Must be Removed from the §303(d) List for Organic Enrichment/Low Dissolved Oxygen.

Currently, the Stockton Ship Channel, located in the Delta Waterways (Water Body ID CAE5440000020021115141407), is listed as a water quality limited segment for organic enrichment/low dissolved oxygen. (Decision ID 7203.) However, nothing in the administrative records for the §303(d) Lists from 1996, 1998, 2002, and 2006 explain the precise rationale for listing the Stockton Ship Channel for low dissolved oxygen. According to the D-1641 EIR:

> The fall-run chinook salmon pass through the Delta on their way to spawning areas in upstream tributaries. In order to migrate successfully to their natal streams, San Joaquin salmon must encounter favorable conditions in the Delta and the lower San Joaquin River. Water quality conditions in the reach of the San Joaquin River near the City of Stockton

> (Stockton), however, are often unfavorable, particularly in regard to temperature and DO levels. The reach of river (see Figure X-1) from Turner Cut to the head of Old River, which includes the Stockton ship channel, the Port of Stockton's turning basin, and the Stockton Wastewater Treatment Plant (Stockton WWTP) outfall has been identified as an area of concern because of low DO levels. DO levels below 5.0 mg/l create an "oxygen block" which impedes salmon migration upstream (Hallock 1970). DO levels as low as 1.5 mg/l have been recorded in the reach of the San Joaquin River from the turning basin to Turner Cut, and levels as low as 0 mg/l have been recorded in the turning basin.

(D-1641 EIR, p. X-1.)

The DO Objective for the Ship Channel is 5.0 mg/l throughout the year, except for September through November, when the objective is 6.0 mg/l. (2006 Bay-Delta Plan, p. 14 Table 3.) The DO Objective lacks a specific averaging period. However, the Listing Policy specifies that, for dissolved oxygen, the seven-day average of minimum daily measurements is used. (Listing Policy, p. 4.)

Although the D-1641 EIR did not discuss exceedance frequency, the Staff Report for the *Control Program for Factors Contributing to the Dissolved Oxygen Impairment in the Stockton Deep Water Ship Channel* ("DO TMDL") determined that historically, the long-term exceedance frequency averaged 17 percent. (CVRWQCB, *Control Program for Factors Contributing to the Dissolved Oxygen Impairment in the Stockton Deep Water Ship Channel Final Staff Report* ("Stockton Ship Channel DO TMDL"), p. 22 (February 28, 2005).)[25] However, Stockton Ship Channel DO TMDL Staff did not address the issue of whether a sufficient number of exceedances of the DO Objective occurred to identify the Stockton Ship Channel as a water quality limited segment for low dissolved oxygen.

Currently, the Rough & Ready Island monitoring station currently monitors dissolved oxygen in the Ship Channel at 15-minute intervals. (*see* Table 5 and Figure 1, below) It began gathering data in 2001. (*see* Table 6, below.)

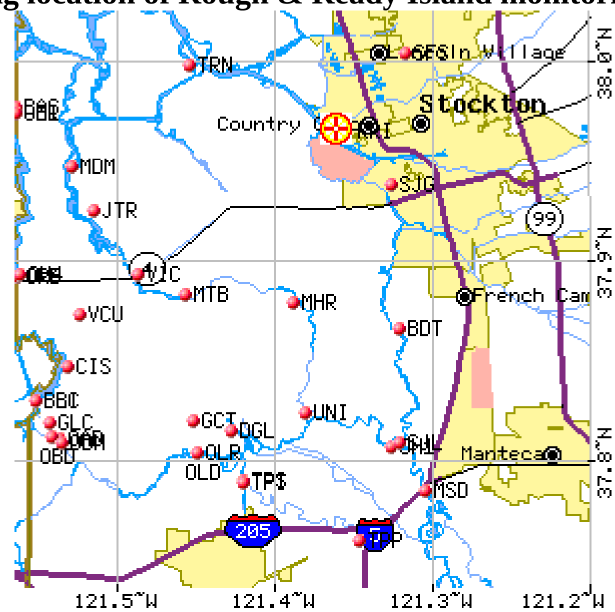
[25] The Staff Report does not provide sample size or number of exceedances. (CVRWQCB, *Control Program for Factors Contributing to the Dissolved Oxygen Impairment in the Stockton Deep Water Ship Channel Final Staff Report*, p. 21-12 (February 28, 2005).)

Table 5. California Data Exchange Center Data for the Rough & Ready Island Monitoring Station

Station ID	RRI	**Elevation**	15' ft
River Basin	SAN JOAQUIN R	**County**	SAN JOAQUIN
Hydrologic Area	SAN JOAQUIN RIVER	**Nearby City**	STOCKTON
Latitude	37.9630°N	**Longitude**	121.3650°W
Operator	CA Dept of Water Resources	**Data Collection**	SATELLITE

River Stage Definitions			
Datum 0	0.00' NAVD	Adjustment to NGVD	-0.87'

Figure 1. Map depicting location of Rough & Ready Island monitoring station

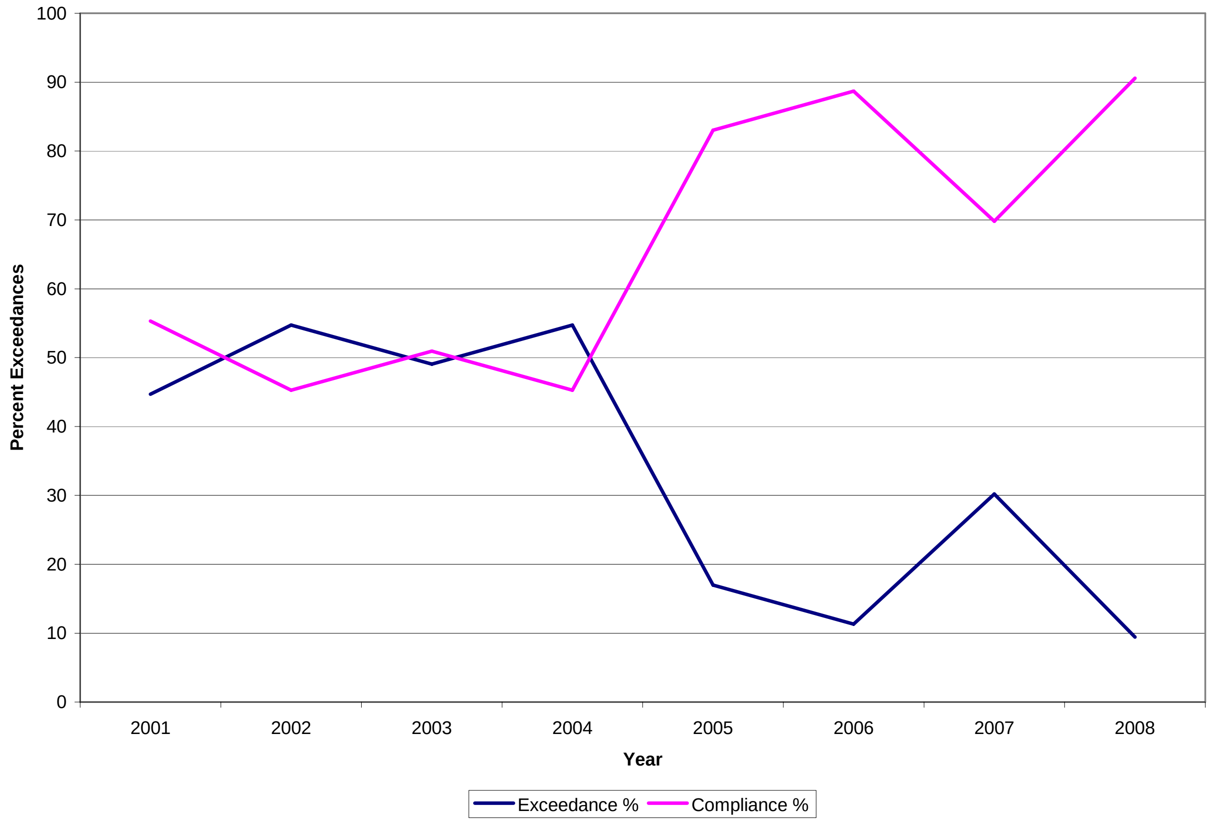


From 2001 through 2008, the overall average exceedance rate, based on the lowest minimum dissolved oxygen sample each day, was approximately 34 percent. (*see* Table 7, below.) Starting in 2005, however, compliance improved substantially, with exceedances occurring only 17 percent of the time. (Id.; *see also* Figure 2, below.) By 2008, exceedances occurred only 9 percent of the time, a total of 5 weeks, based on weekly average minimum daily DO. In 2005 and 2006, also based on weekly average minimum daily DO, the exceedances occurred only 17 and 11 percent of the time.

Table 6. Occurrences and frequencies of compliance for Rough & Ready Island, from 2001 through 2008.[26]

	Year							
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Samples	47	53	53	53	53	53	53	53
Exceedance #	21	29	26	29	9	6	16	5
Compliance #	26	24	27	24	44	47	37	48
Exceedance %	45	55	49	55	17	11	30	9
Compliance %	55	45	51	45	83	89	70	91

Figure 2. Dissolved oxygen exceedance and compliance frequencies at Rough & Ready Island, 2001-2008.



[26] Daily minimum dissolved oxygen data is included in Appendix E. In reviewing the data, there were numerous instances in which the DO would steadily maintain a constituent and high concentration and then drop to zero for a single 15-minute period. In other instances, DO would steadily maintain a constituent and high concentration and then drop to zero and remain at zero for a long period of time. Both occurrences were construed as sampling errors and discarded from the analysis. Weeks wherein the objective changed from 5.0 mg/l to 6/0 mg/l were also not included in the compliance analysis, as this would have significantly complicated the analysis.

Table 7. Average occurrences and frequencies of compliance for Rough & Ready Island, from 2001 through 2008.

		2001-2004		2005-2008	
	2001-2008 Average	**Total**	**Average**	**Total**	**Average**
Samples	52	206	52	212	53
Exceedance #	18	105	26	36	9
Compliance #	35	101	25	176	44
Exceedance %	34		51		17
Compliance %	66		49		83

New management practices have been implemented since 2005. That year the CVRWQCB adopted, and the SWRCB approved, a TMDL for the Ship Channel. (SWRCB Resolution No. 2005-0086, *Approving an Amendment to the Water Quality Control Plan for The Sacramento River and San Joaquin River Basins to Control Factors Contributing to Dissolved Oxygen Impairment in the Stockton Deep Water Ship Channel* (Nov. 16, 2005.)

More significant is the progress in mechanically aerating the Ship Channel. Initial testing of the mechanical aerator occurred in March 2008. (Jones & Stokes, *Initial Testing of Aeration Facility Capacity and Efficiency*, p. 1 (Aug. 2008).) The aerator began operating in May 2008, although pulse tests were still occurring. (*see* Appendix F, p. 1.) The impact of the mechanical aeration is significant. 2007 and 2008 were both Critical years for the San Joaquin Valley, but with the mechanical aerator operating in 2008 compliance occurrence rates were significantly higher, with 91 percent compliance in 2008 compared to only 70 percent compliance in 2007. (*see* Table 7, above.) Compliance should improve even more as the Aeration Facility efficiency and operations improve.

Based on the section 4.2 of the Listing Policy, the period from 2005 through 2008, sufficient compliance with the DO Objective has occurred to require de-listing. (Listing Policy, p. 12, 16.) In 2008 the compliance rate was so high, 91 percent, that under section 4.2 of the Listing Policy, de-listing is required.

VI. The CVRWQCB Must Remove all Exotic Species Listings from the §303(d) List.

The Functional Equivalent Document ("FED") for the *Policy for Developing California's Clean Water Act §303(d) List of Water Quality Limited Segments* ("Listing Policy") determined that TMDLs for exotic species are inappropriate (Listing Policy FED, p. 101.) As a result, "exotic species listings [then] on the section 303(d) list would be removed during the next listing cycle."[27] (Id.) All exotic species listings must be eliminated. Since the Listing Policy and its FED were adopted in 2004 and the subsequent listing cycle occurred in 2006, the water boards are only two years behind in complying with their own policy.

VII. The "Delta Waterways" should be identified with greater particularity.

The Central Valley §303(d) List includes listings for the "Delta Waterways," which are further divided into different subareas. There is, however, no definition of what the Delta Waterways are or of their various subareas.

VIII. Conclusion.

The Clean Water Act only protects existing beneficial uses and the CVRWQCB must interpret water quality as established in the Basin Plan and water quality control plans. Municipal beneficial uses are not existing uses for the San Joaquin River and there is no evidence that they ever will be any time in the foreseeable future. As a result, there the CVRWQCB cannot apply the drinking water MCL for specific conductivity as an objective. COLD beneficial uses are similarly not existing beneficial uses, as defined by the Clean Water Act, as no evidence shows that the requisite temperatures have been achieved or that a stable cold water fishery has existed since 1975. Even if COLD beneficial uses are existing uses, the CVRWQCB has interpreted the Basin Plan temperature objective in a manner resulting in a revised objective. As a result, the §303(d) List should not list the San Joaquin River for temperature and electrical conductivity and should not list the Stanislaus River, Tuolumne River, and Merced River for temperature.

[27] The view that exotic species were inappropriate "pollutants" for the §303(d) List is consistent with the response to Deltakeeper's recommendation in 2002 to list various water bodies for exotic species. (CVRWQCB, Final Staff Report on Recommended Changes to California's Clean Water Act section 303(d) List, p. 28-29 (December 14, 2001).) The CVRWQCB Staff declined, responding that, although exotic species were a problem, they were not "pollutants," as defined by the Clean Water Act and would therefore be excluded from the §303(d) List. (Id.)

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APPENDIX A

SELECTED GENERAL PLANS FOR THE SAN JOAQUIN RIVER WATERSHED

1. Merced

The City of Merced ("Merced") received its water from the Merced River via Lake Yosemite under the water rights of the Merced Irrigation District until 1917. (City of Merced General Plan, p[5-6] (November 29, 1997) (available at http://www.cityofmerced.org/civica/filebank/blobdload.asp?BlobID=3998, accessed June 6, 2006).) Since then, Merced has primarily relied on groundwater recharged from the Merced River. (Id.) Today, in order to meet the needs of increasing urban demand, population growth, the new University of California campus, and groundwater overdraft, Merced, in addition to the communities of Atwater and Livingston, plan to construct new groundwater recharge facilities and increase deliveries to farmers from the Merced Irrigation District in order to decrease agriculture reliance on groundwater. (Id. at [5-7].)

2. Lathrop

The City of Lathrop ("Lathrop") currently derives all of its domestic water supplies from groundwater. (Lathrop General Plan, p[4-D-1] (as amended, November 9, 2004), available at http://www.lathropgov.org/pdf/cdd/doc_general-plan.pdf, accessed June 6, 2006.) Groundwater quality in the area generally west of the former Southern Pacific Railroad remains a problem for Lathrop, primarily because of salt water intrusion and pollution from agricultural and industrial sources. (Id.) The potential for salt water intrusion is especially significant as an obstacle to having a dependable long-term supply of groundwater to meet the needs of the expanding Lathrop urban area. (Id.)

Lathrop currently plans to continue using groundwater and obtaining further groundwater rights in the Oakwood Lake vicinity, it has also expanded its surface water supplies. (Id. at [4-D-2].) Lathrop participates in the South County Water Supply Program ("SCWSP") with the South San Joaquin Irrigation District, in cooperation with Tracy, Escalon, and Manteca.[1] (Tracy Draft General Plan, p[7-24] (available at

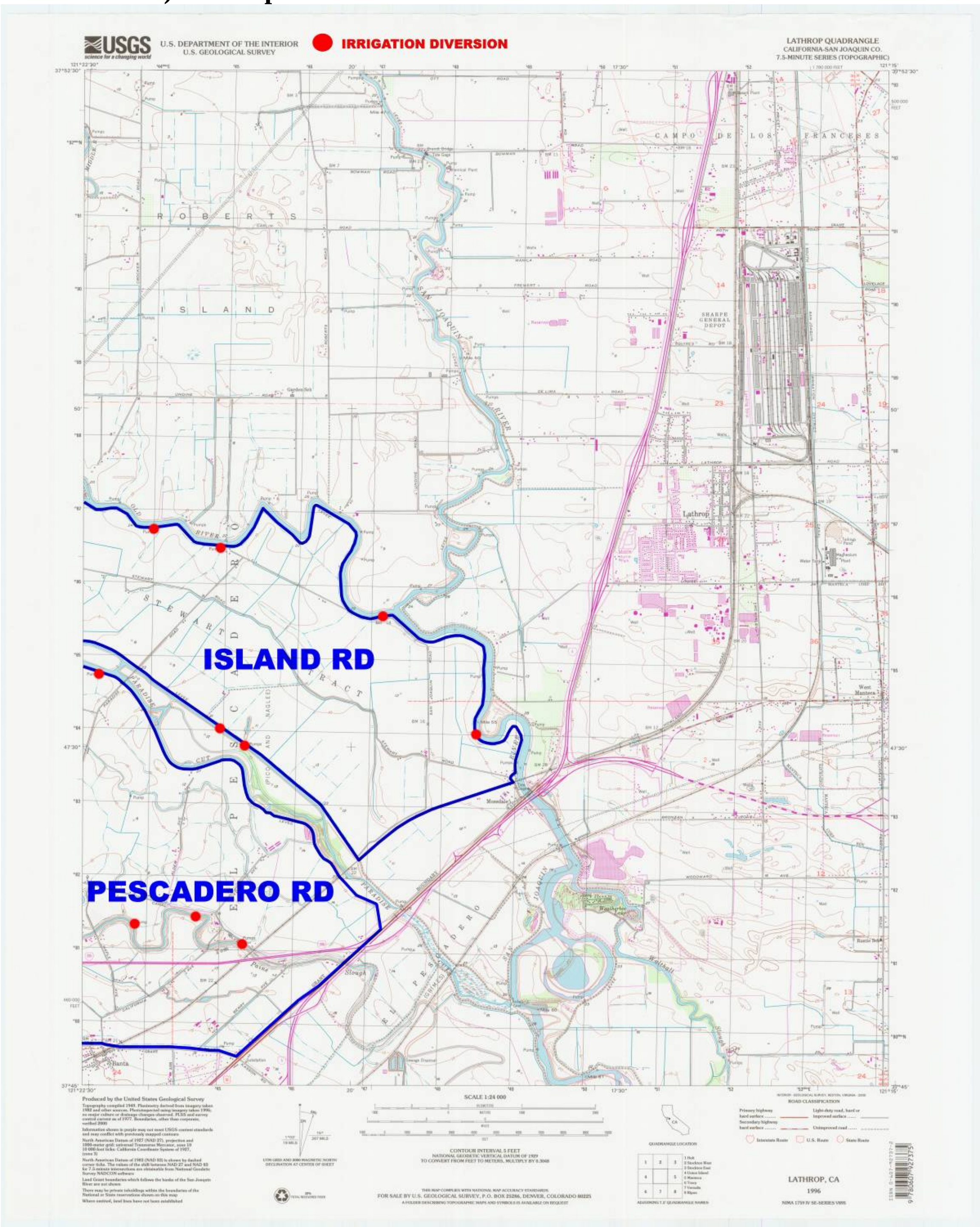
[1] The South San Joaquin Irrigation District obtains has rights to divert water from the Stanislaus River, pursuant to Application No. 2524, Application Nos. 2104, 3091, 5648A, 10872, 10978, 11105, 12490, 12614, 12873, 13309, 13310, 26791, 31502, which are held jointly with the Oakdale Irrigation District, and

http://www.ci.tracy.ca.us/projects/general_plan/docs/draft_general_plan.pdf, accessed May 25, 2006.) The SCWSP diverts water from the Stanislaus River, which is stored at Woodward Reservoir, treated, and delivered to the participating communities under long-term agreements. (Escalon General Plan Background Report (February 2004), p[1-47] (available at http://www.cityofescalon.org/PLANNING/background%20report.pdf, accessed May 25, 2006.) Lathrop already receives water through the SCWSP.

Lathrop is also working to obtain the rights of License 2637 (A005155), currently held by Reclamation District #2062 (Island RD), which has rights to divert water from Old River, Dredger Cut, and the SJR in the Delta, although petitioning for such a change would also require changing the purpose of use from irrigation to domestic use. (Id. at [4-D-3].) Finally, Lathrop is considering obtaining as-yet un-appropriated water from other watersheds, particularly the Calaveras and Stanislaus. (Id.)

Statement No. 4683, which is also held jointly with the Oakdale Irrigation District. Of these water rights, Application No. 5648A is the only right that includes domestic use.

Figure 1: Lathrop quadrangle with Island Reclamation District (Reclamation District #2062) and its points of diversion.



3. Turlock

The City of Turlock ("Turlock") currently derives its domestic water supply from groundwater and serves approximately 12,000 connections. (Turlock General Plan, p[4-

22], available at http://www.ci.turlock.ca.us/pdf/documents/communityplanning/generalplan/4-01.pdf, accessed June 8, 2006.) The City of Modesto ("Modesto") provides water for another 500 connections. (Id.) Irrigation water in Turlock's urban area is provided by the Turlock Irrigation District ("TID"). (Id.) The city has 23 wells. (Id.) A twenty-fourth is under construction and it is estimated that another 10 to 15 will be needed in the next ten years. (Id.) Although currently meets its urban water supply needs entirely with groundwater, it is exploring the possibility of obtaining surface water from the TID.

4. Gustine

The City of Gustine "Gustine" is within the Gustine Watershed and Groundwater Recharge Area. (Gustine General Plan (February 4, 2002), p[1-26].) Its supply is currently drawn from four wells that are approximately 200 feet deep. (Id. at[1-27].) Gustine estimates its water demands will be as high as 3.19 million gallons per day. (Id. at [5-5].) Nothing in the Gustine General Plan indicates any planned reliance or use of surface water from the SJR.

5. Modesto

Modesto depends heavily on groundwater, but is cooperating with the Modesto Irrigation District ("Modesto ID") to develop a new surface water supply that will be used to stabilize groundwater overdraft problems.[2] (Modesto General Plan, p[V-12] (as amended by Resolution 2003-122 (March 2, 2003)), available at http://www.modestogov.com/ced/pdf/documents/general-plan/gp_ch5.pdf, accessed June 8, 2006.) This conjunctive groundwater-surface water management plan will allow Modesto to continue to serve current customers and plan for future expansion. (Id.) A similar strategy is being developed with the TID for the Modesto Urban Area south of the Tuolumne River.

Modesto also provides urban water for the communities of Grayson, Ceres, Hickman, Del Rio, Salida, Waterford, and parts of Turlock.

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[2] Modesto ID obtains water from the Tuolumne River pursuant to A001233, A003648, A006711, and A014127. TID also obtains its water from the Tuolumne River, pursuant to A001233, A003648, A006711, and A014127. When the Modesto General Plan was adopted in 2003, the Del Este Water Company participated in groundwater stabilization efforts. Since then the water company has been purchased by the Modesto ID.

6. Tracy

The City of Tracy ("Tracy") obtains water from both surface water and groundwater sources. (Tracy Draft General Plan, p[7-22] (June 30, 2004), available at http://www.ci.tracy.ca.us/projects/general_plan/docs/draft_general_plan.pdf.) The amount from either source as a percentage of the total water supply used by Tracy varies from year to year based on contractual agreements, annual precipitation, and City policy about how to expend water resources. (Id.) The supply of groundwater sources, which provided 41% of Tracy's supply in 2003, depends on the capacity of the Tracy Aquifer. (Id. at [7-23].)

Surface water generally makes up 50 to 60 percent of Tracy's total supply. (Id.) The majority is obtained under contract from the USBR, but other supplies are obtained under other contracts from the Banta Carbona Irrigation District ("BCID") and West Side Irrigation District ("West Side ID"). (Id.) Tracy is in the process of obtaining additional water from BCID and West Side ID and negotiating an agreement with the Byron-Bethany Irrigation District ("Byron-Bethany").[3] (Id. at [7-24].) Finally, Tracy participates in the SCWSP, which provides it with as much as 10 TAF annually. (Id.)

7. Manteca

The City of Manteca ("Manteca") provides for all of its urban water needs with a series of groundwater wells. (Manteca General Plan EIR, p[14-1] (October 6, 2003).) Groundwater recharge comes from irrigation of agriculture lands surrounding Manteca and from infiltration from stream flowing west out of the Sierra Nevada. (Id.) Recharge occurs in areas with permeable materials which allow for infiltration of water along streams, alluvial fans and foothill areas. (Id.)

Manteca also participates in, and obtains surface water through, the SCWSP. (Id.) Manteca currently has a contract for up to 11,500 AFA until 2010. (Id.) In a subsequent phase, the allocation will increase to 18,500 AFA. (Id.)

[3] BCID obtains water from the SJR in the Delta pursuant to license 5404 (A001933) and Statement 495. West Side ID obtains water under License 1381 (A000301). Byron-Bethany (successor to Plain View Irrigation District) obtains water from Clifton Court Forebay, pursuant to Application 29857, and from the DMC under contract from the USBR.

8. Ripon

Two primary groundwater aquifers underlie the City of Ripon ("Ripon") planning area. (Ripon General Plan, p[2-68] (December 23, 2005).) The two aquifers have a combined annual recharge of 196,000 to 263,000 AFA. (Id.) Ripon was an active participant in the October 2001 Water Management Plan for San Joaquin County that was conducted under the lead of the San Joaquin County Flood Control and Water Conservation District. (Id.) The County Study identified that the Eastern San Joaquin County Groundwater Basin, which includes the Ripon area, is critically over drafted in some parts, but generally not in the southern portion where Ripon is located. (Id.) Ripon is located at the southernmost boundary of the basin and has not experienced overdraft due to its location adjacent to the Stanislaus River and its relatively small demand compared with other users. (Id.) The City has adopted a Groundwater Preservation Plan to proactively address stabilizing and enhancing the groundwater levels in the Ripon area as future growth occurs. (Id.) This plan provides the planning framework for groundwater recharge basins in the general area around the City. (Id.)

All of Ripon's potable water comes from seven groundwater wells that tap aquifers roughly 125 to 450 feet underground. (Id.) Annual water production in Ripon over the last twenty-five years has increased from 1,067 acre-feet in 1980 to 2,195 acre-feet in 1990, to 4,021 acre-feet in 2000 and finally to 4,565 AF in 2002. (Id. at [2-69].) Ripon currently has well capacity in excess of their average daily demand, and uses the wells to help meet summer peaking needs. (Id.) In the future, Ripon will construct additional groundwater wells as needed to meet increased demands. (Id.) Ripon's existing potable wells were pumped at their maximum capacity over the entire year, the total water supply would be almost 16,000 AF.

Ripon has a master plan for expansion of the potable water system to meet the present and future demands of the community. (Id.) Expansion will consist of additional wells and above ground storage capacity to ensure an adequate supply of potable water. (Id.) Ripon plans to construct 10 new elevated storage tanks and 13 new domestic water wells during the planning period covered by the Water Master Plan 2040. (Id.)

Ripon uses surface water as an urban water source via the SCWSP, but has no other plans to use surface water as a urban water source.

9. Escalon

The City of Escalon ("Escalon") currently depends primarily on groundwater for its urban water supply. (Escalon General Plan Background Report, p[1-45].) However, to ensure a continued adequate supply, Escalon is participating in the SCWSP and is scheduled to receive water from the project in the future. (Id., p[1-25].)

10. Patterson

The City of Patterson ("Patterson") currently uses groundwater as its source of domestic supply. (Patterson General Plan, p[II-22] (September 7, 2004), available at http://www.ci.patterson.ca.us/Default.aspx?pi=20&ni=29, accessed June 8, 2006.) However, it plans to pursue the acquisition of surface water rights to supplement its current water supply in order to projected water demand. (Id.) The Patterson General Plan does not indicate where these surface water rights would come from.

11. Oakdale

The City of Oakdale ("Oakdale") currently obtains its domestic water from groundwater. (City of Oakdale 2015 General Plan (January 1994, rev. December 2003), p[6-7] (available at http://www.ci.oakdale.ca.us/community_development/planning_division/images/pdfs/2015_gen_plan/2015%20General%20Plan.pdf, accessed August 23, 2006).) The groundwater Oakdale obtains is of such high quality that no treatment is necessary to comply with drinking water regulations. (Id.) Increasing future demands may require us of water from the Stanislaus River stored in New Melones. (Id.)

The Oakdale Irrigation District, which obtains water from the Stanislaus River, provides domestic water service to some rural areas and improvement districts in outlying areas of Oakdale. (Oakdale Irrigation District, Improvement Districts and Rural Water Systems Location Map (available at http://www.oakdaleirrigation.com/files/ID-RW%20Map%20-%20BobRWS%20Model%20(1).pdf, accessed August 23, 2006).)

12. Newman

The City of Newman ("Newman") is the sole provider of domestic, industrial, and commercial water service to customers within its city limits. (Newman Draft General Plan, p[NR-6] (Summer 2006).) Newman's source of water supply is currently groundwater. (Id.) In addition to Newman's water system, some industrial users have their own wells and use groundwater for their industrial processing. (Id.) Residents in the unincorporated areas rely on private wells. (Id.) Newman will continue to increase its use of groundwater to serve demands associated with growth in the Planning Area and anticipates that it will be able to support all of its future growth with groundwater. (Id.)

Newman and the Central California Irrigation District ("CCID") jointly determined that, as of August 1992, the groundwater inflow into the Newman urban area could be increased from 2,500 AFA, as existed at the time, to at least 5,000 to 7,500 AFA with no adverse migration of poor quality groundwater into an expanded urban area. (Newman General Plan EIR, p[V-2] (October 20, 1992.) The most favorable area for future development of groundwater supply was the west and southwest areas of Newman, where salinity, nitrate, iron, and manganese contents were relatively low. (Id.) Groundwater in the east and northeast areas of Newman had relatively high salinity and iron content, and was therefore considered less suitable for development of future groundwater supplies. (Id.)

Newman planned to continue using groundwater as its principle source of domestic water supply, but planned to investigate the acquisition of surface water rights from CCID and "other sources" in order to decrease its dependence on groundwater. (Id. at [V-3].) The CCID however, is a party to the Exchange Contract and therefore, although it has a water right, actually obtains its water from the DMC. Therefore, even if Newman did obtain a surface water right from the CCID, it would not obtain water from the LSJR, but would instead obtain its water from the DMC.

Lower San Joaquin River Basin-Wide Water Temperature Modeling Project Data Collection Protocol

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March 22, 2006

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1 Introduction

Several factors have been identified as potentially limiting populations of fall-run Chinook salmon (*Oncorhynchus tshawytscha)* and Steelhead Rainbow trout (*O. mykiss)* in the San Joaquin River Basin. Examples of such factors include: lack of suitable spawning habitat, insufficient flow and warm water temperatures. Water temperature is one of the most important physical properties in aquatic ecosystems affecting nearly all biological and chemical processes. Salmonid research has demonstrated that elevated water temperatures can affect growth rates, decrease egg viability, increase predation, and increase disease susceptibility and mortality (Myrick and Cech 2001).

Current restoration actions have focused on improving fishery habitat by replenishing spawning gravels and, providing increased minimum fishery habitat protection flows thru water purchases (e.g., VAMP and CVPIA-B2). In January 2005, the San Joaquin River Basin-Wide Water Temperature Modeling Project (SJR Model Project) began and is an extension of the Stanislaus – Lower San Joaquin River Water Temperature Modeling and Analysis Project (Stanislaus Model Project). The SJR Model Project seeks to improve fishery habitat quality on a SJR system wide basis by accurately characterizing the lower SJR hydrology, channel hydraulics, reservoir operations, meteorology, water temperature response, and salmonid temperature tolerance. Once the SJR Model is built and operable, and salmonid temperature response refined, it is anticipated that a water temperature management program for the lower SJR basin would be developed that may include elevated flows, changed reservoir operations, and/or conveyance infrastructure improvements (e.g., new release ports etc.). The primary purpose of the SJR Model Project is to identify a suite of restoration actions that would, if implemented, lead to suitable water temperatures for fall-run Chinook salmon (salmon) and Steelhead rainbow trout (steelhead) in the lower San Joaquin River Basin.

The SJR model is an extension of the Stanislaus HEC-5Q computer simulation model which is designed to simulate the thermal regime of mainstem reservoirs and river reaches. The SJR Model project focuses on understanding the relationship between air temperature, reservoir operations, river hydraulics, stream flow, and water temperature, both in-reservoir and in-river in an effort to decrease water temperatures to levels that optimize resident and migratory corridor habitat for salmon and steelhead in the lower SJR basin. The HEC-5Q model will analyze different water operation scenarios (e.g., reservoir storage and release patterns) that can optimize water temperatures and improve spawning and rearing habitats, and migration corridors for the steelhead and the fall-run Chinook salmon in the lower SJR Basin. Identification of an optimal thermal regime in response to upstream water management operations throughout these river reaches is critical to anadromous fish restoration measures in the San Joaquin River and its tributaries. The geographic boundaries of the model are (Figure 1) 1) the San Joaquin River from the Stevinson Bridge downstream to the Mossdale Bridge; 2) the Merced River from New Exchequer Reservoir downstream to the SJR confluence; 3) the Tuolumne River from New Don Pedro downstream to the SJR confluence; and 4) the Stanislaus River from New Melones Reservoir downstream to the SJR confluence.

2 Overview

2.1 Background

The Department has for a long time (e.g., since the 1970's) been concerned with the inadequacy of suitable water temperatures in the lower Stanislaus River for salmonids (Loudermilk 1996). This concern has been expressed to both the State Water Resources

Control Board and the Regional Water Quality Control Board who have the legally mandated responsibility to ensure adequate water quality exists for protection of fish beneficial use in the Stanislaus River is achieved and maintained.

In 1987, after New Melones Reservoir had been enlarged, the Department and the U.S. Bureau of Reclamation entered into a joint agreement to conduct studies to better understand the relationship of stream flow and salmon abundance trends. A key component was the collection of water temperature data and construction of a computer simulation model for the purpose of understanding how reservoir operations (e.g., inflow, storage, and release patterns) in combination with Stanislaus River hydrology (i.e., water year types) and meteorology influenced lower Stanislaus River water temperature response.

Additionally, in 1991 and 1992, in the fifth and sixth consecutive dry years, the Department and the USBR, Oakdale and South San Joaquin Irrigation Districts, and the Tri-Dam Project negotiated special water operations in the New Melones / Tulloch / Goodwin Reservoir Complex in an attempt to reduce water temperatures in salmon spawning reaches below Goodwin Dam to suitable (e.g., adult, egg, and juvenile temperature tolerant) levels. In the mid 1990's several temperature models were developed to define, and better understand, the thermal characteristics of the lower Stanislaus River, but none of these were able to link the Stanislaus River system components together to understand collectively how reservoir operations influence lower Stanislaus River temperature response and, how lower Stanislaus River flows influence both reservoir storage levels and reservoir temperature profiles over time.

Stanislaus stakeholders recognized the need to better define the relationship between water operations, water temperature regimes, and fish mortality in the Stanislaus River. In 1998 the Stanislaus Water Temperature Model Project was initiated as a joint venture project of the Stanislaus stakeholders group. Stakeholder members include: U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), Tri-Dam Project, Oakdale Irrigation District (OID), South San Joaquin Irrigation District (SSJID) and Stockton East Water District (SEWD).

This cooperative effort started as a means of analyzing the relationship between water management operations and water temperatures in the Stanislaus River. An extensive program for water temperature and meteorological data collection throughout the Stanislaus Basin began. The extent of the model included the New Melones Reservoir, Tulloch Reservoir, Goodwin Pool, and approximately 60 miles of the Stanislaus River from Goodwin Dam down to the confluence with the San Joaquin River.

The objectives of this effort were to develop and calibrate a model capable of simulating the water temperature responses in the Stanislaus River system and to evaluate how New Melones Reservoir operations influence water temperatures in the lower Stanislaus River.

AD Consultants and Research Management Associates were retained to develop the HEC-5Q model. Historical and current air and water temperature data were used to calibrate and validate the model. Eleven different Stanislaus River operation simulations of New Melones, Tulloch and Goodwin Dams were run to assess the possibility of meeting water temperature objectives at identified critical areas of the river using existing dam structures and outlets. A key process of this assessment was the refinement and application of salmon and steelhead water temperature tolerance criteria.

To determine the water temperature objectives for the Stanislaus River the CDFG researched water temperature criteria for the Chinook salmon and Steelhead trout to establish water temperature range objectives for both species (Guignard 2001). The CDFG further refined these criteria in 2003 based upon new information (Marston 2003). These temperature objectives were used as a means of comparing the different model runs. Three zones of temperature ranges were identified: optimal, sub-lethal and critical. These zones vary by species, life stage and location on the Stanislaus River.

Also in 2001, the Stanislaus stakeholders recommended expanding the Stanislaus River temperature model to include the lower San Joaquin River from the confluence to the Mossdale Bridge. Extending the model to include the lower San Joaquin River allowed for an assessment of how Stanislaus river flows, and associated water temperatures, influence SJR flow and temperature rates. The Stanislaus Model Project proposal was accepted and funded by CALFED.

An additional component of the CALFED funded temperature model was the formation of an independent peer review panel that was charged with evaluating the biological merits, and application of thermal criteria to the Stanislaus River modeling applications. Assessing if the identified criteria are suitable to sufficiently differentiate water temperature benefits to the identified species in order to evaluate the various water operation scenarios (model simulations) being considered.

Temperature criteria, as presented to the Panel by both CDFG and local irrigation districts, were evaluated by the peer review panel that included John Bartholow (USGS), Chuck Hanson (Hanson Environmental), Chris Myrick (Colorado State University) and chaired by Michael Deas (Watercourse Engineering). The Panel concluded that although the use of a seven day average of the daily maximum in the form of a threshold, and three range (e.g., optimum, sub-optimum, and lethal) criteria has been successfully applied in other rivers, it was not successful in application to the Stanislaus because during many periods of the year water temperatures are marginal (ie, sub-optimal but not lethal). The Panel further concluded that although criteria could be selected that would detect differences among operational alternatives, the biological support for criteria values needed to justify their use was lacking (Deas et al, 2004).

The Panel suggested replacing the three tier threshold criteria with a non-linear continuous criterion that retains the seven day daily maximum average metric. The new criteria were based on the survival and mortality of juvenile Chinook salmon response to thermal conditions. A weight is assigned to temperatures above optimum levels according to an exponential function. There are differing optimum levels, and temperature sensitivity exponents, for each life history stage with the egg stage being the most sensitive to temperature change and the adult migration stage the least sensitive. The weights were normalized on a scale of 0 (no impact) to 100 (severe impact) for all life stages. The Panel ultimately concluded that the continuous criteria were a logical extension of multiple threshold criteria (Deas et al, 2004).

In 2004 upon learning that water temperature management in the SJR in both spring and fall transitional time periods is from the mass balance perspective dependent upon tributary flow and water temperature, the Stanislaus stakeholders in conjunction with both the Tuolumne and Merced River stakeholders expressed interest in expanding the Stanisluas-Lower SJR water temperature model project to include both the Tuolumne and Merced Rivers, including thr reach of the SJR from Stevinson down to the confluence with the Stanislaus.

At the end of 2004, an amendment to the original CALFED grant was proposed, approved, and funded to extend the Stanislaus-Lower San Joaquin River Modeling efforts to include temperature monitoring and modeling in the San Joaquin River upstream to Stevinson, in the Merced River up to Crocker Huffman Dam, and in the Tuolumne River up to La Grange Dam.

2.2 Project Description

The extent of this modeling and monitoring effort will include an extensive program of water temperature and meteorological data collection on the mainstem San Joaquin River from Stevinson Bridge downstream to Mossdale Bridge and its three major tributaries, the Stanislaus, Tuolumne and Merced Rivers. Figure 1 identifies the area of study in the lower San Joaquin Basin. This map indicates stream temperature, reservoir profile, and weather station sites. Also indicated, are monitoring sites maintained by the project stakeholders that have provided data for the model. Water temperature data collection occurs upstream of major reservoirs (e.g., New Melones, New Don Pedro, and Lake McClure), in major reservoirs, and downstream of these reservoirs.

The San Joaquin River watershed is located in the Central Valley of California. The San Joaquin River watershed area is 13,537 square miles and extends from the Delta to the Kings River. Total storage is 10,614,000 acre-feet (CVPIA-AFRP website). Only the lower 119 miles from the Merced River confluence to the Delta are presently available to anadromous fish and that will be the area of focus for this project on the San Joaquin River. Temperature monitoring upstream of the Merced River confluence to Stevinson will be carried out to determine boundary conditions (e.g., sources of thermal warming/cooling) allowing water management practices and thermal response to be better understood.

The Stanislaus River is the most downstream tributary to be monitored. It has a watershed area of 1,075 square miles, a total storage of 2,900,000 acre-feet, and an average annual unimpaired run-off of 1,200 taf/year (CVPIA-AFRP website). It flows from the Sierra Nevada Mountains to a confluence with the San Joaquin near the city of Vernalis.

The Tuolumne River, the largest tributary of the San Joaquin River, is located between the Stanislaus and Merced Rivers. Its watershed area is 1,540 square miles, a total storage area of 2,777,000 acre-feet, and an average unimpaired run-off of 1,950 taf/year (CVPIA-AFRP website). It flows from the Sierra Nevada Mountains to a SJR confluence near Shiloh.

The Merced River is the southern most tributary. Its watershed area is 1,273 square miles, a total storage of 1,024,000 acre-feet, and an average unimpaired run-off of 987 taf/year (CVPIA-AFRP website). The Merced River also originates in the Sierra Nevada Mountains and flows to it's SJR confluence near Hills Ferry.

2.3 Objectives

The objectives of this modeling study and temperature data collection protocols are to:

- develop and calibrate a model capable of simulating the water temperatures in reservoirs and river reaches of the lower San Joaquin River basin in response to water management operations
- investigate yet to be defined water management alternatives for improving habitat for salmon and steelhead by decreasing water temperatures
- collect reliable water temperature data in both reservoir and stream environments at time and space intervals that sufficiently document thermal response of lower SJR basin water operations in conjunction with local meteorological conditions
- collect reliable meteorological data at specified locations in the lower SJR basin at sufficient intervals to determine how meteorlogical conditions in concert with water operations influence water temperature response

3 Methods

3.1 Stream Sampling

Several water temperature monitoring stations were established for the Stanislaus River in 1998 and are still currently being used. Continuous monitoring stations were placed at identified spawning and rearing habitat areas (critical points) for fall-run Chinook salmon and steelhead. Figures 2 and 3 identify Stanislaus River thermograph sites below and above Tulloch Reservoir Dam respectively.

The CDFG, and other agencies, have been collecting water temperature data for several years on the Merced and Tuolumne Rivers. The sampling sites on these rivers are similar to the sites chosen for the Stanislaus monitoring sites (i.e. spawning and rearing sites). Figures 4 and 5 identify thermograph sites on the Tuolumne River below and above Don Pedro Reservoir Dam respectively. Turlock Irrigation District (TID) has thermograph sites on the Tuolumne River and has provided stream temperature data for the model. When TID provides coordinates for the site locations these sites will be displayed on the maps. Figures 6 and 7 identify thermograph sites on the Merced River below and above McSwain Reservoir Dam respectively.

Previous monitoring sites on the three tributaries were focused on representing average river conditions at critical points for the model. Several new monitoring sites have been established basin-wide to detect factors that may influence water temperatures such as major spillways, irrigation drains, tributary confluences, and cross-sectional differences. Decisions for the location of these new sites have been based on the input and approval of the stakeholders given at temperature TAC meetings, field inspections, and field tours.

Several monitoring sites on the San Joaquin River were established in 2005 (Figure 8). The CDFG currently has monitoring sites located upstream and downstream of tributary confluences, major inflows, diversions, and locations where substantial thermal warming/cooling is believed to occur. The California Data Exchange Center (CDEC) has 15 monitoring sites on the San Joaquin River that are also being utilized.

All current water temperature monitoring sites that provide data for the model are listed in Table 1. The site operator, CDFG database identifier (ID), river mile, CDEC code (where applicable), and a brief description of each monitoring site location are listed.

Onset thermographs (Stowaways, Tidbits and Hobo Temp Pros) are the data loggers being used by the CDFG for this project. The thermographs are calibrated using the Calibration and Standardization Procedure (Appendix 1) adopted and modified from Lewis et al. 2000. This procedure tests each thermograph logger at room air temperature, room temperature water and cold water temperature against a National Institute of Standards and Technology (NIST) thermometer for precision and accuracy. All thermographs are calibrated before deployment using this procedure unless the manufacturer sends a certification of accuracy for each unit (Onset's Hobo Temp Pro); however, 10% of these certified units are being double-checked for calibration accuracy prior to deployment. All thermographs are set to record data on a continuous, year round, basis rather than seasonal and will be calibrated on an annual basis unless questionable data is retrieved.

Most of the thermographs currently deployed record temperatures on an hourly interval. Previously, 2-hour intervals were used. The CDFG intends to replace all 2-hour interval units with units recording at 1-hour intervals. Sampling at 1.6-hour intervals or less captures more accurate daily maximum temperatures (FSP 1998).

Thermographs will be downloaded monthly when staffing and stream flow conditions permit but should not be less frequent than once every three months. A monthly check of each site will provide a timely opportunity to replace any missing or damaged thermographs due to vandalism, or to take corrective actions such as removing the thermograph from the sand if buried, or replacement of thermographs not working properly (i.e. battery dead or erroneous data). All data are downloaded into a palm pilot and uploaded later into a field computer.

Field auditing (e.g., data quality assurance and control) is done at each site visit. Field crews collecting the data take a water temperature reading at each sampling station using a thermometer. The thermometer should be placed in the stream near the thermograph. The water temperature and time is recorded in a field notebook and is used as a cross reference check for auditing the data. Comments are also recorded in the field and are used to help determine the validity of the data (i.e. thermograph out of the water or buried in sand) and or possibly a malfunctioning thermograph. If the latter is suspected, a second thermograph may be placed to cross reference the data, or the thermograph can be retrieved and recalibrated to find its accuracy using the same procedure listed in Appendix 1.

3.2 Reservoir Profiling

The CDFG has been profiling seven locations at New Melones Reservoir and two locations at Tulloch Reservoir on the Stanislaus River (Figure 3). Figure 5 identifies six profiling sites at Don Pedro Reservoir on the Tuolumne River and Figure 7 identifies five profiling sites at McClure Reservoir and two profiling sites at McSwain Reservoir on the Merced River. Table 2 also lists these sites and includes a brief description.

Reservoir water temperature profiles are collected on a monthly basis using a Hydrolab Datasonde 4. The Hydrolab unit is calibrated monthly using the manufacturer's calibration procedure. The Hydrolab measures and records depth, temperature, dissolved oxygen, pH and conductivity as the unit is lowered into the water. Measurements are recorded approximately every meter unless a drop in temperature exceeding 0.5 C is encountered. The Hydrolab is then lowered and readings are recorded in smaller increments until the temperature change stabilizes. Decreasing the depth increments to record smaller temperature decreases, provides a better characterization of thermal stratification. Larger depth increments are covered until the Hydrolab reaches the bottom of the reservoir. Field crews record time, surface temperature and secci disk readings at each reservoir profiling site.

3.3 Weather Station Monitoring

Currently there are five weather stations that are maintained by the CDFG and are located throughout the Lower San Joaquin River Basin. The stations are located at:

- CDFG La Grange Field Office near the Tuolumne River (Figure 4)
- Merced River Fish Facility (Figure 6)
- Goodwin Pool on the Stanislaus River (Figure 2)
- Riverbank at the Stanislaus River weir (Figure 2)
- The confluence of the Stanislaus and San Joaquin Rivers near Vernalis (Figure 2)

These stations record continuous air temperature, relative humidity, wind speed and direction, and solar radiation. The meteorological data from these weather stations are manually collected once every three months. The data is downloaded directly from the station into WINDS (Weather Information Network Display Software) using a field computer.

There are also active weather stations at McClure Reservoir and a CIMIS station on the Merced River. As water and air temperature data collection progresses, and modeling commences, the need for additional weather stations, or re-deployment of existing stations may be required.

3.4 Safety

The SJR project requires frequent site visits for monitoring and data collection. Site visits can include hiking, wading, boating, and driving. Field crews are subjected to various environmental conditions (e.g. changing stream flows and inclement weather) that require good judgment when determining where, when, and how to place monitoring equipment and collect data. Several actions have been taken to improve field crew safety awareness and include:

- Field work is done by two or more crew members
- Monthly field safety meetings
- Cell phones are provided for all field crews
- American Red Cross First Aide/CPR training course conducted by the CDFG
- Defensive driver training conducted by the CDFG
- Boater Safety Education course offered by the California Department of Boating and Waterways
- Informal field boater training done by CDFG experienced boat operators.

4 Data Management and Reporting

The CDFG staff is responsible for the collection of water temperature and meteorological data from the above mentioned stations for use in model development and application. As previously mentioned the CDFG has collected several years of historical water temperature data for the Stanislaus River model and is currently collecting historical water temperature data for the San Joaquin River Basin model. Collected data are being stored in four databases:

- Stanislaus River Temperature Database – a local database designed specifically for the original Stanislaus project by AD Consultants. The database was developed on a Microsoft Access platform and stores both thermograph and profile data. Historical data is also stored in this database.

- San Joaquin River Tributaries Temperature Database - a second local database also designed by AD Consultants. This database is similar to the Stanislaus River Temperature Database but contains the data collected for the remainder of the basin. This second database was created because of the size constraints of the Access platform

- California Data Exchange Center (CDEC) Internet database - a global database operated and maintained by the California Department of Water Resources (CDWR). Approximately once a month, data from the Stanislaus River Temperature Database has been exported to CDEC for long-term storage and posting on the Internet for general public accessibility. Because of the project extension, the department is seeking to expand our sites available on CDEC to include basin-wide temperature data.

- Weather Information Network Display Software (WINDS) - a database and display software for remote data collection platforms, produced by the Weathernews Company. Meteorological data from the weather stations are downloaded and saved in this database.

An important aspect of data collection and reporting is to ensure data integrity and validity. The structure of the local database and the characteristics of Microsoft Access usually enforce the integrity of the data. However, it is the responsibility of the CDFG staff to ensure valid data. To aid the staff in this task, the database is equipped with a QA/QC Utility to detect questionable data. The QA/QC Utility is designed to flag any data points that have a value in excess of a certain tolerance when compared with adjacent points. To minimize the possibility that erroneous data will migrate to other applications, the database will not allow the user to generate any reports or graphs until a QA/QC check is performed and all the data points tagged with QA/QC codes are cleared.

The QA/QC Utility enables the user to see what data has been tagged and provides the user with an editor to fix the data. The data are also graphed and visually inspected. Data that appear to be erroneous are either modified (accepted) or nullified (deleted). These edits are done in a second data column. The original data is always retained for review. Professional judgment is required to determine whether or not to correct (for example, by interpolating with other points) or to nullify the data. This decision is made on a case by case basis by the CDFG staff in concert with the modeling team who assess the original and modified data.

Once processed, the data can be used for temperature model application purposes as well as to generate graphs and reports. An updated copy of the database is periodically sent to AD Consultants for immediate use with the HEC-5Q Model. Updates are also exported to CDEC for inclusion in the global database.

5 References

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Table 1. Current Water Temperature Monitoring Sites Used in the Lower San Joaquin Basin-Wide Modeling Project.

Operator	Database Site ID	Site Name	River Mile	CDEC Station Code
		Merced River		
CDFG	M59B	Merced River Hwy 59 Bridge	41	
CDFG	M99	Merced River at Highway 99 Bridge	22	
CDFG	MASTVSP	Merced River above Stevinson Spill	4	
CDFG	MBRAT	Merced River Below Ratzlaff	40	
CDFG	MBRICE	Merced River at Briceburg		
CDFG	MBSTVSP	Merced River below Stevinson Spill	4	
CDFG	MDRYCK	Dry Creek above confluence of Merced River		
CDFG	MEX	Merced River Below Exchequer Dam	61	
CDFG	MGAL	Merced River Gallo Ranch Bridge	39	
CDFG	MGST	Merced River G Street Bridge	46	
CDFG	MHAG	Merced River Hagaman Park	13	
CDFG	MHAG2	Merced River at Hagaman Park RST access (side)	13	
CDFG	MHFLD	Merced River Hatfield Park	1	
CDFG	MLIVING	Merced River above Livingston spill	21	
CDFG	MRAT	Merced River on the Ratzlaff property	40	
CDFG	MRH	Merced River Hatchery	52	
CDFG	MROB	Merced River on the Robinson property	43	
CDFG	MRSFB	Merced River near Santa Fe Bridge at Cressey Dairy	28	
CDFG	MRSHAF	Merced River at Shaffer Bridge	31	
CDFG	MRSJR	Merced River above San Joaquin River Confluence	0	
CDFG	MRSWAIN2	Merced River at McSwain Dam	56	
CDFG	MUROB	Merced River upper Robinson	44	
CDWR		Merced River near Cressey	27	CRS
CDWR		Merced River near Stevinson	4	MST
NRS	MRBAG	Merced River at Bagby		
NRS	MREXCH	Merced River at McClure's New Exchequer Dam	61	
NRS	MRRM1	Merced River at River Mile 1	1	
NRS	MRRM12	Merced River at River Mile 12	12	
NRS	MRRM31	Merced River at River Mile 31	31	
NRS	MRRM42	Merced River at River Mile 42	42	
NRS	MRRM47	Merced River at River Mile 47	47	
NRS	MRRM52	Merced River at River Mile 52	52	
NRS	MRSWAIN	Merced River at McSwain Dam	56	
		San Joaquin River		
CDFG	MUDSL	Mud Slough upstream of SJR confluence		
CDFG	SALTSL	Salt Slough upstream of SJR confluence		
CDFG	SJALAIRD	San Joaquin River above Laird Park	91	
CDFG	SJALAT5	San Joaquin River above Lateral #5 canal	102	
CDFG	SJAMUD	San Joaquin River above Mud Slough	121	
CDFG	SJANMW	San Joaquin River above Newman Wastewater canal	121	
CDFG	SJASALT	San Joaquin River above Salt Slough	128	
CDFG	SJATR	San Joaquin River above Tuolumne River	84	
CDFG	SJAWPD	San Joaquin River above Westport Drain	93	
CDFG	SJAWSLC	San Joaquin River above West Side Lift Canal	84	
CDFG	SJBLAIRD	San Joaquin River below Laird Park	89	

Operator	Database Site ID	Site Name	River Mile	CDEC Station Code
CDFG	SJBLAT5	San Joaquin River below Lateral #5 canal	102	
CDFG	SJBSALT	San Joaquin River below Salt Slough	128	
CDFG	SJBST1	San Joaquin River 1/2 mile below the Stanislaus River Confluence (River Left)	74	
CDFG	SJBST2	San Joaquin River 1/2 mile below the Stanislaus River Confluence (River Right)	74	
CDFG	SJDF1	San Joaquin River at Durham Ferry (4 miles downstream from the confluence)	71	
CDFG	SJFFB	San Joaquin River 1.5 miles d/s Freemont Ford Bridge	123	
CDFG	SJHF1	SJR at Hills Ferry u/s of Merced confluence	118	
CDFG	SJLAT5	San Joaquin River in Lateral #5 canal	102	
CDFG	SJMR1	SJR at Hills Ferry d/s of Merced confluence (RV park) River Left	117	
CDFG	SJMR2	SJR at Hills Ferry d/s of Merced confluence (RV park) River Right	117	
CDFG	SJOFC	San Joaquin River at the Old Fisherman's Club	81	
CDFG	SJSTV	San Joaquin River at Stevinson Bridge	132	
CDFG	SJTR1	San Joaquin River above Two Rivers (approx. 100 meters above the confluence)	73	
CDFG	SJTR2	San Joaquin River above Two Rivers (approx. 800 meters above the confluence)	75	
CDWR		San Joaquin River near Patterson	97	SJP
CDWR		Orestimba Creek at River Road near Crows Landing	108	OCL
CDWR		San Joaquin River at Ramona Lake		RML
CDWR		San Joaquin River at Moran Drain	105	MON
CDWR		San Joaquin River at Marshall Drain	105	MSR
CDWR		San Joaquin River at Spanish Land Grant Drain	105	SGD
CDWR		Del Puerto Creek		DPC
CDWR		Hospital Creek		HSP
CDWR		Ingram Creek		ING
CDWR		San Joaquin River at Jerusalem Drain	63	NJD
SJCO		San Joaquin River at Mossdale Bridge	56	MSD
TID	SJDR	San Joaquin River at Dos Rios	86.2	
TID	SJGC	San Joaquin River at Gardner Cove	80	
USBR		San Joaquin River at Vernalis	72	VER
USGS		San Joaquin River Mud Slough near Gustine		MSG
USGS		San Joaquin River Salt Slough at HWY 165 near Stevinson		SSH
USGS		San Joaquin River at Fremont Ford Bridge	125	FFB
USGS		San Joaquin River near Crows Landing	106	SCL
		Stanislaus River		
CDFG	AMCHSP	Stanislaus River above McHenry spill	29	
CDFG	AMIDSP	Stanislaus River above MID spill in Ripon	19	
CDFG	COLL1	Collierville Powerhouse Tailrace		CLP
CDFG	GMB1	Stanislaus River at Gambini Property d/s of pond at Oakdale Rec. Area	38	GMB
CDFG	GOOD1	Goodwin Canyon immediately downstream of Goodwin Dam	58	GDC
CDFG	GWNBTM	Goodwin Dam Log Boom (Bottom of the water column)	58	
CDFG	GWNMID	Goodwin Dam Log Boom (Middle of the water column)	58	
CDFG	GWNTOP	Goodwin Dam Log Boom (Top of the water column)	58	
CDFG	KF1	Stanislaus River at Knights Ferry at the Sonora Road Bridge	54	KFS
CDFG	MCH1	Stanislaus River at McHenry Access	29	
CDFG	NFMF1	Below the confluence of the North and Middle Forks u/s of the Collierville Powerhouse		TCN
CDFG	NMPH1	New Melones Powerhouse Tailrace		NMT
CDFG	OAKR1	Stanislaus River at Oakdale Rec. Area (1/4 mile d/s of Hwy 120 Bridge)	40	ORA
CDFG	OB1	Stanislaus River 1/4 mile downstream of Orange Blossom Bridge	46	OBS
CDFG	RB3	Stanislaus River at Riverbank (Army Corp of Engineers property at Stanislaus Weir)	31	JMP
CDFG	SFRK1	South Fork of the Stanislaus approximately 2 miles upstream of New Melones		SSF
CDFG	SPHF1	Stanislaus Powerhouse (In the Stanislaus canal immediately upstream of the forebay)		SSC
CDFG	ST99	Stanislaus River at Highway 99 in Ripon	15	
CDFG	STTR1	Stanislaus River above Two Rivers (approx. 100 meters above the SJR confluence)	0	TDP

Operator	Database Site ID	Site Name	River Mile	CDEC Station Code
CDFG	STTR2	Stanislaus River above Two Rivers (approx. 800 meters above the SJR confluence)	0	
CDFG	TULT1	Tulloch Powerhouse Tailrace	60	
CDWR		Stanislaus River at Orange Blossom Bridge	47	OBB
USBR		Stanislaus River at Ripon	15	RPN
USGS		Stanislaus River near Oakdale	41	SOK
		Tuolumne River		
CDFG	T7-11	Tuolumne River 7-11 Gravel Company	38	
CDFG	TAHCKSP	Tuolumne River above Hickman Spill	33	
CDFG	TASFRK	Tuolumne River above the South Fork		
CDFG	TBAS	Tuolumne River Basso Bridge	47.5	
CDFG	TBHCKSP	Tuolumne River below Hickman Spill	32	
CDFG	TBSFRK	Tuolumne River below the South Fork		
CDFG	TCKPH	Cherry Creek Power House		
CDFG	TDRYCK	Dry Creek above Tuolumne River		
CDFG	THB	Tuolumne River Hickman Bridge	31	
CDFG	TR9STB	Tuolumne River at 9th Street Bridge	16	
CDFG	TRA1	Tuolumne River Riffle A1	51.6	
CDFG	TRASFB	Tuolumne River above Santa Fe Bridge	21	
CDFG	TRC1	Tuolumne River Riffle C1	49.7	
CDFG	TRCRDB	Tuolumne River at Carpenter Road Bridge	12	
CDFG	TRD2	Tuolumne River Riffle D2	48.8	
CDFG	TREARLY	Tuolumne River at Early Intake		
CDFG	TRFGB	Tuolumne River near Fox Grove Bridge	26	
CDFG	TRG3	Tuolumne River Riffle G3	45	
CDFG	TRI2	Tuolumne River Riffle I2	43.2	
CDFG	TRK1	Tuolumne River Riffle K1	42.6	
CDFG	TRMRDB	Tuolumne River at Mitchell Road Bridge	19	
CDFG	TRQ3	Tuolumne River Riffle Q3	35	
CDFG	TRSHILO1	Tuolumne River at Shiloh Bridge	3.4	
CDFG	TRWARDS	Tuolumne River near Wards Ferry Bridge		
CDFG	TSF	Tuolumne River Santa Fe Gravel	36.5	
CDFG	TSFRK	South Fork of the Tuolumne River near confluence		
CDWR		Tuolumne River near Modesto	15	MOD
TID	TR13B	Tuolumne River at riffle 13B	45.5	
TID	TR19	Tuolumne River at riffle 19	43.4	
TID	TR21	Tuolumne River at riffle 21	42.9	
TID	TR3B	Tuolumne River at riffle 3B	49	
TID	TRA7	Tuolumne River at riffle A7	50.8	
TID	TRFG	Tuolumne River at Fox Grove	26	
TID	TRHUSN	Tuolumne River at Hughson Sewer	23.6	
TID	TRLGPH	Tuolumne River at LaGrange Powerhouse		
TID	TRRFB	Tuolumne River at Roberts Ferry Bridge	39.5	
TID	TRRG	Tuolumne River at Ruddy Gravel	36.7	
TID	TRSHILO2	Tuolumne River at Shiloh Bridge	3.4	

Table 2. Current CDFG Reservoir Profiling Sites Used In the Lower San Joaquin Basin-Wide Modeling Project

Database Site ID	Site Location	Position	
	Merced River		
MC49	McClure Reservoir at Highway 49 Bridge	N 37 39' 40.9"	W 120 12' 29.1"
MCCA	McClure Reservoir at Cotton Arm	N 37 34' 59.0"	W 120 15' 04.6"
MCDAM	McClure Reservoir at New Exchequer Dam	N 37 35' 21.3"	W 120 16' 01.1"
MCHSB	McClure Reservoir at Horseshoe Bend	N 37 40' 03.2"	W 120 14' 01.4"
MCPIN	McClure Reservoir at Piney Creek	N 37 39' 26.7"	W 120 17' 21.5"
MSDAM	McSwain Reservoir at McSwain Dam	N 37 31' 14.9"	W 120 18' 29.9"
MSEXC	McSwain Reservoir Below Exchequer Dam	N 37 33' 12.8"	W 120 16' 54.4"
	Stanislaus River		
NM49	New Melones Reservoir at Hwy 49 Bridge	N 38 00' 15.0"	W 120 29' 59.9"
NMC9	New Melones Reservoir at Camp 9 Bridge	N 38 07' 00.3"	W 120 23' 02.4"
NMNA	New Melones Reservoir at North Arm	N 37 59' 31.0"	W 120 32' 39.0"
NMND	New Melones Reservoir at the New Dam	N 37 57' 04.9"	W 120 31' 08.5"
NMOD	New Melones Reservoir at the Old Dam	N 37 57' 14.5"	W 120 30' 52.2"
NMPF	New Melones Reservoir at Parrots Ferry Bridge	N 38 02' 14.0"	W 120 27' 14.6"
NMSA	New Melones Reservoir at South Arm	N 37 56' 35.2"	W 120 29' 32.3"
TD	Tulloch Reservoir Dam	N 37 52' 35.8"	W 120 36' 06.2"
TOB	Tulloch Reservoir at O'Byrnes Ferry Bridge	N 37 53' 58.6"	W 120 34' 03.8"
	Tuolumne River		
DP49	Don Pedro Reservoir at Highway 49 Bridge	N 37 50' 22.4"	W 120 22' 41.9"
DPDAM	Don Pedro Reservoir Dam	N 37 42' 09.5"	W 120 25' 18.2"
DPJB	Don Pedro Reservoir at Jacksonville Bridge	N 37 50' 14.4"	W 120 20' 42.9"
DPMB	Don Pedro Reservoir at Middle Bay	N 37 46' 04.6"	W 120 21' 25.2"
DPWC	Don Pedro Reservoir at Woods Creek	N 37 52' 52.6"	W 120 24' 55.3"
DPWF	Don Pedro Reservoir at Wards Ferry Bridge	N 37 52' 38.8"	W 120 17' 42.0"

Lat/Lon hddd mm' ss.s" (WGS 84)

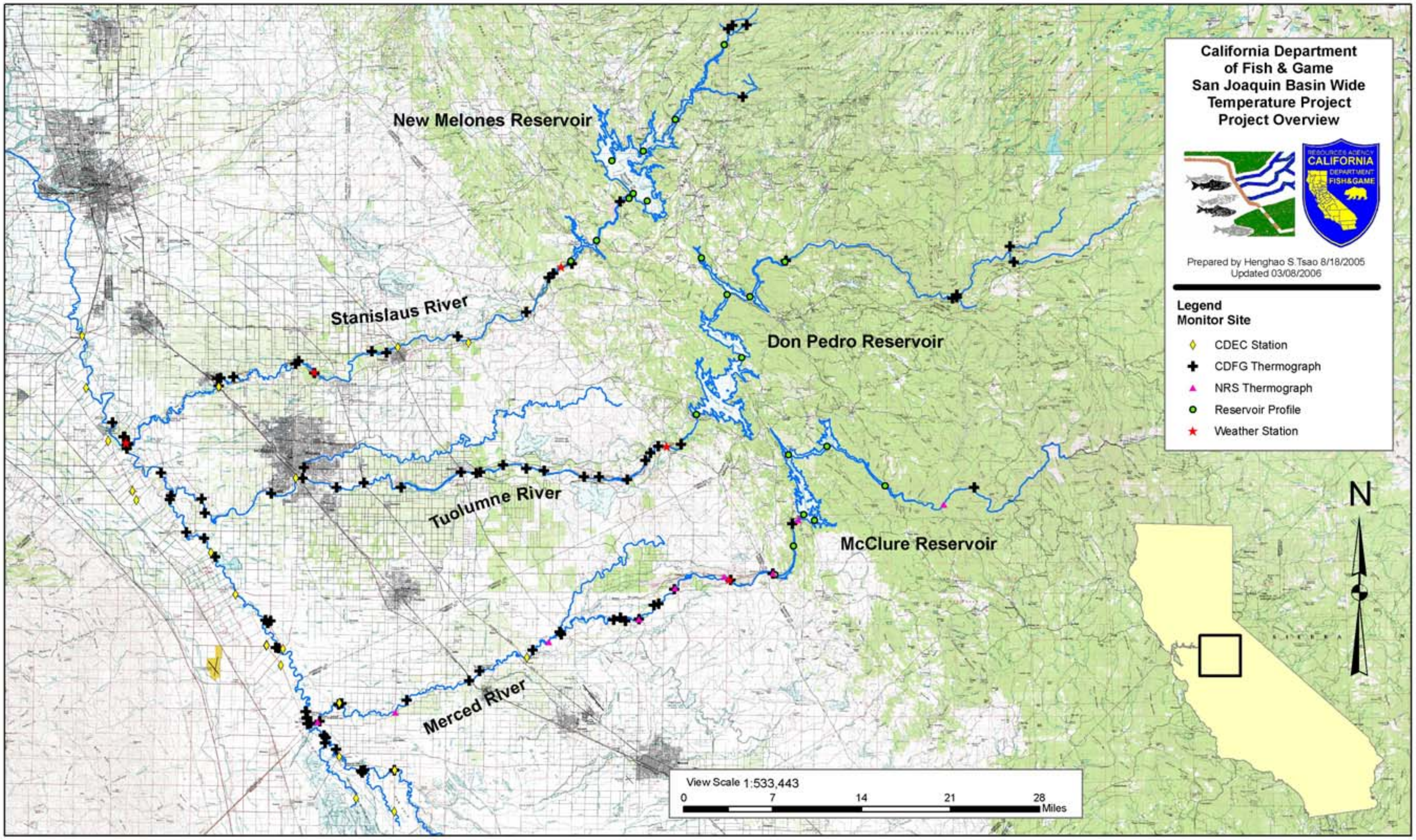

Figure 1. Lower San Joaquin Basin-Wide Water Temperature Modeling Project study area.

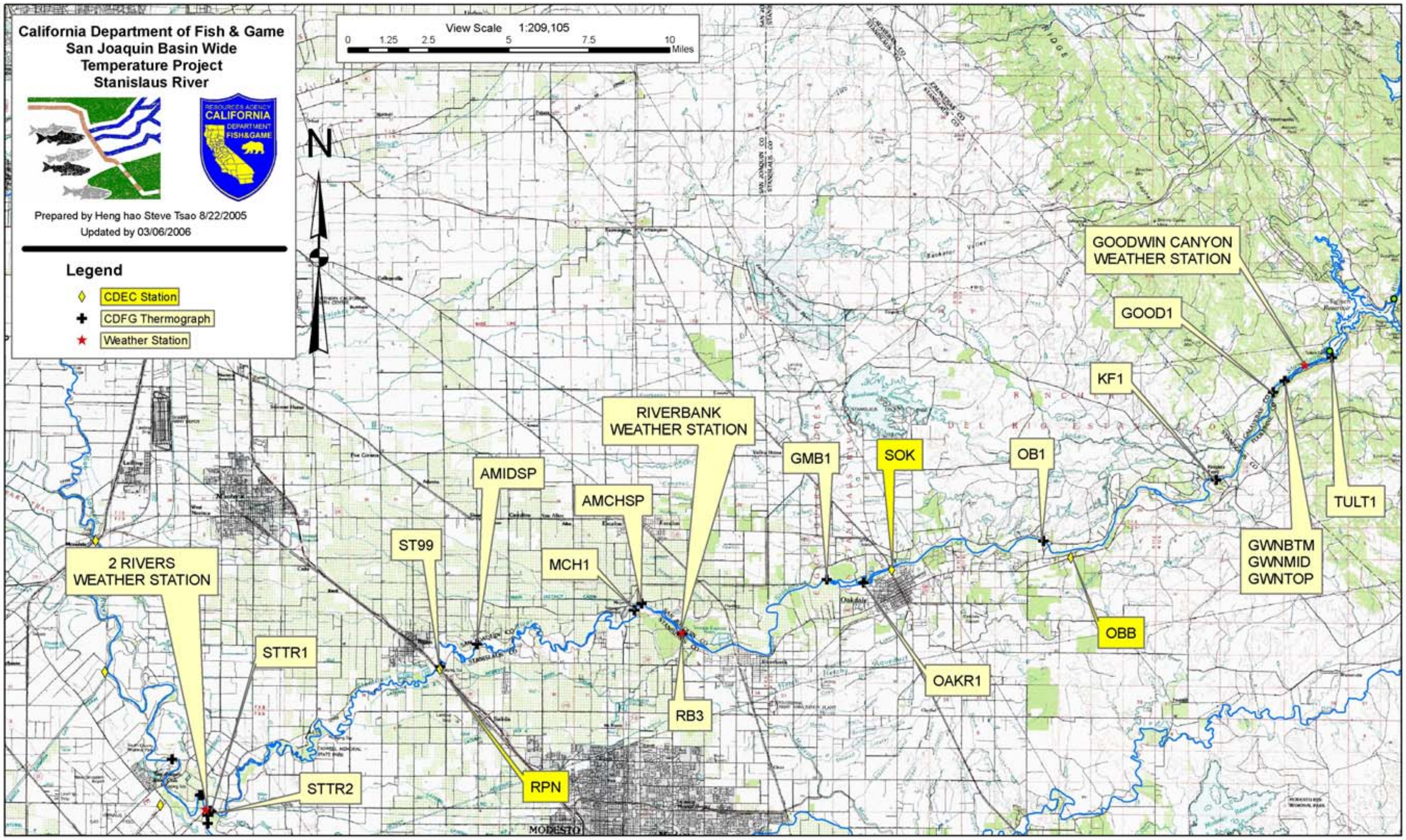

Figure 2. Project monitoring sites on the Stanislaus River below Tulloch Reservoir Dam.

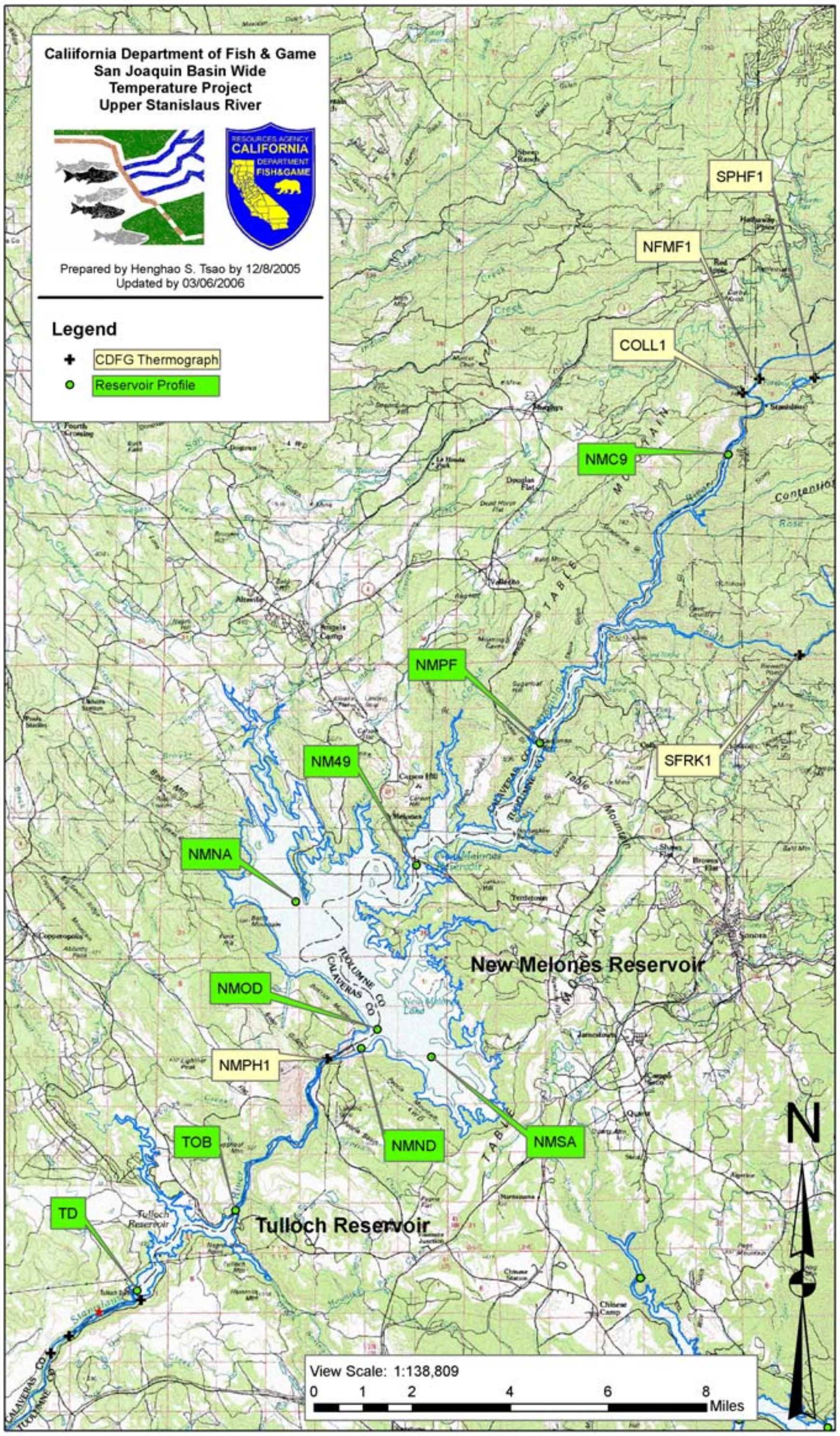

Figure 3. Project monitoring sites on the Stanislaus River above Tulloch Reservoir Dam.

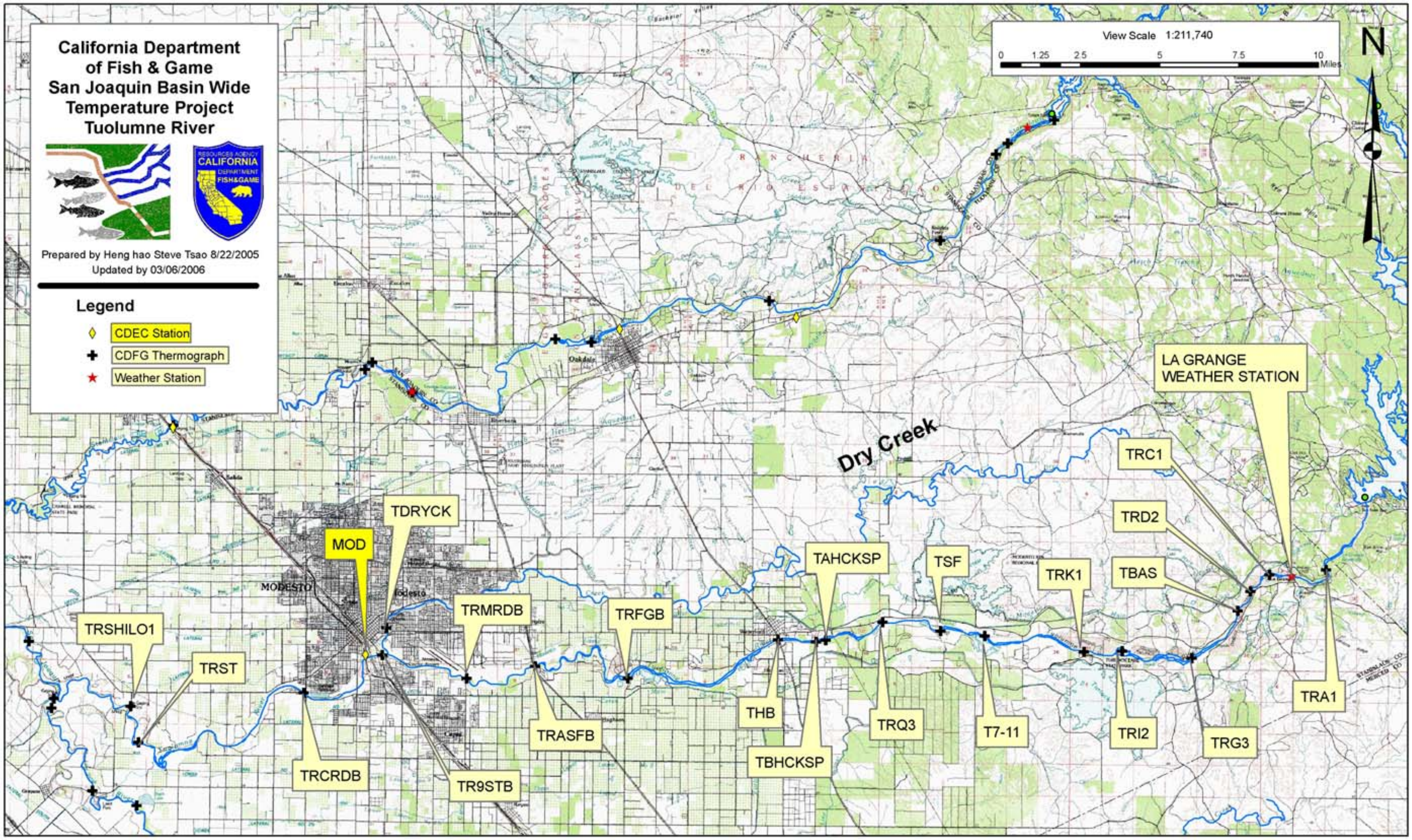

Figure 4. Project monitoring sites on the Tuolumne River below Don Pedro Reservoir Dam.

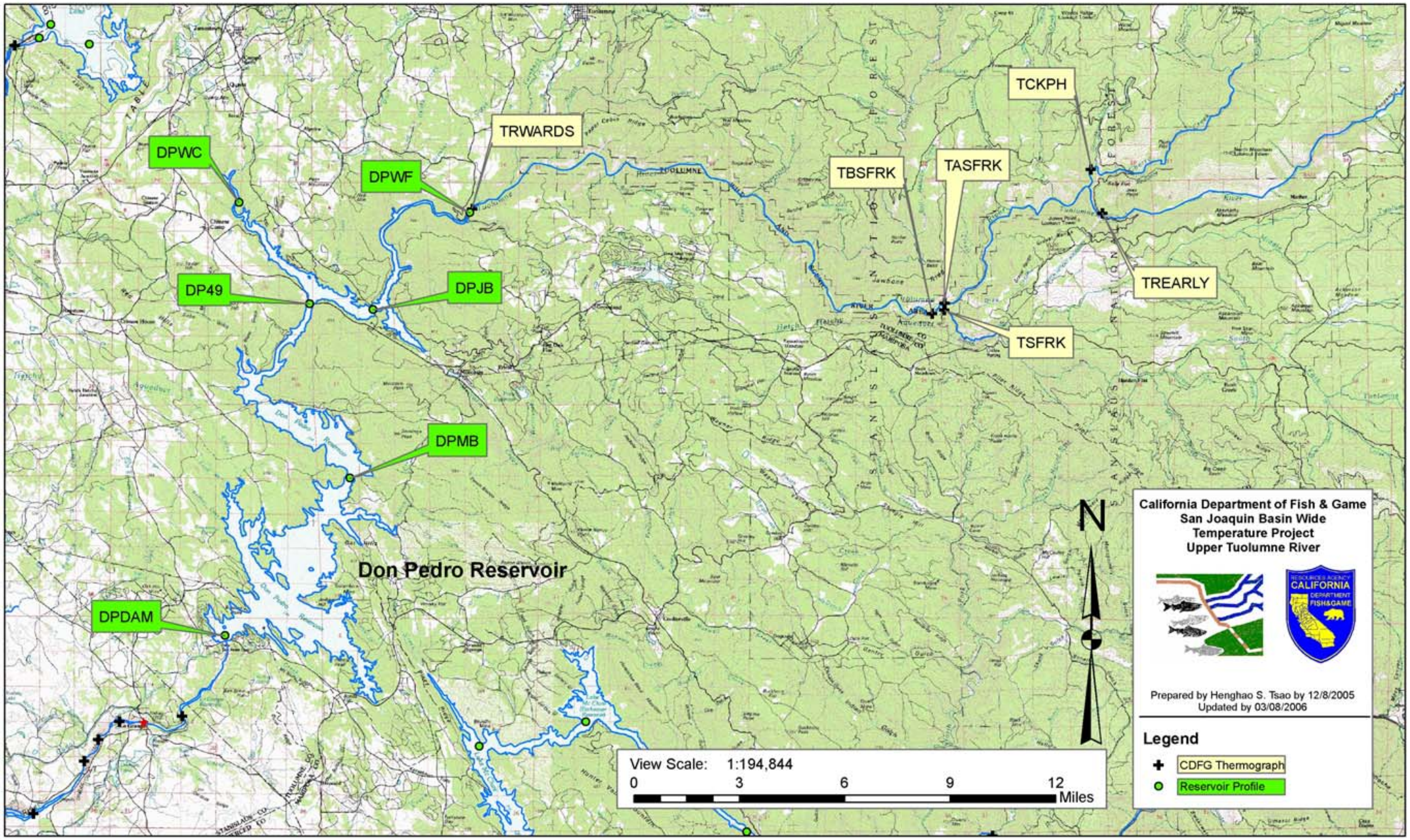

Figure 5. Project monitoring sites on the Tuolumne River above Don Pedro Reservoir Dam.

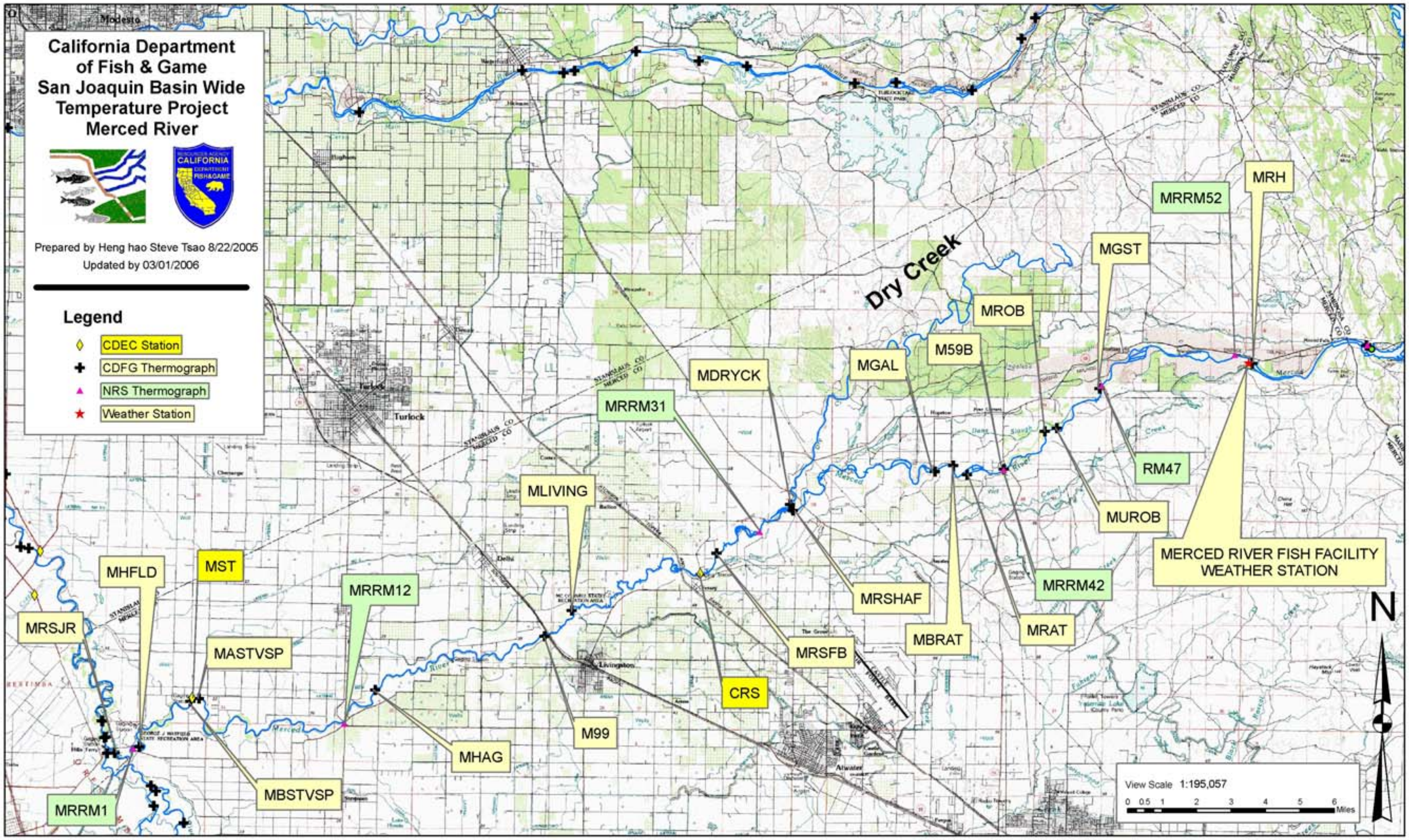

Figure 6. Project monitoring sites on the Merced River below McSwain Reservoir Dam.

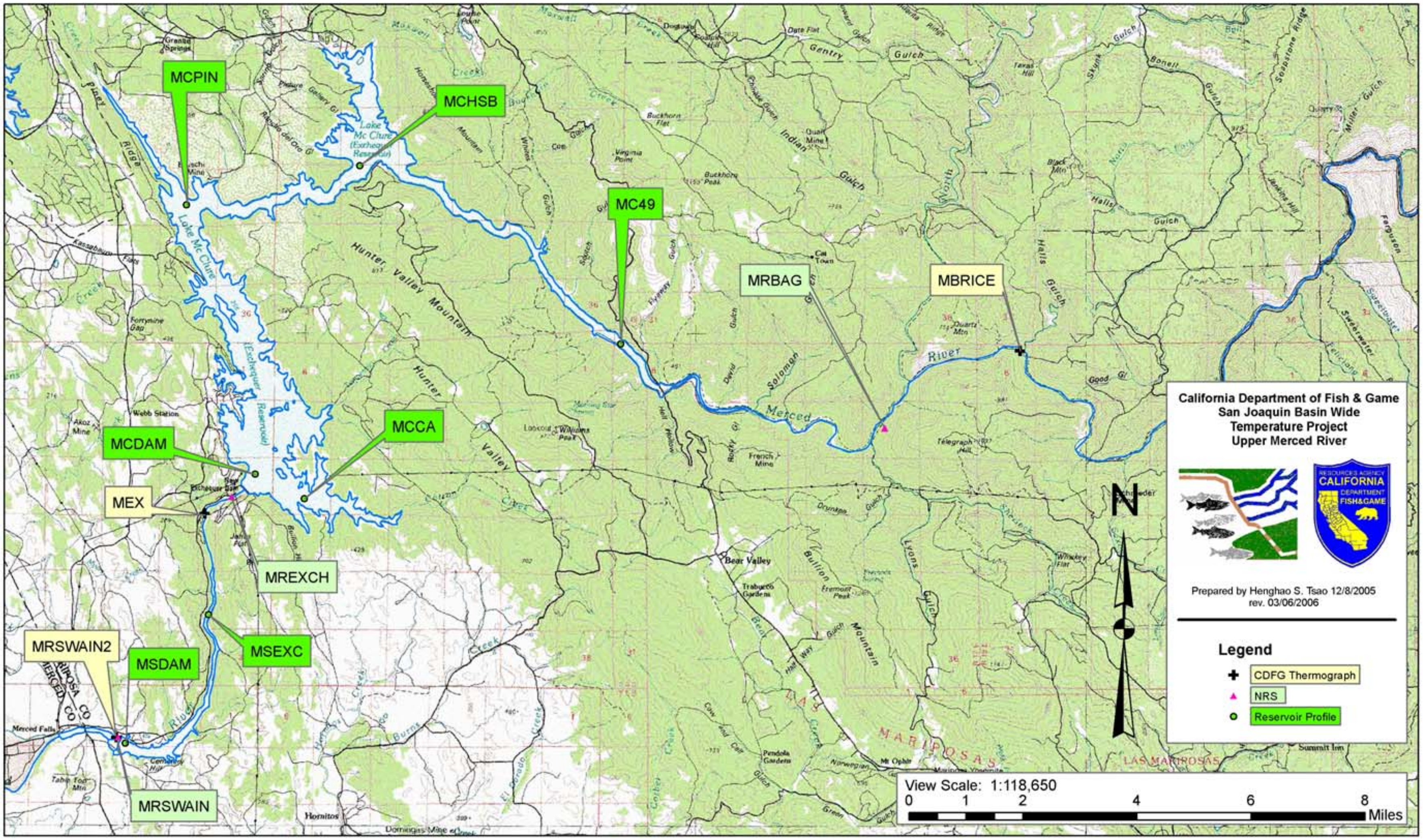

Figure 7. Project monitoring sites on the Merced River above McSwain Reservoir Dam.

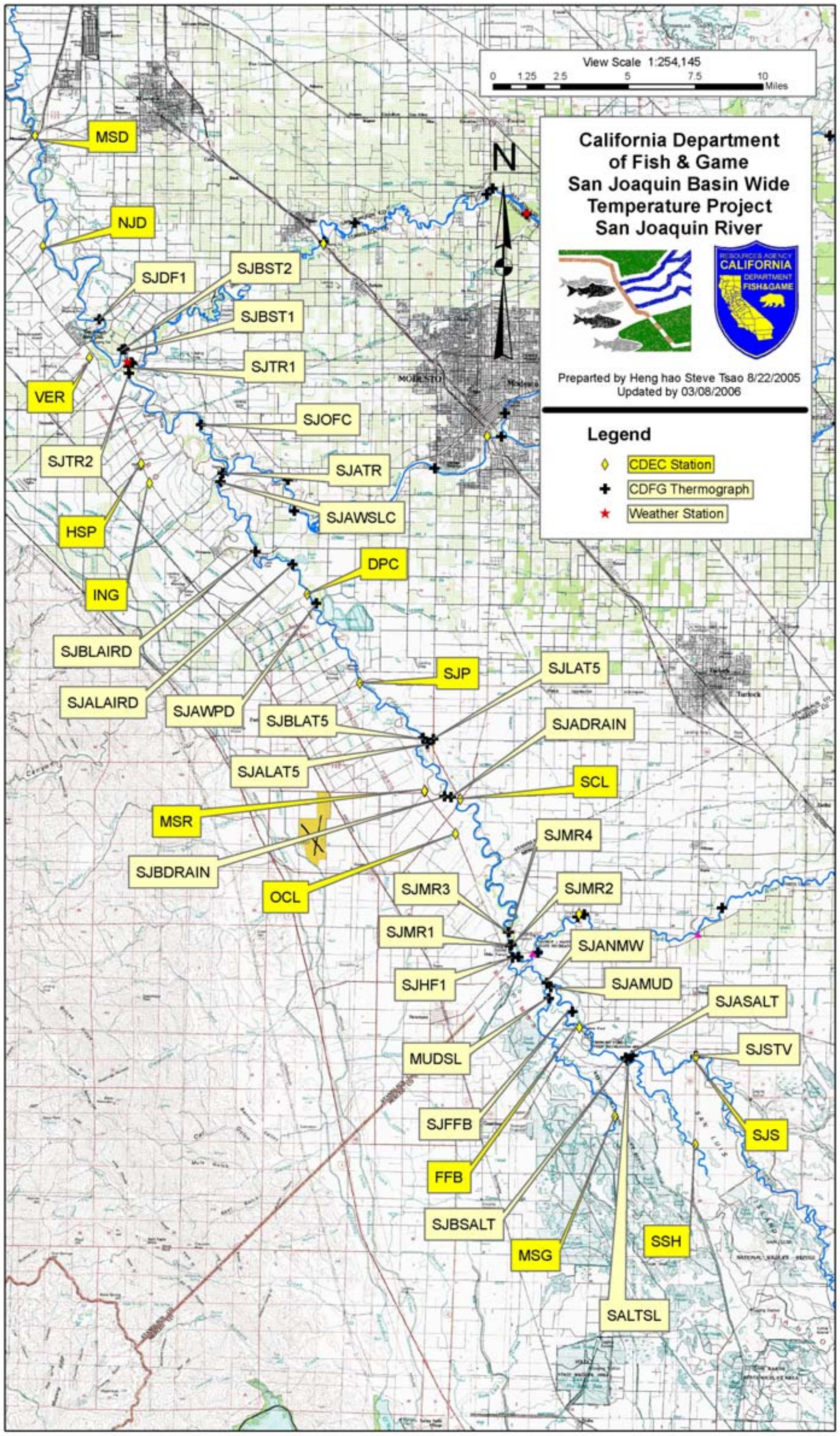

Figure 8. Project monitoring sites on the lower San Joaquin River.

APPENDIX F:

SAN JOAQUIN RIVER GROUP COMMENTS AND OTHER MATERIAL ASSOCIATED WITH THE SEPTEMBER 25, 2007 PUBLIC WORKSHOP ON ASSESSMENT OF POTENTIAL TEMPERATURE IMPAIRMENTS IN THE MERCED, TUOLUMNE, STANISLAUS, AND SAN JOAQUIN RIVERS

Item

1. Notice of a Public Workshop on Assessment of Potential Temperature Impairments in the Merced, Tuolumne, Stanislaus, and San Joaquin Rivers (June 4, 2007)

2. Postponement Notice of a Public Workshop on Assessment of Potential Temperature Impairments in The Merced, Tuolumne, Stanislaus, and San Joaquin Rivers (July 8, 2007)

3. Correspondence, electronic mail from Kenneth Petruzzelli, O'Laughlin& Paris LLP, counsel for the San Joaquin River Group Authority, to Daniel McClure, Central Valley Regional Water Quality Control Board, submitting temperature comments with exhibits (November 19, 2007).

4. Correspondence, electronic mail from Kenneth Petruzzelli, O'Laughlin& Paris LLP, counsel for the San Joaquin River Group Authority, to Daniel McClure, Central Valley Regional Water Quality Control Board, submitting temperature comments with corrected exhibits (November 19, 2007).

5. San Joaquin River Group Authority's Written Comments to Proposal by Central Valley Regional Water Quality Control Board to List The San Joaquin, Tuolumne, Merced And Stanislaus Rivers as Impaired Bodies of Water for Temperature Pursuant to Section 303(d) (Submitted November 19, 2007)

California Regional Water Quality Control Board
Central Valley Region
Karl E. Longley, ScD, P.E., Chair

Linda S. Adams
Secretary for
Environmental Protection

Sacramento Main Office
11020 Sun Center Drive #200, Rancho Cordova, California 95670-6114
Phone (916) 464-3291 • FAX (916) 464-4645
http://www.waterboards.ca.gov/centralvalley

Arnold Schwarzenegger
Governor

NOTICE OF A PUBLIC WORKSHOP ON ASSESSMENT OF POTENTIAL TEMPERATURE IMPAIRMENTS IN THE MERCED, TUOLUMNE, STANISLAUS, AND SAN JOAQUIN RIVERS

Staff of the California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board) will hold a public workshop to provide information and receive comments on potential listing of the Merced, Tuolumne, Stanislaus and San Joaquin Rivers on the State's Clean Water Act Section 303(d) list as impaired by high temperatures.

Workshop topics include:

- California Department of Fish and Game's temperature data and analysis
- The approach the Central Valley Water Board staff plans to use to assess potential temperature impairments in these waterbodies
- Input from interested parties
    - o If you would like to present information relevant to this issue, please contact Jennifer LaBay (916-464-4735) at least a week prior to the workshop.

The temperature data and analysis provided to the Central Valley Water Board by the California Department of Fish and Game, as well as background information on the 303(d) list will soon be available at the following location:
http://www.waterboards.ca.gov/centralvalley/programs/tmdl/index.htm.
If you would prefer a CD with the data please contact Central Valley Water Board staff.

Time and Location of Public Workshop:

Date: 20 July 2006
Time: 10 am to 3 pm
Place: Central Valley Water Board
Board Room
11020 Sun Center Drive, #200
Rancho Cordova, CA 95670

Map and directions to the Central Valley Water Board are available at:
http://www.waterboards.ca.gov/centralvalley/contact_us/index.html

The workshop facilities will be accessible to persons with disabilities. Individuals requiring special accommodation are requested to contact Jennifer LaBay at (916) 464-4735 at least 5 working days prior to the meeting. TTY users may contact the California Relay Service at (800) 735-2929 or voice line at (800) 735-2922.

We anticipate sending out notices during the 303(d) list update process for any public meetings that will be held and for any documents that will be made available to the public. In order to receive notices regarding the 303(d) list update process, interested parties should sign up for the Impaired Waterways 303(d) List email notification system at the following website: http://www.waterboards.ca.gov/lyrisforms/reg5_subscribe.html

For further information, contact Jennifer LaBay at JLaBay@waterboards.ca.gov or (916) 464-4735 or Danny McClure at dmcclure@waterboards.c.a.gov or (916) 464-4751.

*Original Signed By Jerry A. Bruns for* _____
Kenneth D. Landau, Assistant Executive Officer

4 June 2007

Linda S. Adams
Secretary for Environmental Protection

California Regional Water Quality Control Board
Central Valley Region
Karl E. Longley, ScD, P.E., Chair

Sacramento Main Office
11020 Sun Center Drive #200, Rancho Cordova, California 95670-6114
Phone (916) 464-3291 • FAX (916) 464-4645
http://www.waterboards.ca.gov/centralvalley

Arnold Schwarzenegger
Governor

POSTPONEMENT NOTICE OF A PUBLIC WORKSHOP ON ASSESSMENT OF POTENTIAL TEMPERATURE IMPAIRMENTS IN THE MERCED, TUOLUMNE, STANISLAUS, AND SAN JOAQUIN RIVERS

The workshop previously scheduled for 20 July 2007 has been postponed until September.

Date: 25 September 2007
Time: 10:00 am to 3:00 pm
Place: Central Valley Regional Water Quality Control Board
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670

Staff of the California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board) will hold a public workshop to provide information and receive comments on potential listing of the Merced, Tuolumne, Stanislaus and San Joaquin Rivers on the State's Clean Water Act Section 303(d) list as impaired by high temperatures.

Workshop topics include:

- California Department of Fish and Game's temperature data and analysis
- The approach the Central Valley Water Board staff plans to use to assess potential temperature impairments in these waterbodies
- Input from interested parties
  - If you would like to present information relevant to this issue, please contact Jennifer LaBay (916-464-4735) at least a week prior to the workshop.

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http://www.waterboards.ca.gov/centralvalley/programs/tmdl/index.htm.
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We anticipate sending out notices during the 303(d) list update process for any public meetings that will be held and for any documents that will be made available to the public. In order to receive notices regarding the 303(d) list update process, interested parties should sign up for the Impaired Waterways 303(d) List email notification system at the following website: http://www.waterboards.ca.gov/lyrisforms/reg5_subscribe.html

For further information, contact Jennifer LaBay at JLaBay@waterboards.ca.gov or (916) 464-4735 or Danny McClure at dmcclure@waterboards.c.a.gov or (916) 464-4751.

_ *ORIGINAL SIGNED BY* ____
Kenneth D. Landau, Assistant Executive Officer

3 July 2007

Kenneth Petruzzelli

From: Kenneth Petruzzelli

Sent: Monday, November 19, 2007 11:28 AM

To: 'dmcclure@waterboards.ca.gov'

Cc: Allen Short; Art Godwin; avry@aol.com; Bill Johnston; Chedester Steve (schedester@sjrecwa.net); Cory David; Debra Liebersbach; donn.w.furman@sfgov.org; Doug Demko; dvogel@resourcescientists.com; Fuller Andrea (andreafuller@fishbio.com); 'Jacobsma Ronald (rjacobsma@friantwater.org)'; Jeff Shields (jshields@ssjid.com); Jenniefer Buckman (Jennifer.Buckman@bbklaw.com); Ken Robbins; Kenneth Petruzzelli; lowellploss@aol.com; Noah Hume (noah@stillwatersci.com); Robert Nees; Roger K. Masuda (rmasuda@calwaterlaw.com); Ron Yoshiyama (rmyoshiyama@ucdavis.edu); steinerd@ix.netcom.com; Steve Emrick; Steve Knell; Ted Selb; Tim O'Laughlin (towater@olaughlinparis.com); Tim Ramirez; tjford@tid.org; Walter Ward; White Christopher (cwhite@ccidwater.org); William Luce

Subject: SJRGA Comments re Proposed 303(d) Listings for Temperature for the SJR, Stanislaus, Tuolumne, and Merced Rivers

Attachments: SJRGA Temperature Comments (11-19-07) Final with Exhibits.pdf

Danny -

Please see attached comments from the San Joaquin River Group Authority regarding the proposed Clean Water Act section 303(d) listings for the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers for temperature. Exhibit E is a compact disc that will follow by mail with a paper copy and these comments. The paper copy and compact disc is being shipped today by Federal Express. You should receive it tomorrow.

Please contact me if you require anything further, if you have any questions regarding any of the comments, and, especially, if you have any difficulties with the pdf file or compact disc.

Ken Petruzzelli

O'Laughlin & Paris LLP
2580 Sierra Sunrise Terrace
Suite 210
Chico, CA 95928
530-899-9755 (tel)
530-899-1367 (fax)
www.olaughlinandparis.com

Item 3

Kenneth Petruzzelli

From:	Kenneth Petruzzelli
Sent:	Monday, November 19, 2007 12:07 PM
To:	'dmcclure@waterboards.ca.gov'
Cc:	Allen Short; Art Godwin; avry@aol.com; Bill Johnston; Chedester Steve (schedester@sjrecwa.net); Cory David; Debra Liebersbach; donn.w.furman@sfgov.org; Doug Demko; dvogel@resourcescientists.com; Fuller Andrea (andreafuller@fishbio.com); 'Jacobsma Ronald (rjacobsma@friantwater.org)'; Jeff Shields (jshields@ssjid.com); Jenniefer Buckman (Jennifer.Buckman@bbklaw.com); Ken Robbins; Kenneth Petruzzelli; lowellploss@aol.com; Noah Hume (noah@stillwatersci.com); Robert Nees; Roger K. Masuda (rmasuda@calwaterlaw.com); Ron Yoshiyama (rmyoshiyama@ucdavis.edu); steinerd@ix.netcom.com; Steve Emrick; Steve Knell; Ted Selb; Tim O'Laughlin (towater@olaughlinparis.com); Tim Ramirez; tjford@tid.org; Walter Ward; White Christopher (cwhite@ccidwater.org); William Luce
Subject:	FW: SJRGA Comments re Proposed 303(d) Listings for Temperature for the SJR, Stanislaus, Tuolumne, and Merced Rivers
Attachments:	SJRGA Temperature Comments (11-19-07) Final with Exhibits.pdf

Danny –

It came to my attention that some of the graphs and tables in our comments failed to correctly translate to pdf. The attached copy includes all of the correct tables and graphs. I apologize for any confusion this creates.

Ken Petruzzelli

O'Laughlin & Paris LLP
2580 Sierra Sunrise Terrace
Suite 210
Chico, CA 95928
530-899-9755 (tel)
530-899-1367 (fax)
www.olaughlinandparis.com

From: Kenneth Petruzzelli
Sent: Monday, November 19, 2007 11:28 AM
To: 'dmcclure@waterboards.ca.gov'
Cc: Allen Short; Art Godwin; avry@aol.com; Bill Johnston; Chedester Steve (schedester@sjrecwa.net); Cory David; Debra Liebersbach; donn.w.furman@sfgov.org; Doug Demko; dvogel@resourcescientists.com; Fuller Andrea (andreafuller@fishbio.com); 'Jacobsma Ronald (rjacobsma@friantwater.org)'; Jeff Shields (jshields@ssjid.com); Jenniefer Buckman (Jennifer.Buckman@bbklaw.com); Ken Robbins; Kenneth Petruzzelli; lowellploss@aol.com; Noah Hume (noah@stillwatersci.com); Robert Nees; Roger K. Masuda (rmasuda@calwaterlaw.com); Ron Yoshiyama (rmyoshiyama@ucdavis.edu); steinerd@ix.netcom.com; Steve Emrick; Steve Knell; Ted Selb; Tim O'Laughlin (towater@olaughlinparis.com); Tim Ramirez; tjford@tid.org; Walter Ward; White Christopher (cwhite@ccidwater.org); William Luce
Subject: SJRGA Comments re Proposed 303(d) Listings for Temperature for the SJR, Stanislaus, Tuolumne, and Merced Rivers

Danny -

Please see attached comments from the San Joaquin River Group Authority regarding the proposed Clean Water

Item 4

Act section 303(d) listings for the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers for temperature. Exhibit E is a compact disc that will follow by mail with a paper copy and these comments. The paper copy and compact disc is being shipped today by Federal Express. You should receive it tomorrow.

Please contact me if you require anything further, if you have any questions regarding any of the comments, and, especially, if you have any difficulties with the pdf file or compact disc.

Ken Petruzzelli

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530-899-1367 (fax)
www.olaughlinandparis.com

SAN JOAQUIN RIVER GROUP AUTHORITY'S WRITTEN COMMENTS TO PROPOSAL BY CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD TO LIST THE SAN JOAQUIN, TUOLUMNE, MERCED AND STANISLAUS RIVERS AS IMPAIRED BODIES OF WATER FOR TEMPERATURE PURSUANT TO SECTION 303(d)

Submitted November 19, 2007
By O'Laughlin & Paris LLP

2580 Sierra Sunrise Terrace
Suite 210
Chico, CA 95928
(530) 899-9755 (tel)
(530) 899-1367 (fax)

EXECUTIVE SUMMARY

The information provided to, and relied upon by, the staff of the Central Valley Regional Water Quality Control Board is not sufficient to support the proposed listing of the San Joaquin, Stanislaus, Tuolumne and Merced Rivers as impaired for temperature. If the CVRWQCB were to list these rivers as impaired for temperature, based upon the information received to date, such action would be arbitrary, capricious and contrary to the law.

The proposed listing is legally flawed. The CVRWQCB is relying upon the incorrect narrative standard, and has neither solicited nor received information which would support a listing under the applicable narrative standard which prohibits the increase of natural receiving water temperature by 5 degrees Fahrenheit or more. Further, the CVRWQCB's proposed use of Policy 6.1.5.9 to evaluate the available temperature data and information is improper, as such policy's efforts to utilize information on the health of fishery populations in lieu of actual temperature data expressly contradicts the SWRCB's Basin Plan and Thermal Plan.

The proposed listing is also factually flawed as it relies upon information submitted by the California Department of Fish and Game (CDFG) that is irrelevant, incorrect and incomplete. The EPA Region 10 temperature criteria, submitted by the CDFG as the "threshold" temperatures necessary for the survival of anadromous fish species are not applicable to the San Joaquin River Basin, and have been questioned by reputable biologists and scholars, including the CDFG itself. Further, the lifestage timing and reach location criteria identified by CDFG are not supported by the known data, but rather have been purposely manipulated by CDFG in an effort to support the proposed listing. Had CDFG presented accurate lifestage timing and reach location data, there would be no justification for the proposed listing. For example, CDFG contends that the adult upstream migration period begins on September 1 and ends on October 31. Relying upon this, the CVRWQCB staff is prepared to find that the number of temperature exceedances for this period supports a listing. However, the actual period for upstream migration is October 1 through December 20. If the data for this actual migration time period were to be examined, the SJRGA is confident that there would not be enough temperature exceedances to support a listing.

The CDFG made it clear at the September 25, 2007 staff workshop that it believes that reservoir releases can and must be used to reduce temperatures in the San Joaquin, Stanislaus, Tuolumne and Merced Rivers. Model runs demonstrate, however, that it will be virtually impossible to operate the existing reservoirs in such a way as to achieve the CDFG recommended temperature criteria for all time periods and locations. While improvements in temperatures can be achieved in portions of the rivers, such improvements are bought with tremendous costs to reservoir storage and, consequently, water deliveries for all existing beneficial uses. In 1991, the SWRCB concluded that it would be a waste and unreasonable use of water to use reservoir releases to control water temperatures at Vernalis. Current information and technology demonstrate that this conclusion is correct and circumstances have not changed, and further suggest that the use of reservoir storage for temperature control anywhere within the San Joaquin Basin will be a waste and unreasonable use of water.

Finally, the proposed listing is procedurally flawed. The SWRCB established February 28, 2007 as the deadline for the receipt and consideration of information and data as part of the 2008 listing cycle. The SWRCB expressly provided that information and data submitted after February 28, 2007 would be accepted, but would not be used in the 2008 listing cycle, but only in the 2010 listing cycle. The CVRWQCB has acknowledged that it did not receive sufficient information and data by the February 28, 2007 deadline concerning the current and historic state of the San Joaquin River Basin fishery necessary to support a listing. Nonetheless, and in contravention of the SWRCB's deadline, the CVRWQCB contacted the CDFG and asked it to provide the necessary information well after the February 28, 2007 deadline had come and gone. Since the CVRWQCB did not receive the information it needed to support a listing by the February 28, 2007 deadline, it cannot list the San Joaquin, Stanislaus, Tuolumne and Merced Rivers as part of the 2008 listing cycle.

I. INTRODUCTION

Having (1) reviewed the materials submitted to the Central Valley Regional Water Quality Control Board ("CVRWQCB") by the California Department of Fish and Game ("CDFG"), and (2) considered the methodology for determining impairment laid out by CVRWQCB staff at the September 25, 2007 workshop, the San Joaquin River Group Authority ("SJRGA") finds that the legal and factual bases asserted by the CDFG and CVRWQCB's staff in support of the proposed listing are faulty. As such, it is the SJRGA's position that the CVRWQCB cannot list the San Joaquin, Tuolumne, Merced or Stanislaus Rivers as impaired bodies of water for temperature during this listing cycle for numerous reasons described herein.

II. LEGAL OBJECTIONS

A. The "Narrative Objective" the CVRWQCB Claims to Be Complying With Is Not An Objective At All, And Cannot Be Used to Justify the Proposed Action.

In the materials and presentation the CVRWQCB staff gave as part of the September 25, 2007 workshop, RWQCB staff indicated that the first step in the Section 303(d) Listing Policy is to identify the relevant water quality objectives. (*See* Power Point Presentation of Danny McClure, Slide # 7). In this particular instance, the CVRWQCB identified the relevant water quality objective as

> "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses." (Id., Slide # 9; *see also* Preliminary Draft Example Assessment of Merced River, p. 1-2).

While the quoted language is contained in the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (5A-5B)* ("the Basin Plan")(*see* Chapter III, p. 8.00), it does not constitute a "water quality objective" as defined by the Water Code.

A water quality objective is a standard that limits the levels of water quality constituents or characteristics. Specifically, the Water Code defines a "water quality objective" as "**the limits or levels** of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area."(*See* Wat. Code 13050(h)(emphasis added)). The language cited by the CVRWQCB as a "narrative objective" does not qualify as a water quality objective as defined by the Water Code as it does not contain any level, criteria, characteristic or other description or limitation regarding the temperature of an intrastate water. Rather, the language relied upon by the CVRWQCB merely provides that no alteration of temperature will be allowed unless expressly approved by the RWQCB. So, while the language relied upon by the CVRWQCB establishes that alterations of temperature are allowed, it provides for no such alterations unless prior approval is obtained from the CVRWQCB. The need to obtain prior RWQCB approval is not a description or identification of a limit or level of water quality constituents as required by Water Code Section 13050(h).

The language relied upon by the CVRWQCB similarly does not comply with federal requirements under the Clean Water Act. Pursuant to federal regulation, a water quality standard is comprised of both the designation of use to be made of the water, and the criteria necessary to protect such use. (*See* 40 C.F.R. § 131.2). In addition to not identifying any criteria, the language relied upon by the CVRWQCB fails to identify any beneficial use or uses which are to be protected. All that the language relied upon by the CVRWQCB says is that temperature cannot be altered, absent the permission of the CVRWQCB, if it will harm “beneficial uses.” But, both the Water Code and the Clean Water Act require the CVRWQCB to evaluate, weigh and balance a host of factors before identifying the beneficial use or uses for a particular water (not to mention the criteria necessary to protect such beneficial use). (Wat. Code § 13241; *see* 33 U.S.C. § 1313(c)(2)(A); *see also* 40 C.F.R. §§ 131.10-131.13). In this case, the language relied upon by the CVRWQCB indicates that the type of weighing and balancing that the CVRWQCB is supposed to have engaged in did not occur, as the language does not identify any specific beneficial use or uses which are to be protected.

The inappropriateness of using the language relied upon by the CVRWQCB as a water quality objective becomes clearer when looked at in terms of implementing a total maximum daily load (“TMDL”). TMDLs are required to be established at a “level necessary to implement the applicable water quality standards…” (*See* CWA 303(d)(1)(C)). But, given that the language relied upon by the RWQCB does not set any limit or level of temperature, a TMDL cannot be devised which implements such language. Indeed, the only way that a TMDL can be developed in this case is if, after deciding to list the San Joaquin, Tuolumne, Merced and Stanislaus Rivers as impaired for temperature, the CVRWQCB then identifies the specific limits or levels of temperature that are appropriate as part of the TMDL itself. Such an effort would, however, be illegal, as the CVRWQCB does not have the authority to adopt “water quality objectives” as part of the development of a TMDL. (*See* June 12, 2002 memorandum from the SWRCB Office of Chief Counsel entitled *The Distinction Between A TMDL’s Numeric Targets and Water Quality Standards*, attached hereto as Exhibit A).[1] Indeed, “TMDLs are not water quality objectives,” but rather “serve as a means to an end. That end is the attainment and maintenance of existing water quality standards.” (Id., p. 5, 6). In this instance, since the language relied upon by the CVRWQCB does not contain any limits, levels, characteristics or other description of the temperature objectives for the San Joaquin, Stanislaus, Merced and Tuolumne Rivers, nor does it identify the beneficial use or uses to be protected, a TMDL to attain such limits is impossible. Indeed, it is clear that to properly establish a TMDL in this case, a water quality objective, including both the

[1] The June 12, 2002 memorandum explains that a water quality objective is developed after consideration of a variety of policy considerations (*see* Wat. Code § 13241), whereas such policy considerations do not apply to the development of TMDLs. (Id., p. 3-9).

identification of the beneficial use and the temperature criteria necessary to protect such beneficial use, will need to be developed as part of the TMDL.

B. The Applicable Water Quality Objective is Identified in the Basin Plan for COLD Intrastate Waters.

If the CVRWQCB were interested in evaluating whether or not the San Joaquin, Tuolumne, Merced and Stanislaus Rivers were impaired for temperature, the water quality objective that would apply is the narrative objective identified for COLD intrastate waters, which is

> "At no time or place shall temperatures of COLD or WARM intrastate waters be increased more than 5ºF above natural receiving water temperature." (Basin Plan, Chapter III, p. 8.00).

The San Joaquin, Merced, Tuolumne, and Stanislaus Rivers have all been identified as COLD intrastate waters. (Basin Plan, Chapter II, p. 7.00-8.00).

Unlike the language relied upon by the CVRWQCB to date, narrative objective for COLD intrastate waters complies with State and federal law by including both a beneficial use designation and a temperature criteria designed to protect such designated beneficial use.[2] The designation "COLD" means that the recognized beneficial use of these rivers is "Cold Freshwater Habitat" that supports aquatic vegetation, fish and wildlife. (Basin Plan, Chapter II, p. 2.00). The criteria for protecting such designated beneficial uses is that natural receiving water temperatures cannot be increases by more than 5ºF.

None of the information solicited by nor made available to the CVRWQCB uses this water quality objective. As such, there is simply no information available upon which the CVRWQCB could rely to determine, as part of this listing cycle, if the San Joaquin, Merced, Tuolumne and Stanislaus Rivers are impaired for temperature.

C. The CVRWQCB's Proposed Use of Policy 6.1.5.9 Is Inappropriate.

The CVRWQCB indicated that it intends to rely upon the alternate approach to evaluating temperature data as set forth in Section 6.1.5.9 of the September 2004 *Water Quality Control Policy For Developing California's Clean Water Act Section 303(d)*

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[2] This narrative objective would not be applicable in this case even if the language relied upon by the CVRWQCB is considered a "water quality objective." It is hornbook law that where a general regulation conflicts with a specific regulation, the specific controls. (People v. Weatherill (1989) 215 Cal.App.3d 1569, 1577-1578).Here, the CVRWQCB has adopted a general prohibition on alterations unless it gives prior approval. But, then the CVRWQCB actually approves of specific levels of alteration for COLD and WARM waters; ie, that any alteration that does not result in an increase of 5ºF above natural receiving water temperature is acceptable. Since the rivers at issue are designated COLD, this more specific objective would apply in lieu of the more general "objective" relied upon by the CVRWQCB.

List. ("the Listing Policy") (Power Point Presentation of Danny McClure, Slide # 11; *see* Preliminary Draft Example Assessment of Merced River, p. 1). The use of this alternate approach is inappropriate as it is contrary to the Basin Plan and the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California* ("the Thermal Plan") adopted by the SWRCB in 1975.[3] Further, even if alternate policy were to be found to be applicable generally, the factual predicates necessary to using the alternate policy do not exist in this case.

1. **The Alternate Policy is Contrary to the Basin Plan and Thermal Plan**.

The alternate policy expressed in Section 6.1.5.9 of the Listing Policy provides that, in the absence of "historical"[4] or "natural" temperature data, recent temperature data can be compared to the temperature requirements of aquatic life found in the water segment at issue. (Listing Policy, § 6.1.5.9, p. 25). This alternate policy is similarly described in the SWRCB's September 2004 *Final Functional Equivalent Document Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* ("the Functional Equivalent Document").There, the SWRCB stated that the primary problem in assessing a body of water for temperature impairment is the lack of temperature data necessary to determine the "natural receiving water temperature" specified in the Basin Plan's temperature objectives. (Functional Equivalent Document, p. 132). The SWRCB explained that "Determining 'natural receiving water' temperature is limited by the availability of historic temperature monitoring data that is considered representative of unaltered and/or natural conditions in a water body." (Id., p. 132-133). The SWRCB went on to discuss two possible alternative methods of interpreting temperature data, including the one adopted in Section 6.1.5.9 of the Listing Policy. (Id., p. 133-135).

The SWRCB's discussion of the need for an alternate method of interpreting temperature data due to the lack of "historic" or "natural" temperature data representative of "unaltered" conditions is, however, severely wanting. There is simply nothing in the Basin Plan itself which suggests that the "natural receiving water temperature" refers to "unaltered conditions" justifying the SWRCB's development of an alternate policy. To the contrary, the SWRCB's definition of "natural receiving water temperature" expressly belies the SWRCB's stated need for temperatures indicative of the "unaltered" condition.

Both the language relied (inappropriately) upon by the CVRWQCB and the language establishing the narrative objective for COLD and WARM intrastate waters use the term "natural receiving water temperature." This term is expressly defined by the SWRCB in the Thermal Plan to mean "The temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated

[3] The Thermal Plan is expressly incorporated into and made part of the Basin Plan. (Basin Plan, Chapter III, p. 2.00; Chapter IV, p. 10.00, Appendix Item 11). Further, the Thermal Plan is expressly identified by the SWRCB as one of the policies with which all state agencies, including the CVRWQCB, must comply. (Basin Plan, Chapter IV, p. 8.00 (Policy #12)).
[4] The term "historical" is not defined in the Listing Policy.

temperature waste discharge or irrigation return waters." (Thermal Plan, p. 1).[5] The term "elevated temperature waste," used in the definition of "natural receiving water temperature" is likewise defined. That term refers expressly to "Liquid, solid, or gaseous material including thermal waste discharged at a temperature higher than the natural temperature of receiving water. Irrigation return water is not considered elevated temperature waste for the purposes of this plan." (Thermal Plan, p. 1).[6] Thus, "natural receiving water temperature" has nothing to do with "historic" or "unaltered" conditions, but rather is the temperature of the water before the addition of elevated temperature waste discharges and irrigation return waters.

To the extent that this conclusion was at all left in doubt based upon the definitions provided by the SWRCB itself, such doubt is utterly extinguished by the SWRCB when it provides that:

> "Natural water temperature will be compared with waste discharge temperature by near-simultaneous measurements accurate to within 1ºF. In lieu of near-simultaneous measurements, measurements may be made under calculated conditions of constant waste discharge and receiving water characteristics." (Thermal Plan, p. 6).

Given the SWRCB's insistence that temperature comparisons be made using "near-simultaneous measurements," it is clear that the SWRCB was not contemplating the need or use for data reflective of the "historic" or "unaltered" condition of the water body.

Although the definition of "natural receiving water temperature" is in the Thermal Plan and applies only to interstate waters, not intrastate waters such as are at issue in this case, the use of the same term in similar regulations is presumed to have the same meaning. (Boise Cascade Corp. v. USEPA, 942 F.2d 1427, 1432 (9th Cir. 1991)).[7] This is especially true when, as here, the agency has given a specific definition for a term. (Urban Renewal Agency v. Calif. Coastal Zone Conservation Co. (1975) 15 Cal.3d 577, 584-585). Since the SWRCB used the term "natural receiving water temperature" in regards to the interstate waters, coastal waters and enclosed bays covered expressly by the Thermal Plan, and in regards to the intrastate waters which are not discussed in the Thermal Plan, in the absence of some other manifestation of a differing intent, the two terms are to be treated as if they have the same meaning.

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[5] This definition is misquoted in the Functional Equivalent Document on page 132 in such a way as to change the entire meaning of the definition. A comma is inappropriately added between the words "temperature" and "waste" which breaks up, avoids and negates the SWRCB's given definition for the term "elevated temperature waste" discharge.

[6] The term "thermal waste" as used in the definition of "elevated temperature waste" is also expressly defined as "Cooling water and industrial process water used for the purpose of transported waste heat." (Thermal Plan, p. 1).

[7] This standard of statutory interpretation also works in reverse. Where one statute uses a specific term, and another, similar statute omits the specific term, it is evidence that the promulgating body had a different intent in mind. (People v. Licas (2007) 41 Cal.4th 362, 367).

Further, there is no doubt that the SWRCB could have set up a different scheme for measuring temperatures in intrastate waters generally, or in the San Joaquin, Tuolumne, Merced and Stanislaus Rivers specifically. In the Basin Plan, on the very same page that the narrative objective for COLD and WARM waters is provided, the SWRCB identified specific temperatures for specific water bodies. (Basin Plan, Chapter III, p. 8.00, Table III-4 and Table III-4A). Moreover, these specific limitations on temperature changes are not related to "natural receiving water temperature," which is not mentioned at all, but rather are related to "temperature changes due to controllable factors." (Ibid.).

The Basin Plan and Thermal Plan make it clear that the alternate policy contained in Section 6.1.5.9 is inappropriate and unnecessary. To determine whether or not temperatures of a water body are in excess of the "natural receiving water temperature," the RWQCB must take nearly simultaneous temperature readings upstream and downstream of discharges of thermal waste and irrigation return flows. If the temperature of the water downstream of the discharge is more than 5ºF hotter than the temperature upstream of the discharge, then an exceedance exists. There is no reason or justification for the RWQCB to attempt to equate "natural receiving water temperature" with the "unaltered condition."

2. **Even Assuming Section 6.1.5.9 Applies, There Is No Information Justifying Its Use in this Case**.

Assuming, *arguendo*, that the alternate policy set forth in Section 6.1.5.9 does apply generally, there is not enough information justifying its application as to the San Joaquin, Tuolumne, Merced and Stanislaus Rivers in this instance. By its own terms, Section 6.1.5.9 applies only when "'historic' or 'natural' temperature data are not available…" (Listing Policy, § 6.1.5.9, p. 25). The submittal made to the CVRWQCB by the CDFG on February 28, 2007, and the information submitted by the CDFG at the workshop on September 25, 2007, did not show, and made no effort to show, that the "historic" or 'natural" temperatures are not available. Rather, the submittals by CDFG, as well as the Preliminary Draft Example Assessment of Merced River, assumed the unavailability of such "historic" or "natural" temperature data. The CVRWQCB must do more than rely upon this, as yet, unfounded assumption.

First, there is no indication that either the CDFG or the CVRWQCB looked to determine if "historic" or "natural" temperature data existed. Before applying, or attempting to apply, the alternate policy, it is incumbent on the CVRWQCB to determine if such "historic" or "natural" temperature data exist. (*See* EPA's 2004 Final Upper Main Eel River and Tributaries Total Maximum Daily Loads for Temperature and Sediment, p. 12 ["No information on pre-dam conditions was uncovered, nor general stream temperatures before the 1964 flood."]).

Second, "historic" or "natural" temperature data need not be generated solely from actual measurements taken, but may also come from modeling.[8] For example, in the Eel River TMDL, EPA used a computer model to calculate "natural stream temperatures" and also to evaluate the temperature affects of four additional riparian management scenarios. (Id., p. 20-24, 28-32). In so doing, EPA noted that "Modeling of stream temperature is a well developed area of inquiry and many models are available to assist policymakers in understanding the factors controlling stream temperatures." (Id., p. 20).

In this instance, even if data from actual temperature measurements taken at some point in the past are unavailable, "historic" or "natural" temperature can still be accurately calculated using the HEC-5Q model constructed for evaluating temperature in both the upper and lower San Joaquin River system, including the Stanislaus, Merced and Tuolumne Rivers, as part of the San Joaquin River Basin-Wide Water temperature Modeling Project ("the SJR Basin Model").[9] The SJR Basin Model, which is the model used by both the SJRGA and the CDFG for their respective presentations on September 25, 2007,

> "is designed to simulate the thermal regime of mainstem reservoirs and river reaches. The SJR [Basin] Model project focuses on understanding the relationship between air temperature, reservoir operations, river hydraulics, stream flow, and water temperature, both in-reservoir and in-river…the HEC-5Q model will analyze different water operation scenarios (e.g., reservoir storage and release patterns)…" (CDFG's March 22, 2006 *Lower San Joaquin River Basin-Wide Temperature Modeling Project Data Collection Protocol*, p. 4 (attached to CDFG's February 28, 2007 submittal as Exhibit E)).

Just as the SJR Basin Model is capable of predicting future water temperatures given a range of operation scenarios, it is likewise capable of accurately identifying "natural" or "historic" temperatures using the same principles. As an example, in the Case 1 run done for the SJRGA by AD Consultants, the model identified and compared "actual" temperatures with "historic" temperatures at varying locations in the Stanislaus River for the period 1967-1982. The "historic" temperatures were derived solely from the model by removing New Melones Dam and reservoir, installing the original Melones Dam and reservoir, and using historical flow and operation criteria for Melones Dam and reservoir. Similarly, the "actual" temperatures, which assumed the existence of New Melones Dam and reservoir and the Interim Plan of Operation as the operating criteria for the period 1967-1982, were derived solely from the model. Once the run was completed, the results were compared with temperature data collected at Vernalis and downstream of

[8] The SWRCB's December 4, 2006 data solicitation and the January 30, 2007 clarification notice expressly provided that there are no limits on the data and information that the public can provide. The SWRCB made it clear that the RWQCBs would accept any and all data.
[9] The SJR Basin Model is still being reviewed by all of the stakeholders and some minor tweaking and improvements are expected.

Goodwin Dam. The comparison indicated that the model under-predicted the observed temperatures slightly, indicating that the model results are conservative from a temperature increment standpoint. (*See* Exhibit B, p. 6, p. 10 [Figure 7]).

Since the SJR Basin Model is capable of accurately depicting "historic" temperatures for the San Joaquin, Tuolumne, Merced and Stanislaus Rivers, there is no need for the CVRWQCB to rely upon the alternate policy set forth in Section 6.1.5.9 of the Listing Policy.

D. Action Taken as Part of the 2008 Cycle Is Arbitrary and Capricious.

1. **CVRWQCB Does Not Have Sufficient Information About the Current and Historic State of the Fishery**.

The SWRCB initiated the solicitation of data and information regarding water quality conditions from interested parties by public notice dated December 4, 2006. That notice provided, in bold type,

> "**To be considered in this review process, data and information must be submitted to the appropriate Regional Water Board no later than February 28, 2007.**" (SWRCB Notice of Public Solicitation of Water Quality data and Information for 2008 Integrated Report – List of Impaired Waters and Surface Water Quality Assessment [303(d)/305(b)], December 4, 2006, p. 2)(bold in original).

The notice also had attached to it a document entitled "Enclosure 3." Paragraph 4 of Enclosure 3 specifically provided that

> "All new information and data must be received by the respective Regional Water Board…by the close of business on February 28, 2007. Please note that any information received after February 28, 2007 will not be used for the 2008 section 303(d) List or for compiling the section 305(b) Report, but will be considered in developing the 2010 section 303(d) List and Section 305(b) Report." (Enclosure 3, p. 1, ¶ 4).

The SWRCB made it clear to everyone, including the RWQCBs tasked with compiling and assessing the water quality data and information submitted, that no extensions of the February 28, 2007 deadline were permitted or would be granted. Rather, the SWRCB specifically provided that data submitted after the close of the solicitation period would be considered only in the context of the development of the 2010 cycle.

As discussed above, the CVRWQCB is ostensibly relying on the alternate policy of Section 6.1.5.9 to support the proposed listing. This Policy, however, specifically provides that information "on current and historic conditions and distribution of sensitive beneficial uses (e.g., fishery resources) in the water segment **is necessary**…" (Listing Policy, § 6.1.5.9, p. 25-26). In this instance, as the September 12, 2007 Preliminary Draft Example Assessment submitted by CVRWQCB staff at the September 25, 2007 workshop demonstrates, information and data about the current and historic distribution of salmon is still needed.

For example, on page 1 under the heading "Decision," the document indicates "List – Pending information about the fishery." (Similar statements are provided elsewhere on page 1 ["Insert information about current and historic salmonid distribution"]). On page 9, the CVRWQB staff expressly acknowledges the lack of fishery information needed as it specifically admits

> "INFORMATION ABOUT THE HISTORICAL AND CURRENT STATE OF THE FISHERY WILL BE NEEDED TO COMPLETE THE ASSESSMENT." (September 12, 2007 Preliminary Draft Example Assessment, p. 9)(capitalization original).

Since it is clear that information and data regarding the historical and current state of the fishery was not submitted to the CVRWQCB by February 28, 2007 as required by the SWRCB, the CVRWQCB does not have enough information to list the San Joaquin, Tuolumne, Merced and Stanislaus Rivers as impaired for temperature using the alternate policy of Section 6.1.5.9.

2. **CVRWQCB's Apparent Effort to Solicit Information from CDFG After the February 28, 2007 Deadline Was Biased and Unfair, and Any Use of that Information in the 2008 Listing Cycle Will Be Arbitrary and Capricious**.

At the September 25, 2007 workshop, staff from CDFG gave a presentation which, among other things, discussed the current and historic status of the fishery. (*See, e.g.*, Marston slides entitled "Why List?" SJR Salmon Trend" and "Re-Cap Summary"). The SJRGA thought this presentation odd, as the CDFG had not submitted any such information as part of its February 28, 2007 submittal.

Further, Mr. Marston of CDFG indicated that CDFG was, as part of the workshop, submitting to the CVRWQCB a paper regarding the current and historic status of the fishery. This paper, dated September 2007 and entitled "San Joaquin River Fall-run Chinook Salmon and Steelhead Rainbow Trout Historical Population Trend Summary" was provided to the SJRGA on October 18, 2007 as the result of a Public Records Act request.[10] In this paper, Mr. Marston discloses that CDFG submitted information about historic fishery trends ***at the request of the CVRWQCB***. Mr. Marston writes

> "The Central Valley Regional Board asked the Department to submit information regarding the historical trends of salmon and steelhead in the San Joaquin River Basin (excluding the Mokelumne and Cosumnes Rivers)." (San Joaquin River Fall-run Chinook Salmon and Steelhead Rainbow Trout Historical Population Trend Summary, September 2007, p. 4).

Assuming that Mr. Marston's statement is accurate, the request by CVRWQCB that the CDFG submit additional evidence and data regarding current and historic fishery trends after the SWRCB's February 28, 2007 deadline is, at best, inappropriate, and at worst, evidence of prejudice and bias that calls into question the CVRWQCB's entire process.

Regardless of the propriety of the request itself, any effort by the CVRWQCB to use the information submitted by CDFG or any other party regarding current and historic fishery trends in the 2008 listing cycle will be arbitrary and capricious. The SWRCB established the February 28, 2007 deadline to insure that the various regional boards would have enough time to evaluate and assimilate the information submitted such that the Integrated Report could be completed and submitted to the USEPA by April 1, 2008. (*See* December 4, 2006 Notice, p. 2). The SWRCB made no provision for the change, relaxation or other extension of the February 28, 2007 deadline. To the contrary, the SWRCB flatly stated that any information submitted after February 28, 2007 "will not be used" as part of the 2008 listing cycle, but would instead be used in the 2010 listing cycle. (Id., Enclosure 3, p. 1, ¶ 4). The SWRCB expressly considered and resolved how information submitted after February 28, 2007 was to be treated and used. The fact that CDFG and/or other parties failed to submit sufficient information to the CVRWQCB by February 28, 2007 which will enable it to evaluate whether or not there is an impairment for temperature under the alternate policy of Section 6.1.5.9 is not sufficient reason for the CVRWQCB to unilaterally contact CDFG and request that it provide the missing information. (*See* Halaco Engineering Co. v. South Central Coast Regional Com. (1986) 42 Cal.3d 52, 79 [defining arbitrary and capricious conduct as that "not supported by a fair or substantial reason…"]).

Since it is clear from both the CVRWQCB's own September 12, 2007 Preliminary Draft Example Assessment and Mr. Marston's September 2007 paper "San Joaquin River Fall-run Chinook Salmon and Steelhead Rainbow Trout Historical Population Trend Summary" that the CVRWQCB did not receive the information it

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[10] In addition to the September 2007 paper *San Joaquin River Fall-run Chinook Salmon and Steelhead Rainbow Trout Historical Population Trend Summary,* CDFG also furnished copies of two additional items that were submitted to the CVRWQCB after the February 28, 2007 deadline: a June 6, 2007 letter from Mr. John M. Bartolow, USGS (retired), and a September 24, 2007 report by Alice A. Rich, Ph.D., entitled *Impacts of Water Temperature on Fall-Run Chinook Salmon (Oncorhynchus tshawytscha) and Steelhead (O. mykiss) in the San Joaquin River System.*

needs regarding the current and historic state of the fishery to utilize the alternate policy of Section 6.1.5.9 by the SWRCB's February 28, 2007 deadline, the CVRWQCB cannot list the San Joaquin, Tuolumne, Merced and Stanislaus Rivers as impaired for temperature in the 2008 listing cycle.

E. The Use of Stored Water to Reduce Temperature At Vernalis is a Waste of Water In Violation of the California Constitution.

In its February 28, 2007 submittal, CDFG recommended that the San Joaquin River at Vernalis be declared impaired for temperature due to alleged exceedances of temperatures in the April 15-June 15 time frame, and again in the September 1-October 31 timeframe. (*See* February 28, 2007 letter, Table 1). During the September 25, 2007 workshop, staff from CDFG made it clear that the method of lowering temperatures at all proposed compliance points, including Vernalis, was by increasing flow through manipulation of reservoir storage. Mr. Marston submitted a slide entitled "Can H2O Be Cooled?" which specifically contemplates use of coldwater storage accounts in reservoirs as a method of cooling temperatures. (*see* Marston slide from the same presentation linking increased flows from reservoir storage and reduced temperatures, entitled "Flow Level & H2O Temp."). CDFG also contracted with AD Consultants to conduct two modeling runs using the SJR Basin Model to look at the impact of increased flow on temperatures at the confluence of the Tuolumne River and the San Joaquin River (Marston slide entitled "Tuolumne River Confluence (2001)") and Vernalis (Marston slide entitled "San Joaquin River at Vernalis (2001)").

CDFG's focus on the use of reservoir releases to cool temperatures, particularly at Vernalis, is of dubious value as the SWRCB has already concluded that the use of reservoir releases to control temperatures measured at Vernalis would be a waste and unreasonable use of water in contravention of the California Constitution. In the SWRCB's May 1991 Water Quality Control Plan for Salinity ("1991 Salinity Plan"), the SWRCB noted temperature objectives measured at Vernalis, but refused to implement them, stating controlling temperatures at Vernalis by "utilizing reservoir releases does not appear reasonable due to the distance of the [Vernalis] downstream of reservoirs and uncontrollable factors such as ambient air temperature, water temperature in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures [at Vernalis] a waste of water…" (1991 Salinity Plan, Table 1, p. 1-13).

There is no evidence that the CVRWQCB can rely upon to come to a different conclusion than that reached by the SWRCB in 1991. Mr. Marston admitted during the workshop that CDFG did not ask AD Consultants to evaluate the impact on reservoir storage that would result if CDFG's increased releases of reservoir storage were implemented. Further, the SJRGA did ask AD Consultants to evaluate impacts to reservoir storage as part of the model runs they commissioned, and in each case the increased releases not only were unable to achieve the temperature criteria at all times and in all locations, but had profound, detrimental impacts to reservoir storage. (*See*

Results of modeled Cases, attached hereto as Exhibit B, and complete discussion in Section III, *infra*.).

Article X, Section 2 of the California Constitution provides that waters of the state must be put to reasonable and beneficial use. Any use which is unreasonable or non-beneficial can be prohibited. (Gin S. Chow v. City of Santa Barbara (1933) 217 Cal. 673; Antioch v. Williams Irr. Dist. (1922) 188 Cal. 451; Joslin v. Marin Mun. Water Dist. (1967) 67 Cal.2d 132). Moreover, what constitutes a reasonable and beneficial use of water is a question of fact. (People v. Forni (1976) 54 Cal.App.3d 743, 750). As such, any evaluation of the propriety of a use of water must involve the examination of the proposed use and a determination of the proposed use justified the amount of water utilized. (Antioch, *supra*, 188 Cal. 451 (sought flows to prevent saltwater intrusion); Peabody v. City of Vallejo (1935) 2 Cal.2d 351, 375-376 (flows to flood land and to provide incidental recharge); Forni, *supra*, 54 Cal.App.3d 743 (sought water for frost protection); Imperial Irr. Dist. v. State Water Resources Control Bd. (1990) 225 Cal.App.3d 548 (examined irrigation and delivery practices which resulted in tailwater and drainage flowing into the Salton Sea); Erickson v. Queen Valley Ranch Co. (1971) 22 Cal.App.3d 578, 585 (determined method of diversion which resulted in loss of 5/6 of diverted water during transport); Joslin, *supra*, 67 Cal.2d at 141-145 (use of water to transport gravel not reasonable)).

In 1991, the SWRCB concluded that the use of reservoir releases to meet temperatures at Vernalis was a waste and unreasonable use of water "based upon the record in [the] proceedings" before it. (1991 Salinity Plan, p. 1-13). Further, the SWRCB stated that it "will require a test of reasonableness before consideration of reservoir releases" for the purpose of controlling water temperature at Vernalis. (Id.). Here, the information submitted by CDFG has done nothing to demonstrate that the use of reservoir releases to control temperatures at Vernalis is reasonable in contradiction to the findings of the SWRCB in 1991, particularly since the temperatures now cited by CDFG are even lower (*i.e.*, 64.4ºF [18ºC]) than those included in the 1991 Salinity Plan (*i.e.*, 68ºF [20ºC]) at Vernalis in April through June, September and November. Moreover, the information submitted by the SJRGA demonstrates that any attempt to use reservoir releases to achieve the recommended temperatures at Vernalis will (a) be unable to achieve such temperatures during the recommended time periods and (b) have a significant, detrimental impact on reservoir storage. The information submitted to date requires the CVRWQCB to conclude that the use of reservoir releases to meet the recommended temperatures at Vernalis continues to be a waste and unreasonable use of water.[11] Since the current proposed listing is dependent upon the use of reservoir releases, the CVRWQCB cannot list the San Joaquin River as impaired for temperature at this time.

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[11] Given the SWRCB's prior findings, the CVRWQCB must also evaluate and determine whether the use of reservoir releases to meet the recommended temperatures in the other locations is a reasonable and beneficial use of water. The modeling data, discussed in Section IV, *infra*, certainly suggests that the use of reservoir releases to control water temperatures at the confluence of the San Joaquin River and its tributaries is not a reasonable and beneficial use of California's water resources.

III. BIOLOGICAL OBJECTIONS

The CDFG material is clearly selective and was presented to CVRWQCB staff with the sole purpose of obtaining an impairment determination. It is in fact astonishing, and of course extremely troubling to the SJRGA, that the staff did not evaluate the accuracy of that CDFG information as there are many obvious problems and biases with it as is revealed in detail in the following sections. The evaluation process consists of a formulaic assessment largely of “if this (CDFG claims), then this (impairment conclusion)” which in this case results in “Garbage in, garbage out”.

The CDFG material and the staff’s evaluation process makes little recognition of the inherent variability in the natural annual and seasonal hydrology and corresponding water management operations which are based on a purposeful (and often legally required) adaptive management approach that adjusts to changing conditions. Further variability exists within the fishery information and important exogenous factors such as weather and climate. The SJRGA contends that it is important for the staff to understand that such variability exists, that it is a dominant factor in the San Joaquin basin, and that it be reflected in the information and assessment under consideration in this process. The application of absolute temperature criteria to define impairment in the San Joaquin Basin rivers ignores the reality of year-to-year variability in temperature and flow conditions that have always naturally occurred in those rivers. The use of such inflexible, absolute criteria also discounts the adaptive capabilities, within certain limits, of the salmonids and other native biota to variable conditions.

Because there is inevitable natural cycling between warmer, low-flow years and cooler, high-flow years, it would be logical to apply different sets of temperature criteria to define degrees of impairment depending on the environmental/climate conditions prevailing in the San Joaquin Basin in given years. Thus, a river may be considered impaired if its temperature exceeded certain thresholds during normal years, but it would not necessarily be considered impaired if it exceeded the same thresholds during the drier years.

It should also be recognized this is a preliminary review of the information submitted by CDFG as some of it has only recently even been made available to the SJRGA. However this review is intended to bring to the CVRWQCB’s attention many of the inconsistencies, inaccuracies, and inappropriate substitutions of data which invalidate CDFG’s analysis of impairment and the subsequent staff assessment as well. For example, the CDFG analysis:

- uses temperature criteria that are not applicable to the San Joaquin Basin
- is not congruent with, or completely ignored, readily available fisheries information
- misrepresents conditions by substituting data from a distant (up to 28 miles away) thermograph location for a location where data was missing
- does not consider temperature records that are readily available for some locations in the Stanislaus and Tuolumne Rivers to expand the number of observations

- does not evaluate the biological significance of temperature conditions
- does not address other relevant issues.

Based on these issues, which are described in more detail below, the CDFG analysis cannot be used as the basis for a 303(d) listing.

A. Temperature Criteria Recommended By CDFG Are Not Appropriate.

CDFG chose to use EPA Region 10 criteria but did not provide adequate justification for their recommendation. In fact, the very report by A.A. Rich and Associates that was submitted to support their position clearly states that site-specific data are extremely important in ascertaining the effects of water temperature on Chinook salmon and steelhead populations in the San Joaquin River System and CDFG has admittedly performed no evaluation of the biological significance of temperature for these populations. EPA Region 10 temperature criteria are not consistent with other criteria previously cited by CDFG, are based on laboratory studies conducted in the Pacific Northwest, and do not apply to wild Central Valley fall Chinook salmon and steelhead at the southern extent of their range. . Discussion of some of these issues follows.

1. **The A.A. Rich and Associates Report Does Not Support Using the EPA Region 10 Criteria**.

The report from A.A. Rich and Associates recently submitted by CDFG does not provide adequate support for using the EPA Region 10 criteria to assess impairment. In fact, the report clearly states that site specific data are essential to ascertaining the effects of water temperature on Chinook salmon and steelhead populations in the San Joaquin River System and "knowledge of temperature tolerance and sublethal stress responses of Chinook salmon and steelhead are far from adequate to define safe thermal limits for Chinook salmon and steelhead in the San Joaquin River System". Despite this lack of critical information, Dr. Rich and CDFG assert that there has been a dramatic decrease in populations of these species as a result of temperature impairment. In addition to the paucity of site specific temperature criteria, the statement that decreased abundance is the result of in-stream thermal conditions completely ignores the influence of key factors such as ocean conditions on salmon abundance. Many scientists consider poor ocean conditions to potentially be the primary factor responsible for low returns to the Central Valley and along much of the West Coast during 2007. In addition, since most of the salmon life occurs in the ocean, Rich's statement: "…the Chinook salmon and steelhead are each exposed to higher than optimal water temperatures throughout their life cycle" is a misrepresentation.

The report also falsely asserts that Chinook salmon and steelhead are exposed to higher than optimal water temperatures throughout their freshwater lifecycle as a result of increased water temperatures associated with water impoundments and diversions, and the long-term result has been a dramatic decrease in populations of these species. However, recent analyses show that temperatures in the lower Stanislaus River were warmer prior to operation of New Melones Reservoir (*see* Section IV, *infra*), yet salmon abundance was higher during this time period. Again, temperature does not appear to be the limiting factor as reduced temperatures have not increased salmon escapement. The sweeping statement by Rich that “declining fish populations provide strong evidence the increased water temperatures have contributed overwhelmingly to cumulative physiological stress” is unsupported conjecture.

Numerous studies are provided in Tables 1-11 of the report and are supposedly organized to identify lethal, stressful, optimal temperatures ranges for the freshwater life stages of Chinook salmon. However, when compared to the ranges presented on pages 5-6, it is not clear, specifically, how the optimal ranges for each lifestage were established. They are not clearly derived from the tables. For example:

- The range presented for Chinook salmon egg and alevin incubation/fry emergence is 42.5°F (5.8°C) to <55°F (13°C) and no reference is cited for this range. However, Table 6 summarizes results of studies to determine the optimal water temperatures for this lifestage. Only one study is listed and the range was 39.8°F (4.3°C) to 59°F (15°C).
- Ranges are presented for various lifestages of steelhead yet no reference is cited and there are no tables that summarize the results of studies that have been conducted.

The criteria and tables presented in the report appear to be a repeat of testimony presented by Dr. Rich during hearings regarding the Delta Wetlands Project during 1997. These discrepancies were also identified during those proceedings and have clearly not been addressed.

With regard to steelhead, the report presents an optimal incubation temperature of <54°F which is warmer than the temperature reported for adult migration and spawning (<52°F). This does not make sense and in the absence of references there is no way of knowing where these numbers came from.

Perhaps many of the optimal temperatures cited in the report were taken from Dr. Rich’s 1987 report. If so, the results are questionable as discussed in the following excerpt from Williams 2006.[12]

> “Rich (1987) reported maximum growth at 15.3°C (Figure 4-7a), and no survivors at 24°C, in contrast to Marine (1997), Cech and Myrick (1999), and Brett et al. (1982). Possible reasons for the difference are tank effects and disease. Marine (1997) used 400 L circular tanks with filtered surface water from Putah Creek and initial density of 550 fish per tank (0.73 L per fish). Cech and Myrick (1999) used 110 L circular tanks and pathogen-free well water and 30 fish per tank (3.67 L per fish). Both used

[12] The references cited in this Section III are attached hereto as Exhibit C.

directed sprays to maintain a current in the tanks. Brett et al. (1982) did not describe their experimental tanks, each of which held 25 fish. Rich (1987) used 57 L rectangular tanks with unfiltered surface water from the American River, and a high density of fish (initially 160 per tank, or 0.36 L per fish). The densities in both the Myrick and Rich experiments decreased over time as fish were sacrificed for various assays. Dr. Rich noted disease as an indicator of stress for the 19°C and higher treatments, and this, together with confinement in tanks with little current, may explain the difference between her results and those from other studies (there is evidence that confinement in aquaria without current causes stress (Milligan et al. 2000), and the unfiltered surface water probably introduced pathogens). Rich's results underscore the need to consider the extent to which higher temperatures increase the virulence of pathogens (Myrick and Cech 2001), but whether her experimental conditions reasonably reflect natural conditions is questionable."

2. **Biological Significance of Temperature and Previous Criteria Cited by CDFG**.

CDFG's analysis of impairment is also lacking in that it provides no evaluation of the biological significance of their chosen temperature criteria in the San Joaquin Basin – a point that they confirmed during the September 25, 2007 workshop. The approach used by CDFG presumes that there is no impact to the population if temperatures are below the EPA Region 10 criteria, but the population is reduced if temperatures exceed the criteria. The impairment analysis has no function to weight impact based on the proportion of the population affected which is a function of the proportion of the population experiencing a given condition, the severity of the condition (relationship of temperature to mortality rate), and the duration of exposure.

As cited from Moyle 2005 "the most productive spring-run Chinook salmon stream left in California, Butte Creek, can experience daily maxima up to 24ºC (75.2ºF) with minima of 18-20ºC (64.4-68.0ºF) for short periods of time in pools where juveniles are rearing and adults are holding. It is thus possible for Chinook salmon to maintain populations even when they experience periods of suboptimal or even near-lethal conditions. They are also capable of finding, through behavioral means, temperature refuges (where cooler water is present due to ground water seeps, shady areas, and other factors). The bottom line is that Chinook salmon do not have to experience (and usually do not) temperatures that are continuously in the temperature ranges specified by criteria. In fact, it is this flexibility that has made Chinook salmon so successful in the Central Valley and to thrive where less temperature tolerant salmonids (e.g., coho salmon) cannot."

If temperatures were a problem for adult migrants in the San Joaquin Basin, one might also expect to observe problems with pre-spawning mortality. However, studies conducted by CDFG (Guignard 2005, Guignard 2006) demonstrated that the incidence of pre-spawn mortality is quite low (i.e., 2%-4.5%) and appears to be density, not temperature, dependent.

a. *CDFG Has Cited to Temperature Criteria In Other Reports*.

Although CDFG has based its entire recommendation on the notion that the EPA Region 10 criteria are the temperature thresholds against which temperature impairment for anadromous fish beneficial uses, CDFG itself has not and does not rely on such criteria itself. To the contrary, CDFG has and does cite to a variety of temperature criteria. For example:

- CDFG uses <13ºC (<55.4ºF) maximum temperature in the impairment analysis for spawning/ incubation
  - <14.2ºC (<57.6ºF) is acceptable for egg incubation (CDFG 1987)
  - 13.3ºC (56ºF) average daily temperature, not maximum (CDFG 1987 to 2004; CDFG 1992).

- CDFG uses <15ºC for smolt outmigration in the tributaries and <18C (<64.4ºF) for oversummering and smolt outmigration in the San Joaquin River
  - In a previous document the criteria is defined as <20ºC (<68ºF) for fry, smolts, and yearlings (encompasses smolt outmigration and oversummering; CDFG 1987)

It is clear that, despite the impression left by CDFG, CDFG itself does not rely solely on the EPA Region 10 temperature criteria.

b. *Other Sources Also Support the Conclusion that the EPA Region 10 Temperature Criteria Are Inapplicable Here*.

In addition to CDFG, many scholars and scientists are also critical of the EPA Region 10 criteria. A preliminary review of some available sources identified indicates:

- considerable variation in thermal tolerance between stocks, with higher temperatures recommended for some populations;
- the need to consider other factors, such as acclimation conditions in thermal tolerance among populations;
- some evidence suggesting that San Joaquin Basin populations may be adapted to higher temperatures; and
- that local observations support other criteria that those for the Northwest by EPA are better suited to the San Joaquin Basin (SJB).

Specific information from some of the available sources regarding these issues is provided in the following bullets.

- In contrast with the EPA recommended threshold of 15°C (59.0ºF) for smoltification, Chinook salmon juveniles transform into smolts in the wild at temperatures in excess of 19°C (66.2ºF), and in a laboratory study highest growth and survival of smolts was found if they underwent transformation at temperatures of 13-17°C (55.4-62.6ºF; Marine and Cech 2004). Studies evaluating the relationship between growth and temperature of Central Valley Chinook found no difference in growth rates between 13-16°C (55.4-60.8ºF) and 17-20°C (62.6-68.0ºF) temperature treatments (Marine 1997); and found that growth rate increased up to 19°C (66.2ºF; Cech and Myrick 1999).

- (McMahon 2006). The applicability of thermal criteria derived from the laboratory has long been debated, and unfortunately, there has been no confirmatory lab or field data for the growth vs. temperature relationship for any of the listed species in the Central Valley to assess if laboratory results are transferable to these southern stocks (Myrick and Cech 2004). Wurtsbaugh and Davis (1977, as cited in Myrick and Cech 2004) found 61.5ºF (16.4ºC) to be the optimum growth temperature for steelhead, whereas Myrick and Cech (2005) found that American River steelhead grew fastest at 66.2ºF (19.0ºC) over the range of 51.8-66.2ºF (11.0-19.0ºC). If optimal growth in the laboratory represents an upper temperature limit in the field, then the Wurtsbaugh and Davis laboratory results suggest that temperatures above 61.5ºF for prolonged periods may cause reduced growth and survival. As Myrick and Cech (2004) point out, however, these southerly steelhead stocks may have greater thermal tolerance, as perhaps evidenced by their results.

- (Moyle 2005). Optimal temperatures are typically defined under laboratory conditions as those in which physiological processes operate at the least energetic cost, so growth and survival are both high and predictable. The reality of wild Chinook salmon in the Central Valley is that they often experience temperatures higher than "optimal" yet still have high growth and survival. For example, Dr. Hanson indicates that for juvenile Chinook rearing "the seven day average of daily maximum temperatures should not exceed 16ºC (60.8ºF)" while I put optimal conditions for rearing in the range of 13-20ºC (55.4-68.0ºF), temperatures which are based on an exhaustive USEPA report (McCullough 1999). It would not at all be unusual to find juvenile Chinook salmon growing rapidly at daytime maxima of 20ºC (68.0ºF) with temperatures at night dropping to 15-16ºC (59.0-60.8ºF). I also point out that juvenile Chinook can survive exposure to temperatures of 24ºC (75.2ºF), depending on their thermal history, availability of refuges in cooler water, and night-time temperatures. While seven-day single temperature averages such as Dr. Hanson recommends as standards not-to-be-exceeded are often used because of the simplicity of doing so, they do not reflect the temperatures that juvenile Chinook salmon regularly experience in Central

Valley streams at some times of the year. For example, the most productive spring-run Chinook salmon stream left in California, Butte Creek, can experience daily maxima up to 24ºC (75.2ºF) with minima of 18-20ºC (64.4-68.0ºF) for short periods of time in pools where juveniles are rearing and adults are holding (Ward et al. 2003). It is thus possible for Chinook salmon to maintain populations even when they experience periods of suboptimal or even near-lethal conditions. They are also capable of finding, through behavioral means, temperature refuges (where cooler water is present due to ground water seeps, shady areas, and other factors). The bottom line is that Chinook salmon do not have to experience (and usually do not) temperatures that are continuously in the temperature ranges that the Hanson statement says are necessary. In fact, it is this flexibility that has made Chinook salmon so successful in the Central Valley and to thrive where less temperature tolerant salmonids (e.g., coho salmon) cannot.

- (Williams et al. 2007). While much information is available on lifestage-specific temperature ranges of Chinook salmon and steelhead little is known about the specific responses of Central Valley species to temperature. Anecdotal evidence suggests that some species of CV salmonids are heat tolerant: "the high temperature tolerance of San Joaquin River fall run salmon, which survived temperatures of 80°F (26.7ºC), inspired interest in introducing those salmon into the warm rivers of the eastern and southern US (Yoshiyama 1996)."

- (CALFED 1999). It is possible that populations southern range of the Central Valley including the Eastside rivers and San Joaquin tributaries have evolved to tolerate higher water temperatures. Laboratory studies indicate that mortality rates of juvenile Chinook salmon begin to increase at water temperatures above 65°F (18.3ºC). However, historically the San Joaquin basin has had higher water temperatures than all the other rivers that support Chinook salmon and so it is possible that the San Joaquin race has evolved to withstand higher temperatures than 65°F (18.3ºC).

- (Spina 2007). Oversummering Southern California steelhead accept an elevated body temperature in excess of the preference and heat tolerance information reported for the species and remain active and forage throughout the day, apparently as a means for coping with warm water at the southern extent of their range. The relatively high body temperatures that steelhead accept appear to represent a compromise in exchange for maintaining an expanded geographic (latitudinal) range.

- (Myrick and Cech 2001). Cherry et al. acclimated rainbow trout to temperatures of 6-24°C (42.8-75.2ºF; Cherry et al. 1975) and 12-24°C (53.6-75.2ºF; Cherry et al. 1977) in 3°C (37.4ºF) increments. They reported that the preferred or selected temperature changed with acclimation temperature in both studies. As acclimation temperatures increased from 6-18°C (42.8-64.4ºF), selected temperatures were higher than the acclimation temperature, but fish acclimated to temperatures higher than 18°C (64.4ºF) selected cooler temperatures. The overall mean preferred temperatures for the fish in the 6–24°C (42.8-75.2ºF) and 12–24°C (53.6-75.2ºF) experiments were 16.5(61.7ºF) and 18.4°C (65.1ºF), respectively. Myrick (1998) measured American River (Nimbus strain) steelhead thermal preference over the 11–19°C (51.8-66.2ºF) range. He reported a similar increase in thermal preference with acclimation temperature, but did not reach an acclimation temperature where juvenile steelhead began to select cooler temperatures. Myrick's (1998) results are interesting because (1) the steelhead selected higher temperatures than one might expect for a cold-water fish (Moyle 1976), and (2) because the selected temperatures closely match the temperature at which Myrick observed the highest growth rates. Myrick and Cech (2000) measured the thermal preference of hatchery Feather River steelhead acclimated to constant (16°C; 60.8ºF) and diel cycling temperature regimes (16 ± 2°C) (60.8 ± 3.6ºF) and that of wild-caught Feather R. steelhead that were fasted 24 h before testing and fed 24 h before testing. Hatchery fish acclimated to constant and cyclical thermal regimes had similar thermal preferences, selecting temperatures in the 18–19°C (64.4-66.2ºF) range. Wild fish, which probably were exposed to cooler temperatures in the Feather R. (Myrick and Cech 2000), selected slightly cooler temperatures (17°C; 62.6ºF) under both fed and food deprived conditions. Interestingly, the wild fish were collected from much cooler temperatures (< 15°C; <59.0ºF), yet selected warmer temperatures, as one might expect from the trends seen in Cherry et al.'s (1975; 1977) studies (Figure 1).

- Rob Titus of CDFG reported at the 2007 American River Conference on successful steelhead rearing in the lower American River at up to 18°C (64.4ºF) daily **average** [presumably daily maximum temperatures were higher] based on growth rates, condition factor, and absence of disease (Titus 2007).

B. Concerns With Lifestage Timing and Reach Location Criteria.

The critical importance of appropriately applying the temperature criteria with regard to the timing and location of different salmonid lifestages is well recognized by fisheries researchers. In a recent review of the temperature requirements of Pacific salmonid species, Richter and Kolmes (2005: p.38) stated:

> "For all these criteria, the significant challenge of defining the spatio-temporal range over which they should be applied remains. Those spaces occupied by threatened and endangered salmonids need to be regulated at the times of year that sensitive life stages are present, and defining the bodies of water involved and the times to apply the standards requires additional consideration and research. The complex life histories of salmonids, the variety of habitats used by their different life stages, and the spatially and temporally dynamic nature of the habitats involved, make this an enormous scientific undertaking. . . . Laboratory studies cannot fully substitute for field data, because of difficulties in replicating acclimation conditions, food availability, social interactions including territoriality, diurnal physiochemical periodicity, and the complexities of microhabitats accessible to fish in nature . . ."

Richter and Kolmes (2005:p.40) emphasized that the proper application of thermal tolerance information to effectively protect salmonids will require an adaptive and realistic management approach:

> "Definitive criteria for salmonid recovery should eventually define ways to incorporate spatio-temporal variability into them in a realistically complex fashion and have as their eventual goal a process that realigns the distribution of current environmental variables so that they overlay historic conditions rather than simply act as a floor or ceiling. . . . The challenge of this task is exacerbated by the multiple salmonid life stages whose distributions over space and time will need identification and monitoring."

In contrast to the ecologically-based approach recommended by Richter and Kolmes (2005), the information submitted by CDFG provides no justification for the seasons or reaches defined for the presence of each lifestage and used in their analysis of impairment. Information to assess the validity of the seasons and reaches defined by CDFG is readily available from several sources and according to listing policy RWQCBs and SWRCB shall actively solicit, assemble, and consider all readily available data and information. However, historical and current fisheries information was not solicited or considered prior to the September 25, 2007 workshop and a placeholder for current and historic salmonid distribution exists in the draft CVRWQCB assessment for the Merced River. It is impossible to assess potential impairment to a population without describing when a given lifestage is present, where they are located, and the relative proportion of the population that may be affected in a given location at a given time. Given serious flaws in the information submitted by CDFG and reviewed by the CVRWQCB re-analysis using lifestage timing and stream reach criteria supported by readily available scientific data is warranted. Concerns with CDFG's timing and stream reach criteria for each lifestage are provided in the following sections.

1. **Adult Upstream Migration**.

In their analysis submitted to the CVRWCB, CDFG defined the adult upstream migration period as occurring from September 1 through October 31. However, their submittal provided no justification for this assertion and such timing is not consistent with historical conditions, management actions taken by CDFG, and available data. Based on the evidence provided below, the primary adult upstream migration period occurs from October 1 through late December.

a. *Historical conditions and adult upstream migration timing*.

The lowest unimpaired (computed natural) flows of the year typically occur during the month of September. During 1922-1992, the average unimpaired flows during September were 117 cfs in the Stanislaus River, 185 cfs in the Tuolumne River, 84 cfs in the Merced River, and 808 cfs in the San Joaquin River (DWR 1994). Although not widely recognized, September unimpaired flows can be extremely low or nonexistent in dry years – for example, of the ten lowest September flows of the 1922-1992 period for the Tuolumne River (the largest of the three tributaries), five had zero average flow for the month and the other five averaged only 15 cfs. Average unimpaired flows in the San Joaquin River increase to just 933 cfs during October and then to 2,374 during November as average seasonal rainfall increases. The fall-run moved upstream in the fall or early winter after water temperatures had dropped and flows increased (CDFG 1987). Specifically, the Comprehensive Monitoring, Assessment, and Research Program report states that "adult San Joaquin fall-run Chinook salmon begin to enter the western Delta near Jersey Point in September and they migrate upstream slowly, typically entering the San Joaquin tributaries in late October or early November and continuing to migrate through December (Hallock et al. 1970; Department of Fish and Game annual reports; Carl Mesick Consultants 1998)".

b. *Management actions and adult upstream migration timing*.

The timing of management actions that directly involve CDFG for purposes of adult salmon migration in the San Joaquin Basin (i.e., Head of Old River Barrier operation and attraction flows) contradict the migration timing asserted by CDFG in their impairment analysis. This discrepancy has continued even since their analysis was submitted to the CVRWQCB in February 2007. Each year in the fall since 1968, CDFG determines whether and when to request that the temporary Head of Old River Barrier (HORB) be installed to improve conditions for migrating adult Chinook salmon in the San Joaquin River, in particular to address low dissolved oxygen conditions in the Deep Water Ship Channel at Stockton. As directed by CDFG, during 1968-2005 the average date that the HORB was completed is September 30 (Figure 2)[13]. During 2007 it was not until September 27 that CDFG even requested that DWR install the HORB and barrier installation was completed on October 18 (CDWR 2007).

CDFG's fall salmon attraction flow schedules also contradict the migration period used in their impairment analysis. Since the early 1990s, adult attraction flows that have been released from the Stanislaus, Tuolumne, and Merced rivers were scheduled during mid to late October, not September. During 2007, the attraction pulse flow on the Stanislaus River was scheduled for October 16-31 which corresponds to the last two weeks of the migration time period used by CDFG in the impairment analysis. Much of the 2007 attraction pulse flow on the Merced River, scheduled for October 24-November 9, occurred after the end of the migration period designated by CDFG and used in the impairment analysis (i.e., October 31).

In addition, long-standing base flow requirements for the tributaries were established to correspond with the typical timing of the run starting in October and have not included September. For example, the designated summer flow period for the Tuolumne River over the last 36 years has extended through September, with the higher base flow for salmon migration and spawning not starting until October 1 or as late as October 16.

[13] The Tables and Figures referenced in this Section III are attached hereto as Exhibit D.

c. *Available data on timing of adult upstream migration*.

CDFG provided no information to support using the September 1 through October 31 time period in their impairment analysis, and the available data from the Merced River Hatchery (MRH), the Stanislaus River Weir, tributary spawning surveys, and historical weir, trapping, and fish rescue operations provide the following evidence that most migration is much later than September and continues well after October.

i. *Merced River Hatchery*

CDFG annual reports state that "a standard measure of the timing of spawning runs in the San Joaquin Basin is the date on which the first salmon enter the MRH spawning trap each year" (CDFG 1987 to 2004). The average date that the first salmon arrived at the Merced River Hatchery from 1974 to 2003 is October 17 (CDFG 2004). CDFG reports do not present the average date that the last salmon arrived at MRH, however the date that trapping was terminated is reported in annual hatchery operations reports for the period 1996-2004 (CDFG 1997 to 2005). Based on this information the average date that trapping activities are terminated annually is December 20.

ii. *Stanislaus River Weir*

Operations at the Stanislaus River Weir have recorded that more than 97% of adult FRCS migrate after October 1 in recent years (Figure 3). Although temperatures were exceptionally cool during September 2006 (Figure 4), salmon did not migrate earlier than during 2003-2005 (Figure 5). During September 2006 temperatures on average were as much as 5 degrees cooler in the San Joaquin River at Rough and Ready Island (RM 37.9), Mossdale (RM 56.3), and Vernalis (RM 72.3), and as much as 9 degrees cooler in the Stanislaus River at Ripon (RM 15.7) as compared to monthly average temperatures at the same locations during 2003-2005 (Figure 6). September flows in the Stanislaus and San Joaquin Rivers exceeded average unimpaired flow conditions during all of these years (Figure 6, Figure 7).

iv. *Tributary Spawning Surveys*

During annual spawning surveys in the Stanislaus, Tuolumne and Merced rivers CDFG counts live fish observed in river reaches on a weekly schedule. This data provides a long-term measure of run timing and is available from annual CDFG escapement reports and in spreadsheet queries that they have provided from their database. CDFG has typically begun their spawning surveys in early to mid October. The following run timing has been observed based on live counts in the tributaries.

a. *Stanislaus River* live counts (CDFG 2007b) show that the earliest fall-run adult salmon observed in the Stanislaus River during 2000-2006 was September 25, and most of the run is from early October through mid-December (Figure 8).

b. *Tuolumne River* live counts demonstrate that relative numbers of adult salmon are generally very low in early October and after mid-December (Figure 9). Data provided by CDFG (CDFG 2007b) show that the earliest fall-run adult salmon observed in their surveys during 1992-2005 was September 27.

c. *Merced River* live counts (CDFG 2007b) show that the earliest fall-run adult salmon observed in their surveys during 1992-2006 was September 15, but again with most of the run being from early October to mid-December (Figure 10), much later than asserted by CDFG. Timing of first salmon arrival at Merced River Hatchery from 1974-2003 had a median date of October 17 with several years not occurring until November; the earliest date was September 24.

v. *Fish Barrier and Historical Weir Operations in the Tributaries*

a. *Weir counts during 1940s*

During 1940 and 1941 CDFG counted adult Chinook migrants entering each of the tributaries, and counts were also made on the Tuolumne River during 1942, 1944, and 1946 (Figure 11). Counts on the Stanislaus and Merced rivers were described as incomplete since sampling ended in November during both years. Sampling on the Tuolumne River was considered to be complete during 1940 and 98.6% of the run occurred during October through early December in that year. Counts continued through November 30th in 1942 and 1944. (Cloyd 1962; Hatton and Clark 1942).

b. ***Stanislaus River Egg Collection Station***

CDFG operated an egg collection station (trap) on the Stanislaus River at Orange Blossom Bridge (RM 46.9) during 1990 and 1991. In both years trap operation began on October 12 and continued until December 7 and December 10, respectively.

c. *Merced River Fish Guidance Project, Gallo Ranch Barriers*

In 1996, two fish barriers were built and installed by CDFG to prevent adult salmon from entering irrigation return channels on the Gallo Ranch. Dates of operation are provided in CDFG's annual job performance reports for the San Joaquin Drainage Chinook Salmon and Steelhead Habitat Restoration Program. During 1996-1998 the barriers were installed in October and during 2000-2001 the barriers were installed on September 20. The barriers continued to operate until December during all years.

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vi. *San Joaquin River Fish Barrier and Trapping Operations*

a. ***Trapping at Banta Carbona***

During 1977 a decision was made by CDFG to attempt to trap the entire run of migrating adult salmon bound for the Stanislaus, Tuolumne, and Merced rivers (CDFG 1978). Trapping was conducted from November 1 through December 15 and peak catches occurred on November 8 and November 26 (Figure 12). Clearly one may deduce from the stated objectives and timing of this effort that CDFG believed that the majority of salmon migration occurred during November 1 through December 15. However, this period does not even overlap with the September 1 through October 31 period recently designated by CDFG for use in their impairment analysis.

b. Trapping near Los Banos

Trapping near Los Banos was conducted during 1988-1991 to determine the number of adult salmon migrating in the San Joaquin River upstream of the confluence with the Merced River. Based on information from CDFG reports, trapping was initiated in November and terminated in mid-December each year.

c. Hills Ferry Barrier

Since 1992, CDFG personnel have constructed and operated a temporary fish barrier (Hills Ferry Fish Barrier) each fall on the San Joaquin River immediately upstream of its confluence with the Merced River. It is operated from September/October through December each year (CDFG 2003). Dates of operation are provided in CDFG's annual job performance reports for the San Joaquin Drainage Chinook Salmon and Steelhead Habitat Restoration Program. Based on information available from the reports, the barrier has been operated as early as September 17 and as late as December 23 during 1993-2002.

The available data show that the major portion of adult upstream migration occurs well after September 1, generally becoming substantial after the first week of October, and the adult migration period extends well into December. Hence, a much more representative period for most migration based on these many types of concurring and consistent evidence would be from about October 1 to December 20 (or about Julian weeks 40-51). Consequently, any impairment assessment should examine that period instead. We suspect the result would find only a small fraction of the initial flawed approach would be considered to be impaired, even under the biased temperature impairment criteria defined by CDFG.

d. <u>Adult upstream migration location</u>

During development of the CALFED temperature model for the Stanislaus River, CDFG proposed that compliance points for some adult migration dynamically change depending on hydrologic year type as follows: Adult migration= Confluence (Above Normal/Wet); Ripon (Below Normal); McHenry Bridge (Dry/Critical). In contrast to this proposal, CDFG now asserts that conditions are impaired if criteria are not met all the way down to Vernalis under all hydrologic conditions. In Dry/Critical years this is a shift of 32 miles from CDFG's previously proposed criteria.

2. **Spawning and Egg Incubation**

a. *Timing of spawning and egg incubation*

In the analysis of potential impairment submitted by CDFG the spawning (egg deposition) and egg incubation season is defined as October 1 through December 15 which is not supported by existing data. US EPA Region 10 recommends that the season be defined as the average date that spawning begins to the average date that incubation ends. The end of incubation is when fry emerge from the gravel. Based on available data from the Merced River Hatchery, tributary spawning surveys, and rotary screw trap monitoring provided below, the average date that spawning begins is October 10 on the Stanislaus River, October 9 on the Tuolumne River, and October 17 on the Merced River. Incubation extends into March on all three streams.

i. *Merced River Hatchery*

The average date that the first salmon arrived at the Merced River Hatchery from 1974 to 2003 is October 17 (CDFG 1987 to 2004). The average date that the spawning is terminated at MRH is December 20 (CDFG 1997 to 2005).

ii. *Tributary spawning surveys*

Average date of first redds observed during carcass surveys is October 10, October 9, and October 17 on the Stanislaus, Tuolumne and Merced, respectively (CDFG 2007b).

iii. *Rotary screw trap monitoring*

The capture of emergent fry in rotary screw traps provides an indication of emergence timing. Most emergent fry are typically captured by early to mid-March indicating that incubation extends into March. The truncated time period selected by CDFG skews the assessment of impairment by focusing on just a fraction of the time over which spawning and egg incubation actually occurs.

In addition to specific data, several agency documents describe spawn timing in the San Joaquin tributaries as beginning during October or later. For example:

- IFIM studies conducted by the USFWS (Aceituno 1993; USFWS 1995) describe the spawning period as beginning in mid-October and continuing through January.

- A 1987 Agreement between the US Bureau of Reclamation and CDFG states that spawning begins in mid-to-late October, reaches a peak in mid-November, and ends in January (CDFG and USBR 1987).
- A 1967 Davis-Grunsky Contract (Amendment #D-GGr17-A2) between the State of California Department of Water Resources and the Merced Irrigation District specifies that spawning/incubation flows shall be provided November 1 to April 1 on the Merced River (CDFG 1987).
- Emergence of fry increases mid-January to mid-March (CALFED 1999).

In summary, the available data show that the primary spawning and egg incubation season essentially begins about mid-October and extends into March —a substantially longer period than defined by CDFG. Hence, the putative impaired conditions as defined by the CDFG criteria would occur only for a fraction of the actual spawning and egg incubation period.

b. *Location of spawning and egg incubation*

Historically the spawning reaches of the Stanislaus and Tuolumne Rivers were described by G.H. Clark in the 1920s as extending from Knights Ferry to Oakdale and La Grange to Waterford (Clark 1929). These continue to be the reaches where most spawning activity occurs, although a small proportion of late-season spawning occurs on the Stanislaus down to Riverbank and on the Tuolumne down to Fox Grove. For example, less than 5% of spawning occurs below Oakdale and 95% of this activity occurs after November 30.

CDFG has advanced the hypothesis that a higher proportion of spawning would occur in the lower reaches if temperatures were made cooler earlier in the season. However, the spawning distribution on the Stanislaus River did not change during 2006 when temperatures were exceptionally cooler than average (Figure 13).

During development of the CALFED temperature model for the Stanislaus River, CDFG proposed that compliance points for incubation dynamically change depending on hydrologic year type as follows: Incubation= Riverbank (Above Normal/Wet); Oakdale (Below Normal); Valley Oak (Dry/Critical). In contrast to this proposal, CDFG now asserts that conditions are impaired if criteria are not met all the way down to Riverbank under all hydrologic conditions. In Dry/Critical years this is a shift of approximately 12 miles downstream from CDFG's previously proposed criteria.

Based on the temporal and geographic distribution of spawning and egg incubation, the downstream reach boundaries should be Oakdale on the Stanislaus River, Waterford on the Tuolumne River, and Shaffer Bridge on the Merced River from the beginning of the spawning period through November 30 (Table 1). After November 30 the boundaries should be Riverbank on the Stanislaus River, Fox Grove on the Tuolumne River, and Shaffer Bridge on the Merced River.

3. **Juvenile Outmigration and Smoltification**

In the analysis of potential impairment submitted by CDFG the smoltification and emigration season is defined as March 15 through June 15 which is not supported by existing information. Rotary screw trap data collected annually since 1995 indicate that emigration typically begins in January and about 97% of salmon juveniles migrate out of the Stanislaus River by May 15; therefore, temperatures at the confluence to protect smoltification after May 15 are not necessary for such a small portion (i.e., 3%) of the population. Less extensive rotary screw trap data from the Merced and Tuolumne suggest similar outmigration timing.

In particular, there is no evidence to support the June 15 ending being applicable for all years. Most management activities (flow operations and evaluations) have targeted about the April 15-May 15 period for primary smolt outmigration; monitoring data indicate almost all smolt outmigration from the tributaries has concluded by May 31 or earlier.

The period of years selected by CDFG was truncated for the Stanislaus (starting in 2000) and should be extended at least to 1998 to be consistent with the other tributaries. The same period should also be selected for Vernalis as there is no purpose in evaluating years back to 1973 which are not representative of current basin operational conditions.

4. **Oversummering**

CDFG asserts that steelhead are present and rearing in all three tributaries, yet it has not been conclusively established that steelhead exist in the Tuolumne and Merced Rivers. We do agree that rainbow trout are present in all three tributaries and the following discussion pertains to that population.

a. *Timing of oversummering*

CDFG defined the oversummering period as June 15 to September 15; however, National Marine Fisheries Service defines the oversummering period as June 1 to November 30 (NMFS 2004). Logical start and end-dates for the oversummering period would be June 1-September 30 as done by existing flow requirements, or some later date based on the onset of the fall rains. As described for the other lifestages the use of inappropriate time periods invalidates CDFG's assessment of impairment.

b. *Location of oversummering*

CDFG has here defined a 10-mile oversummering reach in the Tuolumne River with a lower boundary at Turlock Lake State Recreation Area (RM 42), yet provides no basis for that requirement. It is interesting to note that in the same month (February 2007) that CDFG filed their temperature impairment package with the Regional Board, CDFG also prepared a joint document with FWS and NMFS dated February 27 and filed with the Federal Energy Regulatory Commission on March 6, stating they wanted to "provide a minimum of 8 miles of habitat" for summer rearing in all but "wet" years (when 13 miles were recommended). Thus inconsistent criteria were identified by CDFG within the same month.

CDFG also agreed to increased flow schedules, including summer flows from June through September, until 2016 in a 1995 FERC Settlement. Those flows are reduced in the summer during the drier 50% of years, but the results have been the expected improvement in providing suitable oversummering conditions for several river miles in those dry years. In fact, it has been well documented that the summer flow regime since 1995 has routinely extended the trout distribution to include the upper 10 river miles. CDFG also is on record of not supporting any allocation of an optional portion of the existing required annual river flow volume to the June through September period. It is egregious for CDFG to even claim temperature impairment under the improved conditions they agreed to, to recommend differing target reaches in different venues, all while at the same time not supporting that existing flows be allocated to the period they have identified as impaired.

CDFG's impairment analysis designates the first 10 miles below Crocker-Huffman Dam as the oversummer rearing reach. However, there is no evidence to support this designation and oversummer rearing in the lower Merced River is generally known to occur within the first few miles downstream of Crocker-Huffman Dam.

c. *Years of assessment*

CDFG selected a biased set of years (2001-2006) for their Tuolumne River assessment that is dominated by dry years, even though CDFG began both the Stanislaus and Merced assessment periods in 1999; the Merced period was truncated at 2005 and should be extended. The first entire summer period under the present Tuolumne flow schedule criteria was in 1997 and it would be appropriate to begin the assessment period then.

C. Concerns With How The Criteria Are Applied

I. CDFG's use of criteria for smoltification is inconsistent between locations. Specifically, the CDFG assessment uses 15ºC as the criteria for the tributaries and 18ºC in the San Joaquin River.

II. CDFG substituted data from distant locations when data was missing for a particular station. For example in the assessment of Tuolumne River adult upstream migration, data are not available from Shiloh (RM 4) during 2002. Instead, data from Waterford (RM 32) is substituted to represent conditions near the confluence. This issue was found by chance while perusing the formulas and hyperlinks used in CDFG's Excel spreadsheets. Obviously the data was not presented properly which casts doubt on the accuracy of the rest of the analysis, especially in light of the other factors identified during this preliminary review.

III. The sub-set of available data used in CDFG's assessment focuses on a string of several dry years and the periods do not generally represent the distribution of water year types. CDFG's decision to only use some of the available data is clearly another bias that was purposefully introduced. Additional data has been provided to CDFG previously and is available from monitoring efforts conducted by TID/MID on the Tuolumne River since 1986 and by Tri-Dam on the Stanislaus River since 1998.

IV. The ability of individual salmon to survive, tolerate, or thrive at a particular temperature is the result of a combination of recent thermal history (i.e., acclimation), availability of thermal refuges, length of exposure time, daily temperature fluctuations, genetic background, life stage, interactions with other individuals and species, food availability, and stress from other factors (e.g., pollution). CDFG's analysis ignores 8 out of the 9 factors.

V. Abundance of a given lifestage is not evenly distributed through time or space and CDFG's analysis does not account for the proportion of the population that may be exposed to the conditions that they have defined as impaired. For example, if 5 out of 20 weeks are impaired, CDFG's approach would calculate that the lifestage is 25% impaired. However, if only 5% of the population was present during that 5 week period, CDFG's approach would have overestimated the impairment five-fold.

VI. The EPA criteria are based on constant laboratory conditions which are not directly comparable to diurnally fluctuating field conditions. Fish in the wild are acclimated to the mean of the average and maximum temperatures, and are not constantly exposed to the 7DADM temperatures. As such, the criteria assume a constant exposure to a given temperature rather than potentially brief exposure under diurnally fluctuating conditions.

VII. Adverse biological impacts associated with attempting to meet temperature criteria through increased flow have not been addressed. For example, increasing flows down the Stan during fall to meet temp criteria will result in negative consequences for spawning Chinook. Flood control releases on the Stanislaus during fall 2006 delayed spawning and very little spawning activity occurs during annual attraction pulses. Other biological issues may include de-watering and strandingand the relationships of these factors to instream flow will differ by stream.

VIII. The approach used by CDFG does not consider whether fish utilize potential areas of thermal refugia such as pools and areas of groundwater upwelling. During June 1989 a groundwater source in the Tuolumne River was identified where temperatures were about 5ºF (~3ºC) cooler than the surrounding water (EA Engineering 1992).

D. <u>Sample Revised Assessment</u>

Based on the corrected location and timing information described previously in the document and supported by actual fisheries information an example of a revised assessment was calculated using the EPA Region 10 criteria and the same basic impairment analysis structure used by CDFG (Table 2). Even with the use of the EPA temperatures which are overly conservative with regard to more heat tolerant stocks of the San Joaquin Basin, the number of exceedances was not adequate for listing adult upstream migration on the Tuolumne River.

E. Other Relevant Issues

Other relevant issues such as the relative benefits to the population that may be achieved through other types of restoration actions and global warming have not been addressed by CDFG. Although CDFG has stated that substantial restoration actions (in this case temperature reductions) must be taken because present average population trends are well short of targeted population levels (Marston 2007), they have failed to take several obvious and prudent actions to protect salmon and steelhead. For example:

- The California Fish and Game Commission establishes angling regulations in Title 14 of the California Code of Regulations. These are published annually in a booklet by CDFG as the California Freshwater Sport Fishing Regulations. Legal sport harvest of San Joaquin salmon has continued, with more liberalized regulations starting in 2004. The season was generally extended by two weeks to the end of October, thus exposing a much greater part of the runs to inland recreational harvest, and the daily limit was increased from zero to one salmon in part of the San Joaquin and Stanislaus Rivers (California Fish and Game Commission 2007). The extent of legal and illegal harvest is unknown and there is limited enforcement of existing regulations.

- CDFG has stymied implementation of collaboratively developed key spawning gravel additions, long recognized as an important habitat restoration need, and extensive monitoring efforts on the Tuolumne River, by withholding all funds from two grants approved by the CALFED Program.

- CDFG continues to support protection and restoration of striped bass, a non-native fish which preys on native salmon and steelhead.

Global warming is a serious concern that should not be ignored. Dettinger (2005) determined that the most likely projection of annual average warming over Northern California is about 5°C by 2100, together with a decrease in precipitation. Recent experience suggests that most climate models have been too conservative and the actual effects occurring are more accelerated than forecasted. Williams (2006) asserts that warming is already affecting Central Valley Chinook. The predicted increase in temperature begs the question whether Central Valley salmon are a lost cause, so that efforts to protect salmon are a waste of resources that should be applied elsewhere (Williams 2006).

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IV. PRACTICAL OBJECTIONS

The SJRGA retained AD Consultants and Resource Management Associates, Inc. (hereinafter referred to as "AD Consultants") to run the SJR Basin Model in an effort to assess a variety of items, including whether or not (1) the model could accurately predict historic temperatures, (2) the construction and operation of New Melones dam and reservoir have made increased temperatures during the spring and fall time periods identified by CDFG, (3) the release of reservoir storage from new Melones could achieve the temperatures recommended by CDFG at Riverbank, the confluence of the Stanislaus and San Joaquin Rivers and Vernalis, and what the affect on reservoir storage would be as a result of such effort, (4) attainment of temperatures at the confluences of all three tributaries and the San Joaquin River would, in combination with additional reservoir releases in the tributaries, would result in achieving the recommended temperature criteria at Vernalis, (5) flows anticipated under the Friant Settlement will adversely affect water temperatures during the spring and fall time periods identified by CDFG, and (6) CDFG recommended temperatures can be met even if all water in the San Joaquin River Basin is allocated for temperature. The actual results of these cases run for the SJRGA by AD Consultants are attached hereto as Exhibit E. The results show that while the additional release of reservoir storage can reduce temperatures, the temperatures recommended by CDFG cannot be met at all times and in all locations and the impacts to reservoir storage are severe.

A. Case 1 Run Shows that the Construction and Operation of New Melones Have Improved Temperatures in the Stanislaus River and at Vernalis.

For Case 1, the SJRGA asked AD Consultants to analyze the time period from 1967-1982, which is the time period that provides the basis for the idea of doubling the natural production of salmon in the San Joaquin River Basin. During the 1967-1982 time period, the SJRGA asked AD Consultants to model temperatures at five times and locations identified by CDFG as critical in terms of evaluating impairment for temperature: the confluence of the Stanislaus River and San Joaquin River between September 1 and October 31, Vernalis between September 1 and October 31, Riverbank between October 1 and December 15, the confluence of the Stanislaus River and San Joaquin River between March 15 and June 15, and Vernalis between March 15 and June 15. As for the operational scenarios, the SJRGA asked AD Consultants to use actual hydrology, but model one scenario as if New Melones reservoir and dam were in place and operated under the terms of the Interim Plan of Operation ("IPO") currently used by the United States Bureau of Reclamation (referred to as the "Actual Temperature" or "IPO Scenario"), and model another scenario as if Old Melones dam and reservoir existed (referred to as the "Historic Temperature" or "Historic Scenario"). (A complete description of the Case 1 assumptions and instructions is found in Exhibit B, p. 2-3).

While we invite the CVRWQCB to review the entire set of results from this run, a few items need to be highlighted. First, the CDFG recommended temperatures were never met at all times and locations in the Historic Scenario. Typically, for each of the three locations – Riverbank, the confluence and Vernalis – the CDFG temperature criteria were achieved only on the shoulders of the recommended time periods. Second, in some instances, the recommended temperatures were barely achieved under the Historic Scenario. For example, in 1976, temperatures at Vernalis and the confluence were met only once in March and during the last 9 days of October. In 1977, the recommended temperatures at the confluence were met approximately the 1st six days of March and the last 10 days of October.[14] Under the Historic Scenario, even assuming that the CDFG recommended temperatures are appropriate, temperatures were hardly ideal for salmon and steelhead.

Things change slightly when the IPO Scenario is examined. In almost all instances, temperatures are improved compared to those identified in the Historic Scenario.[15] Sometimes, the improvement is dramatic. For example, at the confluence, in 1972 the IPO Scenario meets the recommended temperatures approximately 25 days in March and April, and approximately the last 27 days of October. In 1976, the IPO Scenario meets the recommended temperatures approximately 25 days in March and April and approximately the last 28 days of October. In 1977, the IPO Scenario meets the recommended temperatures approximately the 1st 18 days of the March-April time period, and approximately the last 20 days of October. Similar improvement can be found when comparing the results of the IPO Scenario and the Historic Scenario at Riverbank. Under the IPO Scenario, the recommended temperature criteria are met at all times in 1967, 1970 and 1982, as compared with such criteria not once being achieved at all times under the Historic Scenario.

Overall, the results of Case 1 refute the conventional wisdom that the construction and operation of dams and reservoirs generally, and in this case New Melones particularly, have made water temperatures during key times worse than they were before such construction and operation. Case 1 shows that the temperatures in the Stanislaus River and at Vernalis, in the absence of New Melones and the IPO were not met at all locations and time periods identified by CDFG as critical. This means that the construction and operation of New Melones is not the cause of any temperature problem that allegedly exists. Moreover, and to the contrary, the results of Case 1 show that temperatures are generally better, and sometimes significantly so, with the construction and operation of New Melones.

The results of Case 1 are not surprising, as actual data collected at the reservoirs on the Merced River show that the reservoirs dramatically cool the river water as compared to natural conditions during late spring, summer and early fall. During these time periods, water released from Lake McClure is almost always 55º F or less, whereas the temperature of the Merced River as it flows into Lake McClure during the same time period can be as hot as 80º F. (*See* Graphs attached hereto as Exhibit F).[16] Again, the

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[14] Temperatures at Riverbank followed a consistent pattern throughout the 1967-1982 timeframe. In almost every year, CDFG recommended temperatures were achieved in mid-November through December 15. This pattern did not deviate, even in 1976 and 1977.

[15] Temperatures at Vernalis under the IPO Scenario are virtually unchanged from those of the Historic Scenario.

[16] This data also shows that the reservoirs improve winter-time temperatures for optimal salmon egg incubation and fry growth compared to inflow water temperatures. Inflow temperatures are cold enough to

existence and operation of the tributary reservoirs are not the cause of any perceived temperature impairment, but rather already dramatically improve temperature conditions as compared to the temperature of the natural condition.

B. Case 2 Runs Show That New Melones Operations Cannot Be Manipulated to Meet CDFG's Recommended Temperatures at All Times and At All Locations, and that Any Effort to Do So Will Have Dramatic, Negative Affects on Reservoir Storage and Future Operations.

For Case 2, the SJRGA asked AD Consultants to look at the time period of 1980-2003, and assume that the IPO controlled the operation of New Melones throughout that period. Then, AD Consultants was asked to increase releases from Goodwin Dam over and above what would have been released under the IPO such that the releases were equal to the following rates during the identified periods:

- 500 cfs between March 15 and April 15
- 1000 cfs between April 16 and May 15
- 1500 cfs between May 16 and June 15
- 1500 cfs between September 1 and September 31
- 1000 cfs between October 1 and October 15
- 500 cfs between October 16 and October 31 (*see* Ex B, p. 4).

AD Consultants was asked to determine (a) whether or not the identified flow releases would achieve CDFG's recommended temperatures at Riverbank, the confluence and Vernalis during the specified periods, and (b) what impacts, if any, accrued to New Melones storage as a result of making the increased releases. The results of Case 2 demonstrate that the increased releases from New Melones suggested by the SJRGA were not sufficient to meet CDFG's criteria at all specified times and locations. Moreover, making the suggested releases had a significant, detrimental impact on storage at New Melones, and hence on its ability to meet current and future water requirements.

1. **Increased Releases Insufficient to Meet CDFG's Recommended Temperatures**.

The results of Case 2 show that increasing the releases from New Melones as suggested by the SJRGA will not result in the achievement of the CDFG recommended temperature criteria at all times and locations during the modeled period of 1980-2003. Indeed, the percentage of time that the CDFG recommended temperature would be exceeded is virtually unchanged with the additional flow as compared to flow under the IPO.[17] Improvement can be seen in terms of meeting the recommended temperatures at the confluence, particularly in the Fall of some years during the modeled period.

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retard fish growth during the Winter and delay salmon outmigration in the Spring which would not be beneficial to San Joaquin salmon.

[17] During the March 15 through June 15 time period, compliance with the IPO would meet the recommended temperatures at Vernalis approximately 6% of the time, which is almost exactly the same amount of time that the temperatures would be met with the additional releases. During the September 1

2. **Minor Benefits Purchased at Great Cost**

As part of Case 2, AD Consultants evaluated the affect that the additional releases specified by the SJRGA would have on storage at New Melones. The results are striking. Between 1980 and 1987, storage is generally less as a result of the additional releases than it would have been had the IPO been complied with. However, for a 9 ½ year period, from September 1986 through April 1997, the reduction in storage is significant.

Under both the IPO and additional release scenarios, storage in September 1986 is approximately 2 MAF. When the 1987-1992 drought hits, storage under the IPO drops to a low of approximately 200,000 AF in December 1992. Storage returns to approximately 2 MAF at the end of March 1996. However, with the additional releases, storage hits 200,000 AF in May of 1990 (as opposed to December 1992) and remains at or below 200,000 from May of 1990 until February of 1993. In fact, the reservoir is essentially at dead storage from July of 1990 through January of 1993 with the additional releases. Moreover, with the additional releases, storage drops below 200,000 AF again between August 1994 and January 1995 (it never drops below 200,000 AF with the IPO only after December 1992). Storage does not return to 2 MAF until April of 1997. Finally, the modeling shows a precipitous drop in storage begins anew in March of 2000. In that year with the IPO only, storage is at about 2 MAF and drops to approximately 1.2 MAF by November 2003. With the additional releases, storage in March of 2000 is approximately 1.9 MAF and drops to approximately 400,000 AF by November 2003.

The IPO is, of course, a set of operations criteria for New Melones designed to meet the majority of the demands on New Melones over time. (*See* Exhibit G). As a result, allocations and deliveries from New Melones in any given year are made based upon a combination of storage at the end of February plus forecasted inflow between March and September. Under the IPO, if storage plus inflow is between 0 and 1.4 MAF, no water is allocated or released to CVP contractors or for the Bay-Delta. Allocations for fishery are between 0 and 98,000 AF, and allocations for water quality at Vernalis are between 0 and 70,000 AF. These allocations rise as the combination of storage and inflow rises, although it is not until storage plus inflow is between 2.5 MAF and 3 MAF that all of these needs receive an allocation.

While the modeling runs do not show inflow in any given year, it is clear that the reductions in storage which result from the additional releases will mean that all of the needs dependent upon New Melones will get less water than if the increased releases did not occur. For example, storage on February 28, 1995 was 921,000 AF under the IPO, but only 354,000 AF with the additional releases. Assuming that anticipated inflow for that year was 750,000 AF (mean annual inflow is approximately 1.1 MAF). Under the "normal" IPO circumstances, the storage plus inflow would be in excess of 1.6 MAF (921,000 + 750,000). As such, the allocation for fisheries would be between 98,000 and

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through October 31, compliance with the IPO would meet the recommended temperatures at Vernalis approximately 28% of the time, while the additional releases would meet such criteria approximately 33% of the time.

125,000 AF and for water quality at Vernalis would be between 70,000 and 80,000 AF. The Bay-Delta and CVP Contractors would not receive an allocation.

However, under the additional releases scenario, the storage plus inflow number would only be about 785,000 AF (35,000+ 750,000). As such, the allocation for fisheries would be between 0 and 98,000 AF and for water quality at Vernalis between 0 and 70,000 AF. Again, the Bay Delta and CVP Contractors would not receive an allocation.

C. Case No. 3 Shows That CDFG's Recommended Temperatures at Vernalis Cannot Be Met By Increasing Flows From the Tributaries.

The SJRGA asked AD Consultants to evaluate whether or not increasing flows from the tributaries would be an effective method for achieving CDFG's recommended temperatures at Vernalis. (Ex. B, p. 4). Recognizing that CDFG is recommending that certain temperatures be met at the confluence of the San Joaquin River and each of the three tributaries, Case No. 3 assumes that the CDFG recommended temperatures at each confluence is met for the time periods 9/1 – 10/15 and 3/15 – 6/15. (Id.). Flows are then increased from each of the tributaries to determine if CDFG's recommended temperature at Vernalis for these time periods can be met. (*See* Ex. B., p. 4 and p. 19, Table 3, for description of the flow increases).

What these Case No. 3 runs showed is that while it is theoretically possible to reduce temperatures at Vernalis by increasing releases from the tributaries if it is assumed that the CDFG recommended temperature at each confluence is met, the reduction is not sufficient to achieve the CDFG recommended temperature at Vernalis. (*See* Ex. B, p. 17, Figure 15). Moreover, as in Case No. 2, this runs shows that the benefit obtained by increasing releases from the tributaries is extremely slight and not worth the water cost. In the Spring absent the additional releases, the maximum average temperature is 62.8º F. The additional releases reduce the maximum average temperature by .7º F or less. (*See* Ex. B, p. 18, Table 3). The same phenomenon occurs in the Fall, when the additional releases reduce the maximum average temperature by 1.6º F or less. (Id.).

D. Anticipated Friant Restoration Flows Will Make It Harder to Achieve CDFG's Recommended Temperature Criteria.

The first three cases discussed above were each presented to the CVRWQCB staff at the September 25, 2007 workshop. At the workshop itself, CDFG staff indicated that temperatures could be improved by increased flows from the San Joaquin River's tributaries. However, CDFG staff admitted during the question and answer period that it had not looked at what impact, if any, the anticipated flows in the main stem of the San Joaquin River itself resulting from the Friant settlement would have on the ability to use additional tributary releases to meet CDFG's recommended temperature criteria. As a result, after the conclusion of the workshop, the SJRGA asked AD Consultants to evaluate the impact of the anticipated Friant settlement flows on temperatures in the San Joaquin River. The results, which were not presented at the workshop, are contained in full as part of Exhibit E.

The assumptions that went into this Case No. 4 are described on page 5 of Exhibit B. Essentially, the flows restoration flows that are anticipated once the settlement is approved, as well as operation of the Madera and Friant-Kern Canals were added to the 1980-2005 hydrology, and the Stanislaus River was added using both historical and IPO conditions. The relationship between releases from New Exchequer Dam and the new flow and temperature at the confluence of the San Joaquin and Merced Rivers was then developed.

The results of the run show two things. First, the additional water from Friant will not reduce temperatures by themselves. Temperatures at the confluence of the San Joaquin and Merced Rivers will remain essentially unchanged. Although the Friant settlement flows will add more water, the travel time is such that when the new water reaches the confluence, it approaches equilibrium with ambient temperature. (Ex. B., p. 18).

Second, the additional water actually makes it harder to achieve the CDFG recommended temperature at the confluence of the Merced and San Joaquin Rivers. Even though it is anticipated that the water temperature at the confluence of the Merced and San Joaquin Rivers will be the same with and without the anticipated Friant flows, the Friant flows themselves are of such a large volume that it will take a greater volume of water from the Merced River to reduce temperatures at the confluence. (*See* Ex. B, p. 18-19). Given the storage capacity of Lake McClure, the releases necessary to reduce temperatures at the confluence can only be made for limited duration before exhausting the available water supply. (Ex. B, p. 19, Figure 2).

E. The CDFG Recommended Criteria Cannot Be Met At All Times And Locations Even If All of the Water In The Basin Is Dedicated to That Purpose.

Again responding to CDFG staff's indication that its recommended temperature criteria could be met using reservoir releases, the SJRGA asked AD Consultants to evaluate whether or not such criteria could be met at all times and at all locations if all of the water within the basis was dedicated for that purpose. To make this determination, the SJRGA asked AD Consultants to (1) assume that all diversions in the three tributaries were eliminated and allowed to remain in the river, (2) re-shape all such rerouted diversions to maximize temperature reduction in the Spring and Fall time periods identified by CDFG, and (3) evaluate whether or not the additional water would achieve the CDFG recommended criteria. (*See* Ex. B, p. 5-6).

Consistent with all of the other runs performed by AD Consultants, this scenario again demonstrated that temperatures could be improved. However, as with all of the other runs, such temperature improvement was not enough to meet the CDFG recommended criteria at all times and at all locations. (*See* Ex. B, p. 20). Indeed, under the definition for impairment used by the CVRWQCB, dedication of all of the basin's water to meeting CDFG's recommended temperature criteria would still result in all locations during the Spring time frames being impaired, and all of the Fall locations impaired except for the Tuolumne and Stanislaus River confluences. (*See* Ex. B., p. 20, Table 4).

The inability of the system as a whole to meet the CDFG recommended temperature criteria at all times and locations, even assuming that all of the water was dedicated for that purpose, is a stunning indictment of the appropriateness of the CDFG recommendation. The CVRWQCB cannot justify a finding that the San Joaquin, Stanislaus, Tuolumne and Merced Rivers are impaired for temperature based upon the CDFG recommended criteria given that it is almost impossible for such criteria to ever be met.

Thank you for the opportunity to submit these written comments. Please let us know if there are any questions.

Very truly yours,

O'LAUGHLIN & PARIS LLP

By________________________________

TIM O'LAUGHLIN
Attorneys for the San Joaquin River Group Authority

EXHIBIT A

June 12, 2002 memorandum from Michael J. Levy, Office of the Chief Counsel, State Water Resources Control Board, to Ken Harris and Paul Lillebo, Department of Water Quality, regarding the distinction between a TMDL's numeric targets and water quality standards

Winston H. Hickox
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TO: Ken Harris, DWQ
Paul Lillebo, DWQ

FROM: Michael J. Levy
Staff Counsel
OFFICE OF CHIEF COUNSEL

DATE: June 12, 2002

SUBJECT: THE DISTINCTION BETWEEN A TMDL'S NUMERIC TARGETS AND WATER QUALITY STANDARDS

This memorandum is intended to explain the distinction between numeric targets in a total maximum daily load (TMDL) and water quality standards. In general, section 303(d) of the Federal Clean Water Act (CWA)[1] requires each state to establish a TMDL for waters within its boundaries for which effluent limitations are not stringent enough to implement applicable water quality standards.[2] TMDLs, in turn, must be established at a level necessary to implement the applicable water quality standards.[3] In short:

1. TMDLs require a quantitative numeric target necessary to implement existing water quality standards;
2. While a TMDL's numeric target is an interpretation of existing water quality standards, it is not a water quality standard itself, and therefore, the processes required when adopting such standards do not apply;
3. Strategies to attain water quality standards, such as TMDLs, do not change the fact that enforcement of the Clean Water Act against point source dischargers is primarily through their NPDES permits; A TMDL's numeric target is not directly enforceable against dischargers absent a corresponding permit provision.

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[1] The CWA is more accurately identified as the "Federal Water Pollution Control Act." (See 33 U.S.C. § 1251 et seq.) As used above, "section 303(d)" refers to the section number of the CWA as enacted by Congress. The same section is codified in title 33 of the United States Code in section 1313(d). Text in the body of this memorandum refers to the sections of the CWA as enacted by Congress. Corresponding citations to title 33 appear in footnotes.

[2] See generally 33 U.S.C. § 1313(d)(1)(A)-(D); see also 40 C.F.R. § 130.7.

[3] 33 U.S.C. § 1313(d)(1)(C); 40 C.F.R. § 130.7(c)(1).

I. TMDLs Require the Calculation of a Quantitative Numeric Target Necessary to Implement Water Quality Standards in Impaired Water Bodies

Section 303(d) contains two sentences regarding what a TMDL actually is. The first sentence requires establishment of the "total maximum daily load" for those pollutants suitable "for such calculation." The second sentence states that "[s]uch 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."[4] Based on these statements, a TMDL should be based on a quantitative value, or target,[5] designed to attain water quality standards in a particular water body.

The federal regulations corroborate that TMDLs require a quantitative numeric target. First, they repeat essentially the same statements from the statute.[6] Next, they define a TMDL as the "sum" of the individual waste load "allocations" for point sources and load "allocations" for nonpoint sources and natural background.[7] Both types of allocations are based on the concept of "loading capacity," which the regulations define as the greatest "amount" of loading (i.e., the introduction of matter or thermal energy) that a water body can receive without violating water quality standards.[8] Finally, the regulations provide that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate "measures."[9] Federal regulations, therefore, envision TMDLs (including the respective load and waste load allocations) as establishing a quantitative target for a particular water body that will assure attainment of water quality standards.

The developing body of federal case law also views TMDLs in the same way. As was recently noted by the United States District Court for the Northern District of California, "[a] TMDL defines the specified maximum amount of a pollutant which can be discharged or 'loaded' into

[4] 33 U.S.C. § 1313(d)(1)(C).

[5] Although the term "numeric target" does not appear in the CWA, use of the phrase is a matter of convenience due to a peculiarity in the CWA vernacular. The term "TMDL" has come to have two meanings, the first of which is the numeric target, or the literal "load" referenced in section 303(d). The term "TMDL" is also used to reference not merely the load, but the allocations of the load and the implementation plan as well. For clarity, in this document the term "target" or "numeric target" refers to the "load", and the term "TMDL" is reserved to describe the culmination of the state's responsibilities under section 303(d), i.e., the load, allocations, and implementation plan.

[6] 40 C.F.R. § 130.7(c)(1).

[7] *Id.*, § 130.2(i).

[8] *Id.*, §§ 130.2(e) and (f).

[9] *Id.*, § 130.2(i).

the waters at issue from all combined sources."[10] Federal courts outside of California and the Ninth Circuit share the same view.[11]

The U.S. Environmental Protection Agency, Region IX (EPA) also views TMDLs as containing water body-specific targets necessary to attain water quality standards. According to a recent publication from EPA:

> "[a] TMDL is a written, quantitative assessment of water quality problems and contributing pollutant sources. It identifies one or more numeric targets based on applicable water quality standards, specifies the maximum amount of a pollutant that can be discharged (or the amount of a pollutant that needs to be reduced) to meet water quality standards, allocates pollutant loads among sources in the watershed, and provides a basis for taking actions needed to meet numeric target(s) and implement water quality standards."[12]

Numerous pages of that publication are devoted to explaining how TMDL targets are used to interpret narrative or numeric water quality standards and to explaining the requirement to quantify the loading capacity and allocations.[13]

In short, the Clean Water Act, federal regulations, case law, and interpretive guidance from EPA all describe TMDLs as requiring numeric pollutant targets that are established at levels necessary to achieve water quality standards in impaired waters.

II. A TMDL Implements Existing Water Quality Standards; It Does Not Create New Standards

The federal regulations specify essentially four components of water quality standards. These are use designations, water quality criteria based upon those uses, an antidegradation policy, and certain policies generally affecting the application and implementation of water quality standards.[14] Water quality criteria are defined as "elements of State water quality standards,

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10 *Pronsolino v. Nastri* (9th Cir., 2002) --- F.3d ----, 2002 WL 1082428, p. 3, quoting *Dioxin/Organochlorine Center v. Clarke* (9th Cir. 1995) 57 F.3d 1517, 1520.

11 See, e.g., *American Iron and Steel Institute v. EPA* (D.C.Cir. 1997) 115 F.3d 979, 1002, citing 40 C.F.R. § 132.2; *Manasota-88, Inc. v. Tidwell* (11th Cir. 1990) 896 F.2d 1318, 1321; *Scott v. City of Hammond* (7th Cir. 1984) 741 F.2d 1318, 1321.

12 U.S. Environmental Protection Agency, Region IX, Guidance for Developing TMDLs in California (January 7, 2000), p. 1, which is available at: www.epa.gov/region09/water/tmdl.

13 *Id.*, pp. 2-6.

14 40 C.F.R. §§ 131.6(a), (c), and (d); 40 C.F.R. § 131.13. Unlike TMDLs, which are specific plans to attain standards in a specific water body, section 131.13 policies are generally applicable policies, e.g., mixing zones, low flows, and variances. See Memorandum to Paul Lillebo, Basin Planning Unit Chief, Division of Water Quality,

expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use."[15] Federal law contemplates, "[w]hen criteria are met, water quality will generally protect the designated use."[16]

Similar to federal requirements, under state law, each Regional Board must establish water quality objectives that will ensure the reasonable protection of beneficial uses and the prevention of nuisance.[17] Water quality objectives are "the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area."[18] The Water Code provides that such beneficial uses include, but are not limited to: domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.[19]

Under state and federal law, therefore, water quality standards designate the uses to be made of the water and set criteria necessary to protect the uses. These standards have two functions: (1) they establish the water quality goals for a specific water body; and (2) they serve as the regulatory basis for establishing water quality-based treatment controls and strategies (such as TMDLs) beyond the required technology-based levels of treatment.[20]

Water quality objectives or criteria can be expressed in numeric terms (i.e., concentration or mass per time), or narrative terms (e.g., "no toxics in toxic amounts").[21] When adopting a TMDL for an impaired water body, sometimes the numeric criteria can be used as the TMDL target (e.g., mass-per-time criteria). More typically, however, to comply with TMDL requirements, the objective will need to be translated into another measure amenable to allocating the total load (e.g., concentration-based numeric criteria, or narrative criteria). While this translation involves articulating a new number to express the existing criteria for the purposes of section 303(d), selection of this new number does not establish a new water quality standard.

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from Michael J. Levy, Staff Counsel, Office of Chief Counsel, re: *The Extent to Which TMDLs are Subject to the Alaska Rule* (January 28, 2002) (hereinafter "*TMDLs and the Alaska Rule*").

[15] 40 C.F.R. § 131.3(b).

[16] *Ibid.;* 33 U.S.C. § 1313(c)(2)(A).

[17] Wat. Code, § 13241.

[18] *Id.*, § 13050, subd. (h).

[19] *Id.*, § 13050, subd. (f).

[20] 40 C.F.R. § 131.2.

[21] 40 C.F.R. § 131.11.

Although the assignment of a numeric value that ultimately must be implemented in NPDES permits may at first glace appear similar to establishment of a water quality standard, a comparison of the statutory requirements for TMDLs and water quality standards demonstrates they are quite distinct: section 303(c) of the Clean Water Act requires creation of the water quality standards; section 303(d) requires TMDLs to implement those standards when technology-based limits are insufficient.[22] "[T]he basic purpose for which the § 303(d) list and TMDLs are compiled [is] the eventual attainment of state-defined water quality standards."[23] TMDLs are therefore not themselves standards, but mechanisms to implement them. Unlike water quality standards, TMDLs do not designate existing or potential uses. They do not establish new criteria necessary to protect uses, but rather, interpret existing criteria. They do not establish policy guiding the circumstances under which water quality must be protected against degradation. TMDLs merely create an enforceable strategy to attain those standards (with seasonal variations and a margin of safety) that were already established but which are not yet attained in a specific water body.[24] TMDLs thus serve as a means to an end. That end is the attainment and maintenance of existing water quality standards.[25]

III. Water Code Section 13241 Does Not Apply When Establishing the Numeric Targets in a TMDL

Water Code Section 13241 establishes the requirements attendant to the Regional Boards' adoption of water quality objectives. Because "it may be possible for the quality of water to be changed to some degree without unreasonably affecting beneficial uses," the section requires the Regional Boards to consider a number of factors when establishing objectives. These include:

a. Past, present, and probable future beneficial uses of water;

b. Environmental characteristics of the hydrographic unit, including the quality of water available to it;

c. Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area;

d. Economic considerations;

e. The need to develop housing within the region; and

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[22] 33 U.S.C. § 1313(d).

[23] *Pronsolino v. Nastri* (9th Cir., 2002) --- F.3d ----, 2002 WL 1082428, p. 13.

[24] 33 U.S.C. § 1313(d)(1); 40 C.F.R. §§ 130.7(b)(1) and (c)(1).

[25] For a detailed analysis of how the process of creating a TMDL is distinct from and incompatible with the process of adopting a water quality standard, see *TMDLs and the Alaska Rule*, *supra* note 14.

f. The need to develop and use recycled water.[26]

The Clean Water Act similarly provides that water quality standards "shall be established taking into consideration their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other purposes, and also taking into consideration their use and value for navigation."[27] Considering these factors is appropriate because assignment of the appropriate level of water quality properly involves a balance between appropriate "designated" or "beneficial" uses of water, numeric or narrative water quality "objectives" or "criteria," and a host of sometimes-competing policy considerations, including economic and environmental interests.

Since TMDLs are not water quality objectives, the requirements for adopting such objectives do not apply to TMDLs. Nor should they. Numeric targets used by TMDLs to implement standards are not designed to re-balance the policy interests underlying those standards. Although the state must consider a variety of factors in establishing the different elements of a TMDL, considering the economic impact of the required level of water quality, for example, is not among them; that impact was already determined when the standard was adopted. This conclusion is not altered when a TMDL is established to implement a narrative water quality objective. The economic impact associated with maintaining ambient water quality at the level described by the narrative statement was considered when the narrative objective was adopted.[28]

While policy considerations are important in developing water quality standards, they play a smaller role in the formulation of the TMDLs that implement them. The statutory directive to adopt TMDLs to "implement the applicable water quality standards with seasonal variations and a margin of safety,"[29] is not qualified by the predicate "so long as it is economically desirable to do so." Therefore, not only would an in-depth economic analysis be redundant, it would be inconsistent with federal law.

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[26] Wat. Code, § 13241, subds. (a)-(f). Notably, section 13241 contains no dictate as to the weight the Regional Board must afford to any particular factor, only that these factors be considered.

[27] 33 U.S.C. § 1313(c)(2)(A). See also 40 C.F.R. §§ 131.10-13.

[28] That is not to say that no economic analysis is required when adopting a TMDL. Indeed, depending on the specific activity under consideration, different parts of a TMDL may require differing levels of economic considerations. Section 13241 analysis, however, is not among them. For a detailed discussion of economic analysis requirements, see Memorandum to Stefan Lorenzato, TMDL Coordinator, Division of Water Quality, from Sheila K. Vassey, Senior Staff Counsel, Office of Chief Counsel, re: *Economic Considerations in TMDL Development and Basin Planning* (October 27, 1999).

[29] 33 U.S.C. § 1313(d)(1)(C).

In short, a water quality standard defines the water quality goals of a water body by designating the use or uses to be made of the water and by setting criteria necessary to protect the uses.[30] TMDLs, in contrast, establish numeric targets for pollutants—targets that are designed to achieve water quality standards in impaired waterbodies. TMDLs implement the existing objectives that are designed to protect designated beneficial uses and, therefore, serve as a water quality-based treatment control or strategy that necessarily rests on the established goals and balanced policy considerations embodied by water quality standards. As stated in a recent Ninth Circuit decision:

> "TMDLs serve as a link in an implementation chain that includes federally-regulated point source controls, state or local plans for point and nonpoint source pollution reduction, and assessment of the impact of such measures on water quality, all to the end of attaining water quality goals for the nation's waters."[31]

IV. Numeric Targets in a TMDL are not Directly Enforceable Against Dischargers

The difference between water quality standards and TMDLs is highlighted in the context of the "citizen suits", which are authorized by section 505 to enforce the CWA.[32] In pertinent part, section 505 authorizes "any person" to commence a "civil action" against any person who has allegedly violated "*an effluent standard or limitation*" or "an order" issued by the EPA or a "State with respect to such a standard or limitation[.]"[33] The Clean Water Act language does not support the notion that third parties can invoke the effluent provision in section 505 to directly enforce TMDL numeric targets against dischargers.

In contrast to the broad definition of "effluent limits" in section 502 of the Clean Water Act, section 505 limits citizen suits specifically to a narrower subset of effluent standards and limitations. Section 505 states, in particular, that "[f]or purposes of this section," the term "effluent standard or limitation" is limited to seven instances. Citizen suits are permitted to enforce:

a. An unlawful act, under section 301(a);

b. An effluent limitation or other limitation, under section 301 or 302;

c. A "standard of performance" under section 306;

d. A prohibition, effluent standard or pretreatment standards, under section 307;

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[30] 40 C.F.R. § 131.2.

[31] *Pronsolino v. Nastri* (9th Cir., 2002) --- F.3d ----, 2002 WL 1082428, p. 4.

[32] 33 U.S.C. § 1365.

[33] 33 U.S.C. § 1365(a)(1) (Italics added).

e. A certification, under section 401;

f. A permit or condition thereof, issued under section 402; or

g. A regulation under section 405(d).[34]

A TMDL's numeric targets do not fall within any of these provisions. Although the regulations refer to a waste load allocation as a "type of water quality-based effluent limitation,"[35] TMDLs are required by section 303(d), not sections 301, 302, or 307. Nor, for that matter, does a TMDL that establishes a total load or waste load allocation of "zero" establish a directly enforceable prohibition, unlawful act, regulation, or performance standard under sections 301, 306, 307, or 405. Again, the target is established under section 303(d). No section 303(d) limit is enumerated in section 505. Accordingly, a plain reading of the effluent limits that may be directly enforced by way of a citizen suit under the Clean Water Act does not include waste load allocations required by section 303(d).

The federal regulations reveal at least one obvious explanation for the exclusion of TMDLs from matters that can be directly enforced against dischargers. Those regulations contemplate flexibility in translating waste load allocations into permit conditions. The NPDES permitting provisions require that water quality-based effluent limits must be "consistent with the assumptions and requirements of any available wasteload allocation."[36] The provisions do not require the limit to be "identical to the wasteload allocation." This language leaves open the possibility that the Regional Board could determine that fact-specific circumstances render something other than literal incorporation of the waste load allocation to be consistent with its assumptions and requirements.[37] The regulations thus contemplate the additional step of revising applicable NPDES permits to make them "consistent with the assumptions" of the TMDL.[38]

Thereafter, it is the effluent limit set forth in the permit, and not the TMDL, that provides the potential vehicle for citizen suit enforcement under the Clean Water Act.[39] These requirements

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[34] 33 U.S.C. § 1365(f).

[35] 40 C.F.R. § 130.2(h).

[36] 40 C.F.R. § 122.44(d)(1)(vii).

[37] The rationale for such a finding could include a trade amongst dischargers of portions of their load or waste load allocations, performance of an offset program that is approved by the Regional Board, or any number of other considerations bearing on facts applicable to the circumstances of the specific discharger.

[38] Of course, if a permit is already consistent with a newly adopted TMDL, the permit need not be amended to render its terms enforceable. The permit conditions are already enforceable, including by a citizens suit. (33 U.S.C. §§ 1365(a)(1)(B), 1365(f)(6).)

[39] *Id.*

are consistent with section 402(k)'s requirement that compliance with an NPDES permit is deemed compliance that bars most enforcement actions and citizen suits.[40]

CONCLUSION

Section 303(c) of the Clean Water Act obligates the State and Regional Boards to establish water quality standards to protect appropriate designated uses of waters. Section 303(d) requires the states to establish TMDLs at levels necessary to implement those water quality standards in waters that are not attaining them. While extensive policy considerations are evaluated when adopting standards, those considerations are generally not relevant when adopting TMDLs, whose purpose is to cause the compromised waters to attain those policy-based standards.

The distinction between water quality standards and TMDLs is significant both for the manner in which they are adopted, and the manner in which they are enforced. First, because TMDLs are not water quality standards, neither federal nor state law obligates the State and Regional Boards to establish and adopt TMDLs as water quality standards. Second, the provisions of a TMDL, including its numeric targets, are not directly enforceable against dischargers by way of a citizen suit under the Clean Water Act. In general, section 505 permits such suits to directly enforce an effluent limit or standard. Because TMDLs are neither water quality standards nor a type of effluent limit addressed in section 505, TMDLs, including the respective waste load allocations, are not directly enforceable under the citizen suit provision of the Clean Water Act. The NPDES permits implementing the TMDL provide the vehicles for enforcement. The TMDL does not.

Should you have any questions about this memorandum, feel free to contact me at (916) 341-5193 or mlevy@swrcb.ca.gov.

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[40] 33 U.S.C. § 1342(k).

EXHIBIT B

Temperature Modeling and Analysis for the San Joaquin River

Requested by the San Joaquin River Group Authority
in Connection with the 303(d) Proceedings

Prepared by

AD Consultants
RMA, Inc.

November 19, 2007

Temperature Modeling and Analysis for the San Joaquin River

Requested by the SJRGA in Connection with the 303(d) Proceedings

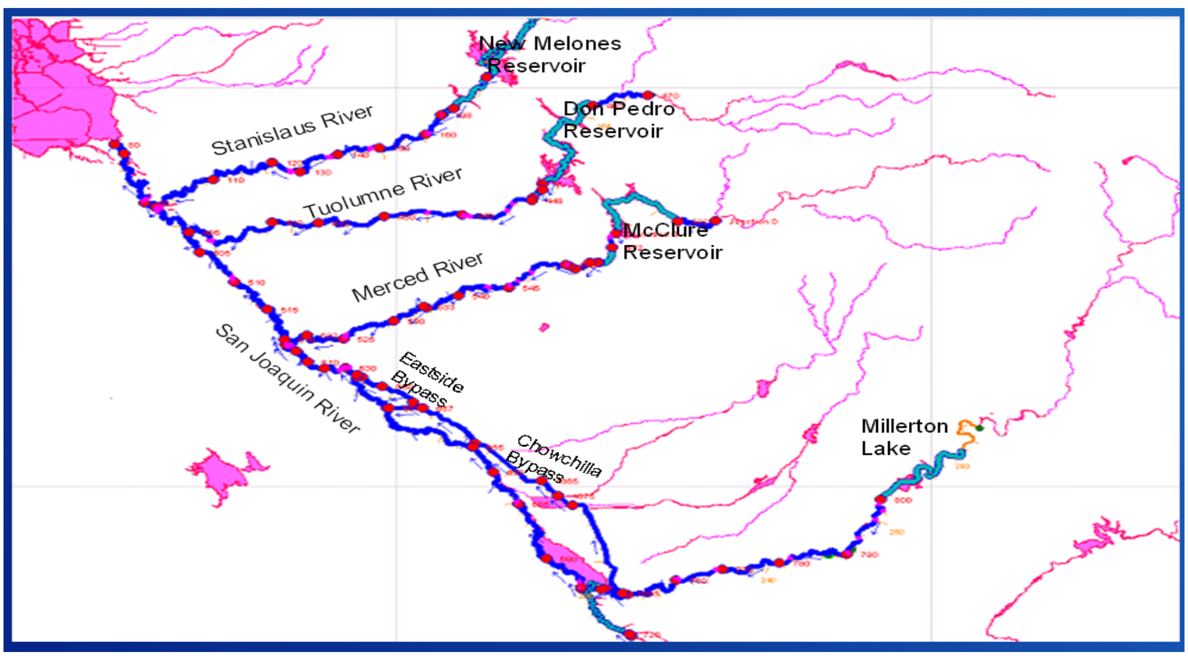
I. General

This report presents the results of water temperature modeling and analysis for the San Joaquin River (SJR) performed by AD Consultants and Resources Management Associates, Inc (RMA) as requested by the San Joaquin River Group Authority (SJRGA). The work was done to address issues in connection with the 303(d) Proceedings.

Most of the modeling results were presented to the Regional Water Quality Control Board (RWQCB) in the September 25 Temperature Workshop in Sacramento, California. Nevertheless, the report provides a more in-depth review of the results, as well as follow up analyses, specifically for the potential impact of the Friant Restoration on temperatures in the SJR in relation to the temperature objectives recommended by the CDFG and a broad view about the possibility to achieve these objectives given all the water physically available in the basin.

The modeling was performed using the CALFED sponsored San Joaquin River Basin-Wide Water Temperature Model. This HEC-5Q model encompasses the Stanislaus, Tuolumne, Merced and the main-stem and upper San Joaquin rivers, including Friant (Millerton Lake), as shown in Figure 1.

Figure 1 - HEC-5Q Model Representation of the San Joaquin Basin



The model has the capabilities to simulate various scenarios of system operation and then compute temperature response at any location throughout the system on a sub-daily basis (6-hour time increments). Using the model, it is possible to assess whether or not certain temperature objectives can be achieved given a prescribed operation scenario and what is the ramification of such operation on system storage.

II. Objective:

The objective of this analysis was to perform simulations with the HEC-5Q model and evaluate thermal conditions in the Stanislaus, main-stem SJR and lower SJR at Vernalis for different operation scenarios in connection with the Impaired Waters and Surface Water Quality Assessment 303(d) initiated by CDFG.

In the letter to the RWQCB on February 28, 2007, the CDFG proposed certain objectives (criteria) for temperatures at discrete locations on the Stanislaus, Tuolumne, Merced and the main-stem SJR at Vernalis. These objectives are summarized in Figure 2 below:

Figure 2 – Table 1 from CDFG letter to Regional Water Quality Control Board, February 28, 2007.

CDFG Proposed Temperature Criteria

River	Location	River Mile	Season	Life Phase	Threshold (ºF)	Affected River Miles	Threshold (ºC)
San Joaquin	Vernalis	72	9/1 - 10/31	Adult/Egg	64.4	118	18
	Vernalis	72	3/15 - 6/15	Smolt	59.0	118	15
Stanislaus	Mouth	0	9/1 - 10/31	Adult/Egg	64.4	58	18
	Riverbank	33	10/1 - 12/15	Egg	55.4	33	13
	Mouth	0	3/15 - 6/15	Smolt	59.0	58	15
Tuolumne	Mouth	0	9/1 - 10/31	Adult/Egg	64.4	52	18
	Waterford	28	10/1 - 12/15	Egg	55.4	24	13
	Mouth	0	3/15 - 6/15	Smolt	59.0	52	15
Merced	Mouth	0	9/1 - 10/31	Adult/Egg	64.4	52	18
	River Mile 28	28	10/1 - 12/15	Egg	55.4	24	13
	Mouth	0	3/15 - 6/15	Smolt	59.0	52	15

As such, all the results for the modeling runs (labeled “tasks” in this report) were evaluated with respect to the above objectives.

III. Tasks:

The following tasks were prepared for the September 25 staff workshop on temperature:

1. How “Actual” Temperatures Compare with “Historic” Conditions?

Model the “Historic” and “Actual” (1967-1982) temperatures for the following locations and times:

- Confluence of the Stanislaus River 9/1 – 10/31
- Vernalis 9/1 – 10/31
- Riverbank 10/1 – 12/15
- Confluence of the Stanislaus River 3/15 – 6/15
- Vernalis 3/15 – 6/15

For the purpose of this analysis, “Historic” temperatures were defined as pre-new storage development and “Actual” as post-new storage development on the Stanislaus River.

Concepts and assumptions:

The existing Stanislaus component of the Temperature Model was modified as follows:

- Removed New Melones and replaced with Old Melones.
- Extended stream section between Old Melones and Tulloch.
- Assumed same river cross sections above Old Melones to Stanislaus PH

- Removed Collierville PH
- Meteorology – extended based on Modesto max/min temperatures
- Hydrology – assumed historical flow and operation for Old Melones and Tulloch

Assess the following:

1) What were the “Historic” temperatures at the above mentioned locations and periods?
2) What were the “Actual” temperatures at the above mentioned locations and periods?
3) How do the “Historic” and “Actual” temperatures compare?
4) Did “Historic” temperatures meet the temperature objectives proposed by CDFG?

2. Can the IPO and Augmented IPO Meet CDFG Criteria?

Model temperatures in the Stanislaus and Lower SJR at Vernalis for the period 1980-2003 under the current IPO. Then, increase New Melones releases (Augmented IPO) and check if CDFG recommended criteria can be met.

Concepts and Assumptions:

Convert the IPO flows to daily time steps. Then run the IPO with the 5Q and track temperatures on a sub-daily basis at three locations: Riverbank, Confluence and Vernalis. Assume historical flows and temperature inflows for the main-stem SJR at the confluence. Increase releases from Goodwin for two periods: Spring and Fall as follows:

$Q_{Goodwin} = \max(Q_{IPO}, Q_{Schedule})$

Where:

$Q_{IPO} =$ minimum flow per the IPO for fish, water quality, etc. (not including spills), and

$Q_{Schedule}$ varies (linearly) as follows:

Period	From	To	Flow Rate (cfs)
Spring	3/15	4/15	500
Spring	4/16	5/15	1000
Spring	5/16	6/15	1500
Fall	9/1	9/31	1500
Fall	10/1	10/15	1000
Fall	10/16	10/31	500

Assess the following:

1) Can the CDFG recommended criteria be met at all times and under all conditions?
2) If not, when and how often does New Melones Reservoir run out of water?

3. Can CDFG Criteria at Vernalis Be Met by Increasing Flows from the Tributaries?

Assume that the CDFG recommended temperatures at the confluences of all three tributaries are met for the time periods 9/1 – 10/31 and 3/15 – 6/15. Then, increase releases from the tributaries and check if CDFG criteria are met at Vernalis.

Concepts and Assumptions:

Use 1995-2006 for an example. First, assume historical flows from the Stanislaus, Tuolumne and Merced for the above periods. Assume temperatures are met (per CDFG criteria) at the confluence of each river with the SJR. Then:

- Route historical flows from the three rivers and check temperatures at Vernalis.
- Set Tuolumne and Merced flows (to equal historical) and increase Stanislaus. Compute temperatures at Vernalis.

- Set Stanislaus flows (to equal historical) and increase Tuolumne and Merced flows (50/50 split between the two rivers). Compute temperatures at Vernalis.

Assess the following:

1) Will the attainment of temperatures at the confluences have any improvement to temperatures at Vernalis?
2) If so, will it be enough to meet the Vernalis temperature criteria recommended by CDFG for those two time periods?

The following tasks were prepared as a follow up to the September 25 staff workshop on temperature:

4. What is the Impact of Friant Restoration on Temperature in the SJR?

Analyze the potential impact of Friant Restoration on temperatures in the SJR with respect to CDFG objectives per the 303(d) proceedings.

Concepts and Assumptions:

- 1980 - 2005 hydrology as defined in the USBR report.
- Restoration flows (minimum flow requirement below Friant Dam) defined by year type (Settlement Decision Tables 1A - 1F of 9/13/2006).
- Historical Friant diversions (Madera and Friant-Kern Canals) with physical operation constraints (maximum diversion rate computed as a function of reservoir elevation).
- Bypass operation and diversion to historical river channel at Sand Slough defined as a function of flow.
- Simulate the 26-year period to compute the flow and temperature in the San Joaquin River at Stevinson to provide upstream boundary of the CalFed Model.
- All subsequent simulations will use the CalFed model with the computed or historical data based Stevinson boundary flow and temperature.
- Simulate historical conditions with Stanislaus operating under IPO and historical boundary conditions.
- Simulate IPO-historical conditions with computed Friant restoration boundary conditions.
- Develop minimum flow relationships at Exchequer to examine feasibility of countering effects of Friant restoration. The minimum flow requirements will also need to be based on hydrologic year type). Simulate various Merced River minimum flow assumptions.

Assess the following:

1) What would be the temperature conditions at the confluence with the Merced River as a result of Friant Restoration?
2) To what extent can the Merced River reduce temperatures at the confluence given the new flow regime?

5. Is the SJR Temperature Impaired Even if All the Water the Basin is allocated for Fish?

Assume that all the water in the basin is allocated for fish release (no diversions). Compute the temperature response at the confluence of each river and at Vernalis. Check if the new computed temperature frequencies will still pass the temperature impairment test defined by RWQCB.

Concepts and Assumptions:

- Use the historical 1995 - 2005 hydrology as a case study.
- Maintain the same storage levels as historically occurred.
- Reroute all the historical diversions back the rivers.
- Reshape the rerouted diversions around the spring and fall to maximize temperature reductions in these seasons.

Assess the following:

1) Would the temperatures in confluences of the Stanislaus, Tuolumne and Merced and at Vernalis pass the temperature impairment test, as defined by the RWQCB?

IV. Modeling Results

All modeling results are saved in HEC-DSS (Data Storage System) files and are provided in the CD attached as Exhibit E to the SJRGA's November 19, 2007 comments. The HEC-DSS is a database developed the U.S. Army Corps of Engineers' Hydrologic Engineering Center designed to efficiently store and retrieve scientific data that is typically sequential. The database was designed to make it easy for users and application programs to retrieve and store data. HEC-DSS is incorporated into most of HEC's major application programs, including the HEC-5Q.

To view the content of the model results in the HEC-DSS files requires a special software called DSS-Vue. This is public domain software and is available for download from the following link:

http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-download.htm

Also included in the CD are Excel and other supporting files used for post processing and analyzing of the results.

The following are summaries of the results for the above-mentioned Tasks.

1. How "Actual" Temperatures Compare with "Historic" Conditions?

Assessment of results:

1) *"Historic" water temperatures in the Stanislaus River and the Lower San Joaquin River at Vernalis are higher than "Actual" water temperatures majority of the time.*
2) *"Historic" water temperatures do not meet the temperature objective set forth by CDFG for the proposed locations in the Stanislaus River and the Lower San Joaquin River at Vernalis majority of the time.*

The first assessment is supported by Figure 3 to Figure 7:

Average daily temperatures at Riverbank, Confluence (of the Stanislaus with SJR) and Vernalis – the three reference points identified by CDFG for temperature objective, are presented in Figure 3. The line labeled "IPO_67" represents "Actual" and the line labeled "Hist1" represents "Historic". The Y-axis on the left shows the absolute values of these lines. The line labeled "Hist-IPO_67 difference" represents the difference between "Actual" and "Historic" (i.e., "Historic" minus "Actual"). The Y-axis on the right shows the values for this line. Whenever this line is above zero, it means that "Historic" temperatures are higher than "Actual".

Figure 4 shows similar results except for maximum daily temperatures (assumed to be at hour 18:00 in the model). Since CDFG proposed to use the average of 7-days maximum temperatures for defining temperature criteria at their proposed reference points, this graph might be more relevant than average temperatures, as far as the 303(d) is concerned.

Table 1 is a summary of Figure 4 and Figure 4 showing the numbers of days, on average, that "Historic" temperatures were higher than "Actual". The table also shows day-count for other locations on the Stanislaus River. This information can be obtained from the attached HEC-DSS file.

Table 1 – Number of days and % of time "Historic" temperatures are higher than "Actual"

Location	Average Temperatures # of days Historic > Actual	Average Temperatures % of Time Historic > Actual	Maximum Temperatures # of days Historic > Actual	Maximum Temperatures % of Time Historic > Actual
GOODWIN	248	68%	340	93%
KNIGHTS FERRY	241	66%	287	79%
ORANGE BLOSSOM	243	67%	278	76%
RIVERBANK	247	68%	318	87%
RIPON	251	69%	328	90%
CONFLUENCE	221	61%	303	83%
VERNALIS	205	56%	279	76%

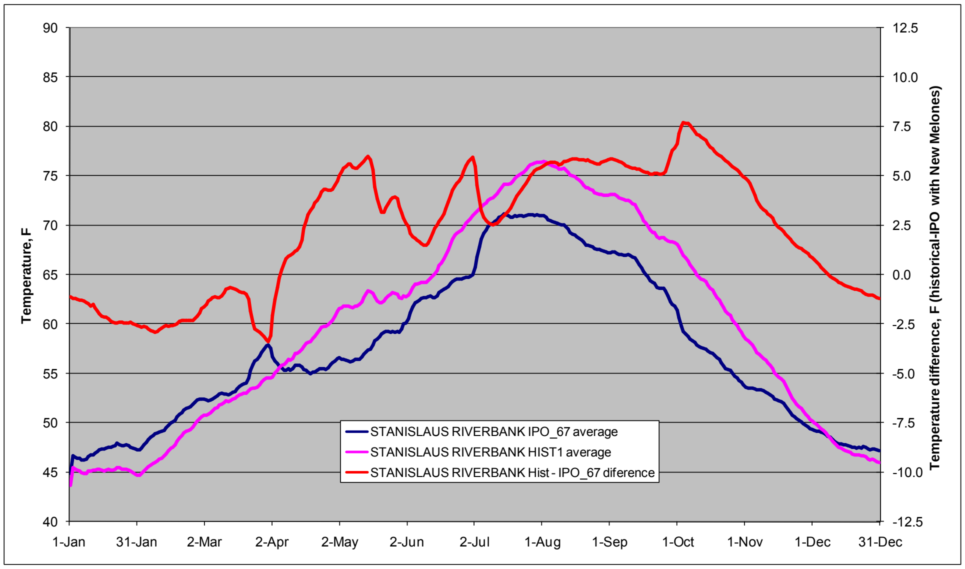
The primary reason for the cooling effect under the "Actual" conditions is the increased storage in New Melones. Old Melones Reservoir had a storage capacity of approximately 110 thousand acre-ft while New Melones Reservoir storage capacity is approximately 2.4 million acre-ft. Old Melones Reservoir would cycle from full to empty on a yearly basis thus either spilling large quantities of water during the flood control season or passing through low flows when the reservoir is empty. New Melones Reservoir, on the other hand, has significantly larger capacity for carry-over storage that allows regulating releases as well providing cool water supply. This observation is demonstrated in Figure 5 which shows reservoirs storages for Old and New Melones, Goodwin release and water temperatures downstream to Goodwin Dam.

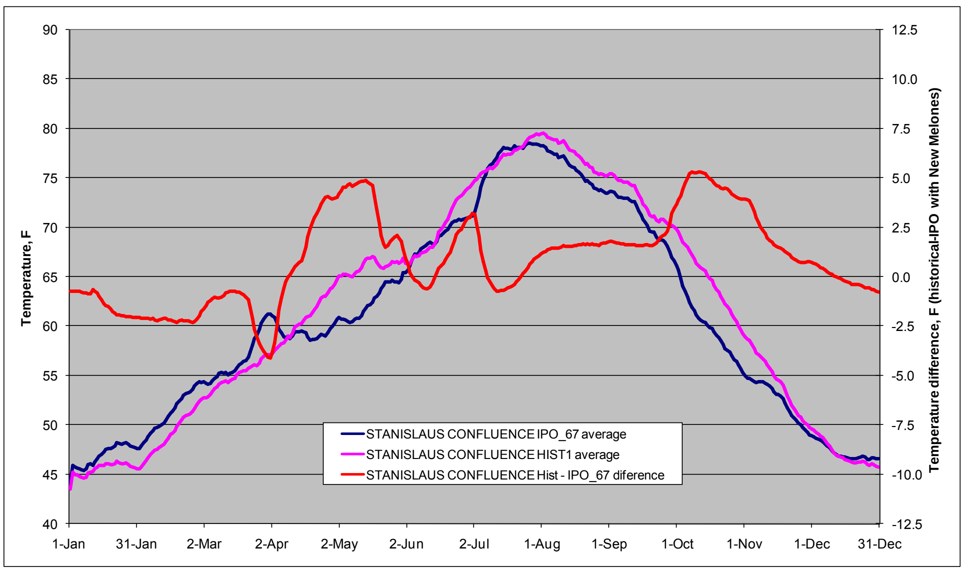
Another observation is the blending effect of Stanislaus River water with the water in the main-stem SJR the at confluence which is often already at ambient temperature (due to the long travel time from the upstream reservoirs, as will be discussed later in the report). As such, the differences between "Historic" and "Actual" temperatures diminish by the time the water reaches Vernalis.

It should be noted that for quality control purposes, model results for the "Historic" temperatures at Vernalis were compared with observed data. As shown in Figure 6, the comparison indicates that the model under-predicts the observed temperatures slightly, indicating that the model results are conservative from a temperature increment standpoint. Nevertheless, model results have a high degree of reliability with a coefficient of determination R^2=0.945, as shown in Figure 7.

The second assessment is supported by Figure 8 to Figure 10. These figures show the temperature objectives proposed by CDFG at Riverbank, the confluence (of the Stanislaus with SJR) and Vernalis and the computed "Historic" temperatures at these locations. The results show that systematically, the temperatures "shave" the beginning and ending periods specified for the objectives. Examples for an above-normal year (1970) and for dry year (1968) are provided in Figure 9 and Figure 10, respectively.

Figure 3 - Average Daily Temperatures at Riverbank, Confluence and Vernalis (1967-1982)





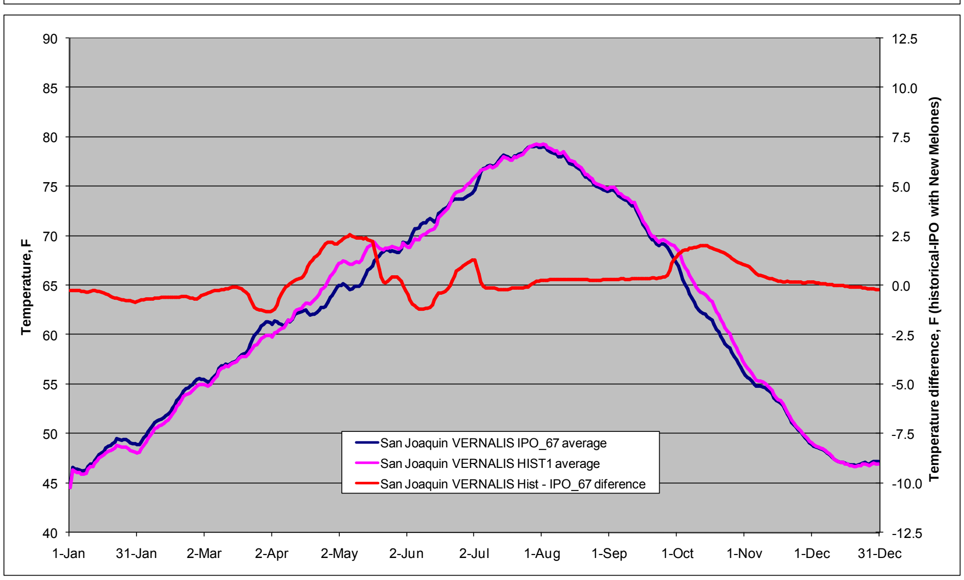
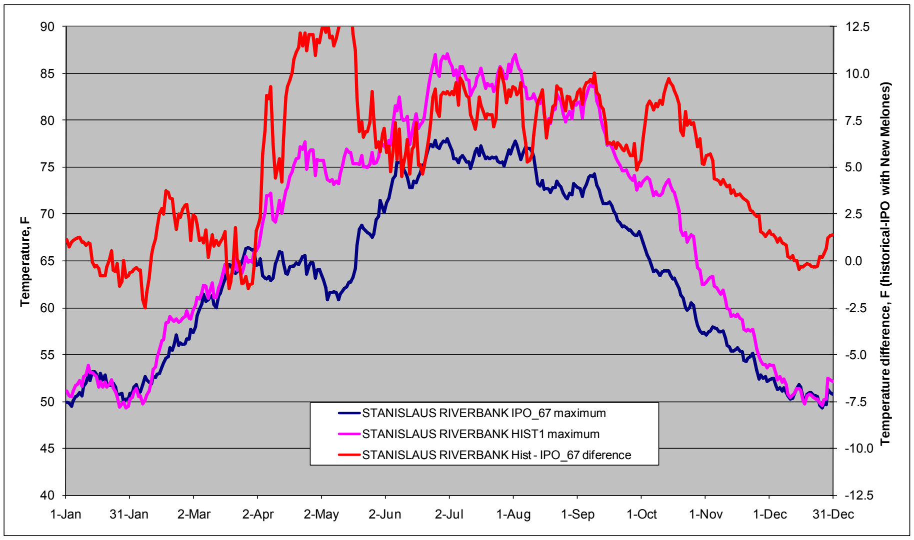
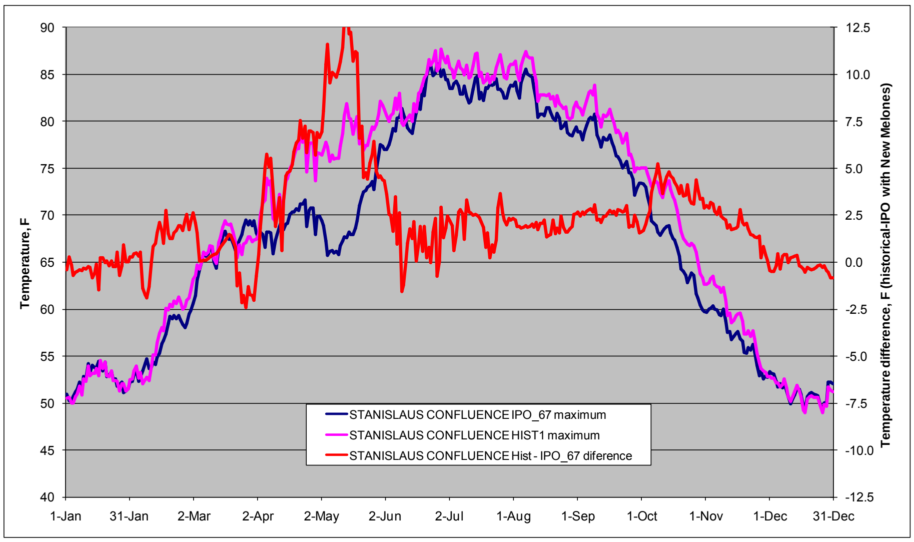


Figure 4 - Maximum Daily Temperatures at Riverbank, Confluence and Vernalis (1967-1982)





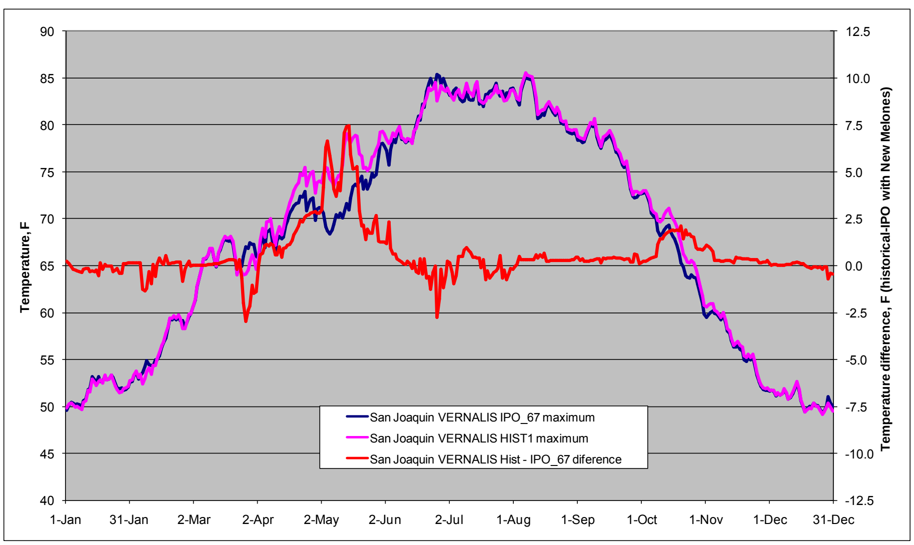


Figure 5 – New and Old Melones Storage, Goodwin Releases and Goodwin Temperatures under "Historic" (HIST1) and "Actual" (IPO_67) Operations.

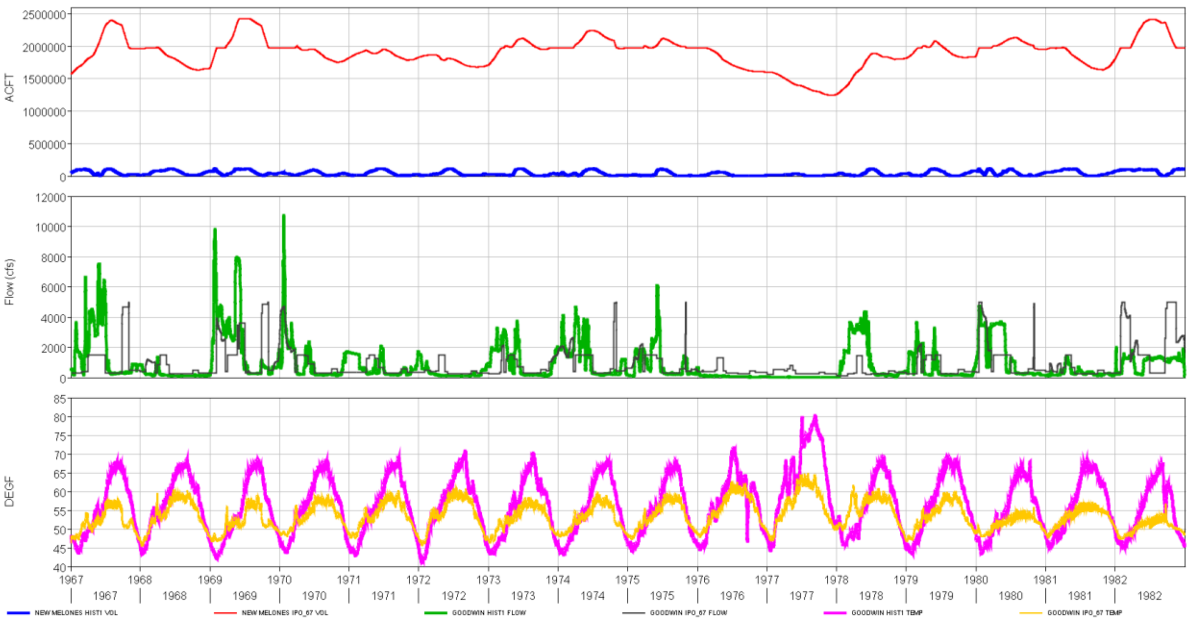


Figure 6 – Computed vs. Observed Temperatures at Vernalis for the "Historic" Conditions

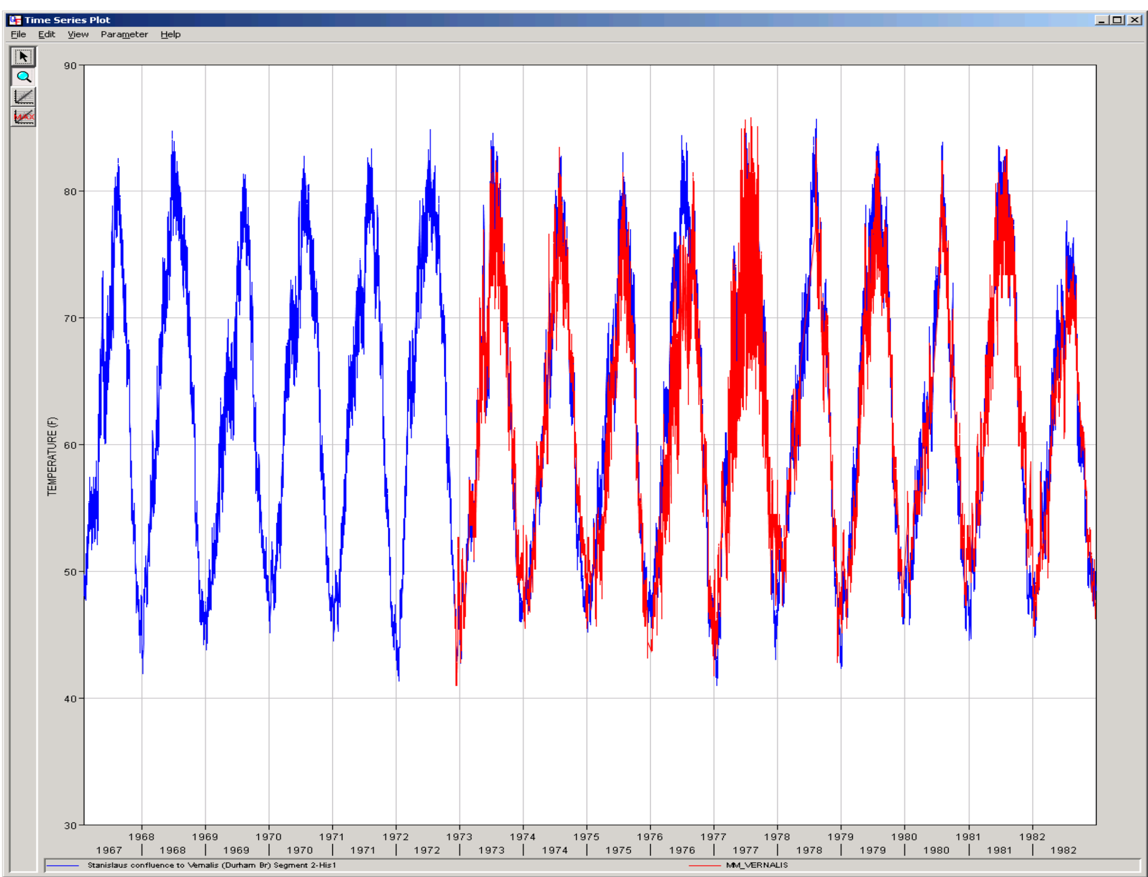


Figure 7 – Correlation between Computed vs. Observed Temperatures at Vernalis for the "Historic" Conditions

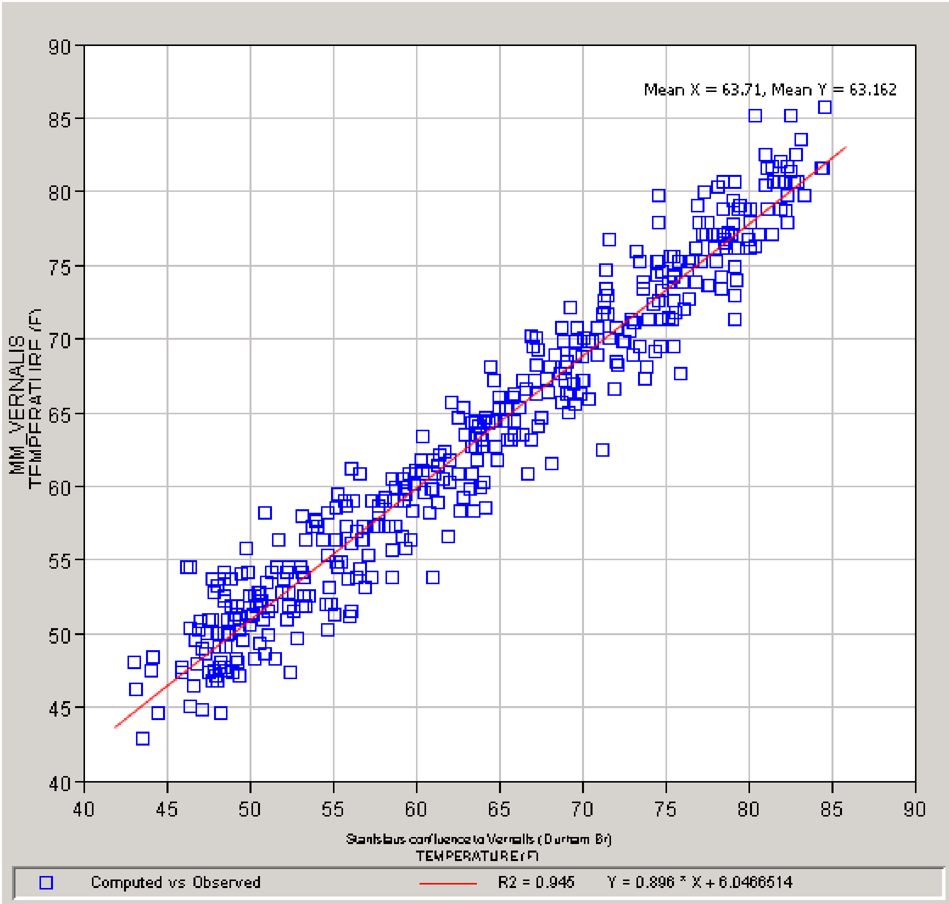
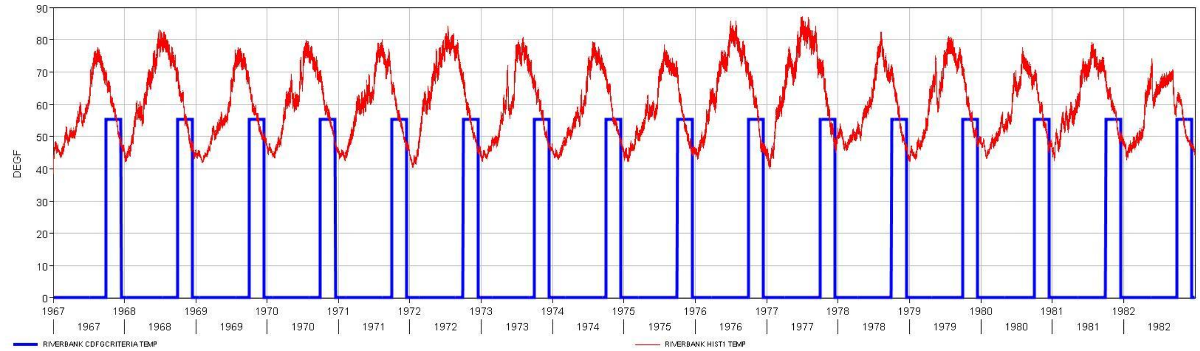
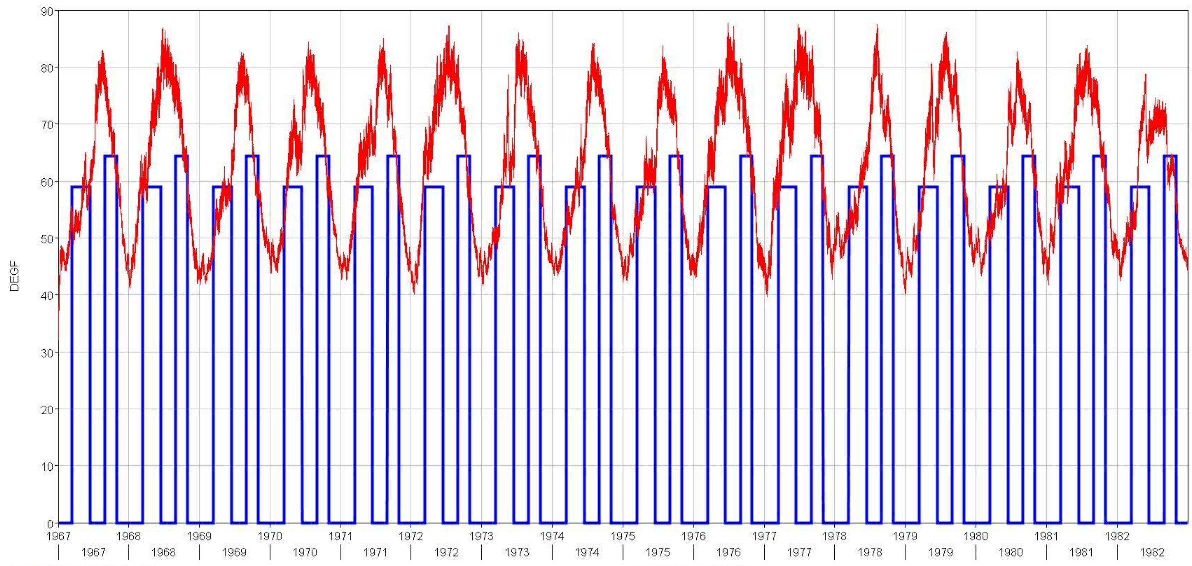


Figure 8 – "Historic" Temperature with respect to CDFG Proposed Temperature Objectives at Riverbank, Confluence (Stanislaus with SJR) and Vernalis.





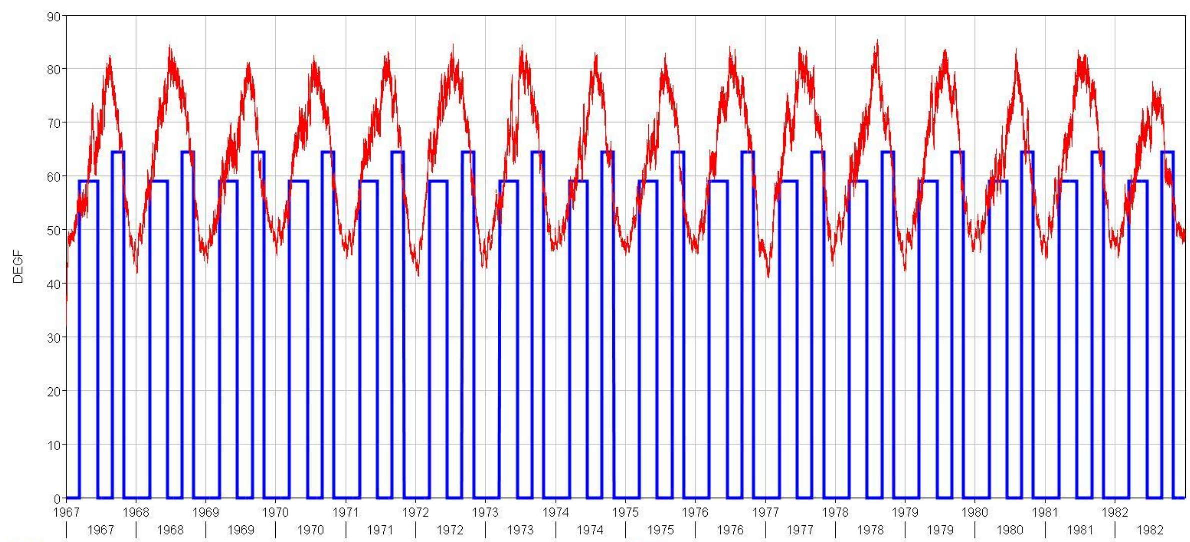


Figure 9 – "Historic" Temperatures vs. CDFG Objectives at the Confluence in Above-Normal Year (1970)

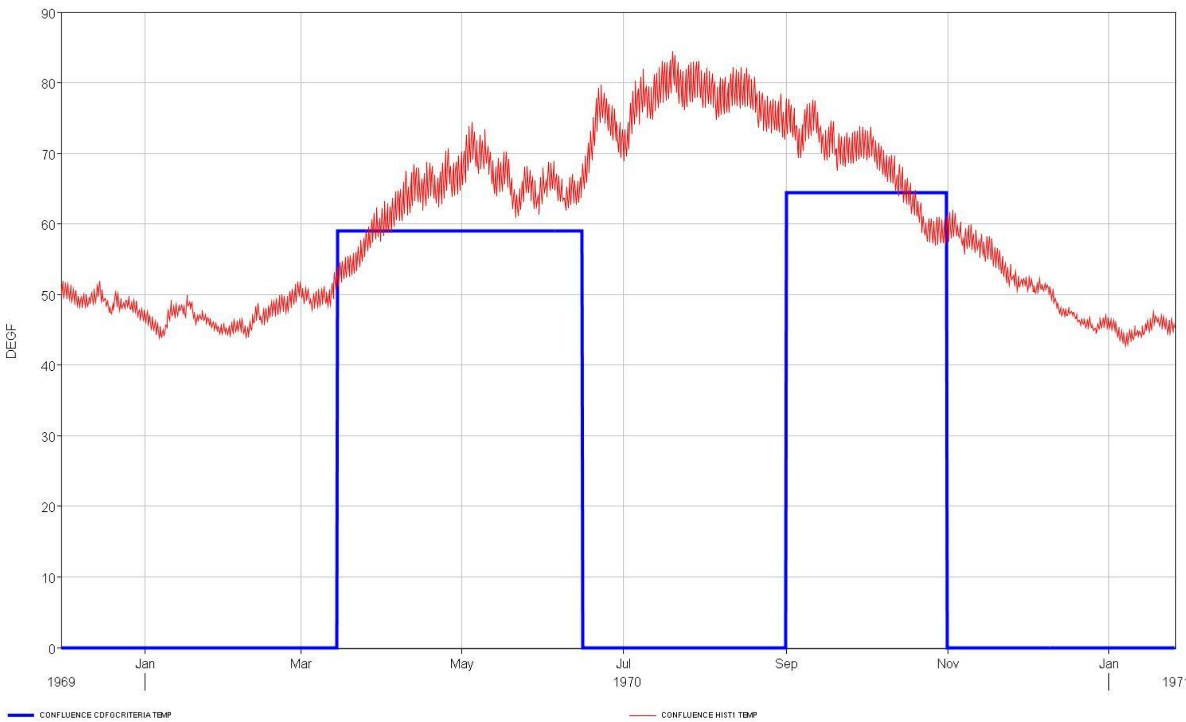
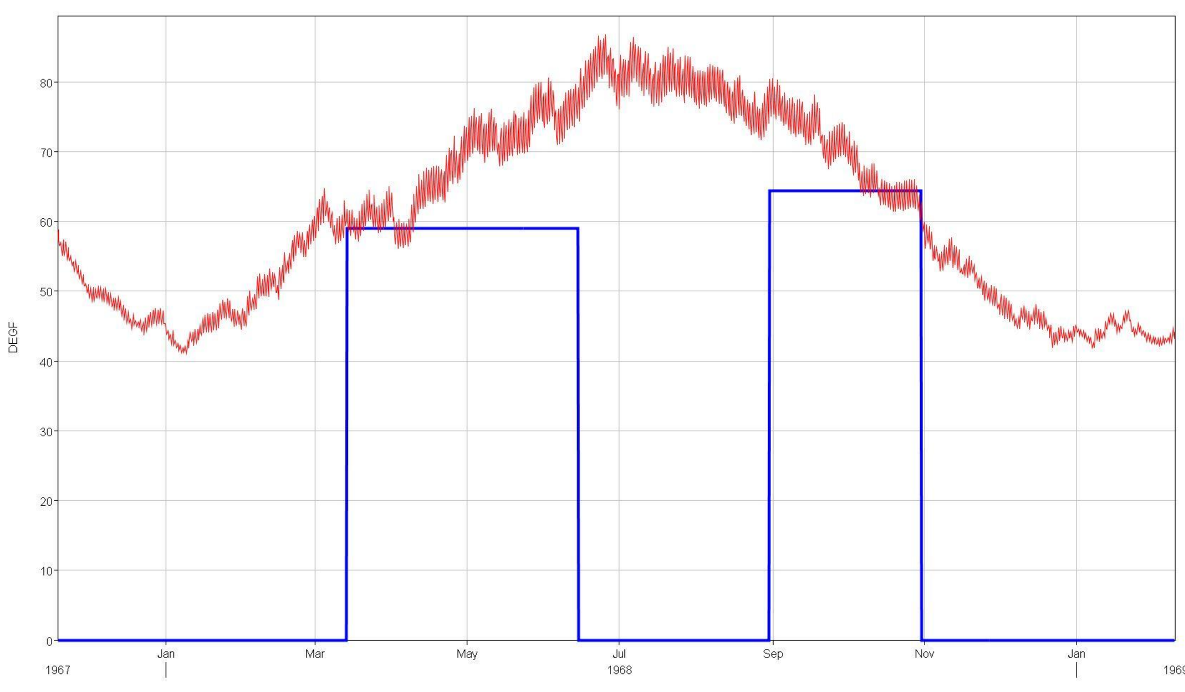


Figure 10- "Historic" Temperatures vs. CDFG Objectives at the Confluence in Dry Year (1968)



2. Can the IPO[1] or Augmented IPO Meet CDFG Criteria?

Assessment of results:

1) *The CDFG recommended criteria cannot be met most of the time under the current IPO or Augmented IPO.*
2) *Using New Melones as a surrogate to reduce water temperatures at Vernalis, through an Augmented IPO, could result in prolonged periods of an empty New Melones Reservoir, yet with minimal ability to meet CDFG recommended criteria.*

The above assessments are supported by the following figures:

Figure 11 and Figure 12 show the percent of the time, during the period 1980-2003, that maximum water temperature conditions at Vernalis equaled to or exceeded CDFG objectives (criteria), for the following cases:

- Historic flows[2].
- IPO flows.
- Augmented IPO flows.

Also shown in the figures are CDFG temperature objectives for the fall (in Figure 11) and spring (in Figure 12). A summary of these figures is presented in Table 2. It shows that although temperatures at Vernalis can be reduced somewhat by augmenting IPO releases from New Melones, the CDFG objectives still cannot be met the majority of the time.

Like in Task 1 above, the results show that systematically, the temperatures “shave” the beginning and ending periods specified for the objectives.

An example for the extent of the thermal improvement at Vernalis due to the Augmented IPO in relation to CDFG objectives is presented in Figure 13. The figure shows computed temperatures at Vernalis for a sequence of 4 years: 2000 to 2003. During this time frame, IPO releases were increased by a total of approximately 600, 000 AF or 155,000 AF annually. At the same time, the number of days during the fall and spring when the increased releases lowered water temperatures to the compliance level, as defined by CDFG objectives, is 17 or approximately 4 days per year.

The ramification of the increased releases (under the Augmented IPO) from New Melones storage is depicted in Figure 14. The figure shows that for the analysis period 1980-2003, New Melones Reservoir would have been dry for solid two and a half years during 1990 to 1993 and again in late 1994 with limited ability to recover in between. New Melones storage would also drop below 500,000 AF in 2003.

[1] The flow regime downstream of New Melones Reservoir is primarily characterized by the current Interim Plan of Operation (IPO) between the USBR and the California Department of Fish and Game that was signed in 1987. The IPO defines allocation of water from New Melones for fishery, Vernalis water quality, Bay-Delta and Central Valley Project contractors as function of New Melones storage and projected inflow. A more complete description of the IPO is attached as Exhibit G to the SJRGA’s November 19, 2007 comments.

[2] Historic flows in this context are daily releases based on actual operation.

Table 2 – Percent of the Time Maximum Temperatures at Vernalis are Equal to or Greater Than CDFG Objectives.

	Fall	Spring
	(9/1 to 10/31)	(3/15 to 6/15)
	% of Time	% of Time
Case	Max Temp >= 59 F	Max Temp >= 64.4 F
Historic Flows	73.4%	93.3%
IPO Flows	71.7%	94.1%
Augmented IPO Flows	67.0%	94.2%

Figure 11 – Duration Curves for Maximum Water Temperatures at Vernalis in the fall (9/10 to 10/31)

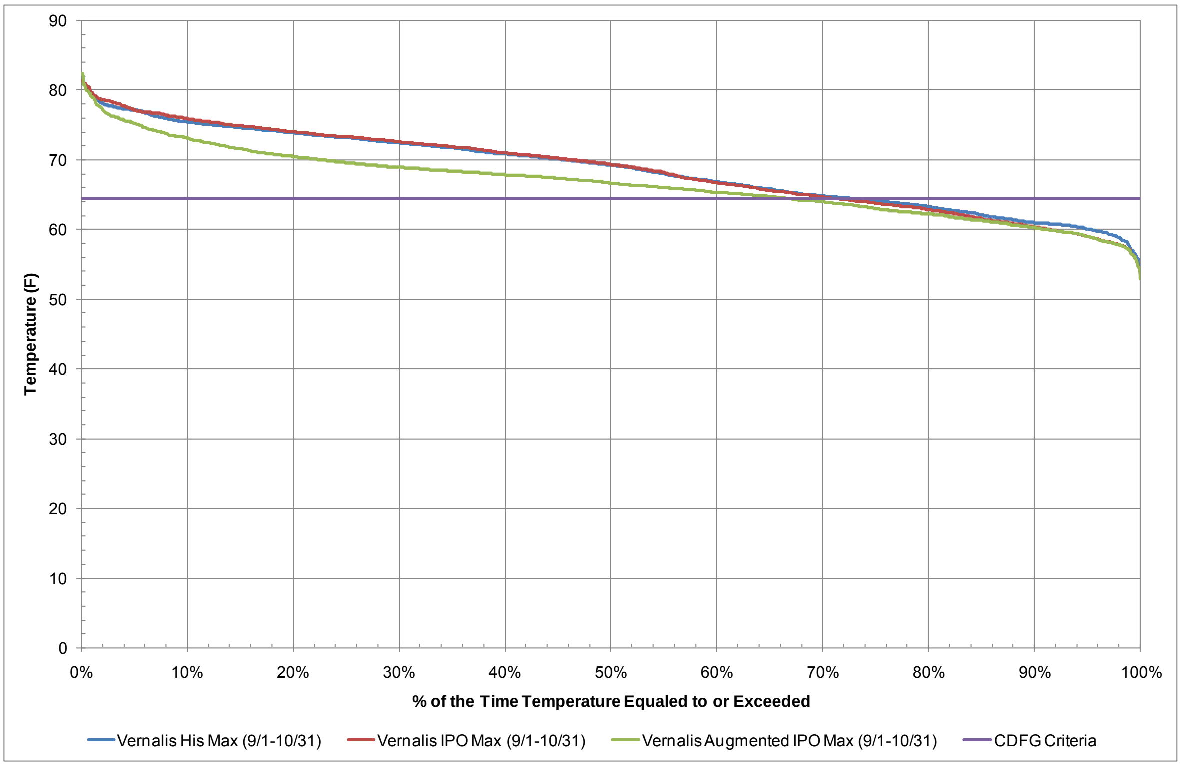


Figure 12 - Duration Curves for Maximum Water Temperatures at Vernalis in the Spring (3/15 to 6/15)

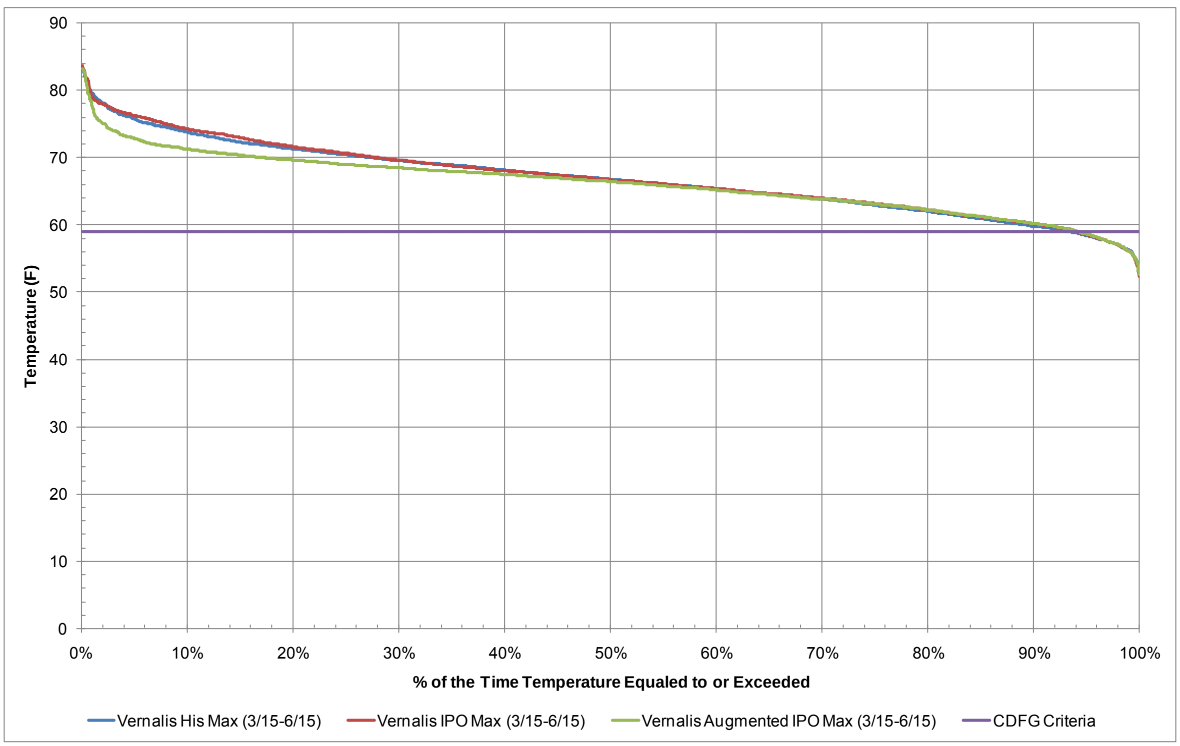


Figure 13 – Potential Thermal Improvements at Vernalis by Augmenting IPO releases and the Effect on New Melones Storage.

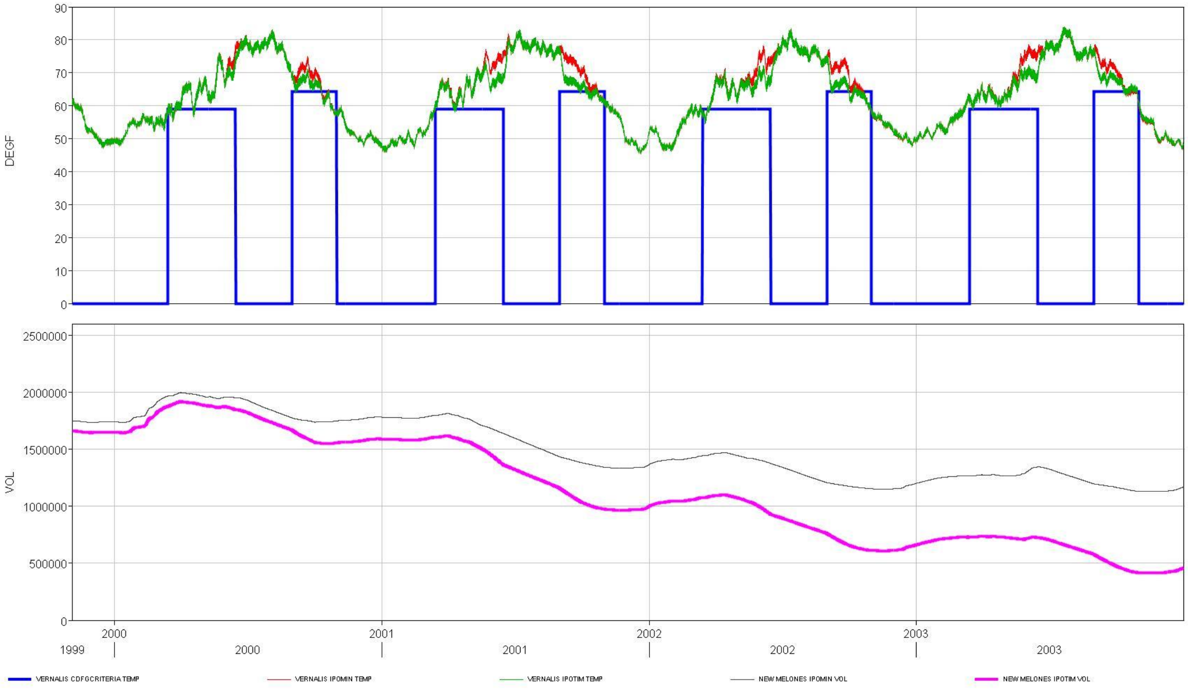
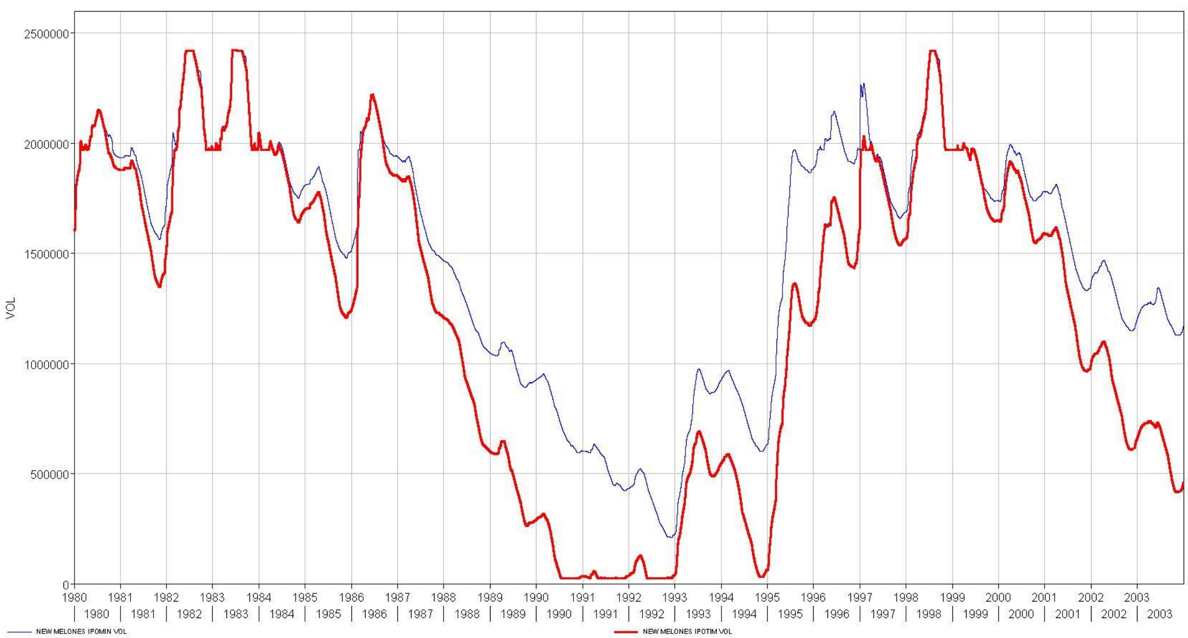


Figure 14 – New Melones Storage under the IPO and Augmented IPO



3. Can CDFG Criteria at Vernalis Be Met by Increasing Flows from the Tributaries?

Assessment of results:

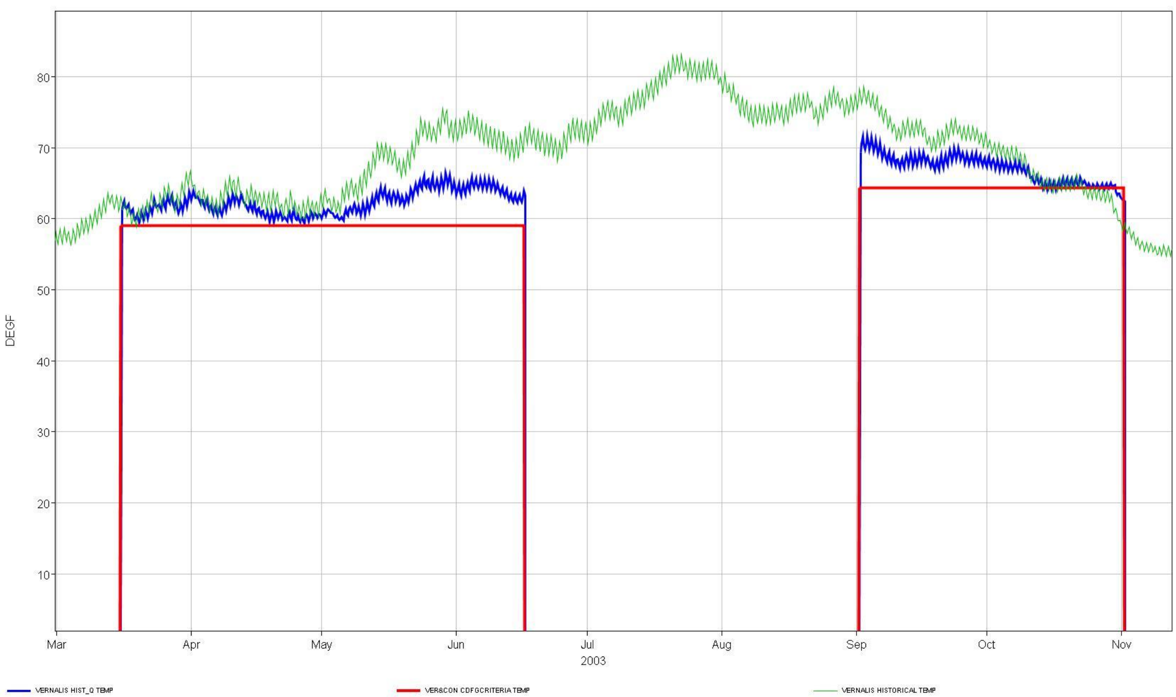
1) *Attainment of temperatures at the confluences may have improvement to temperatures at Vernalis depending on the portion of the flow from each tributary and the time of the year*.
2) *However, attainment of temperatures at the confluences will not be enough to meet the Vernalis temperature criteria recommended by CDFG.*

The first assessment is supported by a typical example in Figure 15. This figure shows two lines that represent computed temperatures at Vernalis for historical flows:

1) HISTORICAL – This is the computed temperatures at Vernalis for the historical conditions.
2) HIST_Q – This is a hypothetical case in which water temperatures at the confluence of each tributary were artificially set to equal CDFG's proposed temperature criteria (59 F for the spring and 64.4 F for the fall).

The graph shows that if, theoretically, water would leave the three tributaries at temperatures equal to CDFG criteria, it could reduce temperatures at Vernalis in late spring and early fall. The graph also shows less temperature improvements in early spring and late fall since in both cases the water approaches ambient temperatures.

Figure 15 – Vernalis Historical Vs. Modified Historical Temperatures Assuming Attainment of CDFG Temperature Criteria at the Three Confluences (Stanislaus, Tuolumne and Merced).



The second assessment is supported by series of runs that were built on top of the Hist_Q case above.

Summary of these runs are given in Table 3. The table shows that, on average, maximum temperatures at Vernalis cannot be met regardless of the amount released from each tributary, even if the initial temperature conditions are artificially set to equal CDFG criteria.

Table 3 – Vernalis average maximum temperatures given different release cases from the tributaries with initial water temperatures set to equal CDFG criteria.

Case	Minimum Flow (cfs) Stanislaus	Minimum Flow (cfs) Tuolumne	Minimum Flow (cfs) Merced	Vernalis Average Max Temperatures (F) Period Spring	Period fall
CDFG CRITERIA	na	na	na	59.0	64.4
HIST_Q	Historic	Historic	Historic	62.8	66.7
SR_M2000	2000	Historic	Historic	62.1	65.3
TR_M1000	Historic	1000	Historic	62.5	65.8
MR_M1000	Historic	Historic	1000	62.8	66.1
TRMR_M1000	Historic	1000	1000	62.5	65.7
S2000_MT1000	2000	1000	1000	62.1	65.1

4. What is the Impact of Friant Restoration on Temperature in the SJR?

Assessment of results:

1) *Friant Restoration will have a minimal effect on temperatures in the SJR at the confluence with the Merced River.*
2) *However, since the Friant Restoration will introduce more water at the confluence, it will require larger releases from the Merced to reduce temperatures. This type of operation can be sustained for only a short period of time because of storage limitation on the Merced River and will not achieve the CDFG recommended criteria at the confluence.*

The above assessments are supported by the following figures:

Figure 16 shows the computed Historical and Settlement (Restoration) flows and temperatures in the SJR upstream to the confluence with the Merced for the period 1998-2001. The figure shows that although the Settlement flows are higher than the Historical, the temperatures are about the same. This phenomenon can be explained by the fact that due to the long travel time, the Friant water approaches equilibrium with ambient temperature by the time it arrives at the Merced confluence.

Figure 17 shows the extent of temperature reduction in the SJR at the confluence and the ramification of on Lake McClure storage when historical releases are augmented. The figure shows that in the first two years (1999 and 2000) that follow a wet year (1998) increased releases from Lake McClure could reduce temperatures at the confluence. However, due to the limited storage capacity of the reservoir, this type of operation will result in depletion of all the water by the third year (2001) and as such will not yield any temperature benefits thereafter.

Figure 16 – Flow and Temperature in the SJR Upstream to the Confluence with the Merced River

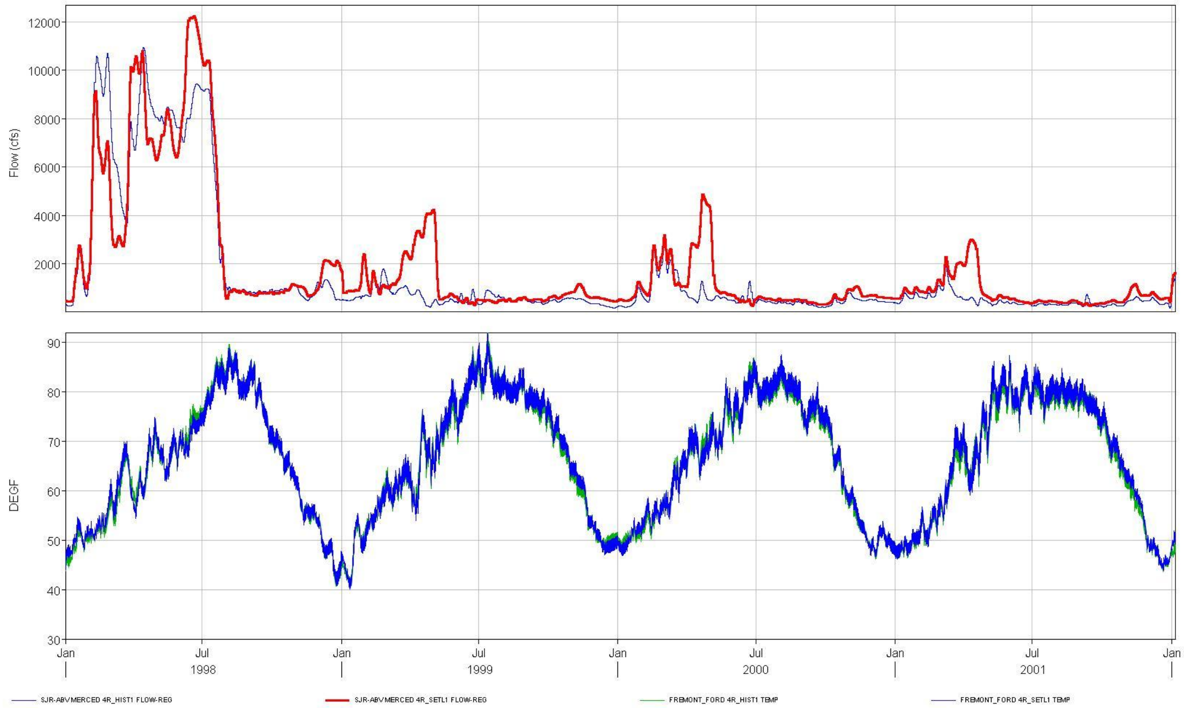
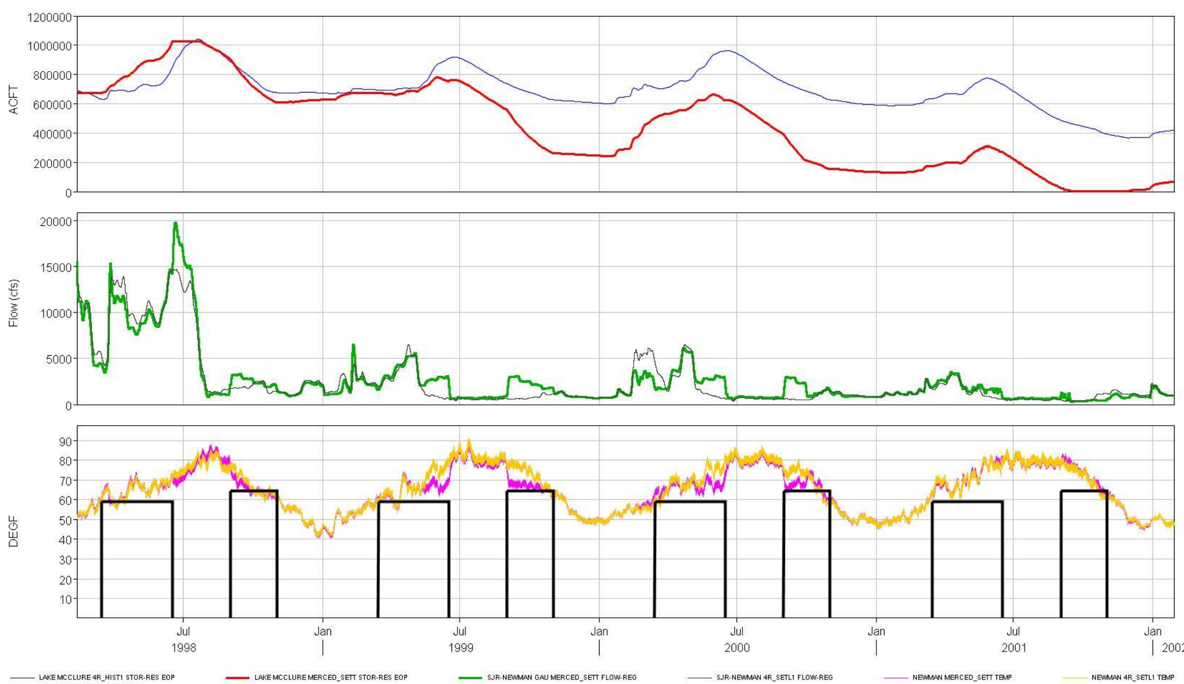


Figure 17 – Lake McClure Storage and Temperature Response at the Merced Confluence for Augmented Releases from the Merced River



5. **Is the SJR Temperature Impaired Even if All the Water in the Basin is Allocated for Fish Release ("All for Fish" case)?**

Assessment of results:

1) *If all the water in the SJR Basin would be allocated for fish release, most the SJR will still be considered temperature impaired, given CDFG temperature criteria and RWQCB impairment threshold.*

The above assessment is supported by the following:

Figure 18 is an example for the Stanislaus River that illustrates the concepts employed for "All for Fish" case: all the diversions are rerouted back to the river and reshaped in accordance with the spring and fall objectives periods, while maintaining the historical storage volumes in New Melones. This concepts was implemented as to all three the tributaries.

Table 4 shows summary results for Case 5. The table shows the RWQCP threshold of exceedances that defines temperature impairment, a number that varies depending on the number of samples. The count of exceedances is then tested against this threshold. If the number of exccedances is greater than the threshold, then by definition, there is temperature impairment.

As shown in the table, except for the Tuolumne and Stanislaus in the fall, in all other locations and periods there is temperature impairment, even if all the water in the SJR basin is allocated for fish release.

Figure 18 – Example of Concepts Employed in the "All for Fish" Case.

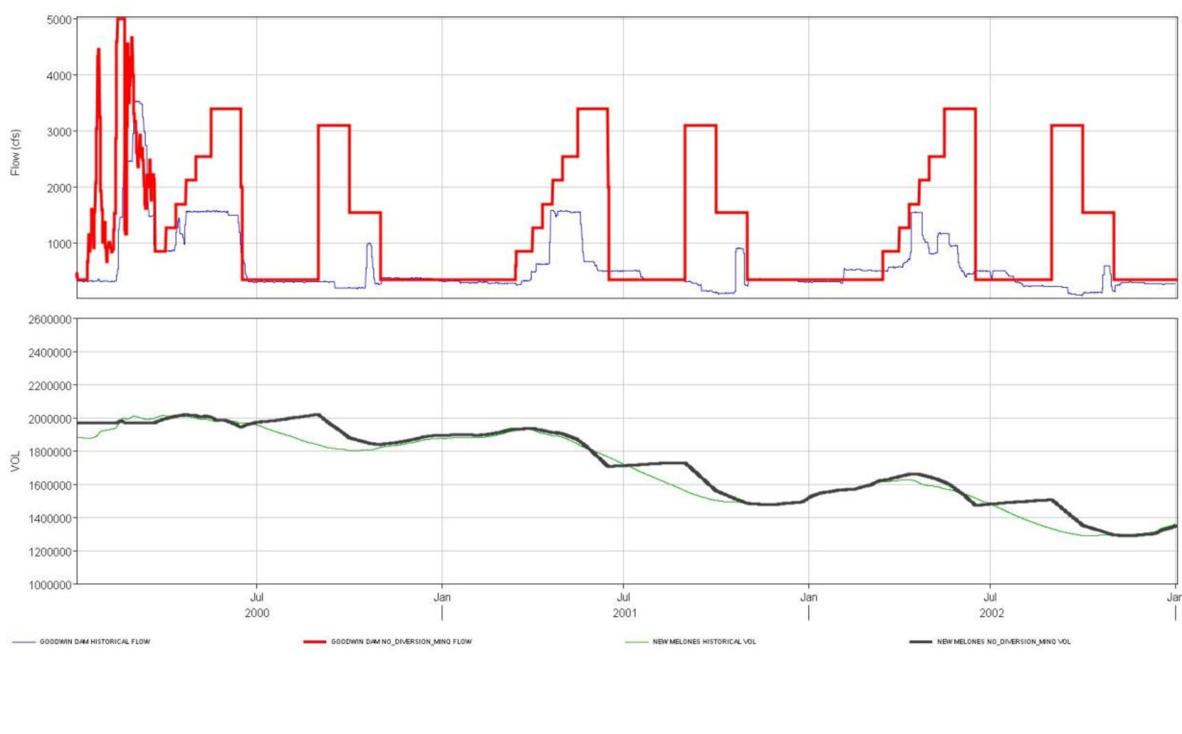


Table 4 – Summary of "All for Fish" case.

Number of samples >>	837	549
Threshold of exceedances for impairment >>	139	92
Counts of Exceedances		
Location	59 F Spring Criteria	64.4 F Fall Criteria
Merced River confluence	729	280
Tuolumne River confluence	410	7
Stanislaus River confluence	523	37
San Joaquin River at Vernalis	743	125

Note:

(yellow)	**Exceeds the threshold that defines impairment**

EXHIBIT C

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EXHIBIT D

TABLES

Table 1. Geographic and temporal distribution of spawning in the Stanislaus, Tuolumne and Merced Rivers.

STANISLAUS RIVER					
		Distribution of Redds[2]			
Date	%Redds Observed[1]	Goodwin	Knights Ferry to Horseshoe	Horseshoe to Oakdale	Oakdale to Riverbank
Before Oct 1	0.1%	100.0%	0.0%	0.0%	0.0%
Oct 1-15	1.5%	32.1%	61.3%	4.8%	1.8%
Oct 16-31	10.5%	17.5%	55.0%	24.5%	3.0%
Nov 1-15	29.4%	15.1%	51.4%	31.1%	2.5%
Nov 16-30	29.4%	13.6%	49.5%	33.6%	3.3%
Dec 1-15	19.0%	19.7%	38.9%	33.2%	8.2%
Dec 16-31	9.0%	14.5%	44.6%	34.3%	6.6%
Jan 1-15	1.1%	0.0%	46.5%	43.9%	9.7%

TUOLUMNE RIVER					
		Distribution of Redds[2]			
Date	%Redds Observed[1]	La Grange Dam to Basso Bridge	Basso Bridge to Turlock Lake	Turlock Lake to ~Waterford	~Waterford to Fox Grove
Before Oct 1	<0.1%	0.0%	0.0%	0.0%	0.0%
Oct 1-15	0.4%	69.6%	17.4%	10.1%	2.9%
Oct 16-31	9.6%	77.5%	18.4%	3.7%	0.3%
Nov 1-15	23.0%	70.5%	18.4%	9.4%	1.7%
Nov 16-30	28.6%	60.2%	21.0%	15.6%	3.2%
Dec 1-15	21.9%	61.4%	18.2%	14.3%	6.1%
Dec 16-31	13.7%	61.2%	19.6%	13.7%	5.5%
Jan 1-15	2.8%	67.2%	17.9%	11.6%	3.2%

MERCED RIVER					
		Distribution of Redds[2]			
Date	%Redds Observed[1]	Merced River Hatchery to Snelling Road	Snelling Road to Hwy 59	Hwy 59 to Shaffer Bridge	Shaffer Bridge to Santa Fe Road
Before Oct 1	0.0%	0.0%	0.0%	0.0%	0.0%
Oct 1-15	<0.1%	100.0%	0.0%	0.0%	0.0%
Oct 16-31	3.1%	71.1%	21.4%	7.1%	0.4%
Nov 1-15	26.1%	65.8%	25.8%	7.7%	0.8%
Nov 16-30	33.6%	60.4%	24.9%	12.5%	2.2%
Dec 1-15	23.8%	31.1%	29.7%	28.7%	10.6%
Dec 16-31	11.1%	17.5%	28.5%	33.5%	20.5%
Jan 1-15	2.4%	5.5%	26.4%	39.2%	28.9%

[1] Based on 1998-2005 CDFG spawning survey data.
[2] Based on 2000-2005 CDFG spawning survey data. CDFG indicated there are problems with earlier data.

Table 2. Revised assessment of temperature impairment summary for adult salmon migration in the Tuolumne River based on the corrected time period.

Tuolumne Salmon Migration Impairment Summary Max 7DADM Temperature												
Year	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**
1998	16.5	15.8	15.4	15.1	14.9	13.6	13.5	13.4	13.1	10.8	10.7	10.1
1999	19.3	18.9	16.8	16.7	16.0	15.3	14.8	12.6	12.1	11.0	10.3	10.4
2000	20.7	17.8	17.9	16.0	15.0	14.6	12.3	11.7	11.4	12.7	11.8	11.0
2001	No data available						16.1	15.3	12.5	12.1	11.1	10.8
2002	20.6	21.3	19.0	17.1	15.1	14.7	15.4	14.3	13.0	12.3	12.0	11.7
2003	21.8	19.9	18.7	18.4	15.6	14.9	14.6	12.4	11.3	13.0	12.0	11.5
2004	No data available								9.9	10.2	13.4	10.9
2005	19.9	19.0	17.3	16.7	15.9	15.0	14.3	12.1	10.8	10.0	9.9	11.0
2006	17.1	17.1	15.0	14.3	13.6	13.9	12.6	12.2	9.5	9.2	10.7	8.3
Average	**19.4**	**18.5**	**17.1**	**16.3**	**15.1**	**14.6**	**14.2**	**13.0**	**11.5**	**11.3**	**11.3**	**10.6**
Total number of observations												**92**
Number of observations >18C												**12**
Number of observations required to list												**16**

FIGURES

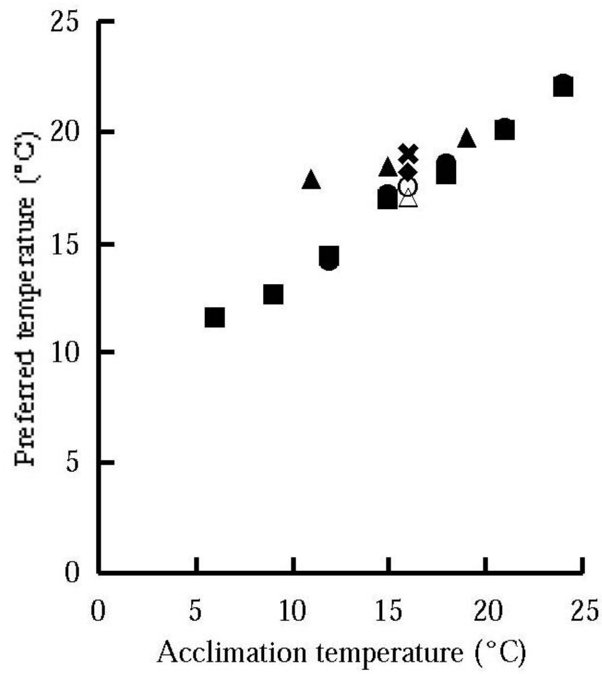


Figure 1. Relationship between preferred temperatures and acclimation temperatures for steelhead. From Myrick and Cech 2004.

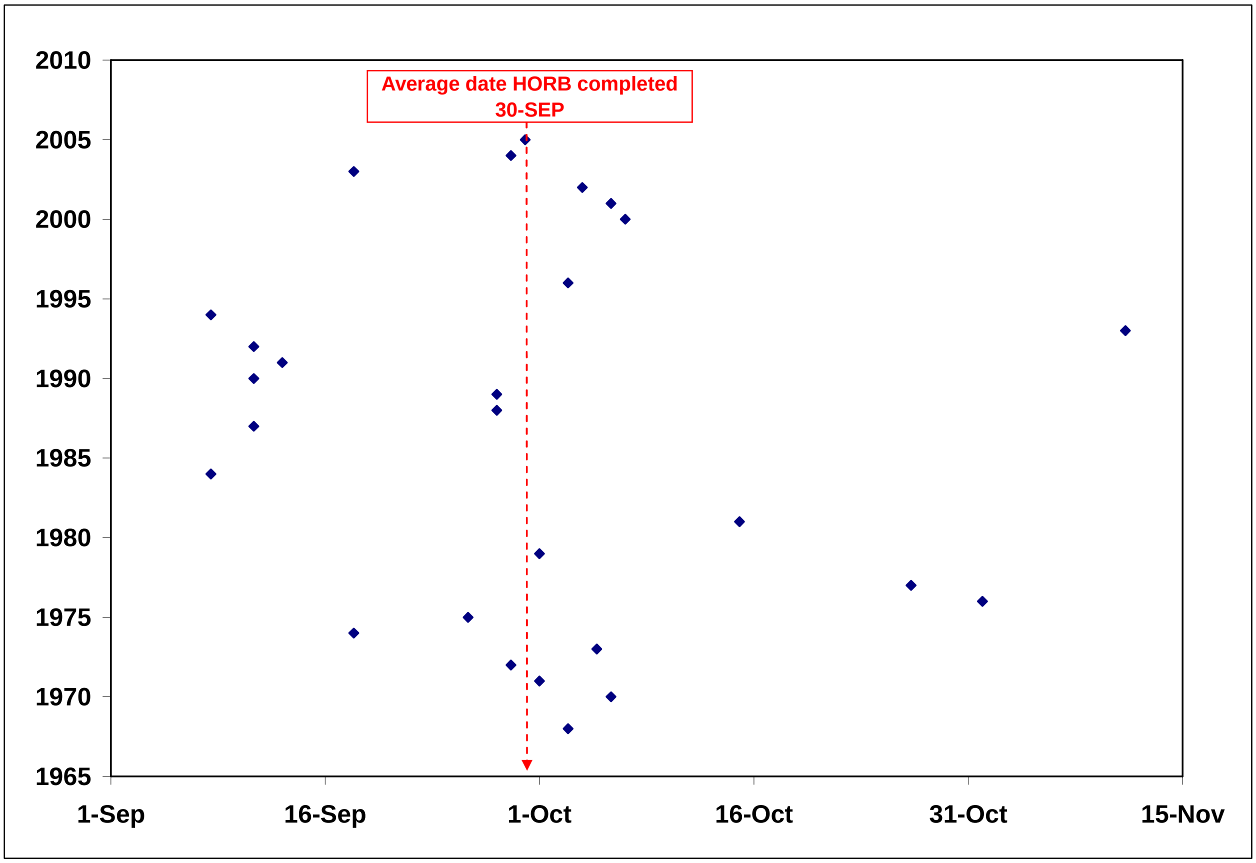


Figure 2. Timing of Head of Old River Barrier completion during fall 1968-2005.

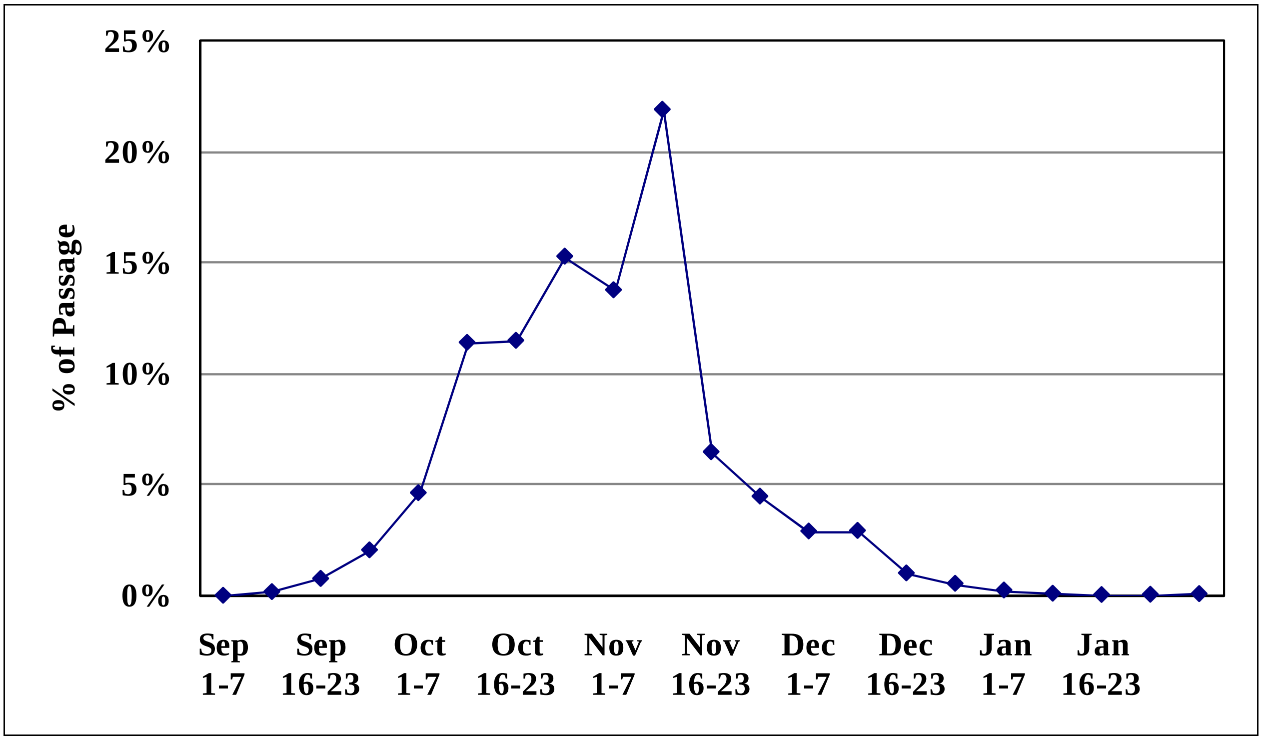


Figure 3. Generalized upstream migration timing pattern observed at the Stanislaus River Weir near Riverbank (River Mile 31.4) during 2003-2006.

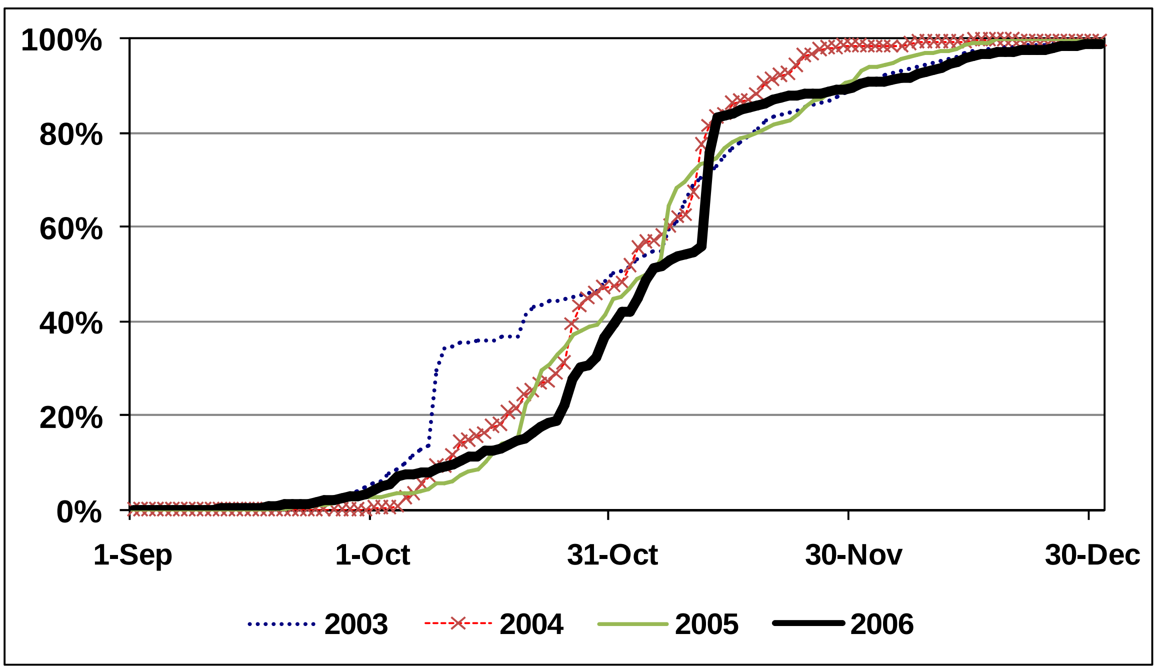


Figure 4. Cumulative passage at the Stanislaus River Weir during 2003-2006.

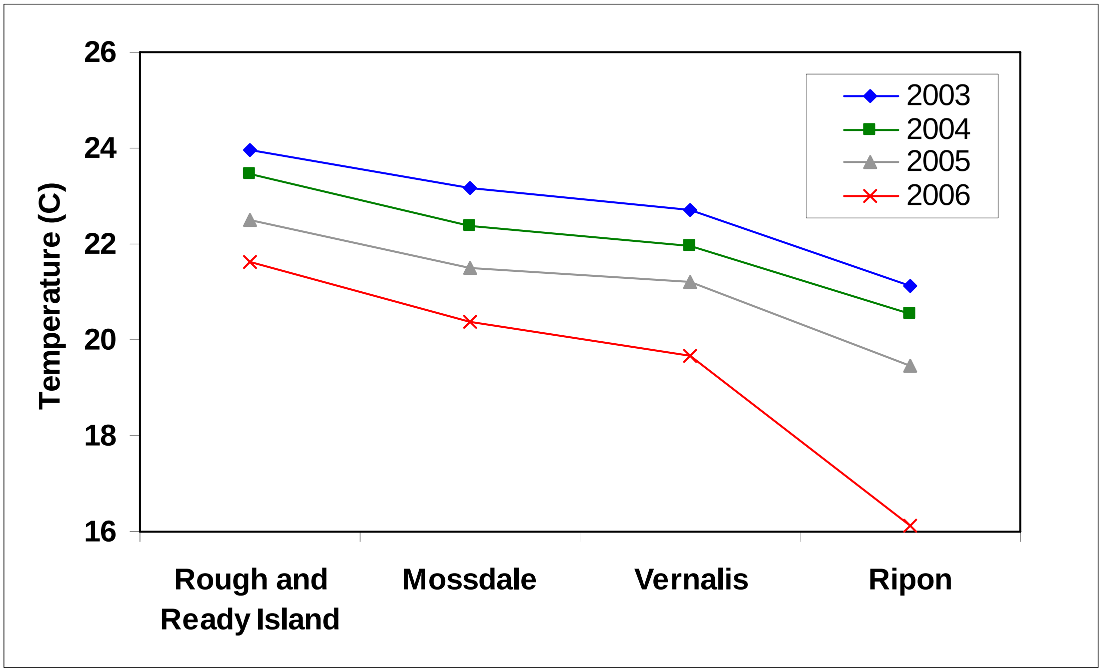


Figure 5. Average monthly temperatures in the San Joaquin and Stanislaus rivers during September 2003-2006.

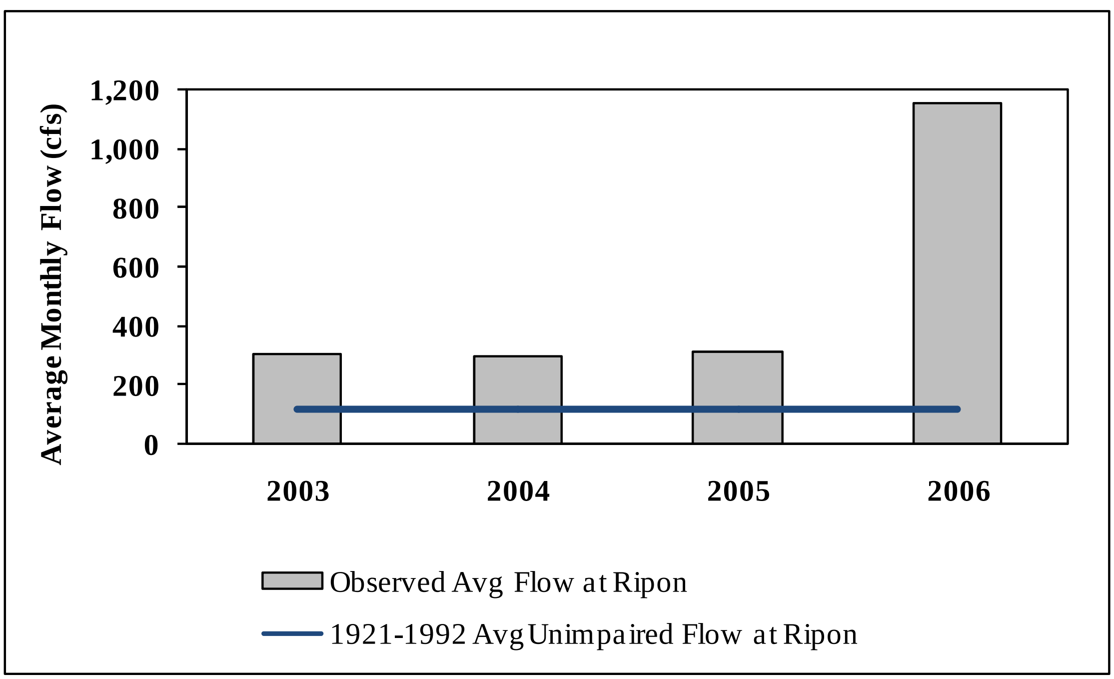


Figure 6. Average unimpaired monthly flow and observed average flow in the Stanislaus River at Ripon during September.

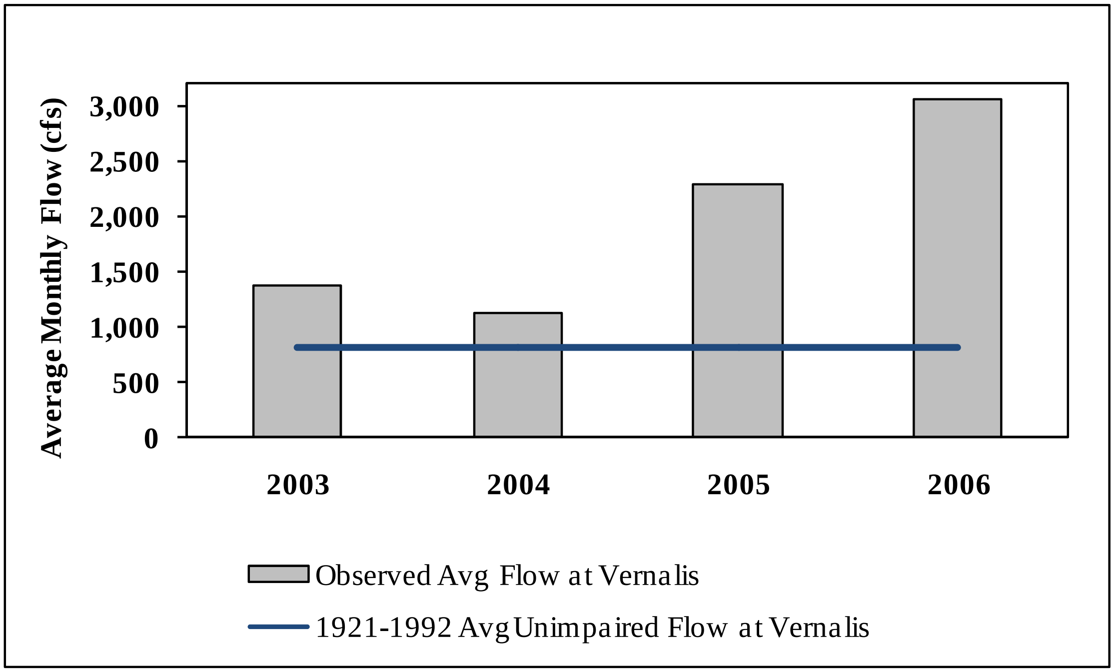


Figure 7. Average unimpaired monthly flow and observed average flow in the San Joaquin River at Vernalis during September.

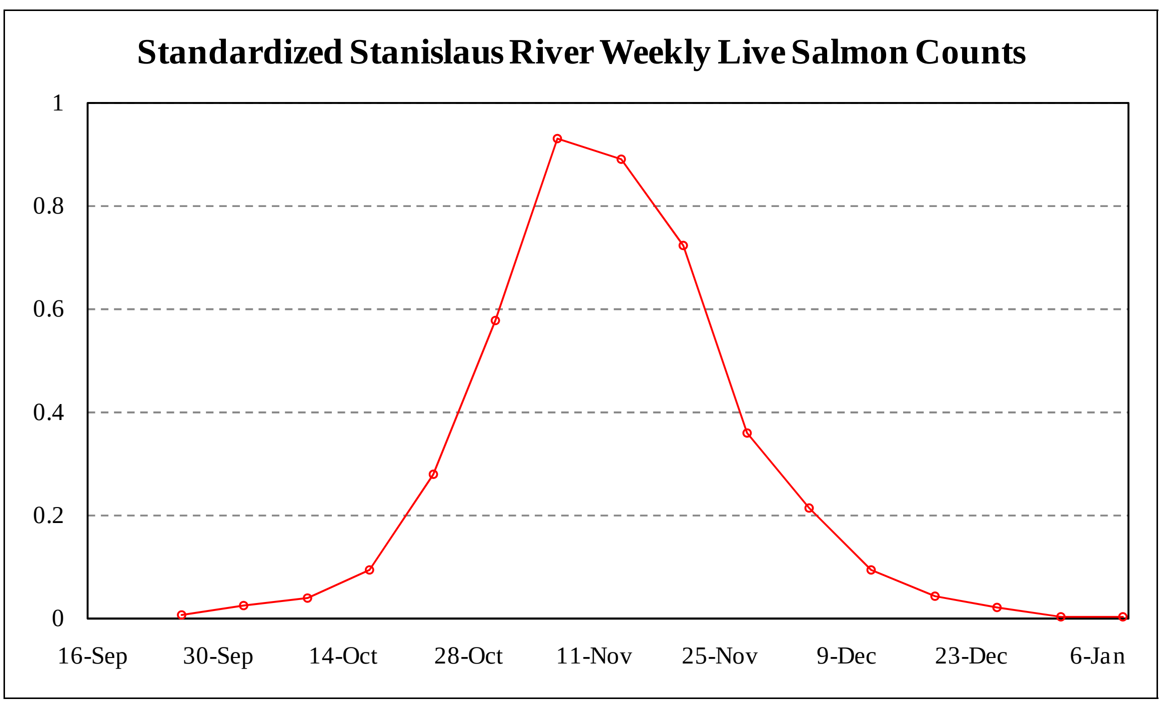


Figure 8. Standardized weekly live salmon counts from spawning surveys conducted on the Stanislaus River during 2000-2006.

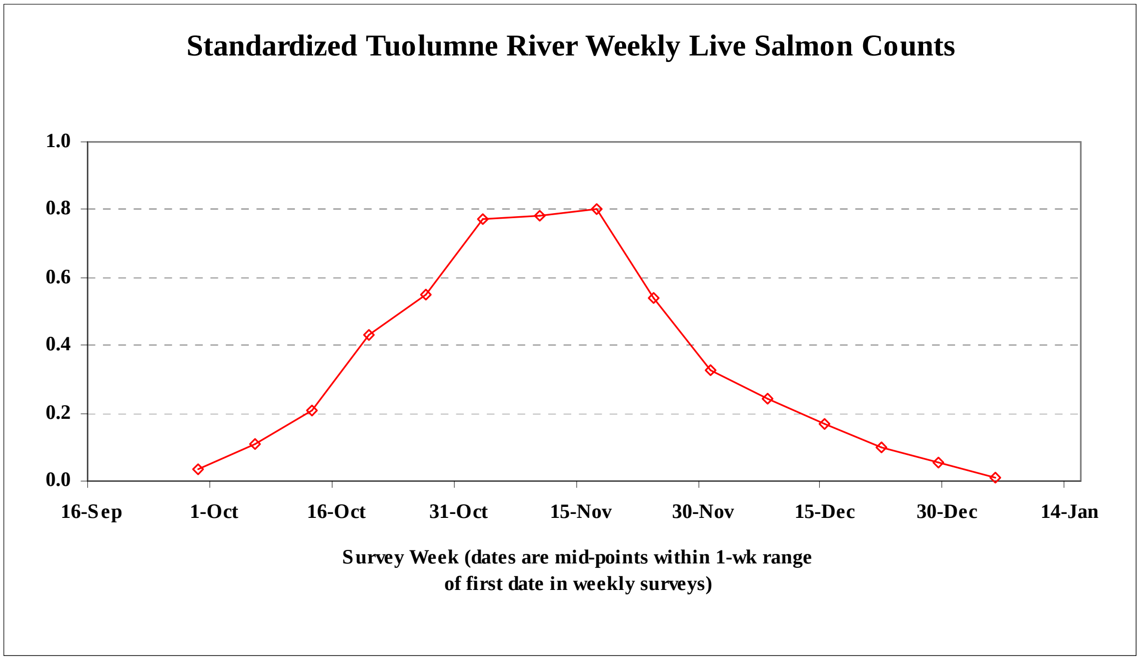


Figure 3. Standardized weekly live salmon counts from spawning surveys conducted on the Tuolumne River during 1982-2005.

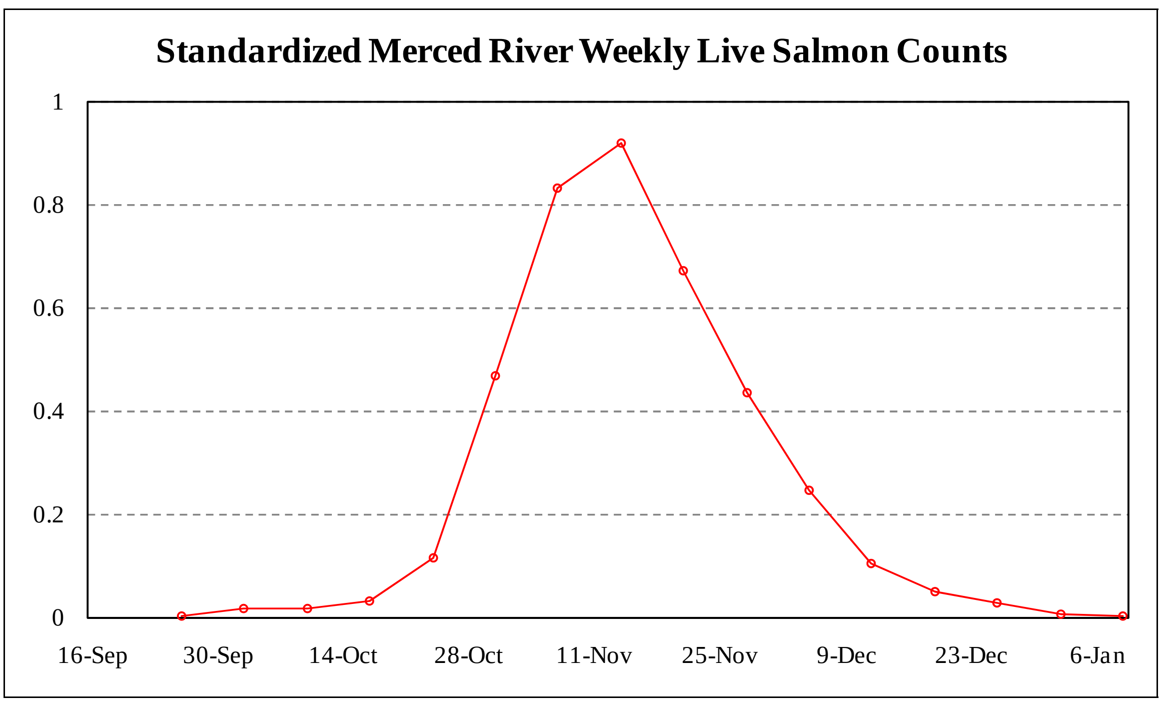


Figure 10. Standardized weekly live salmon counts from spawning surveys conducted on the Merced River during 1992-2005.

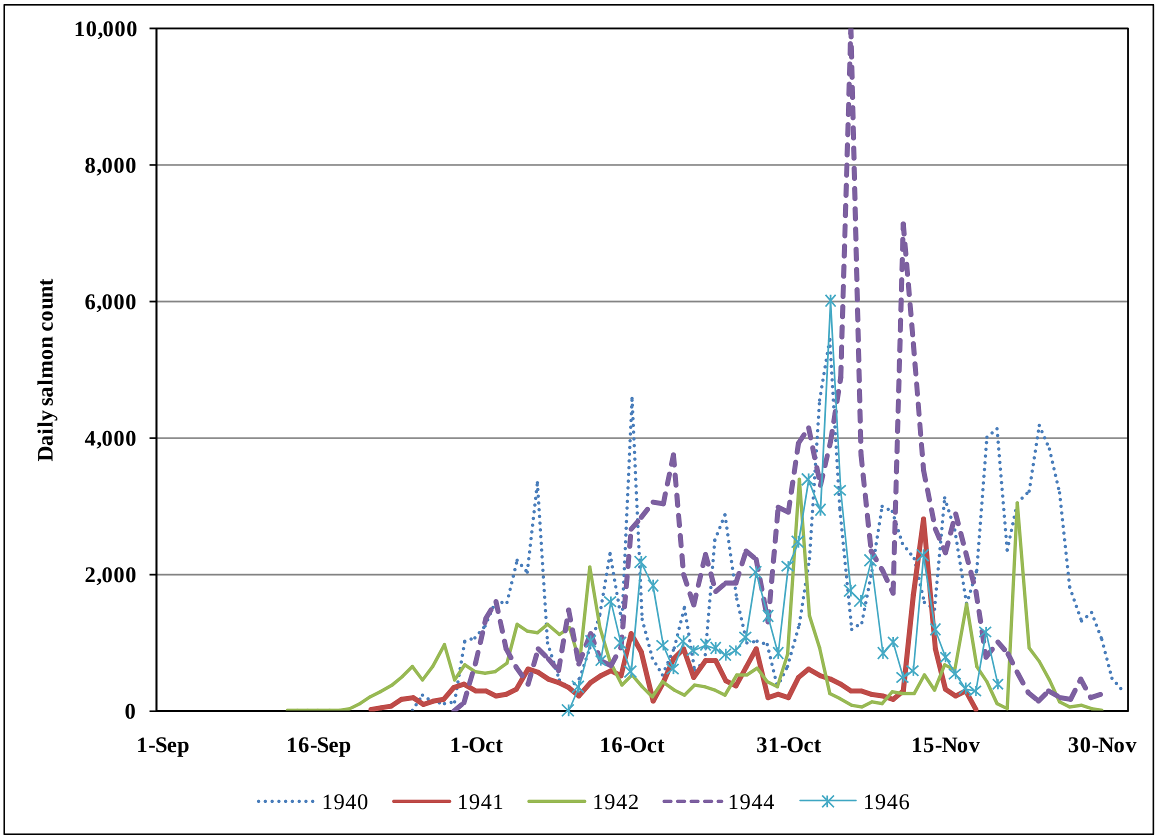


Figure 11. Daily adult salmon counts on the Tuolumne River during weir operations in 1940-1942, 1944, and 1946.

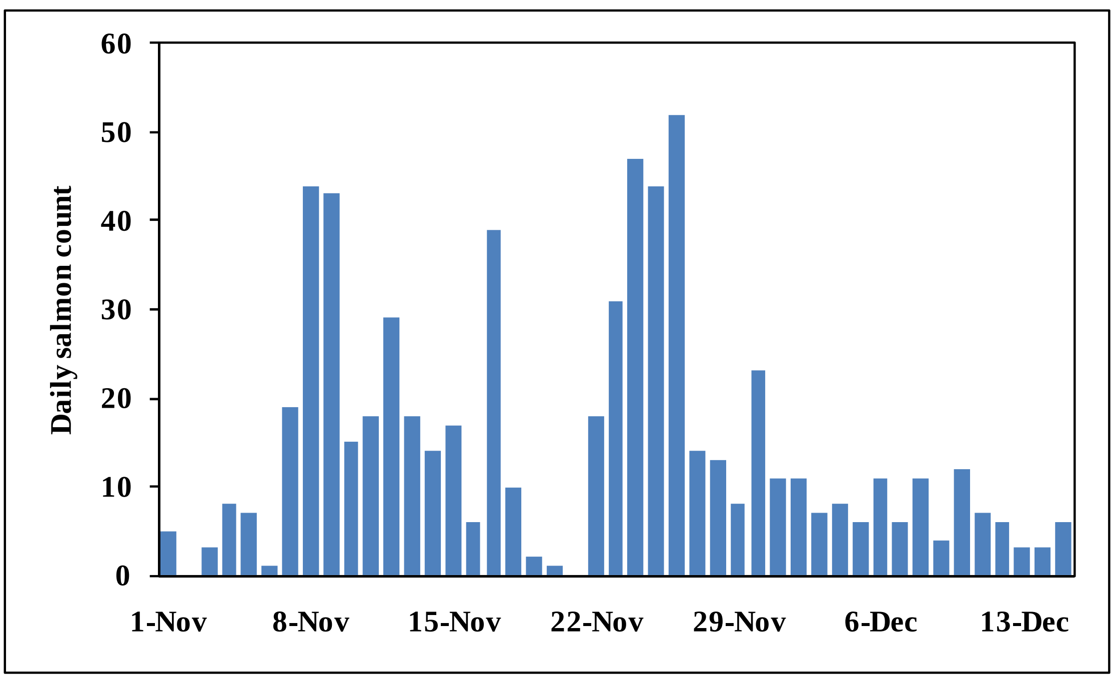


Figure 12. Daily salmon counts during operation of an adult upstream migrant trap in the San Joaquin River near Banta Carbona during 1977.

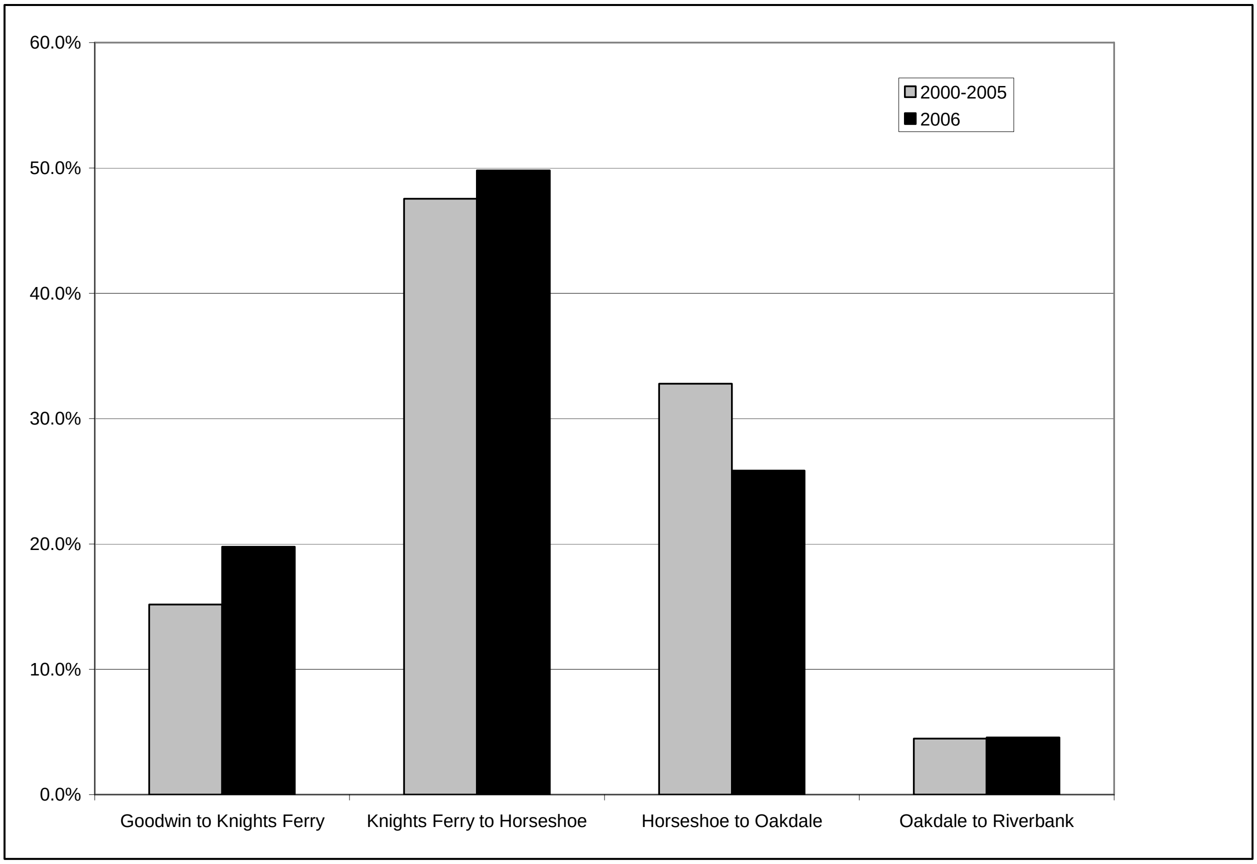
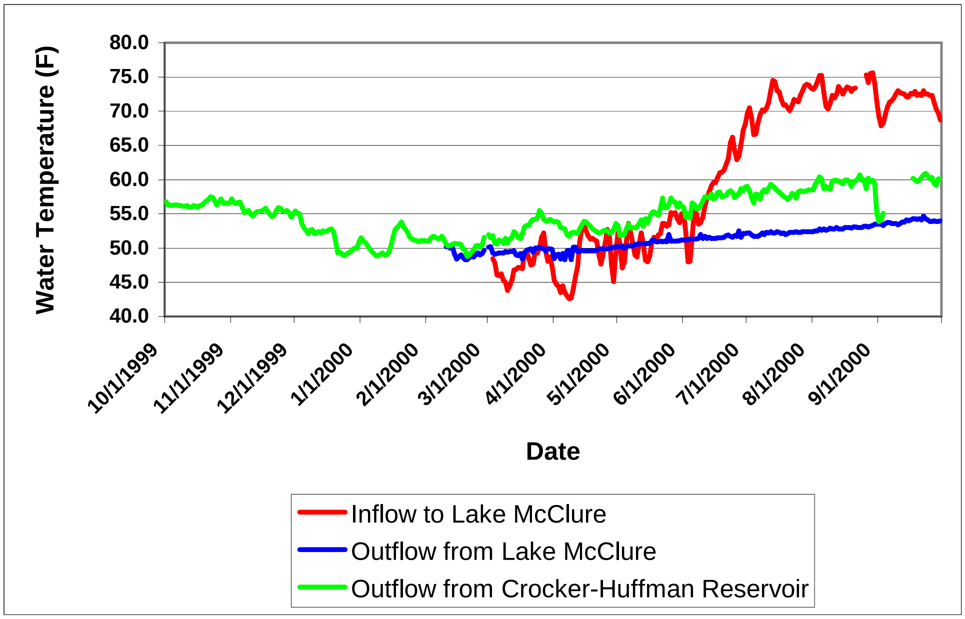


Figure 13. Distribution of redds in the Stanislaus River during 2000-2005 and 2006.

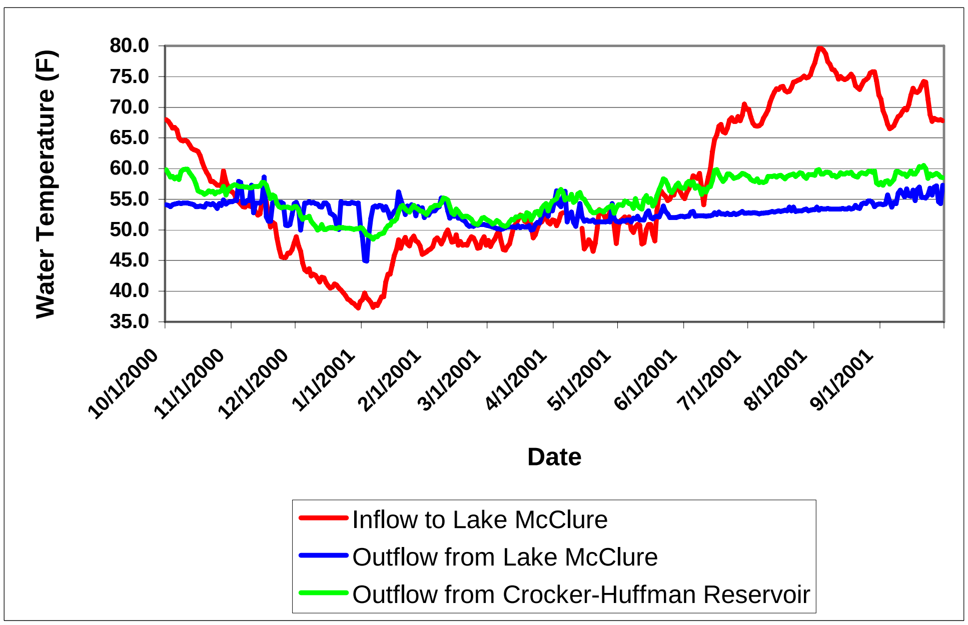
EXHIBIT E

AD Consultants (November 19, 2007) “SJR Temperature Modeling and Analysis” (enclosed compact disc)

EXHIBIT F



Water Temperature (F)
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
10/1/1999
11/1/1999
12/1/1999
1/1/2000
2/1/2000
3/1/2000
4/1/2000
5/1/2000
6/1/2000
7/1/2000
8/1/2000
9/1/2000
Date
Inflow to Lake McClure
Outflow from Lake McClure
Outflow from Crocker-Huffman Reservoir



Water Temperature (F)
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
10/1/2000
11/1/2000
12/1/2000
1/1/2001
2/1/2001
3/1/2001
4/1/2001
5/1/2001
6/1/2001
7/1/2001
8/1/2001
9/1/2001
Date
Inflow to Lake McClure
Outflow from Lake McClure
Outflow from Crocker-Huffman Reservoir

State of California - The Resources Agency ARNOLD SCHWARZENEGGER, Governor
DEPARTMENT OF FISH AND GAME
http://www.dfg.ca.gov
Central Region
1234 E. Shaw Avenue
Fresno, California 93710
(559) 243-4005

June 6, 2008

Ms. Pamela C. Creedon, Executive Officer
Regional Water Quality Control Board
11020 Sun Center Drive #200
Rancho Cordova, California 95670-6114

Dear Ms. Creedon:

Subject: Response to Comments San Joaquin River Group Authority's Written Comments to Proposal by Central Valley Regional Water Quality Control Board to List the San Joaquin, Tuolumne, Merced and Stanislaus Rivers as Impaired Bodies of Water for Temperature Pursuant to Section 303(d).

Thank you for this opportunity for the Department to respond to comments you have received from the San Joaquin River Group Authority (SJRGA) representatives (attached).

If your staff needs the literature references in our scientist response, please encourage them to work with Dr. Andy Gordus, Staff Environmental Scientist (Regional Water Quality Biologist), on my staff at the address or telephone number provided on this letterhead.

Sincerely,

Dean Marston for

W. E. Loudermilk
Regional Manager

Attachment

cc: On Page Two

received 6/9/08 ce
GENERAL MANAGER

cc: Mr. John Engbring
United States Fish and Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento, California 95825

Mr. Thomas Howard
State Water Resources Control Board
Post Office Box 2815
Sacramento, California 95812-2815

Mr. Dan McClure
Central Valley Regional Water Quality Control Board
11020 Sun Center Drive #200
Rancho Cordova, California 95670-6114

Ms. Maria Rae
National Marine Fisheries Service
650 Capital Mall
Sacramento, California 95814

Mr. Allen Short
San Joaquin River Group Association
c/o Modesto Irrigation District
Post Office Box 4060
Modesto, California 95352

ATTACHMENT

Department Of Fish And Game Response to Comments San Joaquin River Group Authority's Written Comments to Proposal by Central Valley Regional Water Quality Control Board to List the San Joaquin, Tuolumne, Merced and Stanislaus Rivers as Impaired Bodies of Water for Temperature Pursuant to Section 303(d).

Overview

The population crash of the Chinook salmon along the Pacific coast has been a common subject in the recent news. The decline has closed all commercial and sportfishing along the Pacific coast, resulting in significant economic loss to the communities and industries that depend on this natural resource. Many the articles emphasize ocean conditions as a cause to this decline. The media interviewed Federal biologists at NOAA whose primary jurisdiction is the marine environment. However, the lack of successful reproduction in California rivers is a major contributor to this population crash. This is clearly the case for anadromous fish in the San Joaquin River system. Dr. Peter Moyle at U.C. Davis presented a commentary identifying the many factors that led to this historic decline (Appendix A). He explained that the ocean conditions is one of many variables that have impacted the recent crash, but they are superimposed on a population that has been declining across the decades as a result of human caused declining river and delta conditions.

The San Joaquin River salmon populations (adult escapement) have substantially declined since 2001 and last year's decline in ocean conditions only accelerated an already steady decline in adult escapement to San Joaquin River tributaries. In addition, concurrent with the adult decline was the sharp decline in spring pulse flow magnitude and duration during the brood production years for which San Joaquin River tributaries salmon escapement abundance also sharply declined. During the fall 2006, the Merced River Fish Hatchery spawned only 36 female salmon out of a total of 79 fish trapped. This group of returning fish were mainly off springs of the 2003 year class from which the Merced Hatchery spawned 248 females from a total of 549 fish trapped.

Historically, the San Joaquin River basin had spring-run, late summer-run, fall-run, and winter-run Chinook salmon populations. In reality, there were salmon in the San Joaquin River Basin on a year-round basis, plus steelhead were also present year-round. This was the case prior to the dams, and as old dams gave way to new dams and California's demand for water use out of rivers increased, the changes in river and Delta habitats has placed higher water quality threats on San Joaquin anadromous fish. Today, three of the four "runs" have been extirpated in the basin with only the fall-runs of salmon and small steel head runs on the Merced, Tuolumne, and Stanislaus Rivers remain. The California Department of Fish and Game (Department), as the fish and wildlife trustee agency, is responsible to protect and maintain these last remaining salmon and steelhead populations in the San Joaquin River Basin.

If one reviews a historic distribution map of the Chinook salmon and steelhead range, their primary water source was from snow melt streams and rivers. Snow melts at the same temperature in California, as it does in the States of Washington and Oregon. The laws of physics do not change based on location. Another major source of cold water was from ground water seeps or springs. Cool water temperatures were also maintained by shade produced from trees and vegetation within the riparian zones. Salmon and steelhead co-evolved under these natural environmental conditions. Today, the much cold snow melt water is blocked and stoned by dams and ground water pumping within the San Joaquin River Basin has diminished surface flows to the rivers. Fish migration into the cool upper watersheds is blocked. So much ground water pumping has occurred across the decades in the San Joaquin Valley that it has resulted in lower water table levels and ground subsidence in many areas. Today, natural water flow regimes, which these fish evolved with no longer exist resulting in the extirpation of three salmon races and the serious decline of the last remaining fall-run Chinook salmon population to the point where listing as an endangered species maybe now be warranted (Mesick 2008) (Appendix B). The steelhead population is already listed as a threatened species in the Central Valley ecologically significant unit under the Federal Endangered Species Act.

Response

We have reviewed the San Joaquin River Group Authority (SJRGA) comment report and present our comments and clarifications. The (SJRGA) comments appear to emphasize "tolerance" temperatures, which is the survival of a group of individuals across a short time line. The Department emphasis is the reproduction and recruitment success of an entire population across each generation in recognition of the evolution and importance of the multi-year class life history strategy of salmon and steelhead. The Department proposal emphasizes Chinook salmon adult migration, egg incubation, smoltification, smolt migration, and steelhead summer rearing temperatures.

Pages 19 to 20. Most of the water temperature literature for fish emphasizes mortality as the end point. Little to no research has been conducted on how sub-lethal temperatures affect fish physiology, reproduction, and recruitment. The SJRGA comments include statements that there is very little pre-spawning mortality. This may be true; however, our purpose for the proposed 303 (d) listing is to protect egg viability before, during and after spawning throughout that life stage.

Their comments refer to the CDFG 1987 report for temperatures. We now have 21 years of additional information that allows us to refine temperature protections for the sustainability of native fish populations.

They suggest that San Joaquin River Basin anadromous fish have adapted to higher temperatures, yet do not demonstrate that these fish co-evolved under a warm water temperature regime. In addition, these fish did not co-evolve under today's altered water management conditions. No evidence exists to show that San Joaquin River Basin salmon/steelhead have higher temperature resistance than northern stocks in the Central Valley or elsewhere. It is assumed that because fish survive in these warmer waters, under today's water management conditions, and they happened to live in the most southern range, that by default these fish in the San Joaquin basin are pre-adapted to warm water temperatures. This premise is based on antidotal comments made by opinions of a number of individuals across time. Yet, no hard scientific evidence supports these opinions. Yet, the genetics evidence in the Central Valley supports a "meta population" conclusion wherein all fall-run and all steelhead in the Central Valley rivers are a common stock. These fish have common lineage and tolerances yet, are subjected to more egregious water temperature in the San Joaquin Basin. One reason why San Joaquin River stocks are facing severe declines and possibly extirpated is because they can not successfully reproduce in elevated (warm) temperature regimes in key river reaches.

Page 21. The SJRGA emphasizes growth temperatures including the statement that Chinook salmon transform into smolts in the wild in excess of 19°C without citing a reference. Marine and Cech (2004) completed a study to determine the effects of temperatures on growth, smoltification, and predator avoidance for juvenile Chinook salmon. Their rearing temperatures were 13-16°C, 17-20°C and 21-24°C. They concluded that Chinook salmon can survive and grow at temperatures up to 24°C, but juveniles reared in the two higher temperature ranges experienced impaired smoltification, and increased predator vulnerability compared to the coolest temperature range. Juveniles reared in the highest temperature range had decreased growth rates compared to the two lower temperature ranges. In addition, impaired smoltification and decreased growth rates result in reduced seawater survival and reduced population abundance. Thus, while they "can grow" in warmer water, it does not appear to be a viable option for sustaining healthy populations.

The SJRGA quoted McMahon (2006) as follows, "The applicability of thermal criteria derived from the laboratory has long been debated, and unfortunately, there has been no confirmatory lab or field data for growth vs. temperature relationship for any of the listed species in the Central Valley to assess if laboratory results are transferable to these stocks (Myrick and Cech 2004)." In the next sentence McMahon (2006) adds this clarification sentence, "However, the target levels (referring to 15.5°C for juvenile salmon rearing in the beginning of his paragraph) do seem to be reasonable targets for species protection given that recent studies suggest that temperatures near optimum growth in a laboratory setting likely frame the upper limits of suitable temperatures for salmonids in nature (McCullough 1999; Selong et al. 2001)."

Myrick and Cech (2005) conducted a study to determine temperature effects on growth, food conversion, and thermal tolerance of Nimbus (American River)-strain steelhead to improve fish rearing and hatchery management. They held juvenile steelhead at 11°C, 15°C and 19°C. Fish reared at 19°C did have increased growth rates compared to the two lower temperatures, which would decrease retention time in the hatchery and feed consumption, thus saving operation costs. The authors also emphasized that although increased growth in hatchery conditions occurred up to 19°C, juvenile steelhead require prolonged cooler temperatures (11°C) for successful smoltification.

Myrick and Cech (2005) cited Wurstbaugh and Davis (1977) who reported that steelhead maximum growth occurred at 16.4°C, however Wurtsbaugh and Davis (1977) (as stated by Myrick and Cech) further stated that optimal growth temperature declined as the ration level decreased from satiation to 60-50% of satiation. Fish in the wild have less available food rations compared to fish raised in a controlled food-rich laboratory or hatchery environment.

Moyle (2005) appears to be a rebuttal to Dr. Chuck Hanson testimony for Chinook salmon juvenile rearing temperature. It is interesting to note that Dr. Hanson's 16°C seven day average of the daily maximum is similar to the Department's rearing temperature presented in Table 1 of our proposal. Dr. Moyle rebuttal continues to point out that it is common to observe salmon survival in valley streams at higher temperatures under "today's" conditions. He fails to recognize that salmon are forced to live in the lower remaining one-third of their original range, under artificial conditions (below dams), and have no other habitat to occupy. Historically, anadromous fish would migrate or rear further upstream to cooler temperatures in the foothills and mountains. Today, they are blocked by dams and are forced to survive higher temperature habitats. Dr. Moyle further discusses survival of individuals, but provides no information as to the reproductive success and recruitment of these populations of fish across many generations, while these populations continue to decline. He further assumes cool water exists from ground water seeps and that temperatures will cool enough at night. If this really occurred in this basin below the dams, we would see it in the water temperature monitoring data either by 1) substantially cooler temperatures at night or 2) reduced warming as water moves downstream. Neither of these occurs. As previously stated, ground water pumping in the valley has resulted in lower water tables and ground subsidence.

<u>Page 22.</u> Williams et al. (2007) does quote Ron Yoshiyama as a personal communication on page 5 of their report. This information was based on an 1875 California Fish Commission report. Salmon were never successfully introduced to the southeastern states. Furthermore, Mr. Yoshiyama statement states that salmon tolerate and survive temperatures up to 80°F (26.7°C), but he does not state whether fish at these temperatures would be highly successful in reproducing or recruitment. Further, in Williams et al. (2007) paragraph where Mr. Yoshiyama is quoted, they stated winter-run Chinook salmon eggs and alevins have complete mortality when water temperatures reach 17.4°C. In addition, the States of Wisconsin and Michigan have a very viable Coho salmon, Chinook salmon and steelhead fisheries in Lake Michigan. Lake Michigan water temperatures are cool enough for the growth and survival of these three species, however, none of these fish reproduce in the surrounding streams because the waters get too hot for

reproduction success. As such, these species are captured in the streams, spawned and raised in hatcheries to maintain the fisheries.

The CalFed (1999), Spina (2007) and Myrick and Cech (2001) referred statements again emphasizes survival of individuals, but does not indicate reproductive success and recruitment for these populations that continue to decline. Spina (2007) stated that rainbow trout in their study streams had no where else to go to seek cooler water temperatures. Myrick and Cech (2001) stated fish can acclimate and survive for short periods in higher preferred water temperatures. None of these studies did any follow-up work to determine if these same fish could successfully reproduce and recruit new individuals into the population.

Page 23. The SJRGA stated that Titus (2007) reported successful steelhead rearing in the lower American River at up to 18°C daily average based on growth rates, condition factor and absence of disease. However, this is incorrect. Titus did observe disease in these fish. Fish exposed to temperatures from 18°C to 21°C had intestinal bacterial infections and prolapsed anus. Nearly fifty percent of the fish observed had these clinical signs. Fish exposed to temperatures below 18°C, had a very low bacterial infection frequency. He further states "the conceptual framework demonstrates the significance of 18°C as an *upper thermal limit* (*emphasis added*) for juvenile American River steelhead." In his presentation he states that the ***mean*** daily temperature standard above 65°F (18.3°C) is not biologically defensible to protect steelhead and post-release (fish captured with hook and line and released) mortality increase substantially above 64°F (17.7°C). Essentially, 64-65°F (17.7 to 18.3°C) appears to be a critical chronic exposure threshold, which, a high level of negative effects were observed: mortality from hooking stress increases sharply, bacterial infection was observed, and ultimately death at around 75°F (23.8°C). Secondary effects are likely as well, especially in predator-rich systems like Central Valley rivers. As thermal optima for steelhead/rainbow trout are exceeded at temperatures above 64-65°F, major predators like pikeminnow, striped bass, and black bass are just entering their thermal optima. So, as cold water fish become stressed at temperatures above 64°F, salmon and trout become more vulnerable to predation and habitat conditions favorable to increasing predator populations in key river reaches occurs.

Page 24. The SJRGA report presented "computed natural" flows stating the lowest flows occur in September. With the existence of dams migration to cooler habitats is blocked and natural flows no longer occur. They provided September unimpaired flows values from 1922 to 1992. However, unimpaired is not defined, especially when all the rivers have multiple dams present. All the low flow values presented did not indicate if dams were present and holding water back or was based on controlled releases during those years.

Page 25. Hallock et al. (1970) documented transmitter tagged Chinook salmon "holing" up in the Delta for almost two months before migrating upstream into the San Joaquin River. They observed low dissolved oxygen and high temperature barrier delayed the upstream migration of fish on the San Joaquin River. Their migration research study also discovered salmon will begin migration up the San Joaquin River once dissolved oxygen is above 5 ppm and water temperatures were at or below 65°F (18.3°C).

As presented in Tables 3, 4, 5 and 6 of the Department's 303 (d) proposal, after adult fish enter San Francisco Bay and estuary, anadromous fish migrate up to 133 miles, 137 miles, and 172 miles to reach the Goodwin Dam (Stanislaus River), La Grange Dam (Tuolumne River), and Crocker-Huffman Dam (Merced River), respectively. The Stanislaus River counting weir is at river mile 33, as such, fish have to migrate 108 miles from the Sacramento River and San Joaquin confluence in the Delta. The Merced River Hatchery is at the Crocker-Huffman Dam. Although not all adult fish will migrate up to the river barriers (dams), this information provides a perspective that the fish are present in the San Joaquin River Basin well before they are physically observed. These fish simply do not jump out of the Pacific Ocean and land at a particular observation point. They must annually migrate long distances across time, as well as confront barriers (i.e. low oxygen and high water temperatures in the Delta and low river flows), to reach their spawning grounds.

The Turlock Irrigation District has documented the first observance of adult salmon near La Grange Dam as early as September 5 (Appendix C). Other September dates included the 10th, 16th, 17th, 18th, 22nd, 24th, and 26th. This observation location is near the LaGrange Dam at mile point 52. As such, these fish had to migrate a total of 137 miles from the confluence of the Sacramento River in the Delta indicating salmon were present in the San Joaquin River system as early as August. In addition, river waters need to be "primed" well before the fish arrive to serve as an attractant to their natal spawning grounds.

The Department does not have the sole discretion to determine when the Head of the Old River Barrier is installed and operated. This is negotiated between the U.S. Fish and Wildlife Service (USFWS), California Department of Water Resources, a Reclamation District, landowners and other stakeholders regulatory. Permit timing and the status or impacts to the other salmon races Delta smelt and soon longfin smelt are factors as well.

Again, the Department does not have the sole discretion to determine fall attraction flow schedules. This is based on a negotiated agreement between a number of stakeholders and water availability, and is *not solely* based on the biological needs of fall migrating salmon.

<u>Page 26.</u> The arrival of fish at the Merced River Hatchery triggers our management approach to begin our hatchery operation to spawn fish and to begin stream surveys. It is not an indication when fish began to migrate up the San Joaquin River Basin. It is an indication when the fish arrived at the farthest most reach of the Merced River.

The Department permitted operation of Stanislaus River weir to begin in 2003. It is operated over a range of flow schedules acress water year types. The years 2003 and 2004 were below normal and dry water years, respectively (Appendix D), years 2005 and 2006 were wet years and 2007 was a critical dry year. They indicated 2006 water temperatures were cooler than other years. However, Figure 5 shows water temperatures downstream on the river system were well above 18°C creating a potential temperature barrier well before the confluence of the Stanislaus River; in addition, they do not provide dissolved oxygen conditions during these same time periods. Figure 5 verifies our reasoning that water temperatures are too warm for migrating salmon and creates a potential migration barrier and/or a delay of upstream movement into the San Joaquin River Basin.

The Department's temperature management strategy for the protection of adult **migrating** Chinook salmon emphasis is from September through October. The Department concurs that adults continue to migrate into December; however, our protection emphasis for egg incubation begins October 1, because if the egg/incubation goals are met (13°C), by default the adult migration goals (18°C) will be met. Our desire is to ensure protection in the entire reaches during the entire migratory season generally in most years, including early migrants, and not just the peak periods. As previously stated, there are a number of "barriers" that delay migration of the remaining populations (fall-run Chinook and steelhead).

Page 27. Department operations and timing depend on a number of factors including funding, staff availability, work loads and management priorities.

Page 28. The SJRGA suggests that the adult timing is October 1 to December 20. We concur that fish migrate through December, however, we do not concur with simply writing off the early or late fall migrants as this serves to further selective pressure of an already stressed population. As previously, stated salmon were once in the San Joaquin River Basin on a year-round basis and flows, temperature and dissolved oxygen conditions impact fish migration during the early season, thus delaying migration.

Pages 28 to 29. It is common sense that fish need water and high water quality to reproduce and maintain sustainable populations across generations. Our proposal emphasizes the temperature protection for the last remaining reach (downstream from the dams), for all life stages, for the last remaining genetic population of Chinook salmon and steelhead in the San Joaquin River Basin.

Page 29. As previously stated salmon have to travel172 miles from the Sacramento River confluence in the Delta to reach the Merced Hatchery which is at River Mile 58. Clearly, these salmon are in the San Joaquin River system well before they arrive at the hatchery at the terminus of this run. Migration delays due to temperature and dissolved oxygen barriers downstream remain an important issue for these stocks.

Page 31. The SJRGA stated that the last remaining 3% of the outgoing juveniles are not important. We do not concur with this philosophy. Flow operations were determined through negotiation of many stakeholders and issues, and *not solely* based on the biological needs of the fish. In addition, monitoring terminated before all the juveniles out migrated, thus the total count and timing is underestimated.

The SJRGA reported that there was no purpose going back to 1973, and also criticized not going back further in the years for other sections of our report. They state that "it is not represented under current basin operations." It has become obvious that certain current water management operations in the San Joaquin River Basin are not beneficial to salmon and steelhead. These populations have continued a steady decline across decades and have experienced precipitations crashed in the last two years.

Newman (2008) (Appendix E) smolt survival evaluation in the reach leading into the South Delta (e.g. Durham Ferry to Mossdale) indicates that smolt survival decreased substantially with increasing water temperatures.

Page 31 to 32. All FERC settlements are based on negotiations with a number of agencies, stakeholders and special interest groups and are not entirely based on the biological needs of the fish. It should be noted that the Department is a large state agency, with many staff who work under a heavy workload, who negotiate with many individual project proponents and other stakeholders that results in a variety of negotiated settlements on a project-by-project basis.

Page 32. Concerns with how the criteria are applied

I. CDFG's use of criteria for smoltification is inconsistent between locations. Specifically, the CDFG assessment uses 15°C as the criteria for the tributaries and 18°C in the San Joaquin River.

In EPA's Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards, the 18°C standard is for protection of the juvenile out-migration corridor while the 15°C standard is for protection of smolt rearing habitat. The main stem San Joaquin River provides primarily out-migrating corridor habitat (18°C) for smolts while the east-side tributaries primarily provide rearing habitat (15°C). As such, there is no inconsistency in Department's smolt protection criteria.

II. CDFG substituted data from distant locations when data was missing for a particular station. For example in the assessment of Tuolumne River adult upstream migration, data are not available from Shiloh (RM 4) during 2002. Instead, data from Waterford RM 32) is substituted to represent conditions near the confluence. This issue was found by chance while perusing the formulas and hyperlinks used in CDFG's Excel spreadsheets. Obviously the data was not presented properly which casts doubt on the accuracy of the rest of the analysis, especially in light of the other factors identified during this preliminary review.

Hyperlinks were not used in the Excel spreadsheets. Empirical (e.g. measured) water temperature data exists at three river mile locations (e.g. river mile's 32, 42, and 52) for the 2002 Tuolumne River Adult upstream migration. Appendix F presents the template that the Department used to evaluate 2002 adult upstream migration temperatures in the Tuolumne River. This example template is the same type that was used in all years and for the Tuolumne, Merced, Stanislaus, and San Joaquin Rivers. Appendix F outlines values from empirical data at river mile's 32, 42, and 52 (e.g. seven day weekly average of empirically measured daily maximum water temperatures). Water temperature values were calculated, by interpolation between river mile's 52 and 42 (+0.9°C/mile) and between river mile's 42 and 32 (+0.3°C/mile), to calculate increasing water temperature on a per mile of river basis. No empirical data exist between river mile 0 and 31, so river mile 32 temperature value was to reflect river mile's 0 to 31. Although river water temperatures do increase as it flows downstream, for analytical purposes we ***assumed*** no additional warming occurred between river mile 32 and the confluence. Thus, the temperature analysis in the Departments document/testimony for this reach of the river (river mile 31 to the confluence) was **conservatively** estimated, even though water temperatures do increase as the water flows downstream. Further refinement may be possible yet, we suspect the resulting conclusion will remain essentially the same.

Based on years where empirical data exists for sites near river mile's 32 and 0 (e.g. immediately upstream of the confluence) the rise in temperature can be dramatic. Appendix G shows an example of the warming that occurs between river mile 37 and river mile 4 in 2003. In 2003 there was a 5ºC (9ºF) elevation in temperature between river mile's 37 and river mile 4. If empirical data existed for all years at river mile's 32 and river mile 0 the temperature impairment analysis would be worse in some years than what was identified in the Departments conservative analytical approach using river mile 32 value for the remaining reach to the confluence. As such, there was no misrepresentation of data in the Department's analysis, neither is there cause to doubt Department's analytical results.

III. The sub-set of available data used in CDFG's assessment focuses on a string of several dry years and the periods do not generally represent the distribution of water year types. CDFG's decision to only use some of the available data is clearly another bias that was purposefully introduced. Additional data has been provided to CDFG previously and is available from monitoring efforts conducted by TID/MID on the Tuolumne River since 1986 and by Tri-Dam on the Stanislaus River since 1998.

The San Joaquin Valley Water Year Hydrologic Classification includes the following year types and water year index (Appendix D):

Year Type:	Water Year Index:	Year
Wet	Equal to or greater than 3.8	1998, 2005, 2006
Above Normal	Greater than 3.1, and less than 3.8	1999, 2000
Below Normal	Greater than 2.5, and equal to or less than 3.1	2003
Dry	Greater than 2.1, and equal to or less than 2.5	2001, 2002, 2004
Critical	Equal to or less than 2.1	

As shown above, the Department's representation of analytical years included years within each water year type except for Critically Dry years. Appendix H shows the flow range conditions, represented as water year types by percent historical Exceedence, that were covered in Department's analysis. As shown in Appendix H, the wetter range of conditions has been included in the Department's assessment for the east-side tributaries. For Vernalis, the entire range of flow conditions was included in the Department's assessment (Appendix I). While the critically dry conditions have not been assessed for the east-side tributaries it is anticipated that water temperatures would exceed those values observed during Dry year type conditions by virtue of 1) lower instream flow levels and 2) the strong relationship between instream flow levels and water temperature.

IV. The ability of individual salmon to survive, tolerate, or thrive at a particular temperature is the result of a combination of recent thermal history (i.e., acclimation), availability of thermal refuges, length of exposure time, daily temperature fluctuations, genetic background, life stage, interactions with other individuals and species, food availability, and stress from other factors (e.g., pollution). CDFG's analysis ignores 8 out of the 9 factors.

Fish are endothermic (e.g. physiologically controlled by ambient water temperature levels). As such, water temperature controls everything about a fish's life, such as physiological function (oxygen/carbon dioxide exchange, blood chemistry/pH, organ function, heart rate, growth, endocrine functions, egg and sperm viability), basic survival, food consumption, rearing location preference, ability to successfully spawn, spawning location preference, growth rates, stress factors, immune function, disease resistance, predator avoidance, etc. Water temperature is as important to fish as air quality is to humans, and, how the population responds over time is of great concern.

V. Abundance of a given lifestage is not evenly distributed through time or space and CDFG's analysis does not account for the proportion of the population that may be exposed to the conditions that they have defined as impaired. For example, if 5 out of 20 weeks are impaired, CDFG's approach would calculate that the lifestage is 25% impaired. However, if only 5% of the population was present during that 5 week period, CDFG's approach would have overestimated the impairment fivefold.

If five out of 20 weeks are impaired due to high water temperature then the overall quality of habitat for a given life history stage normally occurring then is impaired by 25%. The issue of presence and abundance (e.g., relative intensity of habitat use over time), and factors leading up to (or determining) presence and abundance, are separate questions and issues.

Presence of adult salmon in the east-side tributaries is influenced by water temperature, and other water quality parameters such as dissolved oxygen in the Stockton Deep Water Ship Channel (Hallock 1970). Water temperature in the Stockton Deep Water Ship Channel is dependent upon San Joaquin River inflows and river water temperature levels. San Joaquin River inflows are dependent upon several factors including mainstem river flow levels, east-side tributary flow levels, east-side tributary reservoir storage and release water temperature levels, and ambient air temperature level.

In short, instream flow water and temperature levels in the San Joaquin River is a controlling factor when salmon migrate through the South Delta and into the east-side tributaries. The San Joaquin River Group Authority comment on our previous page "IV" points out there are many factors important to individual fish survival in play in the smolt life stage. Additionally, temperature is a controlling factor determining when and where salmon will spawn. Appendix J shows an example of how salmon redd counts increase sharply when water temperature decrease into a suitable range (e.g. ≤13°C). Thermal units determine embryo development rates and the time period for egg hatching and thence fry emergence. Further, water temperature influences growth rates and growth rates influence both size, timing of out-migration, and survival. In summary water temperature is a very important factor controlling habitat quality and both fish presence and abundance population survival.

Evidence submitted to the Regional Water Quality Control Board (provided by the Department, Mr. John Bartholow, and Dr. Alice A. Rich) strongly suggests that water temperature, in combination with instream flow level, is controlling timing of habitat quality and habitat use, and that timing of habitat use (e.g. spawning habitat for example) influences egg emergence, juvenile abundance, and out-migration timing. To say that only 5% of a population is affected mis-characterizes the conditions that led up to the timing of the species being present (i.e later arrival for adult migrants due to elevated temperatures and low dissolved oxygen at the Stockton Deep Water Ship Channel), in specific quantity, and a specific location. Implying that cutting off habitat and a relatively small number of individuals using that habitat is acceptable is not consistent with principles of population ecology and genetic integrity. To say that a certain number of individuals are expendable is not a prudent management action given that fall-run Chinook salmon in the San Joaquin River tributaries are at a high risk of extinction (e.g. Tuolumne River...Mesick 2008) and steelhead populations are low in abundance.

VI. The EPA criteria are based on constant laboratory conditions which are not directly comparable to diurnally fluctuating field conditions. Fish in the wild are acclimated to the mean of the average and maximum temperatures, and are not constantly exposed to the 7DADM temperatures. As such, the criteria assume a constant exposure to a given temperature rather than potentially brief exposure under diurnally fluctuating conditions.

"The EPA criteria are based on constant laboratory conditions which are not directly comparable to diurnally fluctuating field conditions." This statement is not factually correct and infers that the EPA criteria were based solely upon laboratory studies. Our understanding is that EPA criteria were based upon an exhaustive review of laboratory and field studies which individually, and cumulatively, shed light on the relationship between fish response (e.g. growth, mortality, endocrine response etc) and a variety of water temperature metrics (e.g. daily average, daily max etc).

Regarding use of the 7DADM, EPA, in their Region 10 Guidance For Pacific Northwest State and Tribal Temperature Water Quality Standards (2003), said this:

> "This metric is recommended because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day. Thus, it reflects an average of maximum temperatures that fish are exposed to over a weeklong period. Since this metric is oriented to daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions. This metric can also be used to protect against sub-lethal or chronic effects (e.g., temperature effects on growth, disease, smoltification, and competition)..."

EPA (2003) also stated:

> "It is important to note that there are also studies that analyzed sub-lethal effects based on maximum or 7DADM temperature values which need not be translated for purposes of determining protective 7DADM temperatures. For example, there are <u>field studies</u> (emphasis added) that assess probability of occurrence or density of a specific species based on maximum temperatures [Issue Paper 1, Haas (2001), Welsh et al. (2001)]. These <u>field studies</u> (emphasis added) represent an independent line of evidence for defining upper optimal temperature thresholds, which complements laboratory studies."

As such, this criteria (e.g. 7DADM) is a chronic threshold to protect a population of anadromous fish across multiple generations. In addition, this is an average, meaning a range of values, not constant values, were used to calculate a criteria value. Elevated daily temperatures across 7 days indicates the fish are not being briefly exposed across time. The daily water temperature range fluctuation is narrow in the San Joaquin River and tributaries, thus the fish are not briefly exposed to elevated temperatures. Also, there is uncertainty as to whether fish have the luxury of a brief exposure to optimal cool temperatures during a 24-hour period in the San Joaquin Valley Basin river systems.

VII. Adverse biological impacts associated with attempting to meet temperature criteria through increased flow have not been addressed. For example, increasing flows down the Stan during fall to meet temp criteria will result in negative consequences for spawning Chinook. Flood control releases on the Stanislaus during fall 2006 delayed spawning and very little spawning activity occurs during annual attraction pulses. Other biological issues may include de-watering and stranding and the relationships of these factors to instream flow will differ by stream.

Not meeting cool temperature criteria is a biological impact. It serves no purpose to improve spawning habitat only to have adult salmon not be able to utilize it or have non-viable eggs spawned due to temperature associated stress. It is difficult to observe or determine whether or not fish have spawned or are spawning in flows above 500 cfs in the Stanislaus River. So it is unknown if spawning is truly impaired at higher flow levels. That said, the pattern across the historical years of record for the altered water regime is to have excessively high water temperatures during some, if not most, of the spawning period. The result is an unstable and declining fall-run Chinook salmon population that has declined catastrophically in one or more San Joaquin River tributary (i.e. Tuolumne River). The Department believes long term production benefits associated with reduced water temperatures for outweigh the possible impacts of dewatering (e.g. reference to fish that may have spawned in stream margin areas at high flows then are dewatered when flows are ramped down) or stranding.

VIII. The approach used by CDFG does not consider whether fish utilize potential areas of thermal refugia such as pools and areas of groundwater upwelling. During June 1989 a groundwater source in the Tuolumne River was identified where temperatures were about 5°F (~3°C) cooler than the surrounding water (EA Engineering 1992).

Water temperature monitoring demonstrates no significant area of cool water refugia of significance of the overall population. The Department acknowledges that limited isolated areas of temperature refugia may still exist that could provide improved habitat conditions for a relatively few resident fish or short duration refuge for migrating fish. However, it is important to comprehend that: 1) these refuges do not substantively reduce water temperature for large habitat areas, either individually or collectively, for if they did we would see abrupt sustained cooling at one or more sites and neither the empirical data nor the HEC5Q model results demonstrate this; 2) population level impacts occur when temperature impairment over a wide portion of a particular life history stage is present. The Department's temperature assessment indicates that water temperature impairment is occurring temporally (time/duration) and spatially (reach length) for several life history stages (e.g. adult migration, spawning, smolt migration, and summer rearing etc.) and populations continue to decline.

Page 34. This year both salmon commercial and sportfishing has been terminated at the expense of millions of dollars loss to the industries, including commercial and retail markets and restaurants. The forecast for next year is similar for San Joaquin Basin stocks.

The Department and other stakeholders (including the San Joaquin River Group Authority members) have recent spent millions of dollars creating spawning and rearing habitat for fish. However, this effort is fruitless if the fish do not have high quality water during the correct biological timing to be useful and successful.

We concur that exotic predatory fish can impact native species, but species such as striped bass have special interest groups in California who strongly supported this fishery. It is important to note that river temperature regimes favoring anadromous salmonids generally disfavor many predatory fish species population abundance levels.

Below is the entire paragraph from Williams (2006).

> "The predicted increase in temperature begs the question whether Central Valley salmon are a lost cause, so that efforts to protect salmon are a waste of resources that should be applied elsewhere. **The answer seems to be, probably not yet,** because the modeling also shows that the extent of future warming depends largely on future emissions (Hayhoe et al. 2004). Although it may be too late for spring-run in Butte Creek, or perhaps for any Central Valley salmon, if the more extreme predictions considered most likely by Dettinger (2005) turn out to be correct, there is still time for effective actions to reduce future greenhouse gas emissions. Effective actions to reduce the extent of warming are desperately needed for many reasons besides salmon conservation, and may yet be taken."

Note that he added a clarification statement, "The answer seems to be, probably not yet,……"

We concur that climate change and global warming is a new and upcoming challenge to the Department, the State of California, and the nation. However, on an evolutionary scale, native species have under gone the earth's warming and cooling periods across thousands of generations and still exist today. As such, we do not concur with the opinion that the effort to protect the last remaining salmon and steelhead in the San Joaquin River Basin is a "lost cause". As the trustee agency, we are required by California law to protect these natural resources.

<u>Page 35 to 40.</u> We do not concur with the suggested SJRGA approach to use a model to re-write history. Models are designed to use existing data to develop a model, calibrate the model and to predict future management outcomes based on developed/known historical empirical data. The SJRGA's consultant modeled the Stanislaus River temperature backwards to re-write history using today's environmental and physical conditions. Keep in mind that these rivers were significantly altered (dams, mining, diversions, channelization, levees, etc.) by the 1960's and 1970's, thus does not represent the natural environmental conditions that native fish co-evolved. The SJRGA model output and presentation also failed to recognize that fish once could migrate up to higher elevation cooler waters, but today are blocked by dams.

The SJRGA indicated that salmon were abundant in 1970. The use of the term "abundant" is relative. More fish were in the Basin in the 1960's, even more in the 1950's, more in the 1940's and so on and so on. Chinook salmon and steelhead have continued to decline since European settlers entered California. Today's water management in the San Joaquin River Basin clearly is not improving native fish populations across time.

Summary

Historically, over fifty percent of California's Central Valley was some sort of wetland. Riparian zone stretched wide distances on each side of river and stream banks (*Warner, Richard E., and Kathleen M. Hendrix, 1984. California Riparian Systems: Ecology, Conservation, and Productive Management. Berkeley:University of California Press*). California has lost over 95% of its the historical wetlands (*USFWS 1978. Concept plan for waterfowl wintering habitat preservation. Central Valley California. Portland, Oregon*) and today, riparian zones in most places are down to narrow strips (i.e. one row of trees) or none at all. Water temperatures are one of many variables that anadromous fish need to successfully reproduce and survive. Neither we nor the CVRWQCB can not address all the variables at once, but at least concentrate our efforts to what we believe are the most significant to address. The other variables will be addressed in the future. Clearly the fall-run Chinook salmon populations have crashed and steelhead are low in abundance yet, both still persist. We believe that lack of reproduction success and recruitment in our altered river system is one of the most significant factors that we can address. Under current water management, this is a dwindling natural resource. If management regulatory efforts are not immediate to protect these fish, another alternative is for these fish to become listed as endangered under state and federal law, which is even more restrictive on the beneficial uses or water.

A final note, some believe that is it acceptable to cut-off the front (i.e. adult migration/ spawning) or back-end (e.g. smolt out-migration) of a particular life history stage production simply because it is operationally speaking (i.e. reservoir operations) expedient to do so in the name of water conservation or other water use. Truncating the fish production process does not make sense biologically nor genetically, as it exacerbates this stocks ability to survive and adapt over time. For example, if it is desired to move the smolt out-migration season up (e.g. have majority of smolts leave earlier than presently occurs) then spawning must start earlier. However, spawning cannot start earlier if excessively warm water temperatures are present during the early part of the adult migration and spawning season. Genetically speaking, it is not prudent to remove a substantial part of the population's gene pool (i.e., select for) simply because it is operationally expedient (i.e. desirable) to do so. Genetic health, and the ability of a population to endure, is compromised when the gene pool is bottlenecked. Cutting off the "tails" of the fall adult migration/spawning or spring rearing production seasons needs serious examination to ensure that population abundance and genetic health impacts do not occur at levels greater than exists today. Again in addition to restrictions, the geographic range with dams, the historical pattern is to cut-off the front end of the adult migration/spawning run timing and the tail-end of the juvenile out-migration seasons timing due to excessively warm water temperatures. The net result is an unstable and declining fall-run Chinook salmon population that has declined to the point of being at a high rate of extinction in at least one San Joaquin River tributary (i.e. Tuolumne River).

Appendix A.

Dr. Peter Moyle's Commentary on Central Valley Chinook Salmon Decline.

http://www.indybay.org/newsitems/2008/04/06/18490965.php

Central Valley | Environment & Forest Defense

Peter Moyle's Commentary on Central Valley Chinook Salmon Decline
by Dan Bacher
Sunday Apr 6th, 2008 9:02 PM

For the first time in history, recreational fishing boats in Santa Cruz, Moss Landing, Monterey, Morro Bay and other ports along the northern and central California Coast didn't go out fishing for chinook salmon on the traditional opening day of the season. The boats stayed in port on Saturday, April 5, due to an unprecedented emergency closure imposed by the Pacific Fishery Management Council (PFMC).

The federal PFMC and the National Marine Fisheries Service (NMFS) in March took action to close the already open ocean sport fishery between Horse Mountain and Point Arena on April 1, 2008. In addition, they took emergency action to close the April 5 sportfishing openers in San Francisco and Monterey port areas (south of Point Arena to the U.S.-Mexico Border).

"These actions are being taken to protect Sacramento River fall Chinook salmon which returned to the Central Valley in 2007 at record low numbers," according to a statement from the California Department of Fish and Game. "Even if all ocean sport and commercial fisheries are closed throughout California, salmon returns are not projected to meet the escapement goals required by the PFMC Salmon Fishery Management Plan."

The PFMC has produced three ocean salmon fishing season "options" (effective May 1, 2008 through April 30, 2009) for public comment.

Option 1 provides very limited commercial and sport fishing after May 18.
Option 2 provides no commercial or sport fishing after March 31 but allows a non-retention research project to collect tissue samples for genetic stock identification analyses.
Option 3 provides no fishing between Cape Falcon, Oregon and the U.S.-Mexico border.

The PFMC will meet April 7-11 in Seattle to adopt a final regulatory packet from the three "options" listed above. More information regarding the PFMC meetings and options can be found on the PFMC Web site at http://www.pcouncil.org/.

The impact of these closures will be devastating to the lives of fishermen, fisherwomen, and the thousands of people employed by businesses that depend upon healthy runs of salmon.

In light of the salmon disaster, the following is an excellent commentary on the Central Valley Chinook Decline by Peter B. Moyle, Professor of Fish Biology, University of California Davis, on Google News.

Moyle gives a brief history of the many factors that led to the historic decline that culminated in the unprecedented salmon collapse. He explains the complex interaction between freshwater conditions and ocean conditions - and how "blaming 'ocean conditions' for salmon declines is a lot like blaming the iceberg for sinking the Titanic, while ignoring the many human errors that put the ship on course for the fatal collision."

"'Ocean conditions' may be the potential icebergs for salmon populations but the ship is being steered by us humans. Salmon populations can be managed to avoid an irreversible crash, but continuing on our present course could result in loss of a valuable and iconic fishery," says Moyle.

He lists short run remedies as well as long term solutions to the salmon dilemma - and closes with an optimistic note that "there is a reasonable chance that Chinook salmon populations will once again return to higher levels, as they have in the past, although not quickly."

Comment by Peter B Moyle, Professor of Fish Biology, University of California Davis

Multiple Causes Of Central Valley Chinook Salmon Decline - Mar 31, 2008

Ever since EuroAmericans arrived in the Central Valley, Chinook salmon populations have been in decline. Historic populations probably averaged 1.5-2.0 million (or more) adult fish per year. The high populations resulted from four distinct runs of Chinook salmon (fall, late-fall, winter, and spring runs) taking advantage of the diverse and productive freshwater habitats created by the cold rivers flowing from the Sierra Nevada. When the juveniles moved seaward, they found abundant food and good growing conditions in the wide valley floodplains and complex San Francisco Estuary, including the Delta. The sleek salmon smolts then reached the ocean, where the southward flowing, cold, California Current and coastal upwelling together created one of the richest marine ecosystems in the world, full of the small shrimp and fish that salmon require to grow rapidly to large size. In the past, salmon populations no doubt varied as droughts reduced stream habitats and as the ocean varied in its productivity, but it is highly unlikely the numbers ever even approached the low numbers we are seeing now.

Unregulated fisheries, hydraulic mining, logging, levees, dams, and other factors caused precipitous population declines in the 19th century, to the point where the salmon canneries were forced to shut down (all were gone by 1919). Minimal regulation of fisheries and the end of hydraulic mining allowed some recovery to occur in the early 20th century but the numbers of harvest salmon steadily declined through the 1930s. There was a brief resurgence in the 1940s but then the effects of the large rim dams on major tributaries began to be severely felt. The dams cut off access to 70% or more of historic spawning areas and basically drove the spring and winter runs to near-extinction. In the late 20th century, thanks to hatcheries, special flow releases from dams, and other improvements, salmon numbers (mainly fall-run Chinook) averaged nearly 500,000 fish per year, with wide fluctuations from year to year, but only about 10-25% of historic abundance. In 2006, numbers of spawners dropped to about 200,000, despite closure of the fishery. In 2007, the number of spawners fell further to about 90,000 fish, among the lowest numbers experienced in the past 60 years, with expectations of even lower numbers in fall 2008 (probably <64,000 fish). The evidence suggests that these runs are largely supported by hatchery production, so numbers of fish from natural spawning are much lower.

So, what caused this apparently precipitous decline in salmon? Unfortunately, the causes are historic, multiple and interacting. The first thing to recognize is that Chinook salmon are beautifully adapted to living in a region where conditions in both fresh water and salt water can alternate between being highly favorable for growth and survival and being comparatively unfavorable. Usually, conditions in both environments are not overwhelmingly bad together, so when survival of juveniles in fresh water is low, those that make it to salt water do exceptionally well. And vice versa. This ability of the two environments to compensate for one another's failings, combined with the ability of adult salmon to swim long distances to find suitable ocean habitat, historically meant salmon populations fluctuated around some high number. Unfortunately, when conditions are bad in both environments, populations crash, especially when the heavy hand of humans is involved.

The recent crash has been blamed largely on "ocean conditions." Generally what this means is that the upwelling of cold, nutrient-rich water has slowed or ceased, so less food is available, causing the salmon to starve or move away. Upwelling is the result of strong steady alongshore winds which cause surface waters to move off shore, allowing cold, nutrient-rich, deep waters to rise to the surface. The winds rise and fall in response to movements of the Jet Stream and other factors, with both seasonal and longer-term variation. El Nino events can affect local productivity as well, as can other 'anomalies' in weather patterns. And Chinook salmon populations fluctuate accordingly.

The 2006 and 2007 year classes of returning salmon mostly entered the ocean in the spring of 2004 and 2005, respectively (most spawn at age 3). Although upwelling should have been steady in this period, conditions unexpectedly changed and ocean upwelling declined in the spring months, so there were fewer shrimp and small fish for salmon to feed on. According to an analysis by an interdisciplinary group of scientists, conditions were particularly bad for a few weeks in spring of 2005 in the ocean off Central California, resulting in abnormally warm water and low concentrations of zooplankton, which form the basis for the food webs which include salmon. All this could have caused wide scale starvation of the salmon. Note the emphasis on could. While the negative impact of ocean anomalies is likely, monitoring programs in ocean are too limited to make direct links between salmon and local ocean conditions.

"Ocean conditions" can also refer to other factors which can be directly affected by human actions, especially fisheries. For example, fisheries for rockfish and anchovies can directly or indirectly affect salmon food supplies (salmon eat small fish). Likewise, fisheries for sharks and large predators may have allowed Humboldt squid (which grow to 1-2m long) to become extremely abundant and move north into cool water, where they could conceivably prey on salmon. These kinds of effects, however, are largely unstudied.

Meanwhile, what has been going on in the Sacramento and San Joaquin rivers? On the plus side, dozens of stream and flow improvement projects have increased habitat for spawning and rearing salmon. Removal of small dams on Butte Creek and Clear Creek, for example, has increased upstream run sizes dramatically. Salmon hatcheries also continue to produce millions of fry and smolts to go to the ocean. On the contrary side:

* The giant pumps in the South Delta have diverted increasingly large amounts of water in the past decades, altering hydraulic and temperature patterns in the Delta as well as capturing fish directly.
* The Delta continues to be an unfavorable habitat for salmon, especially on the San Joaquin side where the inflowing river water is warm and polluted with salt and toxic materials. Most of the rest of the Delta lacks the edge habitat juvenile salmon need for refuge and foraging.
* Hatchery fry and smolts are released in large numbers but their survivorship is poor, compared to wild fish, although they contribute significantly to the fishery. Nevertheless, they may be competitors with better-adapted wild fish under conditions of low supply in the ocean. Most of the hatchery fish are planted below the Delta, to avoid the heavy mortality there.
* Numbers of salmon produced by tributaries to the San Joaquin River (Merced, Tuolumne, Stanislaus) continue to be exceptionally low, in the hundreds, and the promised restoration of the San Joaquin River appears to be stalled for lack of federal funds.

Thus reduced survival of wild fish in fresh water, especially in the Delta, combined with the naturally low survival rates of hatchery fish; most likely contribute to the plummeting numbers of adult spawners. This is especially likely to happen if young salmon also hit adverse conditions in the ocean, especially as they enter the Gulf of the Farrallons. The growing salmon can also hit other periods when food is scarce in the ocean, along with abundant predators and stressful temperatures, at any time in the ocean phase of their life cycle.

The overall message here is that indeed "ocean conditions" have had a lot to do with the recent crash of salmon populations in the Central Valley. However, they are superimposed on a population that has been declining in the long run (with some apparent stabilization in recent decades). The salmon still face severe problems before they reach the ocean, especially in the Delta. In the short run, there are only a few 'levers' we can pull to improve things for Central Valley salmon which include shutting down the commercial and recreational fisheries, reducing the impact of the big pumps in the South Delta, and perhaps changing the operation of dams (increasing outflows at critical times), regulating hatchery out put, and reducing other ocean fisheries. In the longer run (10-20 years) we need to be engaged in improving the Delta and San Francisco Estuary as a habitat for salmon, reducing inputs to the estuary of toxic materials, continuing with improvements of upstream habitats, managing floodplain areas such as the Yolo Bypass for salmon, restoring the San Joaquin River, and generally addressing the multiplicity of factors that affect salmon populations. There is also a huge need to improve monitoring of salmon in the ocean as well as the coastal ocean ecosystem off California. Right now, our understanding of how ocean conditions affect salmon is largely educated guesswork with guesses made long (sometimes years) after an event affecting the fish has happened. An investment in better knowledge should have large pay-offs for better salmon management.

Thus blaming "ocean conditions" for salmon declines is a lot like blaming the iceberg for sinking the Titanic, while ignoring the many human errors that put the ship on course for the fatal collision. Managers have optimistically thought that salmon populations were unsinkable, needing only occasional course corrections such as hatcheries or removal of small dams, to continue to go forward. The listings as endangered species of the winter and spring runs of Central Valley Chinook were warnings of approaching disaster on an even larger scale. "Ocean conditions" may be the potential icebergs for salmon populations but the ship is being steered by us humans. Salmon populations can be managed avoid an irreversible crash, but continuing on our present course could result in loss of a valuable and iconic fishery.

On a final more optimistic note, there is a reasonable chance that Chinook salmon populations will once again return to higher levels, as they have in the past, although not quickly. However, the lower the population goes and the more the environment changes in unfavorable ways, the more difficult recovery becomes.

Recovery is officially defined by the goals set by the Anadromous Fish Restoration Program under the Central Valley Project Improvement Act which has pledged to use "all reasonable efforts to at least double natural production of anadromous fish in California's Central Valley streams on a long-term, sustainable basis". The final doubling goal is 990,000 fish for all four runs combined. We have a long way to go and some major course modifications to make if we are to reach anything close to that goal.

Appendix B.

Carl Mesick Manuscript

The High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Tuolumne River due to Insufficient Instream Flow Releases

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30 April 2008

The following preliminary analysis indicates that the Tuolumne River fall-run Chinook salmon *(Oncorhynchus tshawytscha)* population of naturally produced fish is at a high risk of extinction because the instream flow releases are too low. Lindley and others (2007) have characterized the risk of extinction for Chinook salmon populations in the Sacramento-San Joaquin Basin relative to population size, rates of population decline, catastrophes, and hatchery influence. Populations with a high risk of extinction (greater than 20 percent chance of extinction within 20 years) have a total escapement that is less than 250 spawners in three consecutive years (mean of 83 fish per year), a precipitous decline in escapement, a catastrophe defined as an order of magnitude decline within one generation occurring within the last 10 years, and a high hatchery influence. Populations with a low risk of extinction (less than 5 percent chance of extinction in 100 years) have a minimum total escapement of 2,500 spawners in three consecutive years (mean of 833 fish per year), no apparent decline in escapement, no catastrophic declines occurring within the last 10 years, and a low hatchery influence. The Tuolumne River fall-run Chinook salmon population is at a high risk of extinction because the population of naturally produced fish was probably less than 83 for three consecutive years (2005 to 2007), there was a precipitous decline, and the fall 2007 escapement was a catastrophe considering the spring 2005 wet year conditions. Dr. Steve Lindley[1] evaluated the Tuolumne River population estimates in Table 1 and confirmed these conclusions. The following summarizes the risk of extinction based on the four criteria presented by Lindley and others (2007).

Population Size

The effective population size criteria relates to the loss of genetic diversity (Lindley et al. 2007). The effective population consists of individuals that are reproductively successful. In Chinook salmon populations, not all individuals are reproductively successful and the mean ratio of the effective population size to total escapement over a three year period (N_e/N) has been estimated to be 0.20 based on genetic assessments from fish collected in over 100 populations from California to British Columbia (Waples et al. 2004 as cited in Lindley et al. 2007). A few examples of why adult salmon may not reproduce successfully in the Tuolumne River include: (1) fish that return as two-year-old males; (2) redd superimposition that destroys eggs; (3) spawning in habitats with excessive levels of fines; and (4) low survival rates for juveniles that migrate late when high water temperatures in the lower Tuolumne River are unsuitable for survival.

[1] Steven Lindley, Ph.D, National Marine Fisheries Service, Fisheries Ecology Division, 110 Shaffer Road, Santa Cruz, California 95060, phone (831) 420-3921.

Therefore based on population size, the Tuolumne River could be considered to be at high risk if annual escapement (N) drops below a mean of 83 fish for three consecutive years and at low risk if escapement remains above a mean of 833 fish for three consecutive years.

The analyses reported here are based on preliminary estimates of the number of naturally produced and hatchery produced adult fall-run Chinook salmon that have returned to the Tuolumne River between 1981 and 2005 (Table 1). The analyses should be considered as preliminary because the estimates for the returns of untagged adult Feather, Nimbus, and Mokelumne hatchery fish are based on relatively few tagged fish that were collected in the Tuolumne River during escapement surveys (see Methods Summary). These surveys were used to estimate the percentage of the millions of unmarked juvenile hatchery fish released from these hatcheries in the Delta and San Francisco Bay that would have returned to the Tuolumne River (see Methods Summary). The preliminary analyses used simple mean rates of adult returns to the Tuolumne River that were estimated by segregating the juvenile release data into three groups: (1) release location, (2) spring or fall releases, and (3) water year type (Merced and Mokelumne hatcheries only). The mean rates of return do not account for year to year variation due to other factors, such as ocean conditions and fall attraction flows, and the statistical level of confidence has not been evaluated.

Since the license was amended in 1996 to improve minimum instream flows, it is likely that the escapement of naturally produced fish has been less than 83 fish between fall 2005 and 2007 (3 consecutive years, Table 1). Therefore, the Tuolumne River would be considered to be at a high risk of extinction according to the recommended criteria by Lindley and others (2007).

Population Decline

Another serious threat to the viability of natural salmonid populations identified by Lindley and others (2007) is a precipitous decline in escapement, which has occurred on the Tuolumne River. Table 1 indicates that the escapement of natural spawners in the Tuolumne River has declined from about 16,000 adults in fall 2000 to few if any fish between fall 2005 through fall 2007. In addition, the abundance of natural Tuolumne River recruits at a given flow declined by about 50% at a statistically significant level between the 1980 to 1995 pre-Settlement Agreement period and the 1996 to 2004 post-Settlement Agreement period (Figure 2). These results provide additional evidence that the Tuolumne River natural salmon population would be considered to be at a moderate to high risk of extinction according to the recommended criteria by Lindley and others (2007). The studies that have been conducted by the Turlock Irrigation District and the Modesto Irrigation District to date are inadequate to explain the cause of the population's decline (*see* Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River, e-Library no. 20070314-0089).

Catastrophe

Catastrophes are defined by Lindley and others (2007) as instantaneous declines in population size due to events that occur randomly in time that reflect a sudden shift from a low risk state to a higher one. The extremely low total escapement of 115 fish in Fall 2007 could be considered a catastrophe. Since the 1940s, fall-run Chinook salmon escapement to the Tuolumne River had been high two years following prolonged winter and spring flows during wet years. For example, during 1996 the mean flow near La Grange Dam was 3,652 cfs between February 1 and June 15 and natural fish escapement in fall 1998 was about 6,940 adult salmon (Table 1). In contrast, during 2005 the mean flow near La Grange Dam was 3,881 cfs between February 1 and June 15, but few if any naturally produced fish returned in fall 2007 (Table 1). Recent findings by the National Marine Fisheries Service (Peterson et al. 2006) indicate that warmer waters in the Pacific Ocean during 2005 caused a decline in marine food production, thus contributing to the marked decline in returning spring Chinook and coho salmon populations along the entire West Coast in 2007. The catastrophically low escapement in fall 2007 is another sign that the Tuolumne River naturally produced Chinook salmon population is at high risk of extinction.

Hatchery Influence

There are no data to directly assess the genetic impacts of adult hatchery fish on the naturally produced Chinook salmon population in the Tuolumne River. If there are impacts from the Feather, Nimbus, and Mokelumne hatchery releases, (an average total of about 570 adults in the Tuolumne River escapement from 1996 to 2005), then the minimum escapement needed to maintain a low risk of extinction would be substantially greater than 1,724 fish.

Minimum Flow Releases

The number of naturally produced adult salmon that return to the Tuolumne River is primarily a response of the juvenile salmon to the flows released at La Grange Dam during the winter and spring (Figure 1; Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River, e-Library no. 20070314-0089). The assessment of the relationship between flows and adult salmon production utilizes estimates of adult recruitment, which are adult salmon that all belong to the same cohort and were either harvested in the ocean or returned to spawn in the escapement. Assuming that ocean harvest rates continue to be about 40 percent (mean 2000 to 2006), a recruitment of 1,388 fish would result in an escapement of 833 fish. The polynomial relationship between the average flows from February 1 through June 15 and Tuolumne River adult recruitment (Figure 1) suggests that when the average winter and spring flows are less than 1,330 cfs, the average adult recruitment of naturally produced salmon is less than 1,388 fish.

There is uncertainty regarding the precise duration and timing of the spring pulse flows needed to produce 1,388 adult Tuolumne River recruits. The correlations between flow releases and salmon recruitment are probably highest for the February 1 through June 15 period because extended floodplain inundation that occurs during wet years produces good conditions for both rearing and migrating juveniles. The exponential increase in recruitment as flows increase above 2,000 cfs (Figure 1) probably reflects the importance of the extended floodplain inundation. Under typical dry and normal water year conditions, it is likely that high flows are primarily protecting outmigrating subyearling smolts in April and May. Therefore, it is likely that the 1,330 cfs pulse flows would have to occur when most of the smolt-sized fish are migrating and conditions are suitable for their survival in the Delta. Studies will be needed to determine the precise timing and duration of these pulse flows (*see* Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River, e-Library no. 20070314-0089). In addition to spring pulse flows, it would be necessary to provide fall pulse flows to minimize the straying of adults to the Sacramento Basin and suitable year-round base flows for spawning, egg incubation, and rearing. A minimum flow schedule that should be able to sustain both naturally producing Chinook salmon and *O. mykiss* (steelhead and rainbow trout) populations includes the following three elements:

- Pulse flows of 1,330 cfs for 45 days during April and May to provide suitable conditions for migrating juvenile salmon and Central Valley steelhead.
- Fall pulse flows of 1,500 cfs for 10 days during mid-October to attract adult Chinook salmon to the Tuolumne River and minimize straying (Mesick 2001).
- Year round base flows of 235 cfs to provide suitable water temperatures throughout the summer in 12.4 miles of habitat for *O. mykiss* (unpublished results of real-time temperature management by Turlock Irrigation District and Modesto Irrigation District in 2002 and 2003) and suitable spawning and rearing conditions for fall-run Chinook salmon.

The total volume of water required for this flow schedule is 292,889 acre-feet (AF). In comparison, the volume of flow releases required in the Tuolumne River in the 1996 FERC order range from 94,000 AF in Critical and Below Normal Water Year Types to 165,002 AF in Median Below Normal water year types (Turlock Irrigation District and Modesto Irrigation District 2005). These relatively dry water year types cumulatively occur 50.7% of the time (Turlock Irrigation District and Modesto Irrigation District 2005). During the wetter water year types (49.3% of the time), the required flow release is 300,923 AF (Turlock Irrigation District and Modesto Irrigation District 2005).

<u>Methods Summary</u>

The analyses described here are based on trends in adult recruits, which are adult salmon that all belong to the same cohort and were either harvested in the ocean or returned to spawn in the escapement. Approximately 40% of the adult recruits have been harvested in the ocean between 2000 and 2006.

The number of recruits is estimated by first segregating the California Department of Fish and Game (CDFG) escapement estimates (GrandTab Excel file, February 20, 2008) into cohorts using an age analysis of fall-run Chinook salmon scales collected from the Tuolumne River between 1981 and 2002 that was conducted by CDFG. The abundance of recruits is then expanded by an index of the percentage of fish harvested in the ocean

(Central Valley Index, Pacific Fisheries Management Council 2006). These methods are described in greater detail in Mesick and Marston (2007) and Mesick, Marston, and Heyne (2007).

The escapement estimates for the lower Tuolumne River in the CDFG database are a combination of naturally produced and hatchery fish. To estimate the number of hatchery reared fish, it was necessary to expand the number coded-wire-tagged (CWT) hatchery adults that returned to the Tuolumne River (Table 2) as well as estimate the number of untagged hatchery fish that were reared in the Merced, Mokelumne, Nimbus (American River), and Feather river hatcheries and returned to the Tuolumne River as adults (Table 3). Expanding the number of CWT fish is a relatively simple computation based on the number of hatchery fish, which are identified with an adipose fin clip, that are observed during the escapement survey, the number of salmon examined for tags, and the total number of salmon in the escapement. These data are considered to be relatively accurate for the lower Tuolumne River. Expanding the number of unmarked fish assumes that the unmarked fish return to the Tuolumne River at the same rate that the marked fish return to the Tuolumne River.

Based on the CWT recoveries in the Tuolumne River, most of the unmarked fish originate from planting juvenile fish in the San Francisco Bay from the Mokelumne, Nimbus, and Feather River hatcheries, in the Delta from the Mokelumne River Hatchery, and in the Merced River from the Merced River Hatchery.

The number of unmarked fish released from each hatchery was obtained from the CDFG annual reports for the Feather, Nimbus, Mokelumne, and Merced hatcheries. Some of the Merced hatchery release data was obtained from planting release records. Expansions of the unmarked hatchery fish were based on the CWT return rates segregated by release location (e.g., river, Delta, or Bay) and whether releases were spring sub-yearling fish or fall yearlings. The expansions for Merced River, Mokelumne River, and Delta releases were also segregated into wet (San Joaquin Index > 3.1 million acre-feet) and dry year conditions (San Joaquin Index ≤ 3.1 million acre-feet); water year type did not substantially affect the return rates for juveniles planted in the Bay. The analyses were conducted using Microsoft Excel spreadsheets and data were sorted into the various release categories (e.g., River, Delta, and Bay) using pivot tables. The escapement of naturally produced salmon was computed by subtracting the estimated number of marked and unmarked hatchery fish that returned to the Tuolumne River from the CDFG escapement estimate.

Preliminary Results

Figure 1. The number of natural adult recruits relative to the average flow release from La Grange Dam from February 1 through June 15 when the cohorts migrated as juveniles toward the ocean from 1996 to 2004. The polynomial equation and the R^2 value computed by Excel are presented for the relationship.

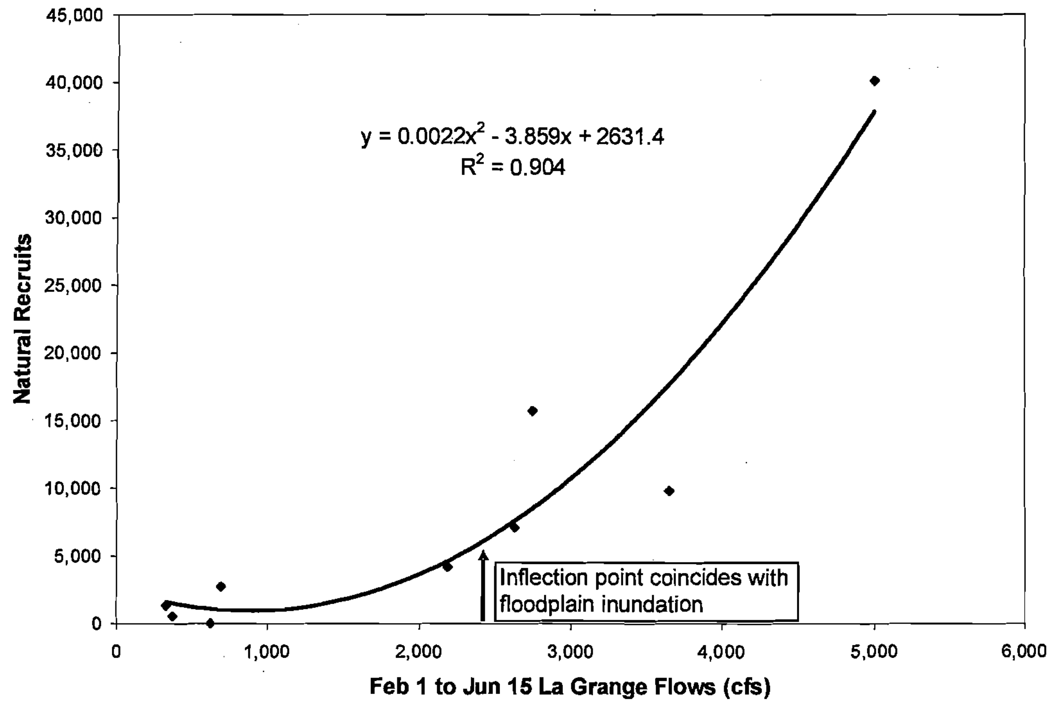

Figure 2. Tuolumne River natural fall-run Chinook salmon recruitment plotted with mean flow in the Tuolumne River at La Grange during February 1 through June 15 during two periods: 1980 to 1990 and from 1997 to 2003. Estimates were excluded when spawner abundance was less than 650 Age 3 equivalent fish to minimize the effect of spawner abundance on the relationship between flow and recruitment. An F test comparing the two data sets indicate that the elevations of the two regressions are significantly different ($P = 0.011$). The variance terms of the two data sets were not statistically different ($P = 0.301$), which is a condition required to compare the slopes and elevations of the two regressions, and the slopes were not significantly different ($P = 0.056$) (Snedecor and Cochran 1989, pages 390-393).

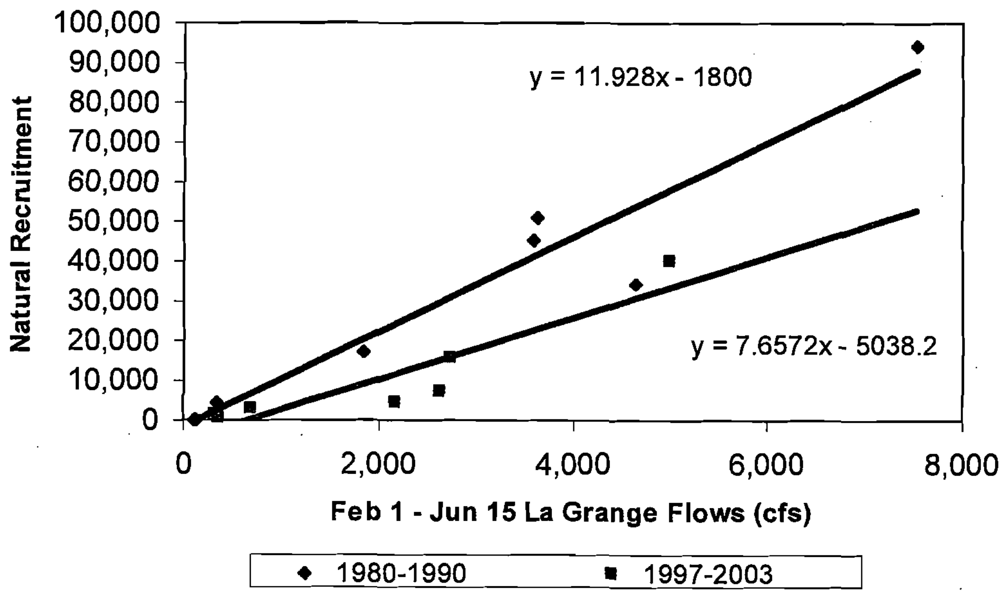

Table 1. **The Department of Fish and Game estimated escapement of fall-run Chinook Salmon in the Tuolumne River (GrandTab), the estimated total number of marked (coded-wire tag and adipose clipped) adults that returned to the Tuolumne River, the estimated number of unmarked hatchery adults from the Mokelumne, Nimbus, Feather, and Merced river hatcheries that returned to the Tuolumne River, the estimated escapement of naturally produced adults, the escapement of hatchery produced adults, and the percent hatchery fish in the escapement from 1978 to 2007. The estimates of unmarked adults are based on bay releases from the Nimbus and Feather River hatchery, Delta and Bay releases from the Mokelumne Hatchery, and Merced River releases from the Merced River Hatchery. The estimates of natural escapement were truncated at zero. The estimates of natural escapement for 2006 and 2007 assume that the average number of out-of-basin hatchery strays that returned to the Tuolumne River between 1996 and 2005, which is 570 fish, also returned in 2006 and 2007.**

			Unmarked Adults						
	Total Escapement	Marked Hatchery Fish	Mokelumne Hatchery	Nimbus Hatchery	Feather River Hatchery	Merced River Hatchery	Estimated Natural Escapement	Estimated Hatchery Escapement	Percent Hatchery
1981	14,253	0	57	1	80	9	14,106	147	1.0%
1982	7,126	30	94	22	83	0	6,897	229	3.2%
1983	14,836	430	82	60	143	0	14,121	715	4.8%
1984	13,689	31	91	69	187	0	13,312	377	2.8%
1985	40,322	208	105	66	195	0	39,747	575	1.4%
1986	7,404	143	75	68	247	1	6,871	533	7.2%
1987	14,751	1,619	74	71	372	43	12,571	2,180	14.8%
1988	5,779	270	104	75	406	105	4,819	960	16.6%
1989	1,275	175	133	71	430	59	407	868	68.1%
1990	96	98	160	68	410	5	0	741	100%
1991	77	20	188	69	332	5	0	613	100%
1992	132	23	173	65	277	4	0	542	100%
1993	471	118	161	59	229	3	0	569	100%
1994	506	107	199	57	432	1	0	797	100%

			Unmarked Adults						
	Total Escapement	Marked Hatchery Fish	Mokelumne Hatchery	Nimbus Hatchery	Feather River Hatchery	Merced River Hatchery	Estimated Natural Escapement	Estimated Hatchery Escapement	Percent Hatchery
1995	827	142	185	53	622	0	0	1,002	100%
1996	4,362	881	104	61	601	18	2,696	1,666	38.2%
1997	7,146	1,321	52	68	496	45	5,165	1,981	27.7%
1998	8,910	1,405	85	65	392	23	6,940	1,970	22.1%
1999	8,232	1,043	112	63	333	31	6,650	1,582	19.2%
2000	17,873	1,291	107	66	270	81	16,059	1,814	10.1%
2001	8,782	1,559	130	68	277	62	6,686	2,096	23.9%
2002	7,173	2,650	159	52	278	40	3,994	3,179	44.3%
2003	2,163	490	185	31	231	30	1,197	966	44.7%
2004	1,984	473	192	49	243	23	1,004	980	49.4%
2005	500	142	204	53	295	21	0	716	100%
2006	500	?	?	?	?	?	0	?	100%
2007	115	?	?	?	?	?	0	?	100%

Table 2. The number of coded-wire-tagged hatchery fish produced in the Feather River, Nimbus (American River), Mokelumne River, and Merced River hatcheries that returned to the Tuolumne River as adults from 1980 to 2005. The estimated number of returns to the Tuolumne River in Table 2 are included in the column "Marked Hatchery Fish" in Table 1.

Tagged Feather River Releases in San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
06/05/1978	066203	164,766	18,183	Port Chicago	0
08/22/1978	065813	97,000	5,820	Port Chicago	3.02
06/10/1980	066209	88,700	4,375	Port Chicago	0
06/13/1980	066212	79,443	2,457	Port Chicago	0
08/14/1980	065817	77,700	15,538	Benicia	51.30
06/08/1981	066215	78,339	5,536	Port Chicago	91.55
06/09/1981	065821	41,917	4,354	Tiburon Net Pens	0
08/10/1985	065860	23,307	2,335	Emeryville Minor Pt	0
06/29/1988	063104	54,151	657	Port Chicago	0
05/04/1994	062517	102,991	1,467	Benicia	2.02
05/04/1994	062517	102,991	1,467	Benicia	3.73
05/31/1994	062518	101,125	5,455	Benicia	0
05/31/1994	063146	51,804	1,608	Benicia	0
07/18/1994	063805	98,795	4,010	Benicia	4.27
07/18/1994	063806	99,394	3,286	Benicia	3.80
06/30/1995	062531	55,498	845	Crockett	0
06/14/1996	062935	56,900	1,669	Monterey	0
06/16/1996	062933	139,443	13,559	Rodeo Minor Port	0
06/26/1996	062937	150,089	4,802	Rodeo Minor Port	0
06/26/1996	062938	149,440	6,232	Rodeo Minor Port	0
04/24/1997	062542	52,597	909	Feather River	0
05/05/1997	0601060215	24,766	3,764	Port Chicago	0
06/07/1999	062631	50,877	1,038	Wickland Oil	0
06/07/1999	062633	51,964	1,060	Wickland Oil	0
06/07/1999	062636	50,932	1,039	Wickland Oil	0
06/07/1999	062637	49,140	1,003	Wickland Oil	0
06/11/1999	062638	50,827	1,037	Wickland Oil	0
06/20/2000	062658	294,362	7,238	Wickland Oil	0
03/27/2001	062674	46,052	2,732	Rodeo Minor Port	0
03/27/2001	062676	44,021	3,010	Wickland Oil	0
03/27/2001	062678	46,052	2,732	Rodeo Minor Port	0
03/29/2001	062666	42,003	2,872	Wickland Oil	0
03/29/2001	062670	46,642	3,189	Wickland Oil	0

Tagged Feather River Releases in San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
03/29/2001	062672	47,369	3,239	Wickland Oil	0
03/29/2001	062673	42,704	2,920	Wickland Oil	3.95
03/29/2001	062673	46,642	3,189	Wickland Oil	4.27
03/29/2001	062674	47,369	3,239	Wickland Oil	0
03/29/2001	062675	42,704	2,920	Wickland Oil	8.54
04/15/2001	062091	202,096	719,407	Wickland Oil	16.86
04/15/2001	062664	202,096	719,407	Wickland Oil	145.77
04/23/2001	062663	142,204	719,713	Wickland Oil	0
04/23/2001	062665	142,204	719,713	Wickland Oil	24.22
04/23/2001	062665	142,204	719,713	Wickland Oil	68.98
05/01/2001	062665	31,384	2,146	Wickland Oil	3.95
05/01/2001	062669	32,082	2,194	Wickland Oil	0
05/01/2001	062670	31,384	2,146	Wickland Oil	0
04/10/2002	060290	263,768	227,882	Wickland Oil	7.07
04/10/2002	060401	263,768	227,882	Wickland Oil	0
04/10/2002	060402	264,738	228,012	Wickland Oil	6.88
04/12/2002	062722	105,753	3,896	Wickland Oil	3.83
04/12/2002	062737	107,348	3,853	Wickland Oil	0
06/09/2003	062773	55,625	1,426	Crockett	0
06/09/2003	062774	53,377	1,369	Crockett	0

Tagged Nimbus Hatchery Releases in San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
07/15/1986	065405	48,920	5,800	Berkeley Marina	0
07/16/1986	065406	53,072	70,528	Benicia	4.75
07/09/1987	065407	51,891	524	Berkeley Marina	0
06/20/1988	065411	36,325	220,389	Benicia	0
06/13/1989	065413	41,125	198,867	Benicia	0
06/14/1989	065414	49,848	220,365	Benicia	0
06/16/1989	065415	48,207	241,210	Benicia	26.20
06/21/1989	065412	49,400	283,181	Benicia	0
05/23/2001	065455	98,171	1,227,785	Wickland Oil	51.24
05/23/2001	065456	99,528	285,184	Wickland Oil	0
05/23/2001	065457	99,102	285,992	Wickland Oil	0
05/23/2001	065458	99,297	322,984	Wickland Oil	0
05/23/2001	065459	99,439	322,984	Wickland Oil	16.98

Tagged Nimbus Hatchery Releases in San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
05/23/2001	065460	96,371	1,088,938	Wickland Oil	0
06/18/2002	062664	238,195	35,749	Wickland Oil	8.50
06/18/2002	062666	238,195	35,749	Wickland Oil	0
06/18/2002	062667	237,231	36,608	Wickland Oil	0
06/18/2002	062668	237,231	36,608	Wickland Oil	0
06/18/2002	062668	238,193	35,751	Wickland Oil	4.36

Tagged Mokelumne Hatchery Releases in San Joaquin Delta					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
10/01/1976	060205	25,059	511	Brannan Island	0
02/01/1977	060206	26,912	1,995	Brannan Island	0
09/28/1977	064807	32,915	3,985	Brannan Island	0
10/01/1979	064812	43,370	0	Rio Vista	0
05/10/1994	064803	53,606	487	Thornton	0
05/10/1994	064804	49,864	352	Thornton	0
05/23/1994	064801	51,314	414	Thornton	4.14
05/23/1994	064801	51,314	414	Thornton	6.82
05/23/1994	064802	51,518	415	Thornton	0
04/18/1995	060211	48,345	4,898	Thornton	0
04/18/1995	060212	49,531	5,019	Thornton	4.52
04/25/1995	060213	49,837	4,511	Thornton	0
04/25/1995	060214	49,625	4,492	Thornton	0
05/15/1995	060210	51,757	719,462	Thornton	0
05/15/1996	060216	49,946	3,415	Thornton	0
05/15/1996	060217	52,123	1,282	Thornton	0
05/20/1996	060218	50,832	1,898	Jersey Point	4.26
05/20/1996	060218	50,832	1,898	Jersey Point	7.19
05/20/1996	060218	50,832	1,898	Jersey Point	0
05/20/1996	060219	52,389	636	Jersey Point	8.31
04/30/1997	064912	52,022	0	Jersey Point	0
04/30/1997	064913	51,978	130	Jersey Point	0
04/28/1998	060234	51,227	1,046	Jersey Point	0
04/28/1998	060235	52,127	1,065	Jersey Point	0
05/21/1999	054115	49,740	860	Sherman Island	0
05/21/1999	060247	51,366	2,140	Sherman Island	4.16
05/21/1999	060248	49,740	860	Sherman Island	4.07
05/21/1999	064920	25,162	514	Sherman Island	8.16

Tagged Mokelumne Hatchery Releases in San Joaquin Delta					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
05/21/1999	064921	25,200	514	Sherman Island	0
05/21/1999	064922	25,121	513	Sherman Island	4.08
05/21/1999	064923	25,579	522	Sherman Island	4.08
05/01/2000	055113	50,445	1,560	Sherman Island	0
05/01/2000	060248	51,167	867	Sherman Island	0
05/01/2000	060253	50,445	1,560	Sherman Island	20.60
05/01/2000	060254	51,167	867	Sherman Island	16.26
04/24/2001	060268	51,207	206	Jersey Point	11.14
04/24/2001	060269	51,746	0	Jersey Point	3.70
04/24/2001	060270	51,207	206	Jersey Point	4.01
04/24/2001	060271	51,746	0	Jersey Point	3.79
04/24/2001	060271	51,746	0	Jersey Point	19.98
04/26/2001	062675	25,384	128	West Sacramento	3.72
04/26/2001	062677	25,872	130	West Sacramento	0
04/26/2001	062716	25,384	128	West Sacramento	0
04/26/2001	062717	25,872	130	West Sacramento	4.02
05/09/2001	062708	25,201	1,009	West Sacramento	0
05/09/2001	062709	24,527	982	West Sacramento	0
04/09/2002	062716	25,661	259	Jersey Point	0
04/09/2002	062717	25,600	0	Jersey Point	0
04/09/2002	062722	25,661	259	Jersey Point	0
04/09/2002	062723	25,600	0	Jersey Point	18.97
04/23/2002	064453	25,500	0	Jersey Point	11.38
04/23/2002	065459	25,245	255	Jersey Point	0
04/23/2002	065863	25,245	255	Jersey Point	15.33
10/07/2002	064930	25,981	0	Sherman Island	7.59
10/08/2002	060277	50,387	253	Beaver Slough,	0
10/15/2002	064931	25,811	261	Sherman Island	3.83
10/23/2002	064928	25,240	127	Sherman Island	15.25
10/30/2002	064929	25,912	130	Sherman Island	11.44

Tagged Mokelumne Hatchery Releases in the San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
04/12/1995	060208	49,769	1,912	Crockett	3.60
05/22/1995	060208	49,769	1,912	Crockett	0
06/06/1996	060229	52,704	745,388	Rodeo Minor Port	0
06/02/1997	060230	50,235	948,965	Rodeo Minor Port	0

Tagged Mokelumne Hatchery Releases in the San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
06/12/1998	060240	51,059	352,416	Carquinez Strait	65.33
06/12/1998	060241	51,427	352,426	Carquinez Strait	64.92
06/15/1999	060215	95,203	782,097	Crockett	0
05/08/2000	060250	51,389	437,894	Wickland Oil	76.10
05/08/2000	060251	51,765	438,256	Wickland Oil	75.66
04/27/2001	062706	25,550	128	Benicia	0

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
10/01/1978	064610	49,498	1,113	MRH	0
09/26/1979	064611	16,059	874	Gallo	0
10/15/1981	064612	40,760	15,445	Gallo	0
04/22/1982	064617	49,217	2,590	Gallo	0
11/10/1982	064626	23,804	36,756	MRH	0
11/10/1982	064627	23,804	25,636	MRH	0
10/01/1983	064629	41,143	8,857	MRH	0
10/19/1984	064638	49,649	1,273	Gallo	0
10/17/1985	064644	35,535	33,660	Gallo	0
11/10/1982	0601110101	25,357	72,217	Merced River	0
11/10/1982	0601110102	25,276	1,786	Merced River	0
11/14/1991	064512	29,653	1,681	MRH	0
11/14/1991	064513	29,653	1,681	MRH	0
11/14/1991	064514	29,653	1,681	MRH	0
03/04/1992	064515	22,815	12,210	Merced River	9.59
02/18/1993	064651	14,946	1,850	MRH	2.24
02/18/1993	064651	14,946	1,850	MRH	3.13
02/18/1993	064651	14,946	1,850	MRH	35.10
11/05/1993	064517	35,064	283	MRH	2.01
11/05/1993	064518	13,145	106	MRH	3.71
11/05/1993	064620	521	4	MRH	0
11/05/1993	064621	2,364	19	MRH	0
11/12/1993	064516	32,891	265	MRH	0
11/12/1993	064517	35,064	283	MRH	0
04/22/1994	0601020112	48,943	2,576	MRH	0
04/22/1994	0601110210	24,946	252	MRH	3.72
04/22/1994	0601110210	24,946	252	MRH	6.84
04/22/1994	0601110211	24,946	252	MRH	3.72
04/22/1994	0601110212	24,946	252	MRH	0
04/22/1994	0601110213	24,946	252	MRH	3.72
04/22/1994	0601110214	24,349	701	Merced River	0
04/22/1994	0601110215	27,349	701	Merced River	0

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
	0601110301	27,349	701	Merced River	0
11/17/1994	0601020112	48,943	2,576	MRH	7.12
11/17/1994	0601020112	48,943	2,576	MRH	7.74
11/17/1994	064624	10,021	528	MRH	7.74
11/17/1994	064625	8,904	469	MRH	2.10
11/28/1994	0601020111	48,889	5,241	Merced River	0
11/28/1994	064516	32,891	265	MRH	2.01
11/28/1994	064622	7,600	458	Merced River	0
11/28/1994	064623	7,586	458	Merced River	0
05/03/1995	0601110401	28,349	579	MRH	3.75
05/03/1995	0601110401	28,349	579	MRH	62.15
05/03/1995	0601110402	27,961	571	MRH	7.51
05/03/1995	0601110402	27,961	571	MRH	27.62
05/03/1995	0601110403	26,839	548	MRH	6.91
05/03/1995	0601110404	28,141	574	MRH	4.19
05/03/1995	0601110404	28,141	574	MRH	7.51
05/03/1995	0601110404	28,141	574	MRH	20.72
05/04/1995	0601110402	27,961	571	MRH	0
05/04/1995	0601110405	27,317	1,066	Merced River	4.27
05/04/1995	0601110405	27,317	1,066	Merced River	15.29
05/04/1995	0601110405	27,317	1,066	Merced River	42.19
05/04/1995	0601110406	27,642	1,079	Hatfield State Park	4.27
05/04/1995	0601110406	27,642	1,079	Hatfield State Park	15.29
05/04/1995	0601110406	27,642	1,079	Hatfield State Park	42.19
05/04/1995	0601110407	28,052	1,095	Hatfield State Park	15.29
05/04/1995	0601110407	28,052	1,095	Hatfield State Park	49.22
04/25/1996	0601110410	22,637	4,902	MRH	0
04/25/1996	0601110411	21,691	1,698	MRH	0
04/26/1996	0601110504	22,018	4,768	Merced River	0
04/26/199	0601110505	20,613	4,464	Merced River	0
04/20/1997	0601110511	26,045	3,131	MRH	0
04/20/1997	0601110512	27,683	3,316	MRH	0
04/20/1997	0601110513	31,930	3,828	MRH	0
04/20/1997	0601110514	24,880	2,969	MRH	0
04/22/1997	0601110515	24,398	5,495	Hatfield State Park	0
04/22/1997	0601110601	29,011	6,547	Hatfield State Park	0
04/22/1997	0601110602	25,761	5,817	Hatfield State Park	0
04/22/1997	0601110603	25,317	5,705	Hatfield State Park	0
05/14/1997	0601110614	33,064	4,511	MRH	0
05/14/1997	0601110615	28,294	3,861	Hatfield State Park	0
05/14/1997	0601110702	5,856	796	Hatfield State Park	0
04/12/1998	062520	27,973	1,664	MRH	3.67
04/12/1998	064523	35,800	2,129	MRH	3.67
04/12/1998	064524	36,289	2,158	MRH	17.52

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
04/14/1998	062521	34,805	5,872	Hatfield State Park	5.68
04/14/1998	062521	34,805	5,872	Hatfield State Park	8.10
04/14/1998	062522	30,857	5,206	Hatfield State Park	8.10
04/14/1998	062522	30,857	5,206	Hatfield State Park	38.65
04/14/1998	062523	8,447	1,425	Hatfield State Park	0
05/03/1998	0601110709	28,248	257	MRH	16.68
05/03/1998	0601110710	25,482	232	MRH	9.80
05/03/1998	0601110711	25,220	230	MRH	7.00
05/03/1998	0601110711	25,220	230	MRH	9.80
05/03/1998	0601110712	25,046	228	MRH	0
05/04/1998	0601110710	25,482	232	MRH	25.03
05/04/1998	0601110711	25,220	230	MRH	0
05/05/1998	0601110502	49,873	866	Hatfield State Park	4.94
05/05/1998	0601110502	49,873	866	Hatfield State Park	33.64
05/05/1998	0601110713	25,314	439	Hatfield State Park	4.94
05/05/1998	0601110713	25,314	439	Hatfield State Park	7.05
05/05/1998	0601110713	25,314	439	Hatfield State Park	33.64
05/05/1998	0601110801	25,923	1,198	MRH	0
05/05/1998	0601110802	23,868	1,103	MRH	0
04/14/1999	064528	25,462	628	MRH	0
04/14/1999	064529	25,445	628	MRH	0
04/14/1999	064530	25,221	622	MRH	0
04/16/1999	064531	24,123	1,493	Hatfield State Park	25.79
04/16/1999	064532	24,640	1,525	Hatfield State Park	4.24
04/16/1999	064532	24,640	1,525	Hatfield State Park	5.16
05/05/1999	0601110714	24,075	1,112	MRH	0
05/05/1999	0601110801	25,923	1,198	MRH	0
05/05/1999	0601110802	23,868	1,103	MRH	0
05/05/1999	0601110803	23,936	1,106	MRH	4.18
05/07/1999	064534	24,337	2,390	Hatfield State Park	0
05/07/1999	064535	23,215	2,281	Hatfield State Park	5.33
05/07/1999	064536	23,436	2,302	Hatfield State Park	0
04/12/2000	064487	25,507	869	Snelling	0
04/12/2000	064488	25,318	862	Snelling	0
04/12/2000	064539	25,313	862	Snelling	0
04/12/2000	064540	25,395	865	Snelling	0
04/12/2000	064541	24,490	1,369	Hatfield State Park	0
04/12/2000	064542	24,432	1,366	Hatfield State Park	0
04/12/2000	064543	24,525	1,371	Hatfield State Park	0
04/12/2000	064544	24,490	1,369	Hatfield State Park	0
04/12/2000	064545	24,432	1,366	Hatfield State Park	0
04/27/2000	064552	26,189	0	Hatfield State Park	0
04/27/2000	064553	25,794	0	Hatfield State Park	11.99
04/27/2000	064554	26,189	0	Hatfield State Park	0

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
	064555	25,444	0	Hatfield State Park	4.00
04/28/2000	064549	25,794	0	Hatfield State Park	0
04/21/2001	064412	25,029	908	MRH	3.83
04/21/2001	064414	24,077	873	MRH	7.66
04/21/2001	064415	24,342	883	MRH	0
04/21/2001	064416	24,034	872	MRH	3.83
04/21/2001	064417	24,342	883	MRH	0
04/21/2001	064418	24,034	872	MRH	0
04/23/2001	064419	24,925	483	Hatfield State Park	0
04/26/2001	064417	24,925	483	Hatfield State Park	0
04/26/2001	064418	24,958	483	Hatfield State Park	0
04/26/2001	064419	24,885	482	Hatfield State Park	0
04/26/2001	064420	24,958	483	Hatfield State Park	0
04/26/2001	064421	24,885	482	Hatfield State Park	0
05/08/2001	064420	24,722	479	MRH	0
05/08/2001	064421	24,121	467	MRH	0
05/08/2001	064422	24,722	479	MRH	0
05/08/2001	064424	25,972	503	MRH	0
05/10/2001	052418	24,401	1,017	Merced River	7.70
05/11/2001	064423	23,038	2,195	Hatfield State Park	0
05/11/2001	064424	23,227	2,213	Hatfield State Park	0
05/11/2001	064426	23,428	164,233	MRH	0
05/11/2001	064427	23,227	2,213	Hatfield State Park	0
05/11/2001	064428	23,428	164,233	MRH	0
04/03/2002	064443	24,380	1,065	Hatfield State Park	19.29
04/03/2002	064444	24,228	1,059	Hatfield State Park	19.30
04/03/2002	064451	24,380	1,065	Hatfield State Park	0
04/03/2002	064548	24,890	1,087	Hatfield State Park	0
04/05/2002	064544	24,890	1,087	Hatfield State Park	0
04/21/2002	064484	23,140	2,449	MRH	0
04/21/2002	064485	22,183	2,347	MRH	0
04/26/2002	064480	23,363	2,010	Hatfield State Park	0
04/26/2002	064481	23,639	2,033	Hatfield State Park	0
04/26/2002	064486	23,349	2,009	Hatfield State Park	0
04/26/2002	064487	23,363	2,010	Hatfield State Park	0
04/26/2002	064488	23,639	2,033	Hatfield State Park	0
04/13/2003	064489	22,677	3,389	MRH	0
04/13/2003	064490	22,817	3,409	MRH	0
04/13/2003	064491	22,945	3,429	MRH	0
04/13/2003	064492	21,725	3,246	MRH	0
04/16/2003	064493	23,274	1,883	Hatfield State Park	3.07
04/16/2003	064493	23,274	1,883	Hatfield State Park	4.10
04/16/2003	064494	23,872	1,932	Hatfield State Park	0
04/16/2003	064495	23,833	1,929	Hatfield State Park	0

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
04/25/2003	064496	24,231	1,539	MRH	0
04/25/2003	064498	23,758	1,508	MRH	0
04/29/2003	064564	24,544	1,023	Hatfield State Park	0
04/29/2003	064565	24,484	1,020	Hatfield State Park	0
04/29/2003	064566	24,358	1,015	Hatfield State Park	2.96
04/29/2003	064566	24,358	1,015	Hatfield State Park	3.95
05/04/2003	062777	23,591	1,892	MRH	0
05/04/2003	062778	23,862	1,914	MRH	0
05/04/2003	064449	23,512	1,886	MRH	0
05/04/2003	064450	24,330	1,952	MRH	0
05/07/2003	064546	22,605	2,937	Hatfield State Park	0
05/07/2003	064547	22,715	2,952	Hatfield State Park	0
05/07/2003	064572	22,650	2,943	Hatfield State Park	0
04/20/2004	064595	23,038	2,588	Hatfield State Park	0
04/28/2004	064667	25,306	649	Hatfield State Park	0
05/09/2004	064669	24,418	755	MRH	0
05/12/2004	064599	24,769	900	Hatfield State Park	0

Table 3. The number of unmarked hatchery juveniles produced in the Feather and Nimbus hatcheries that were released in the San Francisco Bay, Mokelumne hatchery that were released in the San Joaquin Delta and San Francisco Bay, and Merced hatchery that were released in the Merced River from 1978 to 2004. The estimated total numbers of adult returns to the Tuolumne River from these unmarked releases are presented in the columns identified as "Unmarked Adults" in Table 1.

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/1978	Tiburon Net Pens	150,500	8.1
07/01/1979	Bodega Bay	12,040	0.6
08/01/1979	Tiburon Net Pens	35,950	1.9
07/01/1980	Carquinez Strait	42,000	2.3
05/01/1981	Benicia	793,981	42.8
06/01/1981	Benicia	282,300	15.2
06/01/1981	Benicia	1,057,300	57.1
07/01/1981	Benicia	814600	44.0
08/01/1981	Benicia	343,850	18.6
09/01/1981	Benicia	190,510	10.3
04/01/1982	Benicia	860,900	46.5
05/01/1982	Benicia	110,220	5.9
05/01/1982	Benicia	498,930	26.9

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/1982	Benicia	1,220,200	65.8
07/01/1982	Benicia	173,600	9.4
08/01/1982	Benicia	256,425	13.8
09/01/1982	Benicia	9,600	0.5
09/01/1982	Benicia	24,700	1.3
02/01/1983	Feather River	2,558,400	138.1
06/01/1983	Benicia	743,200	40.1
07/01/1983	Benicia	599,700	32.4
07/01/1983	Tiburon Net Pens	49,300	2.7
07/01/1983	Vallejo	48,600	2.6
08/01/1983	Tiburon Net Pens	48,000	2.6
08/01/1983	Vallejo	44,800	2.4
09/01/1983	Vallejo	42,700	2.3
10/01/1983	Tiburon Net Pens	21,000	1.1
10/01/1983	Tiburon Net Pens	23,200	1.3
06/01/1984	Benicia	63,000	3.4
06/01/1984	Vallejo	42,750	2.3
06/01/1984	Port Chicago	44,100	2.4
07/01/1984	Benicia	634,550	34.2
08/01/1984	Berkeley Marina	230,200	12.4
08/01/1984	Benicia	1,051,175	56.7
09/01/1984	Berkeley Marina	100,200	5.4
09/01/1984	Benicia	476,650	25.7
01/01/1985	Feather River	182,400	9.8
04/01/1985	Benicia	943,050	50.9
05/01/1985	Feather River	22,000	1.2
05/01/1985	Benicia	465,500	25.1
05/01/1985	Benicia	479,077	25.9
05/01/1985	Port Chicago	53,100	2.9
05/01/1985	Berkeley Marina	52,700	2.8
06/01/1985	Tiburon Net Pens	28,500	1.5
06/01/1985	Benicia	465,500	25.1
07/01/1985	Benicia	2,412,575	130.2
08/01/1985	Benicia	2,190,825	118.2
09/01/1985	Benicia	1,718,380	92.7
10/01/1985	Benicia	112,800	6.1
04/01/1986	Feather River	14,400	0.8
05/01/1986	Feather River	8,400	0.5
05/01/1986	Benicia	573,750	31.0
06/01/1986	Benicia	313,200	16.9
06/01/1986	Tiburon Net Pens	50,000	2.7
07/01/1986	Benicia	1,136,800	61.3
08/01/1986	San Francisco Bay	1,829,275	98.7
09/01/1986	San Francisco Bay	686,150	37.0

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
10/01/1986	Feather River	1,451,450	78.3
04/01/1987	Benicia	821,300	44.3
05/01/1987	Benicia	926,500	50.0
06/01/1987	Benicia	2,382,800	128.6
07/01/1987	Benicia	2,477,075	133.7
08/01/1987	Benicia	1,860,400	100.4
09/01/1987	Benicia	435,850	23.5
03/01/1988	Benicia	129,200	7.0
04/01/1988	Benicia	827,600	44.7
05/01/1988	Benicia	704,850	38.0
06/01/1988	Tiburon Net Pens	50,050	2.7
06/01/1988	Benicia	1,525,450	82.3
07/01/1988	Benicia	2,701,750	145.8
12/01/1988	Feather River	538,400	29.1
01/01/1989	Feather River	371,800	20.1
04/01/1989	Benicia	685,500	37.0
05/01/1989	Benicia	537,000	29.0
06/01/1989	Benicia	972,100	52.5
06/01/1989	Tiburon Net Pens	43,500	2.3
07/01/1989	Benicia	911,400	49.2
08/01/1989	Benicia	1,075,900	58.1
05/01/1990	Benicia	882,000	47.6
06/01/1990	Benicia	3,414,050	184.2
07/01/1990	Benicia	1,214,800	65.6
08/01/1990	Benicia	1,449,650	78.2
09/01/1990	Benicia	549,200	29.6
05/01/1991	Tiburon Net Pens	55,900	3.0
01/01/1992	Feather River	1,400,000	75.5
03/01/1992	Feather River	1,655,440	89.3
04/01/1992	Monterey	35,000	1.9
04/01/1992	Feather River	768,995	41.5
05/01/1992	Benicia	465,500	25.1
05/01/1992	Monterey	59,850	3.2
05/01/1992	Monterey	26,500	1.4
05/01/1992	Ventura	4,600	0.2
05/01/1992	Benicia	1,173,850	63.3
06/01/1992	Benicia	1,314,900	71.0
07/01/1992	Benicia	1,634,100	88.2
08/01/1992	Benicia	1,186,400	64.0
09/01/1992	Benicia	443,100	23.9
10/01/1992	Benicia	276,160	14.9
01/01/1993	Feather River	1,920,000	103.6
02/01/1993	Feather River	160,000	8.6
05/01/1993	Tiburon Net Pens	54,000	2.9

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
05/01/1993	Monterey	77,400	4.2
05/01/1993	Benicia	1,836,000	99.1
06/01/1993	Benicia	3,077,270	166.1
07/01/1993	Benicia	1,848,518	99.7
12/01/1993	Feather River	264,000	14.2
01/01/1994	Feather River	4,995,200	269.5
03/01/1994	Feather River	120,000	6.5
04/01/1994	Benicia	712,642	38.5
05/01/1994	Benicia	2,632,217	142.0
06/01/1994	Monterey	24,000	1.3
06/01/1994	Tiburon Net Pens	51,150	2.8
06/01/1994	Benicia	1,548,320	83.5
07/01/1994	Benicia	250,400	13.5
07/01/1994	Wickland Oil	518,300	28.0
07/01/1994	Unocal	627,000	33.8
01/01/1995	Feather River	674,786	36.4
02/01/1995	Feather River	3,142,258	169.6
03/01/1995	Feather River	219,200	11.8
03/01/1995	Feather River	750,075	40.5
04/01/1995	Benicia	269,152	14.5
05/01/1995	Unocal	103,400	5.6
05/01/1995	Benicia	396,952	21.4
05/01/1995	Wickland Oil	593,080	32.0
05/01/1995	Feather River	200,007	10.8
06/01/1995	Oceangraph Center	47,600	2.6
06/01/1995	Unocal	89,700	4.8
06/01/1995	Benicia	225,100	12.1
06/01/1995	Wickland Oil	907,432	49.0
07/01/1995	Wickland Oil	179,400	9.7
07/01/1995	Wickland Oil	1,365,575	73.7
01/01/1996	Feather River	156,000	8.4
03/01/1996	Feather River	652,000	35.2
04/01/1996	Wickland Oil	388,700	21.0
04/01/1996	Benicia	556,400	30.0
05/01/1996	Montezuma Slough	24,986	1.3
05/01/1996	Montezuma Slough	24,990	1.3
05/01/1996	Montezuma Slough	24,999	1.3
05/01/1996	Feather River	25,000	1.3
05/01/1996	Unocal	126,500	6.8
05/01/1996	Wickland Oil	527,850	28.5
05/01/1996	Benicia	545,100	29.4
06/01/1996	Wickland Oil	24,000	1.3
06/01/1996	Tiburon Net Pens	49,400	2.7
06/01/1996	Wickland Oil	179,200	9.7

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
07/01/1996	Wickland Oil	48,000	2.6
07/01/1996	Unocal	73,364	4.0
07/01/1996	Wickland Oil	96,000	5.2
07/01/1996	Wickland Oil	146,728	7.9
07/01/1996	Wickland Oil	147,200	7.9
07/01/1996	Wickland Oil	184,000	9.9
07/01/1996	Wickland Oil	202,400	10.9
07/01/1996	Wickland Oil	213,900	11.5
07/01/1996	Wickland Oil	282,900	15.3
07/01/1996	Wickland Oil	345,904	18.7
07/01/1996	Wickland Oil	460,000	24.8
07/01/1996	Wickland Oil	635,652	34.3
05/01/1997	Benicia	25,200	1.4
05/01/1997	Wickland Oil	36,830	2.0
05/01/1997	Tiburon Net Pens	52,650	2.8
05/01/1997	Monterey	58,000	3.1
06/01/1997	Wickland Oil	55,000	3.0
06/01/1997	Moss Landing	60,140	3.2
06/01/1997	Bennett's Marina	62,100	3.4
06/01/1997	Benicia	66,700	3.6
06/01/1997	Wickland Oil	67,500	3.6
06/01/1997	Port San Lucas	71,300	3.8
06/01/1997	Benicia	80,500	4.3
06/01/1997	Bennett's Marina	93,800	5.1
06/01/1997	Benicia	105,300	5.7
06/01/1997	Benicia	121,900	6.6
06/01/1997	Wickland Oil	131,100	7.1
06/01/1997	Bennett's Marina	135,700	7.3
06/01/1997	Wickland Oil	168,200	9.1
06/01/1997	Benicia	177,100	9.6
06/01/1997	Wickland Oil	210,600	11.4
06/01/1997	Wickland Oil	222,400	12.0
06/01/1997	Wickland Oil	239,200	12.9
06/01/1997	Wickland Oil	393,600	21.2
06/01/1997	Wickland Oil	487,600	26.3
06/01/1997	Wickland Oil	542,800	29.3
07/01/1997	Wickland Oil	55,200	3.0
07/01/1997	Bennett's Marina	78,200	4.2
07/01/1997	Wickland Oil	115,000	6.2
07/01/1997	Wickland Oil	156,400	8.4
07/01/1997	Wickland Oil	188,600	10.2
07/01/1997	Bennett's Marina	218,400	11.8
07/01/1997	Wickland Oil	297,250	16.0
07/01/1997	Wickland Oil	326,600	17.6

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
07/01/1997	Wickland Oil	345,000	18.6
07/01/1997	Wickland Oil	384,100	20.7
07/01/1997	Wickland Oil	407,100	22.0
07/01/1997	Wickland Oil	806,400	43.5
07/01/1997	Wickland Oil	95,800	5.2
05/01/1998	Wickland Oil	2,392,200	129.1
06/01/1998	Wickland Oil	388,800	21.0
06/01/1998	Wickland Oil	411,700	22.2
06/01/1998	Wickland Oil	443,400	23.9
05/01/1999	San Francisco Bay	791,670	42.7
06/01/1999	San Francisco Bay	845,725	45.6
06/01/1999	San Francisco Bay	1,780,858	96.1
06/01/1999	San Francisco Bay	2,307,282	124.5
05/01/2000	Monterey	182,850	9.9
05/01/2000	San Francisco Bay	478,180	25.8
05/01/2000	San Francisco Bay	959,850	51.8
05/01/2000	San Francisco Bay	1,971,010	106.4
06/01/2000	San Francisco Bay	74,100	4.0
06/01/2000	Benicia	486,100	26.2
06/01/2000	San Francisco Bay	1,467,050	79.2
04/01/2001	Shore Terminal	170,200	9.2
04/01/2001	Shore Terminal	397,900	21.5
05/01/2001	Benicia	60,000	3.2
05/01/2001	Benicia	80,500	4.3
05/01/2001	Monterey	107,810	5.8
05/01/2001	Benicia	1,566,350	84.5
05/01/2001	Benicia	491,500	26.5
06/01/2001	Benicia	487,600	26.3
03/01/2002	Benicia	162,800	8.8
04/01/2002	Benicia	2,773,538	149.7
05/01/2002	Benicia	117,200	6.3
05/01/2002	Monterey	120,000	6.5
05/01/2002	Benicia	1,283,800	69.3
06/01/2002	Benicia	422,050	22.8
05/01/2003	Benicia	54,000	2.9
05/01/2003	Bennett's Marina	904,000	48.8
05/01/2003	Benicia	1,320,700	71.3
05/01/2003	Benicia	968,900	52.3
06/01/2003	Benicia	8,360	0.5
06/01/2003	San Francisco Bay	133,400	7.2
06/01/2003	Benicia	531,000	28.7
06/01/2003	Benicia	1,163,800	62.8
05/01/2004	Benicia	589,788	31.8
05/01/2004	Benicia	3,436,200	185.4

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/2004	Benicia	854,800	46.1
06/01/2004	Benicia	2,377,800	128.3
08/01/1988	Benicia	1,595,220	86.1
09/01/1988	Benicia	109,000	5.9
08/01/1993	Benicia	2,615,660	141.1
09/01/1993	Benicia	309,500	16.7

Untagged Nimbus Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00157%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
09/01/1980	Benicia	270281	4.26
04/01/1981	Benicia	335699	5.29
04/01/1981	Pittsburg	1536048	24.19
05/01/1981	Benicia	877820	13.82
06/01/1981	Benicia	60550	0.95
06/01/1981	Benicia	1276700	20.10
07/01/1981	Benicia	1739360	27.39
07/01/1982	Benicia	1458625	22.97
08/01/1982	Benicia	1457905	22.96
12/01/1982	Cosumnes River	599040	9.43
04/01/1983	Benicia	615000	9.68
04/01/1983	Vallejo	1012500	15.94
05/01/1983	Benicia	391400	6.16
06/01/1983	Benicia	87000	1.37
06/01/1983	Benicia	516300	8.13
07/01/1983	Benicia	1915200	30.16
08/01/1983	Benicia	49940	0.79
08/01/1983	Berkeley Marina	50000	0.79
08/01/1983	Port Chicago	50350	0.79
05/01/1984	Benicia	180000	2.83
06/01/1984	Benicia	862650	13.58
07/01/1984	Fort Baker	50600	0.80
07/01/1984	Berkeley Marina	50675	0.80
07/01/1984	Port Chicago	50710	0.80
07/01/1984	Benicia	2826300	44.50
05/01/1985	Benicia	228500	3.60
05/01/1985	Benicia	463900	7.30
06/01/1985	Benicia	1027100	16.17
06/01/1985	Benicia	1960600	30.87
07/01/1985	Berkeley Marina	25500	0.40
07/01/1985	Benicia	846100	13.32
05/01/1986	Benicia	209300	3.30
05/01/1986	Benicia	288490	4.54

Untagged Nimbus Hatchery Releases in the San Francisco Bay.
Mean Return Rate to the Tuolumne River = 0.00157%

Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/1986	Benicia	2850750	44.89
07/01/1986	Benicia	1717270	27.04
05/01/1987	Benicia	492000	7.75
05/01/1987	Benicia	818975	12.90
06/01/1987	Benicia	372600	5.87
06/01/1987	Benicia	2221400	34.98
07/01/1987	Benicia	375150	5.91
05/01/1988	Benicia	264000	4.16
06/01/1988	Benicia	1364200	21.48
06/01/1988	Benicia	2130400	33.54
07/01/1988	Benicia	182200	2.87
07/01/1988	Benicia	398500	6.27
06/01/1989	Benicia	1789517	28.18
07/01/1989	Benicia	2629870	41.41
05/01/1990	Benicia	338800	5.33
06/01/1990	Benicia	376200	5.92
06/01/1990	Benicia	2714150	42.74
07/01/1990	Benicia	1001650	15.77
03/01/1991	Cosumnes River	97920	1.54
05/01/1991	Benicia	1029300	16.21
06/01/1991	Benicia	791000	12.45
06/01/1991	Benicia	801700	12.62
07/01/1991	Benicia	443100	6.98
05/01/1992	Benicia	2664950	41.96
06/01/1992	Benicia	1557000	24.52
07/01/1992	Benicia	177200	2.79
02/01/1993	Cosumnes River	200380	3.16
07/01/1993	Unocal	110000	1.73
07/01/1993	Benicia	490600	7.72
07/01/1993	Wickland Oil	639800	10.07
01/01/1994	Cosumnes River	206800	3.26
06/01/1994	Unocal	78000	1.23
06/01/1994	Benicia	1565900	24.66
06/01/1994	Wickland Oil	2509100	39.51
07/01/1994	Benicia	36600	0.58
02/01/1995	Cosumnes River	200720	3.16
06/01/1995	Unocal	484000	7.62
06/01/1995	Benicia	874450	13.77
06/01/1995	Wickland Oil	973650	15.33
07/01/1995	Benicia	187000	2.94
07/01/1995	Unocal	204000	3.21
07/01/1995	Wickland Oil	1500600	23.63
05/01/1996	Unocal	253000	3.98
05/01/1996	Benicia	538600	8.48
05/01/1996	Wickland Oil	1078600	16.98
06/01/1996	Unocal	67200	1.06

Untagged Nimbus Hatchery Releases in the San Francisco Bay.
Mean Return Rate to the Tuolumne River = 0.00157%

Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/1996	Wickland Oil	200000	3.15
06/01/1996	Wickland Oil	884600	13.93
06/01/1996	Benicia	1008450	15.88
05/01/1997	Benicia	367600	5.79
05/01/1997	Wickland Oil	1003800	15.81
06/01/1997	Wickland Oil	283600	4.47
06/01/1997	Wickland Oil	336300	5.30
06/01/1997	Wickland Oil	2063500	32.49
04/01/1998	Monterey	60720	0.96
05/01/1998	Monterey	60200	0.95
05/01/1998	Monterey	70210	1.11
05/01/1998	Wickland Oil	108000	1.70
05/01/1998	Wickland Oil	264000	4.16
05/01/1998	Benicia	570400	8.98
06/01/1998	Tiburon Net Pens	52000	0.82
06/01/1998	Bennett's Marina	132000	2.08
06/01/1998	Wickland Oil	2693254	42.41
05/01/1999	Monterey	60200	0.95
05/01/1999	Monterey	61600	0.97
05/01/1999	Benicia	120000	1.89
05/01/1999	Wickland Oil	896900	14.12
06/01/1999	Tiburon Net Pens	52008	0.82
06/01/1999	Monterey	70000	1.10
06/01/1999	San Francisco Bay	217500	3.42
06/01/1999	Benicia	509208	8.02
06/01/1999	Wickland Oil	2741792	43.17
05/01/2000	Wickland Oil	129600	2.04
05/01/2000	Benicia	356200	5.61
05/01/2000	Wickland Oil	1605900	25.29
06/01/2000	Wickland Oil	144000	2.27
06/01/2000	Wickland Oil	1616000	25.44
05/01/2001	Monterey	142200	2.24
06/01/2002	Tiburon Net Pens	50400	0.79
06/01/2002	Monterey	60016	0.94
06/01/2002	Wickland Oil	576000	9.07
06/01/2002	Wickland Oil	1738800	27.38
07/01/2002	Wickland Oil	512000	8.06
07/01/2002	Wickland Oil	1224850	19.29
05/01/2003	Wickland Oil	480000	7.56
06/01/2003	Treasure Island USCG Station	502300	7.91
06/01/2003	Wickland Oil	994300	15.66
06/01/2003	Wickland Oil	2384700	37.55
08/01/1993	Benicia	362000	5.70
08/01/1993	Wickland Oil	604200	9.51

Untagged Mokelumne Hatchery Releases in the Sacramento River Delta. Mean Rates of Return to the Tuolumne River Wet Years, spring releases = 0.01148% Wet Years, fall releases = 0.01760% Dry Years, spring releases = 0.00507%			
Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
11/01/1978	Rio Vista	9,076	1.60
11/01/1978	Rio Vista	93,000	16.36
01/01/1979	Rio Vista	30,000	3.44
01/01/1979	Rio Vista	45,000	5.17
10/01/1979	Rio Vista	174,200	30.65
11/01/1979	Rio Vista	19,167	3.37
10/01/1980	Rio Vista	194,250	34.18
10/01/1980	Rio Vista	478,500	84.19
11/01/1980	Rio Vista	38,500	6.77
11/01/1980	Rio Vista	50,000	8.80
12/01/1980	Rio Vista	12,100	2.13
12/01/1980	Rio Vista	13,200	2.32
12/01/1980	Rio Vista	15,400	2.71
11/01/1982	Rio Vista	6,050	1.06
11/01/1982	Rio Vista	152,880	26.90
11/01/1982	Rio Vista	170,765	30.05
11/01/1982	Rio Vista	186,450	32.81
12/01/1982	Rio Vista	40,000	7.04
10/01/1983	Rio Vista	337,500	59.38
10/01/1983	Rio Vista	367,500	64.66
06/01/1984	Thornton	15,250	1.75
04/01/1993	Tracy Pumping Plant	3,658	0.42
04/01/1993	Byron	15,000	1.72
05/01/1993	Tracy Pumping Plant	7,630	0.88
04/01/1998	Jersey Point	105,450	12.10
02/01/1999	Tracy Pumping Plant	500	0.06
03/01/1999	Tracy Pumping Plant	752	0.09
04/01/1999	Tracy Pumping Plant	744	0.09
05/01/1999	Tracy Pumping Plant	800	0.09
05/01/1999	Jersey Point	205,072	23.54
09/01/1999	Antioch Boat Ramp	9,600	1.10
10/01/1999	Antioch Boat Ramp	206,620	23.72
04/01/2000	Lighthouse Marina	52,632	6.04
05/01/2000	Jersey Point	104,039	11.94
11/01/1983	Rio Vista	25,200	4.43
11/01/1983	Rio Vista	27,440	4.83
10/01/1981	Rio Vista	51,940	2.63
10/01/1981	Rio Vista	212,803	10.79
11/01/1981	Rio Vista	220,500	11.18
11/01/1981	Rio Vista	366,405	18.57
12/01/1981	Rio Vista	56,200	2.85
10/09/1985	Rio Vista	27,300	1.38

04/01/1988	Clifton Court	18,000	0.91
05/01/1988	Clifton Court	19,250	0.98
03/01/1992	Clifton Court	5,100	0.26
04/01/1992	Byron	36,050	1.83
04/01/1992	Rio Vista	472,840	23.97
06/01/1994	Sacramento River	514,350	26.07
04/01/2001	Jersey Point	103,073	5.22
02/01/2002	Jersey Point	102,609	5.20
10/01/2002	Jersey Point	103,219	5.23
05/01/2003	Antioch Boat Ramp	575	0.03
04/01/2004	Thornton	4,000	0.20
04/01/2004	Thornton	1,009,700	51.18
05/01/2004	Clifton Court	3,000	0.15
05/01/2004	Thornton	2,488,857	126.15
06/01/2004	Thornton	210,800	10.68

Untagged Mokelumne Hatchery Releases in the San Francisco Bay. Mean Rates of Return to the Tuolumne River = 0.00622%			
Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
08/13/1984	Benicia	42,000	2.61
08/13/1984	Benicia	56,350	3.51
08/14/1984	Benicia	42,000	2.61
08/14/1984	Benicia	63,250	3.94
08/15/1984	Benicia	48,000	2.99
08/15/1984	Benicia	64,400	4.01
08/16/1984	Benicia	51,600	3.21
08/16/1984	Benicia	69,230	4.31
08/17/1984	Benicia	52,200	3.25
08/17/1984	Benicia	70,035	4.36
08/20/1984	Benicia	33,750	2.10
08/20/1984	Benicia	42,500	2.64
08/21/1984	Benicia	20,250	1.26
08/21/1984	Benicia	25,500	1.59
06/25/1986	Benicia	50,400	3.14
06/26/1986	Benicia	56,000	3.48
06/27/1986	Benicia	66,000	4.11
07/01/1986	Benicia	1,000,400	62.24
08/01/1986	Benicia	39,600	2.46
08/01/1986	Berkeley Marina	170,100	10.58
09/01/1986	Bennett's Marina	50,600	3.15
09/01/1986	Benicia	191,500	11.91
05/01/1993	Benicia	437,500	27.22
06/01/1993	Benicia	1,547,500	96.28
07/01/1993	Benicia	1,026,600	63.87
05/01/1996	Benicia	983,494	61.19

Untagged Mokelumne Hatchery Releases in the San Francisco Bay. Mean Rates of Return to the Tuolumne River = 0.00622%			
Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
06/01/1996	Benicia	850,700	52.93
04/01/1997	Benicia	254,200	15.82
05/01/1997	Benicia	636,000	39.57
06/01/1997	Benicia	858,000	53.38
07/01/1997	Wickland Oil	58,800	3.66
07/01/1997	Bennett's Marina	140,000	8.71
06/01/1998	Wickland Oil	453,500	28.22
07/01/1998	Wickland Oil	596,900	37.14
08/01/1998	Wickland Oil	144,900	9.02
06/01/1999	Wickland Oil	738,407	45.94
07/01/1999	Wickland Oil	440,200	27.39
10/01/1999	Wickland Oil	297,600	18.52
04/01/2000	Benicia	181,800	11.31
04/01/2000	Bennett's Marina	185,300	11.53
04/01/2000	Wickland Oil	463,700	28.85
05/01/2000	Wickland Oil	792,050	49.28
06/01/2000	Wickland Oil	642,925	40.00
09/11/1985	Benicia	24,000	1.49
09/12/1985	Benicia	24,000	1.49
09/16/1985	Benicia	26,000	1.62
09/17/1985	Benicia	23,100	1.44
09/18/1985	Benicia	23,100	1.44
09/19/1985	Benicia	27,300	1.70
09/20/1985	Benicia	13,000	0.81
09/24/1985	Benicia	13,300	0.83
09/25/1985	Benicia	27,930	1.74
09/26/1985	Benicia	48,400	3.01
09/27/1985	Benicia	46,200	2.87
09/30/1985	Benicia	33,600	2.09
10/01/1985	Benicia	51,200	3.19
10/02/1985	Benicia	100,800	6.27
10/03/1985	Benicia	103,700	6.45
10/04/1985	Benicia	159,800	9.94
10/07/1985	Benicia	92,400	5.75
10/08/1985	Benicia	93,800	5.84
10/09/1985	Benicia	59,800	3.72
10/10/1985	Benicia	74,100	4.61
10/11/1985	Benicia	28,600	1.78
10/17/1985	Benicia	24,200	1.51
10/18/1985	Benicia	35,200	2.19
10/21/1985	Benicia	44,200	2.75
10/22/1985	Benicia	42,000	2.61
04/01/1987	Benicia	601,665	37.43
05/01/1987	Benicia	398,700	24.81

Untagged Mokelumne Hatchery Releases in the San Francisco Bay. Mean Rates of Return to the Tuolumne River = 0.00622%			
Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
06/01/1987	Benicia	208,050	12.94
06/01/1987	Benicia	259,900	16.17
06/01/1987	Bennett's Marina	391,100	24.33
07/01/1987	Benicia	135,050	8.40
07/01/1987	Mare Island	216,250	13.45
08/01/1987	Benicia	130,620	8.13
04/01/1988	Berkeley Marina	524,500	32.63
05/01/1988	Benicia	316,300	19.68
05/01/1988	Berkeley Marina	638,400	39.72
05/01/1988	Bennett's Marina	690,400	42.96
06/01/1988	Benicia	133,300	8.29
05/01/1989	Benicia	92,400	5.75
05/01/1989	Bennett's Marina	896,800	55.80
06/01/1989	Bennett's Marina	1,066,900	66.38
07/01/1989	Berkeley Marina	149,320	9.29
07/01/1989	Bennett's Marina	476,700	29.66
08/01/1989	Bennett's Marina	761,800	47.40
09/01/1989	Bennett's Marina	37,200	2.31
06/01/1990	Bennett's Marina	517,500	32.20
06/01/1990	Benicia	649,825	40.43
07/01/1990	Benicia	459,700	28.60
07/01/1990	Bennett's Marina	650,500	40.47
08/01/1990	Bennett's Marina	488,900	30.42
05/01/1991	Bennett's Marina	821,400	51.11
06/01/1991	Bennett's Marina	771,400	47.99
07/01/1991	Benicia	390,600	24.30
04/01/1992	Benicia	39,000	2.43
05/01/1992	Benicia	967,537	60.20
06/01/1992	Benicia	1,091,873	67.93
07/01/1992	Benicia	1,164,100	72.43
08/01/1992	Benicia	213,800	13.30
05/01/1994	Benicia	136,800	8.51
06/01/1994	Benicia	1,107,570	68.91
04/01/2001	Benicia	51,520	3.21
04/01/2001	Shore Terminal	1,464,200	91.10
05/01/2001	Shore Terminal	1,398,452	87.01
02/01/2002	Shore Terminal	1,160,079	72.18
05/01/2002	Monterey	140,500	8.74
05/01/2002	Shore Terminal	1,980,300	123.21
04/01/2003	Conoco Phillips	2,175,025	135.33
05/01/2003	Tiburon Net Pens	50,600	3.15
05/01/2003	Monterey	142,800	8.88
05/01/2004	Tiburon Net Pens	51,700	3.22
05/01/2004	Moss Landing	123,000	7.65

Untagged Mokelumne Hatchery Releases in the San Francisco Bay. Mean Rates of Return to the Tuolumne River = 0.00622%			
Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
05/01/2004	Monterey	140,000	8.71
05/01/2004	Benicia	1,792,400	111.52
06/01/2004	Benicia	216,800	13.49

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
10/14/1985	MRH	63,000	3.11
10/19/1987	MRH	254,842	12.57
04/18/1988	MRH	3,200	0.20
10/24/1988	MRH	1,000	0.05
10/06/1989	MRH	10,285	0.51
10/06/1989	MRH	41,184	2.03
10/06/1989	MRH	44,865	2.21
10/07/1989	MRH	36,673	1.81
10/07/1989	MRH	46,175	2.28
10/21/1991	Merced River	8,190	0.40
10/21/1991	Merced River	9,945	0.49
10/21/1991	Merced River	10,637	0.52
10/21/1991	Merced River	23,400	1.15
10/21/1991	Merced River	25,740	1.27
10/21/1991	Merced River	26,910	1.33
01/18/2001	Hagaman Park	1,000	0.06
01/18/2001	Hagaman Park	1,000	0.06
01/26/2001	Hagaman Park	1,010	0.06
01/31/2001	Gallo	507	0.03
01/31/2001	Gallo	633	0.04
02/01/2001	Hagaman Park	2,029	0.13
02/06/2001	Hagaman Park	1,070	0.07
03/01/2001	Gallo	810	0.05
03/07/2001	Hagaman Park	2,014	0.13
03/19/2001	Gallo	651	0.04
03/19/2001	Gallo	746	0.05
03/22/2001	Hagaman Park	2,016	0.13
03/29/2001	Hagaman Park	2,014	0.13
04/02/2001	Gallo	300	0.02
04/02/2001	Gallo	400	0.02
04/02/2001	Gallo	600	0.04
04/03/2001	Hagaman Park	24	0.00
04/06/2001	Hagaman Park	2,016	0.13
04/16/2001	Gallo	672	0.04

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
04/16/2001	Gallo	708	0.04
04/16/2001	Gallo	717	0.04
04/16/2001	Robinson Ranch	3,043	0.19
04/18/2001	Hagaman Park	2,008	0.12
04/18/2001	Hagaman Park		0.00
04/22/2001	Gallo	702	0.04
04/22/2001	Gallo	718	0.04
04/22/2001	Gallo	784	0.05
04/22/2001	Robinson Ranch	3,150	0.20
04/25/2001	Gallo	327	0.02
04/25/2001	Gallo	462	0.03
04/26/2001	Hagaman Park	2,053	0.13
04/26/2001	Hagaman Park		0.00
04/27/2001	Gallo	375	0.02
05/02/2001	Hagaman Park	2,055	0.13
05/02/2001	Hagaman Park		0.00
05/04/2001	Gallo	360	0.02
05/04/2001	Gallo	487	0.03
05/09/2001	Gallo	711	0.04
05/09/2001	Gallo	738	0.05
05/09/2001	Robinson Ranch	3,021	0.19
05/10/2001	Hagaman Park	2,017	0.13
05/10/2001	Hagaman Park		0.00
05/11/2001	MRH	78,120	4.85
05/11/2001	MRH		0.00
05/11/2001	MRH	83,880	5.21
05/11/2001	MRH		0.00
05/14/2001	MRH	40,964	2.54
05/14/2001	MRH		0.00
05/14/2001	MRH		0.00
05/14/2001	MRH		0.00
05/16/2001	Hagaman Park	2,050	0.13
05/16/2001	Hagaman Park		0.00
05/21/2001	Gallo	802	0.05
05/21/2001	Gallo	806	0.05
05/21/2001	Gallo	807	0.05
05/21/2001	Robinson Ranch	3,249	0.20
05/24/2001	Hagaman Park	2,020	0.13
05/26/2001	Gallo	600	0.04
05/31/2001	Hagaman Park	1,618	0.10
02/07/2002	Hagaman Park	20	0.00
02/13/2002	Hagaman Park	1,859	0.12
02/20/2002	Gallo	687	0.04
02/23/2002	Gallo	1,268	0.08

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
02/27/2002	Hagaman Park	2,224	0.14
03/06/2002	Gallo	764	0.05
03/06/2002	Hagaman Park	2,015	0.13
03/13/2002	Hagaman Park	2,075	0.13
03/19/2002	Gallo	1,881	0.12
03/20/2002	Hagaman Park	2,018	0.13
03/27/2002	Hagaman Park	2,068	0.13
03/30/2002	Hagaman Park	893	0.06
03/30/2002	Hagaman Park	1,130	0.07
04/02/2002	MRH	5,928	0.37
04/03/2002	Hagaman Park	2,042	0.13
04/04/2002	Gallo	2,067	0.13
04/04/2002	Robinson Ranch	3,050	0.19
04/10/2002	Hagaman Park	2,024	0.13
04/12/2002	Gallo	2,596	0.16
04/16/2002	MRH	7,100	0.44
04/17/2002	Hagaman Park	2,022	0.13
04/18/2002	Gallo	2,044	0.13
04/18/2002	Robinson Ranch	3,006	0.19
04/21/2002	Gallo	2,500	0.16
05/01/2002	MRH	7,019	0.44
05/01/2002	MRH	178,001	11.05
05/01/2002	MRH	183,140	11.37
05/02/2002	Hagaman Park	2,025	0.13
05/03/2002	Gallo	1,086	0.07
05/03/2002	Gallo	2,028	0.13
05/03/2002	Robinson Ranch	3,088	0.19
05/04/2002	Gallo	1,246	0.08
05/08/2002	Hagaman Park	2,116	0.13
05/14/2002	Hagaman Park	2,014	0.13
05/15/2002	MRH	7,149	0.44
05/17/2002	Gallo	2,008	0.12
05/17/2002	Robinson Ranch	3,025	0.19
05/20/2002	Gallo	2,400	0.15
05/22/2002	Hagaman Park	2,077	0.13
05/29/2002	Hagaman Park	2,048	0.13
02/22/2003	Gallo	800	0.05
03/12/2003	Gallo	1,652	0.10
03/22/2003	MRH	17,400	1.08
03/26/2003	Gallo	20,500	1.27
04/02/2003	Hagaman Park	100	0.01
04/03/2003	Gallo	2,000	0.12
04/03/2003	MRH	20,800	1.29
04/03/2003	Robinson Ranch	3,000	0.19

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
04/04/2003	MRH	19,800	1.23
04/05/2003	MRH	17,500	1.09
04/03/2003	MRH	29,900	1.86
04/03/2003	Shaffer Bridge	21,375	1.33
04/06/2003	Shaffer Bridge	26,250	1.63
04/08/2003	Hagaman Park	101	0.01
04/08/2003	Hagaman Park	2,000	0.12
04/13/2003	MRH	11,625	0.72
04/14/2003	MRH	10,000	0.62
04/15/2003	Hagaman Park	2,000	0.12
04/16/2003	Gallo	2,000	0.12
04/16/2003	Robinson Ranch	3,000	0.19
04/22/2003	Hagaman Park	2,040	0.13
04/23/2003	MRH	10,209	0.63
04/25/2003	Gallo	2,000	0.12
04/25/2003	Robinson Ranch	3,000	0.19
04/29/2003	Hagaman Park	2,016	0.13
04/30/2003	MRH	1,807	0.11
05/02/2003	Hagaman Park	2,021	0.13
05/05/2003	MRH	9,979	0.62
05/06/2003	Hagaman Park	2,015	0.13
05/07/2003	Gallo	2,185	0.14
05/07/2003	Robinson Ranch	3,000	0.19
05/12/2003	MRH	7,550	0.47
05/12/2003	MRH	35,550	2.21
05/13/2003	Hagaman Park	2,009	0.12
04/05/2004	MRH	10,200	0.63
04/07/2004	Gallo	2,000	0.12
04/07/2004	Robinson Ranch	3,000	0.19
04/19/2004	MRH	10,200	0.63
04/21/2004	Gallo	2,032	0.13
04/21/2004	Robinson Ranch	3,003	0.19
05/03/2004	MRH	10,200	0.63
05/05/2004	Gallo	2,010	0.12
05/05/2004	MRH	9,156	0.57
05/05/2004	MRH	29,547	1.83
05/05/2004	MRH	44,012	2.73
05/05/2004	MRH	82,715	5.13
05/05/2004	Robinson Ranch	3,027	0.19
05/17/2004	MRH	10,200	0.63
05/19/2004	Gallo	2,000	0.12
05/19/2004	MRH	11,402	0.71
05/19/2004	MRH	36,088	2.24
05/19/2004	MRH	47,490	2.95

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
05/19/2004	Robinson Ranch	3,017	0.19

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Wet Years, spring releases = 0.03181%
Wet Years, fall releases = 0.00127%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
06/21/1978	MRH	100,000	0.32
09/29/1978	MRH	195,000	2.48
10/17/1984	MRH	73,600	0.93
03/08/1986	MRH	15,876	0.05
03/14/1986	MRH	20,448	0.07
03/18/1986	MRH	88,830	0.28
03/20/1986	MRH	38,762	0.12
03/26/1986	MRH	14,544	0.05
04/03/1986	MRH	49,298	0.16
04/08/1986	MRH	12,760	0.04
05/30/1986	MRH	351,250	1.12
06/18/1986	MRH	24,960	0.08
04/14/1995	Shaffer Bridge	2,430	0.01
05/02/1995	MRH	138,000	0.44
05/03/1995	Hagaman Park	1,000	0.00
05/03/1995	MRH	74,800	0.24
05/10/1995	MRH	130,050	0.41
05/10/1995	MRH	146,400	0.47
05/10/1995	MRH	276,450	0.88
04/01/1998	Hagaman Park	1,500	0.00
04/06/1998	Hagaman Park	2,010	0.01
04/13/1998	Hagaman Park	2,000	0.01
04/20/1998	Hagaman Park	2,000	0.01
04/27/1998	Hagaman Park	2,008	0.01
05/04/1998	Hagaman Park	2,000	0.01
05/12/1998	Hagaman Park	2,001	0.01
05/13/1998	MRH	113,500	0.36
05/18/1998	MRH	113,450	0.36
05/19/1998	Hagaman Park	1,001	0.00
05/19/1998	Hagaman Park	2,006	0.01
05/27/1998	Hagaman Park	1,000	0.00
05/27/1998	Hagaman Park	2,000	0.01
05/27/1998	MRH	60,546	0.19
05/29/1998	MRH	107,900	0.34
05/31/1998	MRH	84,945	0.27

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Wet Years, spring releases = 0.03181%
Wet Years, fall releases = 0.00127%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
06/03/1998	Hagaman Park	1,000	0.00
06/03/1998	Hagaman Park	2,004	0.01
06/08/1998	Hagaman Park	2,000	0.01
06/17/1998	Hagaman Park	150	0.00
06/17/1998	Hagaman Park	850	0.00
06/17/1998	Hagaman Park	2,037	0.01
06/24/1998	MRH	24,480	0.08
06/25/1998	Hagaman Park	20	0.00
03/04/1999	Hagaman Park	1,005	0.00
03/17/1999	Hagaman Park	1,501	0.00
03/30/1999	Hagaman Park	2,000	0.01
04/06/1999	Hagaman Park	2,002	0.01
04/13/1999	Hagaman Park	2,007	0.01
04/21/1999	Gallo	421	0.00
04/21/1999	Gallo	442	0.00
04/21/1999	Hagaman Park	2,000	0.01
04/28/1999	Gallo	500	0.00
05/06/1999	Hagaman Park	2,008	0.01
05/11/1999	MRH	44,500	0.14
05/12/1999	Gallo	300	0.00
05/12/1999	Hagaman Park	2,000	0.01
05/17/1999	Robinson Ranch	5,000	0.02
05/18/1999	Gallo	500	0.00
05/18/1999	Gallo	501	0.00
05/18/1999	Hagaman Park	2,012	0.01
05/19/1999	Gallo	265	0.00
05/19/1999	Gallo	266	0.00
05/21/1999	Gallo	265	0.00
05/21/1999	Gallo	275	0.00
05/21/1999	Gallo	20,340	0.06
05/23/1999	Gallo	268	0.00
05/23/1999	Gallo	271	0.00
05/25/1999	Gallo	265	0.00
05/25/1999	Gallo	279	0.00
05/25/1999	Hagaman Park	1,000	0.00
05/25/1999	Hagaman Park	1,017	0.00
05/25/1999	Hagaman Park	1,024	0.00
05/27/1999	Hagaman Park	2,025	0.01
05/27/1999	Robinson Ranch	5,001	0.02
05/27/1999	Robinson Ranch	5,025	0.02
No Date	Robinson Ranch	5,001	0.02
No Date	Robinson Ranch	5,025	0.02
03/08/2000	Merced River	2,038	0.01
03/13/2000	Merced River	1,152	0.00

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Wet Years, spring releases = 0.03181%
Wet Years, fall releases = 0.00127%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
03/14/2000	Merced River	346	0.00
03/14/2000	Merced River	360	0.00
03/15/2000	Hagaman Park	2,002	0.01
03/21/2000	Hagaman Park	2,000	0.01
03/28/2000	Hagaman Park	2,117	0.01
04/03/2000	Gallo	500	0.00
04/04/2000	Hagaman Park	2,028	0.01
04/05/2000	Robinson Ranch	2,001	0.01
04/12/2000	Gallo	2,038	0.01
04/13/2000	Hagaman Park	2,008	0.01
04/24/2000	Gallo	2,004	0.01
04/25/2000	Snelling	5,000	0.02
04/26/2000	Hagaman Park	2,000	0.01
04/29/2000	Gallo	509	0.00
05/12/2000	Gallo	393	0.00
05/12/2000	Gallo	503	0.00
05/14/2000	MRH	152,438	0.48
05/15/2000	Gallo	3,003	0.01
05/15/2000	Snelling	5,002	0.02
05/16/2000	Hagaman Park	2,026	0.01

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Appendix C.

Tuolumne Irrigation District
First Observed Dates of Adult Salmon near LaGrange (1981-2004)

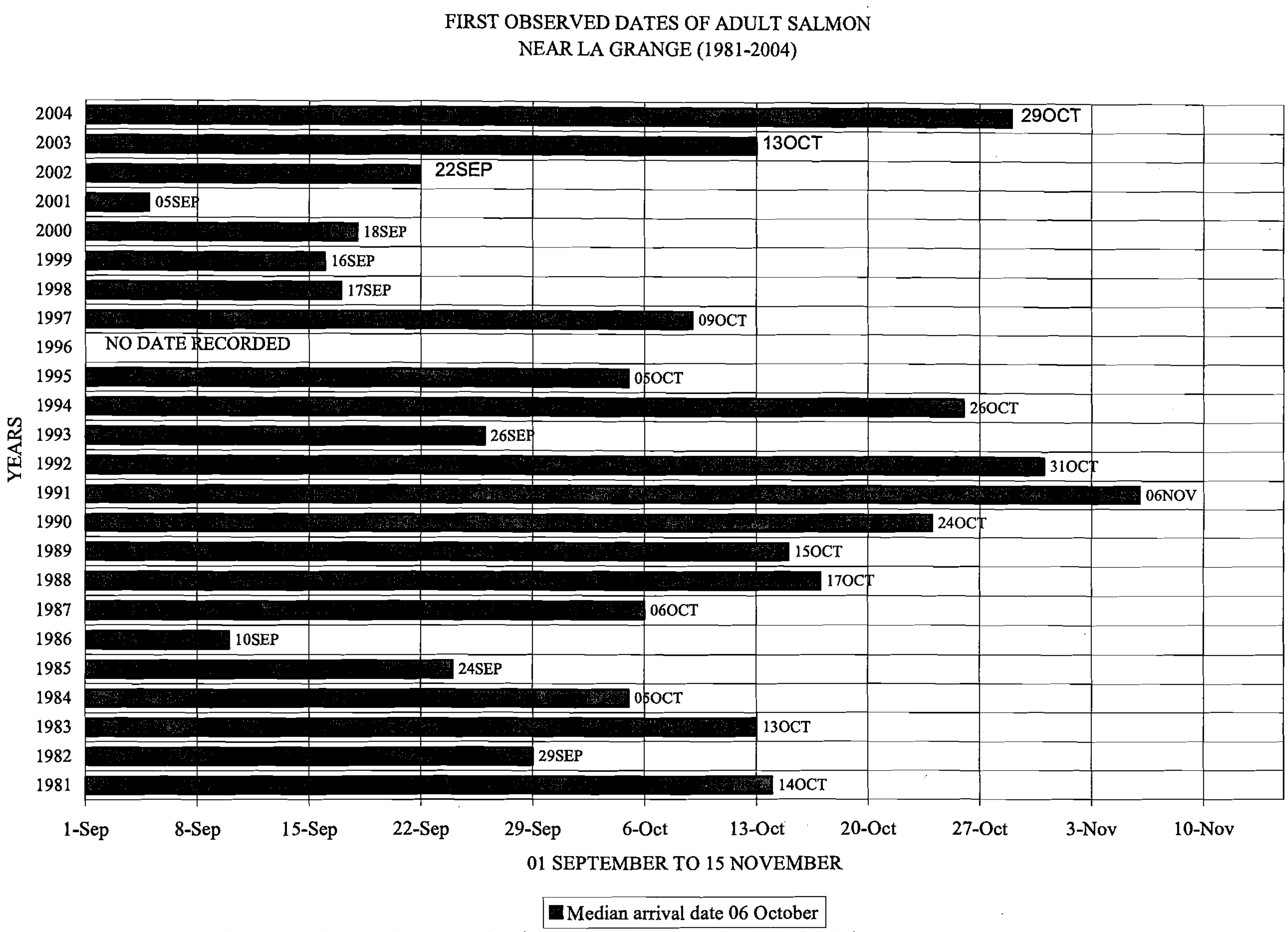

Figure 4. Tuolumne River salmon arrival near La Grange (1981-2004)

Appendix D.

Department of Water Resources
Water Year Classification Indices

Department of Water Resources
California Data Exchange Center

WSIHIST (12/11/07 1223)

Department of Water Resources
California Cooperative Snow Surveys

Chronological Reconstructed Sacramento and San Joaquin Valley
Water Year Hydrologic Classification Indices

Based on measured unimpaired runoff (in million acre-feet), subject to revision.
*** See explanatory notes at bottom ***

	[..........Sacramento Valley..........]					[.........San Joaquin Valley..........]				
	[.....Runoff (maf).....]			[..WY Index..]		[.....Runoff (maf).....]			[..WY Index..]	
WY	Oct-Mar	Apr-Jul	WYsum	Index	Yr-type	Oct-Mar	Apr-Jul	WYsum	Index	Yr-type
1901						3.49	5.58	9.39	4.60	W
1902						1.12	3.81	5.08	3.41	AN
1903						1.45	4.13	5.71	3.45	AN
1904						1.96	5.37	7.64	4.31	W
1905						1.82	3.36	5.30	3.24	AN
1906	12.57	12.92	26.71	11.76	W	2.53	9.24	12.43	6.70	W
1907	18.96	13.45	33.70	14.07	W	3.67	7.61	11.82	6.20	W
1908	8.29	5.60	14.77	7.73	BN	0.98	2.17	3.32	2.40	D
1909	20.61	8.98	30.68	12.10	W	2.85	5.91	8.97	4.59	W
1910	13.12	6.11	20.12	9.38	W	2.87	3.62	6.64	3.65	AN
1911	12.27	13.12	26.38	11.74	W	3.63	7.52	11.48	5.97	W
1912	4.84	5.65	11.41	6.71	BN	0.54	2.57	3.21	2.55	BN
1913	5.72	6.29	12.85	6.24	D	0.44	2.34	3.00	2.00	C
1914	16.72	10.08	27.81	10.92	W	2.72	5.67	8.69	4.35	W
1915	11.41	11.42	23.86	10.99	W	1.29	4.95	6.40	4.10	W
1916	14.25	8.89	24.14	10.83	W	2.67	5.50	8.38	4.65	W
1917	7.25	9.14	17.26	8.83	AN	1.66	4.84	6.66	4.13	W
1918	5.27	4.89	10.99	6.19	D	1.07	3.40	4.59	3.08	BN
1919	8.12	6.77	15.66	7.00	BN	1.06	2.99	4.09	2.62	BN
1920	3.63	4.91	9.20	5.15	C	0.72	3.29	4.09	2.64	BN
1921	15.47	7.52	23.80	9.20	AN	1.97	3.84	5.90	3.23	AN
1922	6.63	10.57	17.98	8.97	AN	1.51	5.99	7.68	4.54	W
1923	6.21	6.27	13.21	7.06	BN	1.39	3.95	5.51	3.55	AN
1924	3.27	1.94	5.74	3.87	C	0.45	1.03	1.50	1.42	C
1925	8.76	6.51	15.99	6.39	D	1.45	3.93	5.51	2.93	BN
1926	6.37	4.79	11.76	5.75	D	0.89	2.56	3.49	2.30	D
1927	14.34	8.75	23.83	9.52	W	1.80	4.56	6.50	3.56	AN
1928	10.24	5.86	16.76	8.27	AN	1.69	2.64	4.37	2.63	BN
1929	4.00	3.84	8.40	5.22	C	0.52	2.29	2.84	2.00	C
1930	8.24	4.65	13.52	5.90	D	0.76	2.44	3.25	2.02	C
1931	3.52	2.09	6.10	3.66	C	0.46	1.18	1.66	1.20	C
1932	6.28	6.24	13.12	5.48	D	1.79	4.69	6.63	3.41	AN
1933	3.73	4.66	8.94	4.63	C	0.49	2.77	3.34	2.44	D
1934	5.68	2.45	8.63	4.07	C	0.98	1.26	2.28	1.44	C
1935	6.27	9.69	16.59	6.98	BN	1.26	5.03	6.41	3.56	AN
1936	10.32	6.41	17.35	7.75	BN	2.00	4.38	6.49	3.74	AN
1937	5.50	7.24	13.33	6.87	BN	1.78	4.66	6.53	3.90	W
1938	17.96	12.93	31.83	12.62	W	3.58	7.33	11.24	5.89	W
1939	4.56	3.04	8.18	5.58	D	1.00	1.83	2.90	2.20	D
1940	14.78	6.93	22.43	8.88	AN	2.49	4.04	6.59	3.36	AN
1941	16.32	9.77	27.08	11.47	W	2.22	5.51	7.93	4.43	W
1942	14.33	9.93	25.24	11.27	W	1.93	5.28	7.38	4.44	W
1943	13.37	6.90	21.13	9.77	W	2.86	4.28	7.28	4.03	W
1944	4.81	4.93	10.43	6.35	D	0.87	2.97	3.92	2.76	BN
1945	8.42	5.92	15.06	6.80	BN	2.07	4.37	6.60	3.59	AN
1946	10.89	5.97	17.62	7.70	BN	1.99	3.65	5.73	3.30	AN
1947	5.90	3.83	10.39	5.61	D	1.26	2.12	3.42	2.18	D
1948	5.39	9.55	15.75	7.12	BN	0.56	3.58	4.21	2.70	BN
1949	5.73	5.59	11.97	6.09	D	0.62	3.12	3.79	2.53	BN

1950	7.01	6.72	14.44	6.62	BN	1.02	3.57	4.65	2.85	BN
1951	16.77	5.42	22.95	9.18	AN	4.35	2.83	7.25	3.14	AN
1952	13.86	13.68	28.60	12.38	W	2.18	6.84	9.30	5.17	W
1953	10.84	8.26	20.09	9.55	W	1.07	3.18	4.35	3.03	BN
1954	9.74	6.81	17.43	8.51	AN	1.10	3.16	4.30	2.72	BN
1955	5.19	5.07	10.98	6.14	D	0.78	2.67	3.50	2.30	D
1956	20.32	8.60	29.89	11.38	W	4.14	5.29	9.67	4.46	W
1957	7.72	6.29	14.89	7.83	AN	1.02	3.19	4.29	3.01	BN
1958	16.37	12.24	29.71	12.16	W	1.67	6.40	8.36	4.77	W
1959	7.40	3.84	12.05	6.75	BN	0.98	1.85	2.98	2.21	D
1960	7.72	4.65	13.06	6.20	D	0.85	2.07	2.96	1.85	C
1961	6.87	4.39	11.97	5.68	D	0.54	1.50	2.10	1.38	C
1962	8.17	6.23	15.11	6.65	BN	1.26	4.24	5.61	3.07	BN
1963	12.01	10.09	22.99	9.63	W	1.68	4.37	6.24	3.57	AN
1964	5.90	4.37	10.92	6.41	D	0.93	2.14	3.14	2.19	D
1965	16.59	8.13	25.64	10.15	W	3.20	4.55	8.13	3.81	W
1966	7.42	4.84	12.95	7.16	BN	1.49	2.42	3.98	2.51	BN
1967	12.14	11.01	24.06	10.20	W	2.46	7.09	9.98	5.25	W
1968	8.66	4.12	13.64	7.24	BN	1.02	1.85	2.94	2.21	D
1969	15.33	10.68	26.98	11.05	W	3.84	8.14	12.29	6.09	W
1970	18.87	4.35	24.06	10.40	W	2.55	2.96	5.61	3.18	AN
1971	12.71	8.90	22.57	10.37	W	1.56	3.23	4.91	2.89	BN
1972	7.61	5.02	13.43	7.29	BN	1.25	2.22	3.57	2.16	D
1973	12.80	6.38	20.05	8.58	AN	1.87	4.48	6.47	3.50	AN
1974	21.69	9.78	32.50	12.99	W	2.43	4.53	7.12	3.90	W
1975	9.24	8.95	19.23	9.35	W	1.37	4.65	6.18	3.85	W
1976	4.63	2.75	8.20	5.29	C	0.78	1.07	1.97	1.57	C
1977	2.49	1.93	5.12	3.11	C	0.22	0.80	1.05	0.84	C
1978	14.90	8.12	23.92	8.65	AN	2.57	6.50	9.65	4.58	W
1979	6.06	5.64	12.41	6.67	BN	1.87	3.99	5.98	3.67	AN
1980	15.49	6.00	22.33	9.04	AN	3.74	5.41	9.47	4.73	W
1981	6.81	3.63	11.10	6.21	D	0.85	2.29	3.22	2.44	D
1982	20.56	11.82	33.41	12.76	W	3.78	7.00	11.41	5.45	W
1983	22.75	13.66	37.68	15.29	W	5.42	8.73	15.01	7.22	W
1984	15.98	5.52	22.35	10.00	W	3.51	3.48	7.13	3.69	AN
1985	6.24	4.00	11.04	6.47	D	1.11	2.41	3.60	2.40	D
1986	19.45	5.45	25.83	9.96	W	4.36	4.92	9.50	4.31	W
1987	5.85	2.80	9.27	5.86	D	0.55	1.48	2.08	1.86	C
1988	5.78	2.90	9.23	4.65	C	0.86	1.55	2.48	1.48	C
1989	9.03	5.07	14.82	6.13	D	1.07	2.42	3.56	1.96	C
1990	4.94	3.72	9.26	4.81	C	0.83	1.59	2.46	1.51	C
1991	3.90	4.01	8.44	4.21	C	0.56	2.57	3.20	1.96	C
1992	5.41	2.93	8.87	4.06	C	0.86	1.66	2.58	1.56	C
1993	12.44	8.98	22.21	8.54	AN	2.49	5.65	8.38	4.20	W
1994	4.55	2.73	7.81	5.02	C	0.66	1.80	2.54	2.05	C
1995	19.83	13.60	34.55	12.89	W	3.67	8.01	12.32	5.95	W
1996	13.05	8.37	22.29	10.26	W	2.57	4.51	7.22	4.12	W
1997	20.22	4.39	25.42	10.82	W	5.75	3.59	9.51	4.13	W
1998	17.65	12.54	31.40	13.31	W	2.82	7.11	10.43	5.65	W
1999	12.97	7.26	21.19	9.80	W	1.90	3.85	5.91	3.59	AN
2000	12.06	5.96	18.90	8.94	AN	1.98	3.78	5.90	3.38	AN
2001	5.64	3.46	9.81	5.76	D	0.92	2.23	3.18	2.20	D
2002	9.32	4.57	14.60	6.35	D	1.27	2.75	4.06	2.34	D
2003	10.71	7.74	19.31	8.21	AN	1.25	3.49	4.87	2.81	BN
2004	10.95	4.40	16.04	7.51	BN	1.51	2.25	3.81	2.21	D
2005	8.40	9.28	18.55	8.49	AN	2.73	6.28	9.21	4.75	W
2006	18.04	12.93	31.88	13.13	W	2.87	7.37	10.45	5.90	W
2007	6.56	3.02	10.25	6.17	D	0.98	1.44	2.46	1.96	C
min	2.49	1.93	5.12	3.11		0.22	0.80	1.05	0.84	
mean	11.27	6.52	18.62	8.33		1.97	3.81	5.96	3.29	
max	22.75	13.68	37.68	15.29		5.75	9.24	15.01	7.22	

1956-2005 mean

Eight River Index
River Runoff [maf]

WY	Dec	Jan	Feb	Mar	Apr	May

1901						
1902						
1903						
1904						
1905						
1906	0.55	3.69	2.93	7.00	5.34	6.43
1907	2.14	2.83	6.01	10.40	7.32	5.86
1908	1.43	2.27	2.12	2.19	2.53	2.59
1909	0.66	11.14	6.85	3.71	4.22	4.78
1910	3.09	2.90	2.55	4.84	4.21	3.30
1911	1.15	4.11	3.61	5.88	6.36	5.71
1912	0.55	1.20	0.94	1.61	1.58	3.33
1913	0.77	1.60	1.01	1.32	2.81	3.31
1914	1.72	8.50	3.99	4.18	5.05	5.28
1915	0.76	1.86	5.43	3.54	4.43	6.38
1916	1.52	3.75	4.89	5.71	5.03	4.44
1917	1.28	1.01	3.13	2.15	4.29	4.37
1918	0.70	0.57	1.22	2.99	3.09	2.53
1919	0.68	1.20	3.13	2.74	3.89	4.06
1920	0.68	0.57	0.58	1.71	2.58	3.20
1921	2.90	4.34	3.15	4.22	3.30	4.01
1922	1.16	1.07	2.63	2.41	3.66	6.68
1923	2.03	1.75	1.20	1.51	3.38	3.66
1924	0.49	0.56	1.16	0.64	1.07	1.10
1925	0.92	0.94	4.99	2.18	3.82	3.70
1926	0.67	0.76	3.18	1.73	3.79	2.18
1927	2.01	2.22	6.05	3.53	4.82	4.28
1928	1.10	1.37	1.94	5.69	3.73	3.02
1929	0.64	0.61	1.12	1.29	1.63	2.49
1930	2.37	1.41	1.84	2.78	2.64	2.29
1931	0.39	0.80	0.78	1.20	1.23	1.18
1932	1.68	1.33	1.84	2.50	2.73	4.16
1933	0.42	0.70	0.58	1.89	1.97	2.36
1934	1.04	1.47	1.59	1.90	1.61	1.09
1935	0.79	1.87	1.56	2.13	6.18	4.74
1936	0.51	3.22	5.04	2.77	3.83	3.71
1937	0.45	0.54	2.36	3.28	3.77	4.92
1938	4.81	1.86	5.27	7.50	5.98	7.34
1939	0.80	0.79	0.81	1.91	2.26	1.47
1940	0.68	3.88	5.68	6.22	4.61	3.77
1941	3.41	4.28	5.07	4.72	4.62	5.75
1942	3.58	4.18	5.10	2.23	4.64	4.76
1943	1.83	4.67	2.84	5.33	4.23	3.59
1944	0.55	0.78	1.44	1.94	1.88	3.34
1945	1.50	1.07	4.13	2.17	2.82	3.82
1946	4.60	2.64	1.31	2.29	3.45	3.68
1947	1.06	0.64	1.57	2.51	2.20	2.05
1948	0.50	1.91	0.70	1.56	4.34	4.51
1949	0.66	0.53	0.92	3.32	3.27	3.39
1950	0.43	1.82	2.54	2.46	3.74	3.73
1951	5.95	3.40	3.52	2.66	2.81	3.15
1952	3.36	3.48	4.03	3.68	6.35	7.51
1953	1.92	5.40	1.52	2.06	3.25	3.38
1954	0.80	2.20	2.84	3.66	4.56	3.27
1955	1.35	1.16	0.96	1.27	1.97	3.22
1956	9.14	7.52	3.71	3.07	3.51	5.24
1957	0.61	0.79	2.65	3.41	2.36	3.85
1958	1.62	2.39	7.61	4.71	6.04	6.74
1959	0.58	2.25	2.50	1.98	2.27	1.82
1960	0.47	0.90	3.15	3.22	2.50	2.39
1961	1.36	0.86	2.14	1.93	2.02	2.16
1962	1.19	0.78	4.08	2.39	3.89	3.14
1963	1.90	1.70	4.66	2.10	5.60	4.99
1964	0.85	1.55	1.01	1.15	1.92	2.44
1965	8.66	5.61	2.26	1.97	4.74	3.81
1966	1.04	1.85	1.56	2.52	3.33	2.52
1967	2.98	3.34	2.52	4.09	3.82	6.26
1968	0.85	1.49	3.71	2.55	2.17	2.15
1969	1.77	7.91	4.73	3.36	5.44	7.34

1970	3.30	10.68	3.02	3.12	1.82	2.77
1971	3.26	3.05	1.83	3.73	3.40	4.18
1972	1.19	1.40	1.73	3.30	2.52	2.61
1973	1.83	4.08	3.66	3.27	3.08	4.76
1974	3.68	6.93	2.10	6.18	5.07	4.69
1975	0.86	1.01	2.92	4.65	2.89	5.40
1976	0.76	0.65	0.88	1.34	1.35	1.44
1977	0.38	0.47	0.48	0.54	0.69	0.91
1978	1.90	5.91	3.48	5.36	4.40	4.70
1979	0.53	1.44	2.10	2.90	2.67	4.50
1980	1.24	6.89	5.93	3.62	3.11	3.67
1981	0.92	1.57	1.76	2.48	2.32	2.11
1982	5.58	3.50	5.57	4.74	8.05	5.68
1983	3.69	4.25	6.46	10.57	4.87	6.96
1984	6.72	2.85	2.29	3.08	2.50	3.60
1985	1.20	0.84	1.21	1.59	2.79	2.14
1986	1.25	2.62	11.55	7.09	3.19	3.56
1987	0.53	0.78	1.48	2.60	1.73	1.48
1988	1.70	1.84	1.01	1.26	1.48	1.59
1989	0.72	0.85	0.99	6.17	3.59	2.22
1990	0.45	1.27	0.88	1.84	1.80	1.77
1991	0.34	0.37	0.45	2.64	1.95	2.40
1992	0.47	0.58	2.41	1.99	2.17	1.33
1993	1.25	4.06	3.13	5.70	4.33	5.23
1994	0.78	0.78	1.23	1.49	1.57	1.79
1995	1.06	8.11	3.12	10.19	5.61	7.18
1996	1.72	2.47	6.25	4.25	3.97	5.50
1997	6.84	12.15	2.74	2.45	2.70	2.96
1998	1.18	5.19	7.44	5.11	4.53	5.53
1999	1.88	2.60	4.59	3.67	3.26	4.27
2000	0.65	2.55	5.49	4.08	3.55	3.62
2001	0.67	0.87	1.50	2.39	2.03	2.49
2002	2.50	2.70	1.74	2.31	2.82	2.60
2003	3.24	3.40	1.66	2.52	3.27	4.82
2004	2.14	1.90	3.98	3.47	2.64	2.29
2005	1.56	2.49	2.01	3.75	3.18	7.23
2006	5.82	5.21	3.44	5.30	8.52	6.80
2007	1.31	0.85	2.14	2.06	1.73	1.66
min	0.34	0.37	0.45	0.54	0.69	0.91
mean	2.02	3.04	3.11	3.48	3.21	3.70
max	9.14	12.15	11.55	10.57	8.52	7.51

1956-2005 mean

Official Year Classifications based on May 1 Runoff Forecasts

	Sacramento Valley Index		San Joaquin Valley Index	
WY	Index	Yr-type	Index	Yr-type
1995	12.4	W	5.5	W
1996	9.7	W	3.9	W
1997	11.0	W	4.2	W
1998	12.4	W	4.9	W
1999	10.0	W	3.4	AN
2000	9.2	W	3.3	AN
2001	5.9	D	2.3	D
2002	6.5	D	2.3	D
2003	8.0	AN	2.7	BN
2004	7.7	BN	2.2	D
2005	7.4	BN	4.2	W
2006	13.0	W	5.5	W
2007	6.2	D	1.9	C

Abbreviations:

WY	Water year (Oct 1 - Sep 30)
W	Wet year type
AN	Above normal year type
BN	Below normal year type
D	Dry year type

C Critical year type
% exc. Probability in % that a given value will be exceeded
[maf] Million acre-feet

Notes:
Unimpaired runoff represents the natural water production of a river basin, unaltered by upstream diversions, storage, export of water to or import of water from other basins.

Sacramento River Runoff is the sum (in maf) of Sacramento River at Bend Bridge, Feather River inflow to Lake Oroville, Yuba River at Smartville, and American River inflow to Folsom Lake. The WY sum is also known as the Sacramento River Index, and was previously referred to as the "4 River Index" or "4 Basin Index". It was previously used to determine year type classifications under State Water Resources Control Board (SWRCB) Decision 1485.
Sacramento Valley Water Year Index = 0.4 * Current Apr-Jul Runoff Forecast (in maf) + 0.3 * Current Oct-Mar Runoff in (maf) + 0.3 * Previous Water Year's Index (if the Previous Water Year's Index exceeds 10.0, then 10.0 is used). This index, originally specified in the 1995 SWRCB Water Quality Control Plan, is used to determine the Sacramento Valley water year type as implemented in SWRCB D-1641. Year types are set by first of month forecasts beginning in February. Final determination is based on the May 1 50% exceedence forecast.
Sacramento Valley Water Year Hydrologic Classification:

Year Type:	Water Year Index:
Wet	Equal to or greater than 9.2
Above Normal	Greater than 7.8, and less than 9.2
Below Normal	Greater than 6.5, and equal to or less than 7.8
Dry	Greater than 5.4, and equal to or less than 6.5
Critical	Equal to or less than 5.4

San Joaquin River Runoff is the sum of Stanislaus River inflow to New Melones Lake, Tuolumne River inflow to New Don Pedro Reservoir, Merced River inflow to Lake McClure, and San Joaquin River inflow to Millerton Lake (in maf).
San Joaquin Valley Water Year Index = 0.6 * Current Apr-Jul Runoff Forecast (in maf) + 0.2 * Current Oct-Mar Runoff in (maf) + 0.2 * Previous Water Year's Index (if the Previous Water Year's Index exceeds 4.5, then 4.5 is used). This index, originally specified in the 1995 SWRCB Water Quality Control Plan, is used to determine the San Joaquin Valley water year type as implemented in SWRCB D-1641. Year types are set by first of month forecasts beginning in February. Final determination for San Joaquin River flow objectives is based on the May 1 75% exceedence forecast.
San Joaquin Valley Water Year Hydrologic Classification:

Year Type:	Water Year Index:
Wet	Equal to or greater than 3.8
Above Normal	Greater than 3.1, and less than 3.8
Below Normal	Greater than 2.5, and equal to or less than 3.1
Dry	Greater than 2.1, and equal to or less than 2.5
Critical	Equal to or less than 2.1

Eight River Index = Sacramento River Runoff + San Joaquin River Runoff
This Index is used from December through May to set flow objectives as implemented in SWRCB Decision 1641.

The 'reconstructed' table is based on observed runoff, and does NOT show the official year-types, which are based on May 1 forecasts of future runoff.
The current water year indices based on forecast runoff are posted at http://cdec.water.ca.gov/water_supply.html and published in DWR Bulletin 120 (also available at http://cdec.water.ca.gov/snow/bulletin120)
These indices have been used operationally since 1995, and are defined in SWRCB Decision 1641 (see http://www.waterrights.ca.gov/baydelta/d1641.htm)
This report is updated each fall once the data is available.

For more information, contact CDWR Flood Management, Hydrology Branch
Stephen Nemeth (916) 574-2634 nemeth@water.ca.gov
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Report name: Get report

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Appendix E.

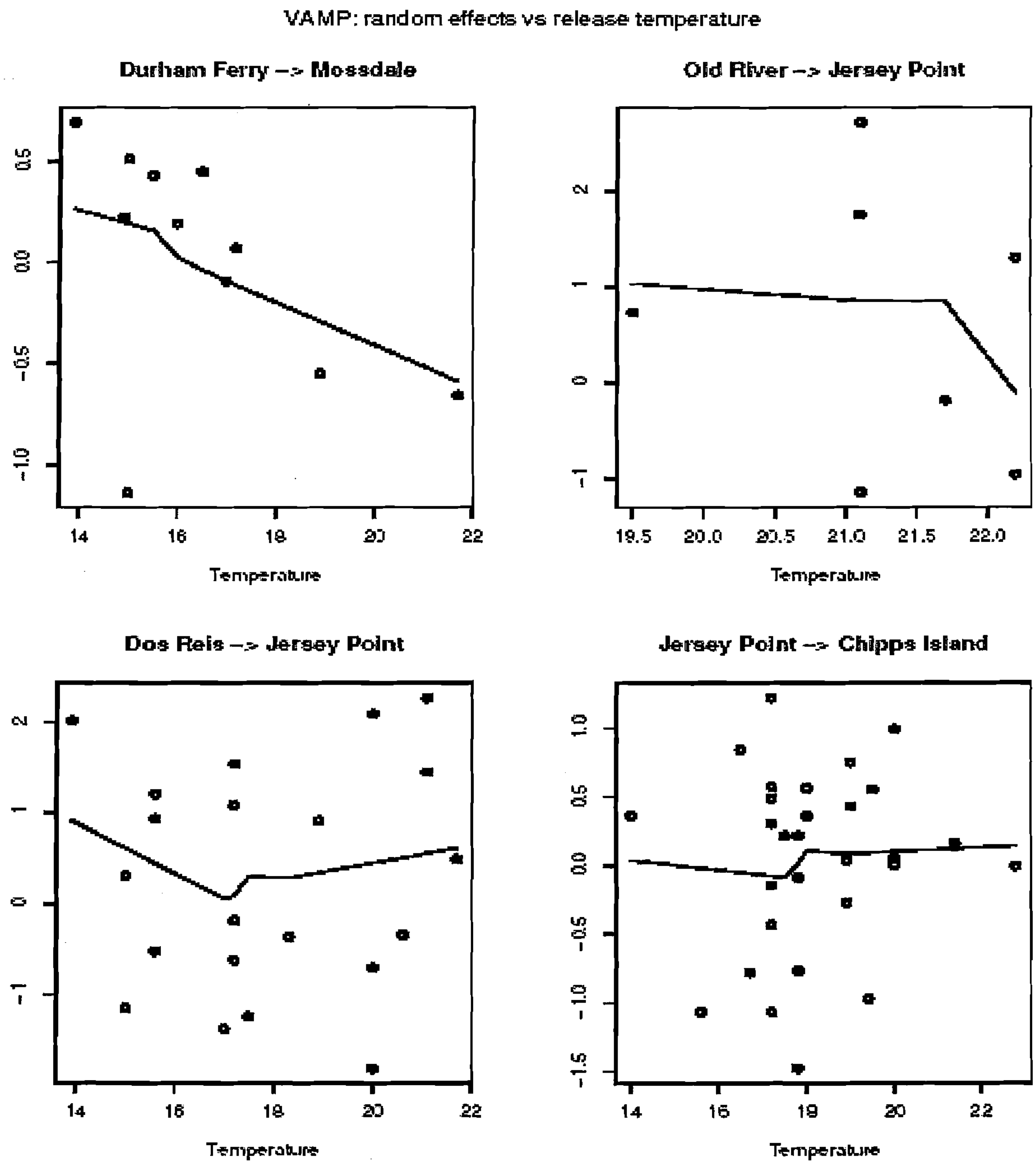
Newman (2008)
An evaluation of four Sacramento-San Joaquin River Delta juvenile salmon survival studies.

An evaluation of four Sacramento-San Joaquin River Delta juvenile salmon survival studies

Ken B. Newman[1]
Stockton FWO
US Fish and Wildlife Service

March 31, 2008

FIGURE 30. VAMP: Random effects residuals, by stream section, for logit of survival plotted against water temperature at release with supersmoother fit superimposed. The effects for Jersey Point are for the logit of Chipps Island recovery rate, either $r_{JP \to Ant \to CI}$ or $r_{JP \to CI}$. (Based on Null.FE.FE model.)



Appendix F.

Tuolumne River 2002 water temperature example.

Appendix F.

Tuolumne River 2002 water temperature example.

2002	Julian Week							
River Mile	36	37	38	39	40	41	42	43
52	12.1	12.3	12.6	12.1	11.9	12.1	11.9	11.7
47								
45.5								
43.4								
42	21.5	21.6	21.7	19.9	17.9	16.7	14.1	13.6
40.4								
36.7								
32	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
26								
23.6								
4								
3.4								
0.1								

Adult Migration/Egg Viability

Impaired Temperature = >18 Degrees C

Year	2002							
	Julian Week							
River Mile	36	37	38	39	40	41	42	43
52	12.1	12.3	12.6	12.1	11.9	12.1	11.9	11.7
51	13.0	13.2	13.5	12.9	12.5	12.5	12.1	11.9
50	13.9	14.2	14.4	13.7	13.1	13.0	12.4	12.1
49	14.9	15.1	15.3	14.5	13.7	13.4	12.6	12.3
48	15.8	16.0	16.2	15.2	14.3	13.9	12.8	12.5
47	16.8	17.0	17.1	16.0	14.9	14.4	13.0	12.7
46	17.7	17.9	18.1	16.8	15.5	14.8	13.2	12.9
45	18.7	18.8	19.0	17.5	16.1	15.3	13.5	13.0
44	19.6	19.8	19.9	18.3	16.7	15.8	13.7	13.2
43	20.5	20.7	20.8	19.1	17.3	16.2	13.9	13.4
42	21.5	21.6	21.7	19.9	17.9	16.7	14.1	13.6
41	21.8	21.9	22.0	20.1	18.0	16.9	14.3	13.7
40	22.1	22.2	22.2	20.4	18.2	17.2	14.5	13.8
39	22.3	22.4	22.5	20.7	18.4	17.4	14.6	14.0
38	22.6	22.7	22.8	20.9	18.6	17.6	14.8	14.1
37	22.9	22.9	23.0	21.2	18.8	17.9	15.0	14.2
36	23.2	23.2	23.3	21.5	19.0	18.1	15.2	14.3
35	23.5	23.5	23.6	21.7	19.2	18.4	15.3	14.4
34	23.8	23.7	23.8	22.0	19.4	18.6	15.5	14.5
33	24.0	24.0	24.1	22.3	19.6	18.8	15.7	14.6
32	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
31	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
30	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
29	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
28	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
27	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
26	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
25	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
24	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
23	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
22	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
21	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
20	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
19	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
18	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
17	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
16	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
15	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
14	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
13	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
12	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
11	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
10	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
9	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
8	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
7	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
6	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
5	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
4	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
3	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
2	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
1	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
0	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8

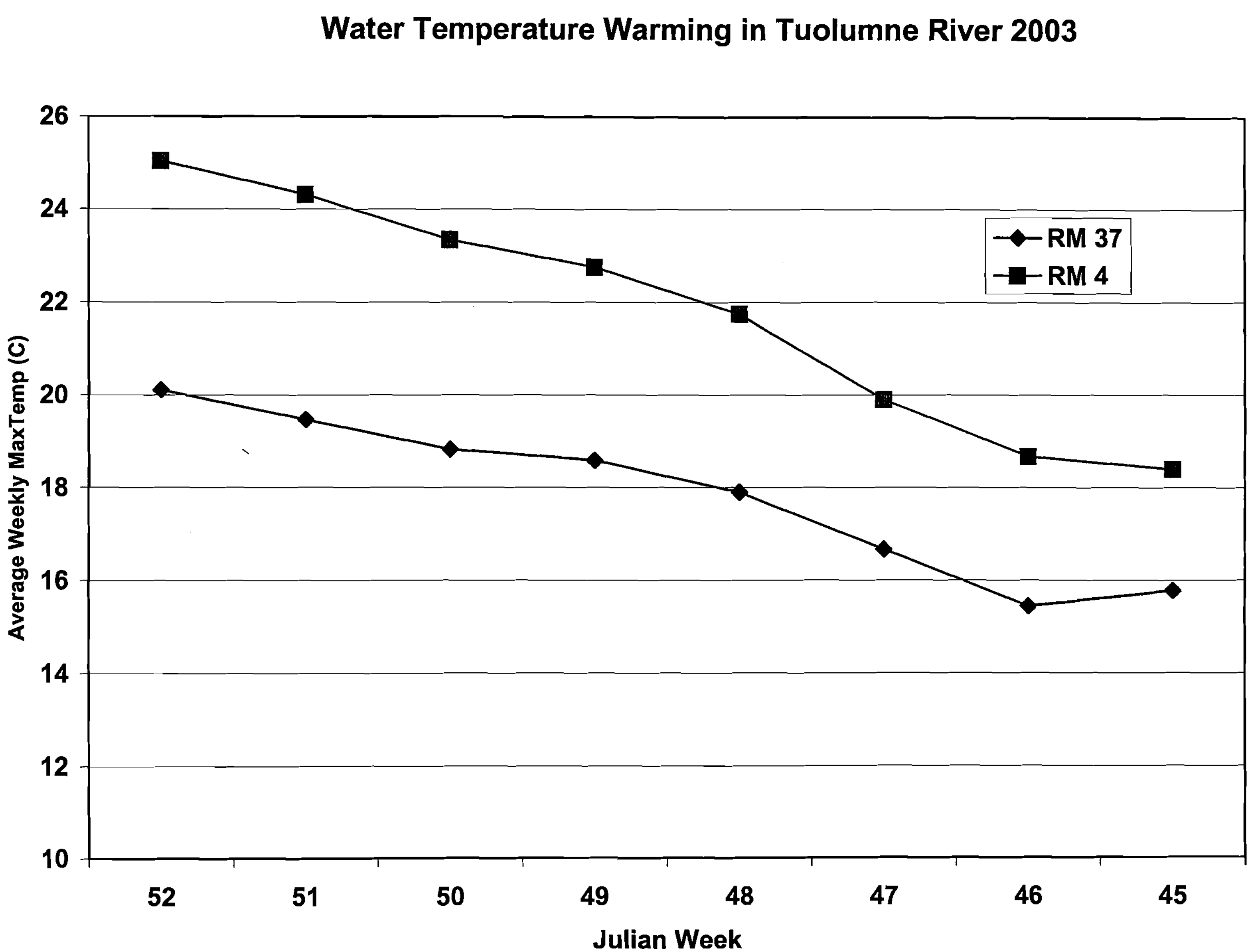
Empirical Data

Assumed Values

Summary								
	Average Reach 7DAM							
	24.3	24.2	24.4	22.5	19.8	19.1	15.9	14.8
	Impaired Miles							
Summary	46	46	47	45	42	37	0	0
	Total Miles							
	52	52	52	52	52	52	52	52
	Percent Impairment							
	88%	88%	90%	87%	81%	71%	0%	0%
	2002			Total Impairment				
				63%				

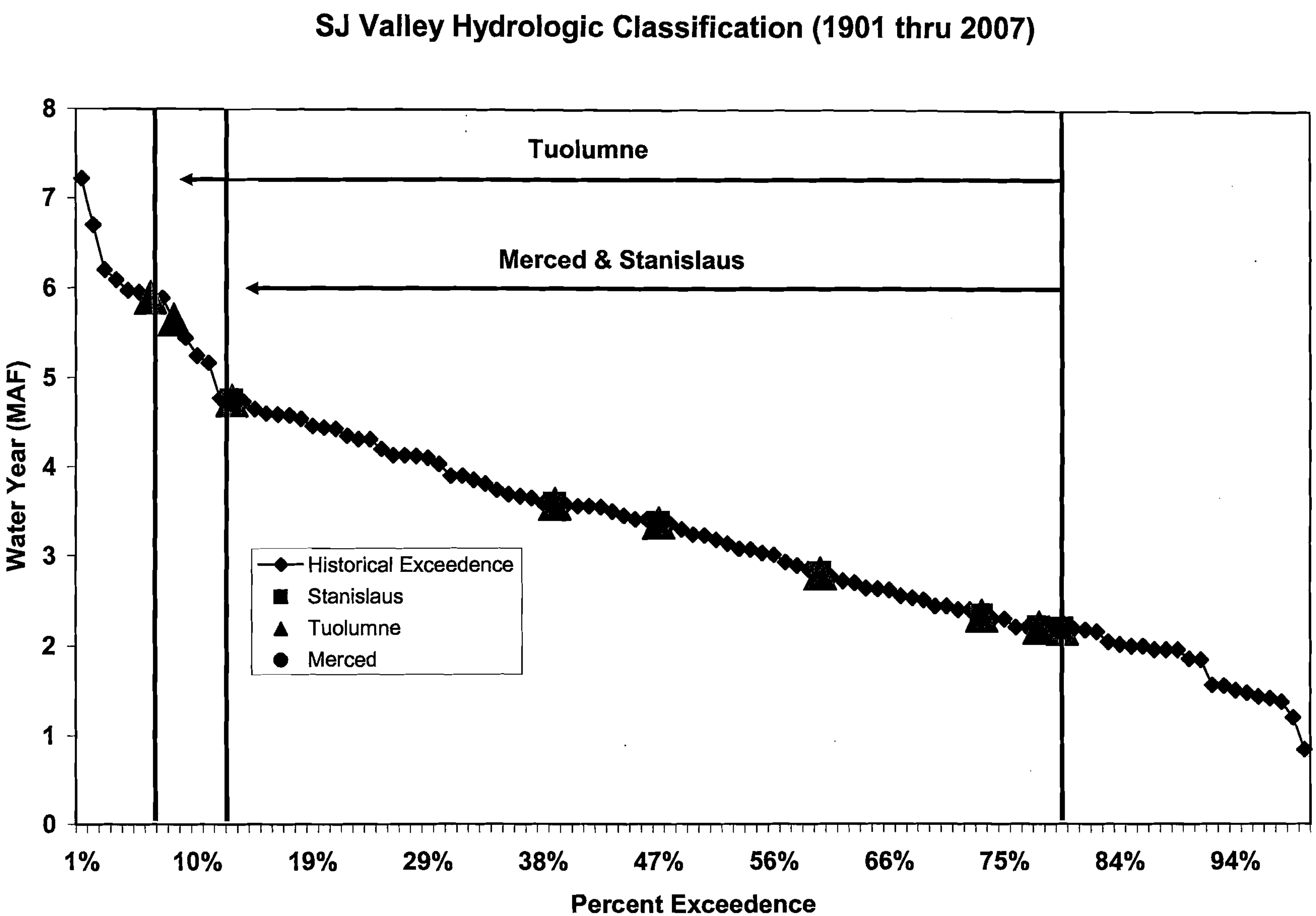
Appendix G.

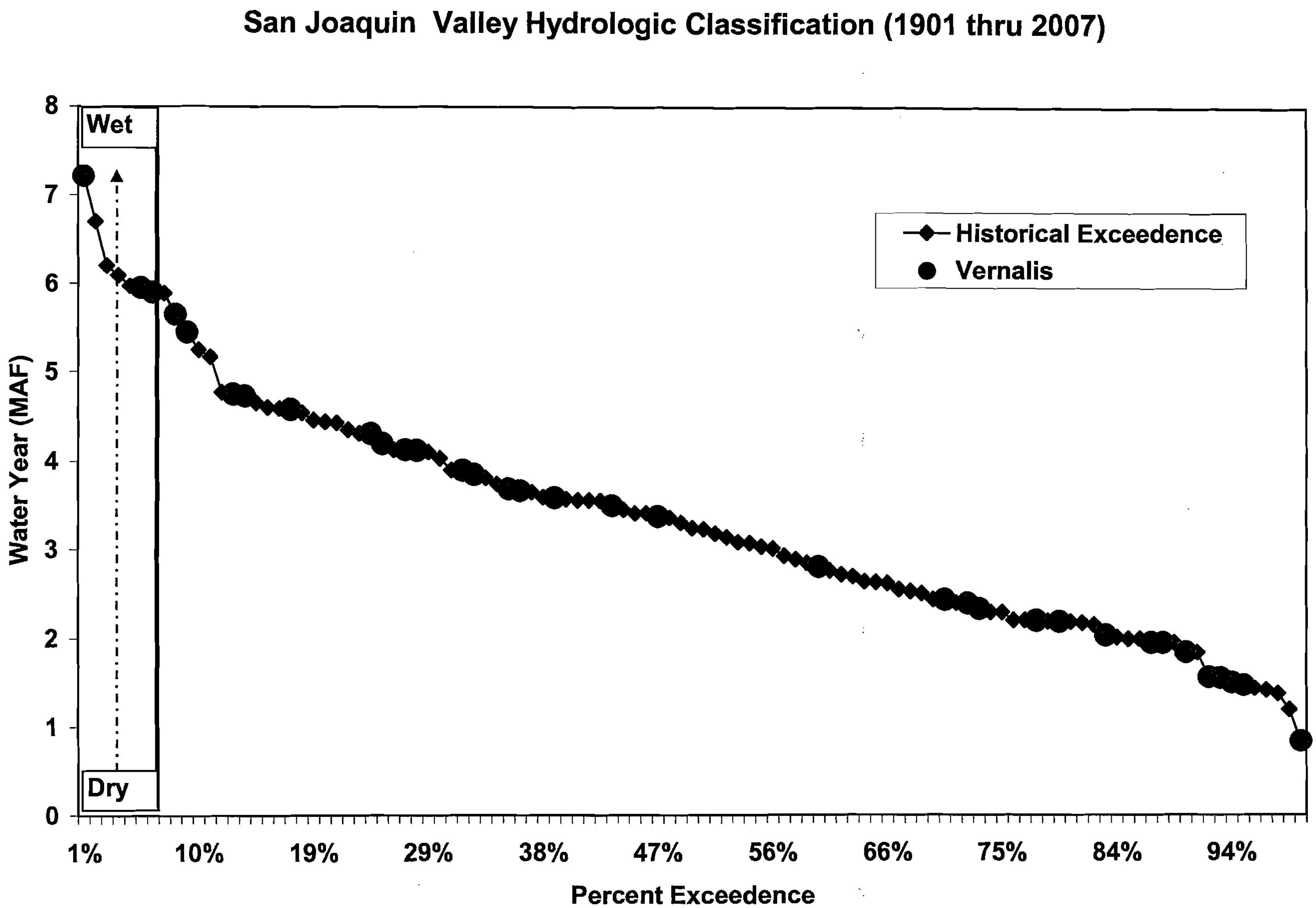
Water Temperature Warming in Tuolumne River 2003


Water Temperature Warming in Tuolumne River 2003
Average Weekly MaxTemp (C)
26
24
22
20
18
16
14
12
10
RM 37
RM 4
52
51
50
49
48
47
46
45
Julian Week

Appendix H.

San Joaquin Valley Hydrologic Classification (1901 thru 2007)
Tuolumne, Merced and Stanislaus Rivers

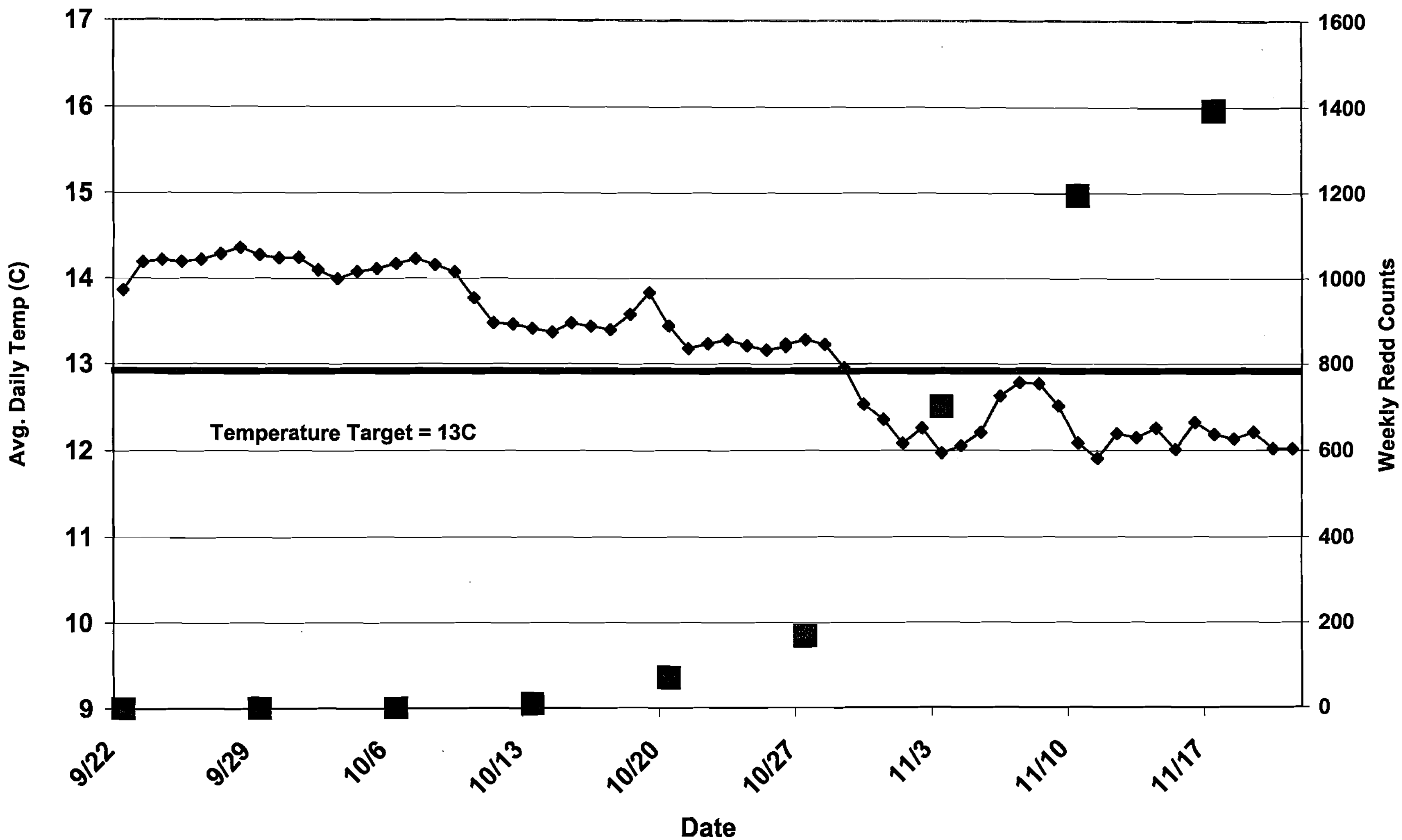

SJ Valley Hydrologic Classification (1901 thru 2007)
Tuolumne
Merced & Stanislaus
Historical Exceedence
Stanislaus
Tuolumne
Merced
Water Year (MAF)
0
1
2
3
4
5
6
7
8
1%
10%
19%
29%
38%
47%
56%
66%
75%
84%
94%
Percent Exceedence


San Joaquin Valley Hydrologic Classification (1901 thru 2007)
Wet
Dry
Historical Exceedence
Vernalis
Water Year (MAF)
8
7
6
5
4
3
2
1
0
1%
10%
19%
29%
38%
47%
56%
66%
75%
84%
94%
Percent Exceedence

Appendix J.

2003 Temperature vs. Redd Counts
Knights Ferry

2003 Temperature vs. Redd Counts
Knights Ferry



Appendix E: Dissolved oxygen data from Rough & Ready Island, 2001-2008.

Table 1. California Data Exchange Center Data for the Rough & Ready Island Monitoring Station

Station ID	RRI	**Elevation**	15' ft
River Basin	SAN JOAQUIN R	**County**	SAN JOAQUIN
Hydrologic Area	SAN JOAQUIN RIVER	**Nearby City**	STOCKTON
Latitude	37.9630°N	**Longitude**	121.3650°W
Operator	CA Dept of Water Resources	**Data Collection**	SATELLITE

River Stage Definitions			
Datum 0	0.00' NAVD	Adjustment to NGVD	-0.87'

Figure 1. Map depicting location of Rough & Ready Island monitoring station

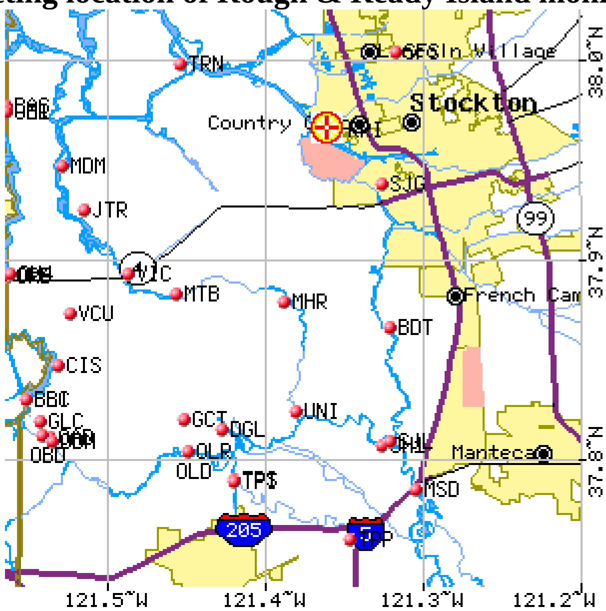


Table 2. Occurrences and frequencies of compliance for Rough & Ready Island, from 2001 through 2008.[1]

	Year							
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Samples	47	53	53	53	53	53	53	53
Exceedance #	21	29	26	29	9	6	16	5
Compliance #	26	24	27	24	44	47	37	48
Exceedance %	45	55	49	55	17	11	30	9
Compliance %	55	45	51	45	83	89	70	91

[1] Weeks when the objective changed from 5.0 mg/l to 6/0 mg/l were not included in the compliance analysis.

Table 3. Average occurrences and frequencies of compliance for Rough & Ready Island, from 2001 through 2008.

		2001-2004		2005-2008	
	2001-2008 Average	Total	Average	Total	Average
Samples	52	206	52	212	53
Exceedance #	18	105	26	36	9
Compliance #	35	101	25	176	44
Exceedance %	34		51		17
Compliance %	66		49		83

Table 4. Weekly average dissolved oxygen (mg/l), 2001-2008 at Rough & Ready Island.

Week	2001	2002	2003	2004	2005	2006	2007	2008
1	4.8	6.0	6.0	7.5	4.4	8.8	10.2	9.4
2	5.8	6.2	5.2	6.1	6.4	7.9	10.4	8.5
3	6.3	4.9	4.2	6.2	7.7	8.5	11.4	7.0
4	6.5	4.9	3.3	5.0	7.7	9.3	12.0	7.5
5	6.5	5.2	2.3	4.5	7.4	9.1	12.3	8.1
6	5.7	4.6	1.4	5.3	7.5	9.2	10.8	8.2
7	6.8	4.1	0.1	4.7	7.0	8.9	8.0	7.2
8	5.6	4.5	0.1	4.8	5.8	9.9	7.7	5.9
9	5.5	4.2	0.7	4.5	7.0	7.1	8.1	7.2
10	5.1	4.5	2.5	6.4	7.5	9.9	8.6	6.8
11	4.8	5.8	4.6	5.3	7.9	9.9	8.8	6.1
12	No Data	6.2	5.6	5.5	8.9	10.0	8.0	7.3
13	No Data	6.3	6.3	7.0	8.7	9.5	7.8	7.7
14	No Data	5.7	5.0	6.7	8.3	7.3	7.3	9.6
15	No Data	4.9	5.3	7.0	8.7	6.4	6.7	8.9
16	8.0	7.0	7.4	6.9	9.1	5.8	5.7	9.3
17	8.8	7.5	7.9	7.9	9.3	5.0	9.3	7.6
18	7.5	8.7	9.4	6.0	8.9	6.8	9.1	9.2
19	7.7	8.6	6.7	7.8	8.9	5.8	10.2	7.7
20	7.7	8.1	8.3	8.0	8.8	6.9	9.5	7.2
21	6.3	7.5	7.7	9.1	8.2	7.5	8.0	5.9
22	5.5	7.0	5.1	6.4	8.3	7.7	5.9	5.3
23	3.9	5.6	4.4	4.0	7.7	5.1	5.0	5.2
24	3.9	5.6	3.6	3.9	6.3	7.4	3.7	5.1
25	3.3	4.9	3.7	3.8	7.5	6.9	2.6	5.0
26	2.9	3.7	5.1	3.7	8.3	6.4	2.7	5.2
27	2.9	3.8	3.1	3.8	7.5	6.5	3.4	5.3
28	3.2	2.8	3.7	3.0	6.8	5.8	3.2	5.7
29	3.1	2.6	3.7	2.2	6.9	4.6	4.1	5.5
30	3.1	2.7	2.6	2.0	5.5	4.2	4.0	5.9
31	3.2	2.6	2.6	2.6	5.3	3.3	4.2	5.4
32	3.6	2.8	3.0	2.6	4.3	4.8	4.3	6.0
33	3.4	2.4	3.6	2.4	4.4	5.3	4.6	5.5
34	3.5	1.8	1.8	2.6	4.4	5.6	4.8	6.0
35	2.9	1.7	1.1	2.4	5.2	4.7	4.0	5.3
36	4.0	2.0	1.2	2.5	4.8	3.8	4.8	6.8
37	4.3	3.4	2.8	2.0	5.4	6.3	4.8	5.7
38	3.9	3.1	4.4	2.0	4.9	6.4	4.9	5.8
39	4.4	2.1	5.2	2.3	5.0	5.9	6.0	6.3
40	4.8	2.2	6.1	3.3	5.1	7.0	6.4	5.7
41	6.0	4.3	6.8	4.6	5.9	7.4	6.1	5.5
42	6.0	6.6	7.6	4.6	6.8	7.8	6.6	7.8

Week	2001	2002	2003	2004	2005	2006	2007	2008
43	7.2	7.7	7.5	4.7	6.8	8.0	8.3	8.3
44	7.2	7.3	7.8	5.6	7.0	8.7	9.3	8.4
45	7.6	7.5	8.4	7.2	7.3	7.9	9.0	6.9
46	6.6	5.3	7.6	6.2	7.3	8.1	7.4	7.1
47	7.1	4.7	6.6	5.3	6.8	7.7	7.2	6.9
48	6.0	3.7	6.6	4.6	5.8	8.1	7.2	7.1
49	7.0	3.0	6.4	5.3	5.5	7.2	6.9	6.8
50	6.0	2.9	6.0	5.4	5.3	8.3	8.1	7.3
51	6.5	3.7	4.5	3.9	5.0	7.8	8.1	8.7
52	6.4	5.0	6.4	2.8	6.1	9.2	8.6	9.5
53	6.6	5.7	6.7	4.2	7.7	10.0	9.0	9.9

Table 5. Daily minimum dissolved oxygen measurements (mg/l) at Rough & Ready Island, 2001-2008.[2]

Day	Objective	2001	2002	2003	2004	2005	2006	2007	2008
1-Jan	5.0	4.8	6.2	6.3	7.5	4.4	9.3	10	8.9
2-Jan	5.0	4.6	6	6.2	7.5	4.7	9.2	9.9	9
3-Jan	5.0	4.8	5.9	5.9	7.6	5.2	9	10.1	9.3
4-Jan	5.0	4.9	5.7	5.7	7.4	6.5	8.9	10.2	9.9
5-Jan	5.0	4.8	6.1	5.4	0.3	6.2	8.6	10.3	9.7
6-Jan	5.0	4.9	6.2	5.3	7.1	7	8.4	10.5	9.5
7-Jan	5.0	4.9	6.2	5.2	7.1	7.6	8.4	10.6	9.2
8-Jan	5.0	5.1	6.2	5.1	7.1	7.9	8.4	10.5	9
9-Jan	5.0	5.2	6.8	5	7	7.8	8.4	8.6	8.6
10-Jan	5.0	5.5	6.5	5.1	6.8	7.6	8.6	10.7	8.3
11-Jan	5.0	6.3	5.9	5.1	6.7	9.1	8	10.8	7.5
12-Jan	5.0	6.8	5.4	4.8	6.7	7.5	7.7	10.9	7.6
13-Jan	5.0	6.8	5.3	4.5	6.1	7.2	7.4	11	7.4
14-Jan	5.0	6.9	5.1	4.4	6.3	7.1	7.1	11	7.1
15-Jan	5.0	6.6	4.9	4.2	6.1	7.3	7.2	10.9	7
16-Jan	5.0	6.7	4.8	4	6	7.3	7.1	10.9	7.3
17-Jan	5.0	6.5	4.7	3.9	5.8	7.4	7.2	11	7
18-Jan	5.0	5.1	4.8	3.7	5.6	7.3	9.7	11.6	6.9
19-Jan	5.0	6.2	4.8	3.5	5.4	7.4	9.7	12	6.6
20-Jan	5.0	6.4	4.9	3.4	5	8.3	9.5	12.2	6.9
21-Jan	5.0	6.4	5	3.3	4.9	8.1	9.4	12.3	6.9
22-Jan	5.0	6.4	5.2	3.2	4.8	7.9	9.4	12.3	6.9
23-Jan	5.0	6.4	5.5	3.1	4.7	7.8	9.4	12	7.3
24-Jan	5.0	6.2	5.5	3.3	4.7	7.8	9.2	12	7.7
25-Jan	5.0	6.5	3.1	3.1	4.6	7.4	9.4	11.9	8.5
26-Jan	5.0	6.8	5	3	3.9	7.4	9.3	11.8	8
27-Jan	5.0	6.7	5	2.7	4.8	7	9.2	11.7	8.8
28-Jan	5.0	6.7	5.1	2.6	5.2	7.4	9.2	11.8	8.3
29-Jan	5.0	6.6	5.1	2.3	5	7.2	9.2	11.9	7.7
30-Jan	5.0	6.8	5.3	2	3	7.3	9.1	12	8
31-Jan	5.0	6.6	5.4	1.8	5	7.8	9	11.9	8.2
1-Feb	5.0	6.4	5.4	1.7	5.1	7.4	8.9	16	8
2-Feb	5.0	6.3	5.4	2.1	5.1	7.2	9.3	11.3	7.7
3-Feb	5.0	6	5.5	2.1	5.5	7.7	9.1	11.3	8.5
4-Feb	5.0	5.7	5.6	1.8	5.4	7.8	8.9	11.1	8.4
5-Feb	5.0	5.4	4.5	1.6	5.3	7.3	9	11.1	8.4
6-Feb	5.0	5.4	4.2	1.3	5.3	7.2	8.9	11.3	8.1
7-Feb	5.0	5.7	4	1.1	5.2	7.2	9.2	11.1	8.2
8-Feb	5.0	6	4.1	0	5.3	7.3	9.4	10.9	8
9-Feb	5.0	5.9	4.3	0.4	5.1	7.2	9.5	10.5	7.7
10-Feb	5.0	6.1	4.1	0.2	4.9	7	9.4	9.7	7.7
11-Feb	5.0	6.2	4	0.1	4.7	6.8	9.2	9.7	7.4
12-Feb	5.0	6.4	3.8	0	4.5	6.6	9.1	8.3	6.6
13-Feb	5.0	6.4	3.9	0	4.3	6.5	8.9	8.2	6.9

[2] The Rough & Ready Island monitoring station samples dissolved oxygen at 15-minute intervals. Isolated samples of 0 mg/l dissolved oxygen, such as a single sample between two samples of 10 mg/l, were regarded as sampling errors.

Day	Objective	2001	2002	2003	2004	2005	2006	2007	2008
14-Feb	5.0	7	3.9	0	4.2	0	8.8	7.9	7.9
15-Feb	5.0	7.1	4.7	0	4.1	6.5	9.3	7.5	6.9
16-Feb	5.0	7.2	4.5	0.1	4.6	6.6	9.4	7.3	7
17-Feb	5.0	7.3	4.4	0.1	5.1	7.1	7.5	7.2	6.7
18-Feb	5.0	7.2	4.3	0	5.3	6.8	9.5	7.4	6.6
19-Feb	5.0	7.2	4.3	0.1	5.3	6.9	9.7	7.5	6.6
20-Feb	5.0	2	4.8	0.3	4.8	7	9.8	7.7	6.7
21-Feb	5.0	6.9	4.7	0.4	4.5	7.1	9.9	7.7	6.6
22-Feb	5.0	7	4.5	0	4.2	6.7	9.8	7.8	0.6
23-Feb	5.0	6.7	4.4	0.5	3.8	7	10.1	7.9	7.5
24-Feb	5.0	2	4.4	0	3.7	6.9	10.1	7.9	7.9
25-Feb	5.0	7.5	4.3	0	3.7	7.2	9.8	8	7.3
26-Feb	5.0	0	4.2	1.2	5	7.4	9.4	8	7.3
27-Feb	5.0	7.7	4	1.4	5.1	7.4	0	7.8	7.5
28-Feb	5.0	2	3.9	1.6	5.8	7.5	3.5	8.1	7.5
29-Feb	5.0	No Data	No Data	No Data	6.4	No Data	No Data	No Data	6.5
1-Mar	5.0	7.5	4.2	0	6.7	7.5	9.1	8.3	6.6
2-Mar	5.0	7.7	4.3	2.3	6.7	7.6	9.2	8.3	7.6
3-Mar	5.0	6	4.2	2.7	6.5	7.5	9.3	8.5	7
4-Mar	5.0	7.5	4.3	2.8	6.4	7.6	9.3	8.5	6.9
5-Mar	5.0	4	4.2	3.1	6.1	7.4	9.7	8.5	6.8
6-Mar	5.0	7.1	4.3	3.3	6	7.5	9.8	8.8	6.4
7-Mar	5.0	7	4.3	3.5	5.9	7.5	9.8	8.7	6.6
8-Mar	5.0	6.4	4.8	0	5.6	8.1	9.7	8.7	6.6
9-Mar	5.0	2	5.3	0	5.6	8.2	9.9	8.6	6.6
10-Mar	5.0	2	5.5	4.6	5.5	8	10.1	8.7	6.2
11-Mar	5.0	No Data	5.6	5	4	7.8	10	8.6	6.6
12-Mar	5.0	4	5.6	5.1	5.4	7.9	10	8.7	6
13-Mar	5.0	4	5.7	5.7	5.2	7.9	9.7	8.8	4.2
14-Mar	5.0	4	6	5.8	5.3	8.3	9.7	9.1	6.7
15-Mar	5.0	7.2	6.1	6.1	5.4	8.8	9.5	9.1	6.4
16-Mar	5.0	No Data	6.1	5.7	5.6	9.2	10.2	8.9	8
17-Mar	5.0	No Data	6.2	5.6	5.7	9.3	10.2	8.6	7.5
18-Mar	5.0	No Data	6.3	5.9	5.6	9.3	10.2	8.4	7.4
19-Mar	5.0	No Data	6.2	6	5.4	9.3	10.3	8.4	7.2
20-Mar	5.0	No Data	6.1	4.6	5.2	9.1	9.9	8.5	7
21-Mar	5.0	No Data	6.2	5.1	5.5	9.2	9.9	8.4	6.8
22-Mar	5.0	No Data	6.2	6.2	6.9	9.1	10	6	7
23-Mar	5.0	No Data	6.1	6.2	7.8	8.8	10.3	8.3	6.4
24-Mar	5.0	No Data	6.4	6.1	7.6	8.6	10	8	6.6
25-Mar	5.0	No Data	6.4	6	7.4	8.1	9.8	7.7	6.4
26-Mar	5.0	No Data	6.6	6.3	7.1	8	9.6	7.4	8.5
27-Mar	5.0	No Data	6.3	6.3	6.8	8.2	9.5	7.4	8.7
28-Mar	5.0	No Data	6.3	6.6	6.6	8.1	9.4	8.4	8.6
29-Mar	5.0	No Data	6.1	6.4	6.4	8.2	9.5	8.2	8.9
30-Mar	5.0	No Data	6	6.5	6.3	8.3	9.6	7.8	9.3
31-Mar	5.0	No Data	5.8	5.8	6.4	8.5	9.5	7.7	9.7
1-Apr	5.0	No Data	5.7	5.4	6.4	8.5	9.5	7.6	10
2-Apr	5.0	No Data	5.6	4.9	7.4	8.5	9.3	7.5	9.9
3-Apr	5.0	No Data	6	4.4	7.2	8.5	9.1	7.6	9.8
4-Apr	5.0	No Data	5.8	4.1	7.1	8.5	9	7.4	9.5

Day	Objective	2001	2002	2003	2004	2005	2006	2007	2008
5-Apr	5.0	No Data	5.5	3.8	6.7	8.6	8.6	7.2	9.3
6-Apr	5.0	No Data	5.4	4	6.9	8.8	7.9	7	8.9
7-Apr	5.0	No Data	5.2	4.2	7	8.9	7.4	7	8.7
8-Apr	5.0	No Data	5.1	5.2	7.2	8.9	0	6.9	8.6
9-Apr	5.0	No Data	4.9	6.3	7.1	8.8	6.9	6.9	8.6
10-Apr	5.0	No Data	4.8	6.1	7	8.9	6.5	6.9	8.8
11-Apr	5.0	No Data	4.7	5.9	6.9	9.1	6.6	6.6	9.2
12-Apr	5.0	No Data	4.9	5.5	6.8	8.9	6	6.8	9.6
13-Apr	5.0	No Data	4.9	5.2	6.7	9	6.3	6.7	10
14-Apr	5.0	No Data	5	5.2	6.6	9.2	6.3	6.2	9.9
15-Apr	5.0	No Data	5.1	6.1	6.5	9.4	6.3	6.2	9.5
16-Apr	5.0	No Data	5.8	8.2	7	9.2	6.3	5.8	9.5
17-Apr	5.0	No Data	7.4	9.5	7.9	9.2	6.4	5.6	9.2
18-Apr	5.0	No Data	8.1	9.3	7.7	9.1	7	5.7	8.7
19-Apr	5.0	8.2	8.6	8	7.7	9.2	7.3	5.6	8
20-Apr	5.0	8	9	9.1	7.8	9.4	7.4	5.4	7.7
21-Apr	5.0	7.9	9	0	7.9	9.5	3.2	5.4	7.3
22-Apr	5.0	8.5	9.3	9.4	8	9.4	3.1	6.5	7
23-Apr	5.0	8.7	6.8	9.6	8.4	9.2	7.2	8.7	7.2
24-Apr	5.0	9	1.5	9.3	No Data	9	7.2	9.4	7.7
25-Apr	5.0	8.8	8.8	9	No Data	9	7.4	10.4	8
26-Apr	5.0	8.9	8.7	9.1	8.9	9.1	3.2	10.6	8.2
27-Apr	5.0	8.6	8.7	9.3	9.3	9	3.1	10	8.6
28-Apr	5.0	8.8	8.8	9.1	0	8.7	3.6	9.4	9.4
29-Apr	5.0	8.8	8.6	9.3	9	8.5	3.5	9.4	9.3
30-Apr	5.0	8.8	8.3	9.7	8.7	8.8	5.4	4.7	9.2
1-May	5.0	8.7	8.5	9.8	0	8.7	7	10.8	9.3
2-May	5.0	8.6	8.8	9.7	8.5	8.9	7.2	10.2	9.3
3-May	5.0	8.6	9	9.2	8.4	9.1	7.1	9.8	9.5
4-May	5.0	0	8.9	4.8	7.7	9.1	7	9.5	8.5
5-May	5.0	8.9	8.8	4.5	7.4	8.8	6.9	9.4	8.3
6-May	5.0	8.9	8.5	9.5	7.4	8.7	6.9	10	7.9
7-May	5.0	8.6	8.6	9.3	7.7	8.7	3.3	9.2	7.5
8-May	5.0	9.1	8.8	5	7.4	8.9	6.9	10.8	7.2
9-May	5.0	0	8.5	4.7	7.6	8.9	3.9	10.5	7.2
10-May	5.0	9.2	8.4	9.3	7.9	9.3	6.7	10	7.4
11-May	5.0	9.2	8.8	9.3	8	9	6.6	10.3	7.3
12-May	5.0	8.8	8.5	9.2	8.2	8.7	6.6	10.3	7.5
13-May	5.0	8.3	8.4	9.3	8.2	8.5	6.5	10.8	7.6
14-May	5.0	8.1	8.2	8.7	8.1	8.2	6.5	11	7.5
15-May	5.0	7.6	8.2	8.6	8.3	7.9	6.6	8.3	7.2
16-May	5.0	7.6	8.2	8.5	8.3	7.4	7.1	9.4	6.8
17-May	5.0	7.4	7.9	4.5	8.4	8.4	7.1	9.3	6.8
18-May	5.0	7.5	7.6	8.5	8.8	8.3	7.1	9	6.5
19-May	5.0	7.6	7.9	8.4	9.3	8.4	7.1	9	6.1
20-May	5.0	7.6	7.1	8.3	9.6	8.3	7	8.9	5.5
21-May	5.0	7.5	4.8	7.8	9.7	8.4	7.2	8.5	5.5
22-May	5.0	3.9	7.7	7.5	9.7	8.1	7.2	8.5	6.1
23-May	5.0	3.8	8.3	6.9	9.2	8.2	7	8.3	6
24-May	5.0	7.4	8.5	6.4	8.4	8.6	7.4	8	5.7
25-May	5.0	7.1	8.5	5.9	7.5	8.6	7.7	7.4	5.5

Day	Objective	2001	2002	2003	2004	2005	2006	2007	2008
26-May	5.0	6.9	8	5.7	5.7	8.2	8	6.7	5.3
27-May	5.0	6.3	7.7	5.6	5	8.2	8.1	6.3	5.4
28-May	5.0	6	7	5.2	4.6	8	8.1	6.3	5.3
29-May	5.0	6	7	4.9	4.6	8.1	8.2	6.3	5.2
30-May	5.0	5.7	6.9	4.5	4.4	7.9	8.2	6	5.2
31-May	5.0	5.2	6.5	4.1	4.2	7.8	7.8	5.7	5.2
1-Jun	5.0	4.8	6.2	4.2	4.1	7.7	7.6	5.4	5.1
2-Jun	5.0	4.4	6	4.4	4	7.6	7.2	5.3	5.2
3-Jun	5.0	3.9	5.9	4.5	3.8	7.4	7	5.1	5.2
4-Jun	5.0	3.5	5.6	4.5	3.9	7.4	0	4.9	5.3
5-Jun	5.0	4.3	5.4	4.4	3.9	7.4	6.6	5.2	5.4
6-Jun	5.0	4	5.5	4.6	3.9	7.4	0	5.1	5.2
7-Jun	5.0	3.9	5.2	4.5	3.9	7.4	7.2	5	5
8-Jun	5.0	4.1	5.4	4.2	3.9	0	7.3	4.9	5.2
9-Jun	5.0	3.9	6.3	4.1	3.6	7.4	7.1	4.8	4.9
10-Jun	5.0	3.8	6.1	3.9	4	7.3	7.2	4.7	5
11-Jun	5.0	3.7	5.7	3.5	3.9	7.2	7.2	4.4	5.1
12-Jun	5.0	4.2	5.5	3.1	3.8	7.3	7.4	3.9	5.2
13-Jun	5.0	3.9	5.2	2.9	3.8	7.4	7.2	3.7	5.1
14-Jun	5.0	3.9	5.2	3.2	3.6	7.2	7.4	3.2	4.9
15-Jun	5.0	3.7	4.9	3.4	3.5	7.4	7.5	3	4.7
16-Jun	5.0	3.8	5.3	3.8	3.2	7.7	7.5	2.8	4.5
17-Jun	5.0	3.8	6.3	4.2	3.5	7.5	7.3	2.6	4.8
18-Jun	5.0	3.5	4.8	4.7	4.5	7.8	7.1	2.7	5.2
19-Jun	5.0	3.7	7	4.9	4.2	7.9	6.9	2.7	5.3
20-Jun	5.0	3.4	1.5	5.1	4.1	8.3	6.6	2.6	5.5
21-Jun	5.0	3.3	4.7	0	3.9	8.2	6.6	2.7	5
22-Jun	5.0	3.1	4.5	5.5	3.3	8.2	6.6	2.6	4.9
23-Jun	5.0	2.5	4.2	5.4	3.3	8.3	7	2.2	4.8
24-Jun	5.0	2.5	4	5.4	3.5	8.4	7.2	1.9	5
25-Jun	5.0	2.6	3.9	5.2	3.8	8.5	7	1.8	5.5
26-Jun	5.0	2.4	3.7	5.1	4	8	6.9	2.9	5.4
27-Jun	5.0	2.6	3.5	4.9	4	8	7.6	2.7	5.5
28-Jun	5.0	2.9	3.4	4.5	4	7.8	7.7	2.8	5.4
29-Jun	5.0	3.4	3.5	4.1	4.3	7.6	7.8	3.2	5
30-Jun	5.0	3.8	3.9	1.5	4.1	7.4	0	3.3	4.9
1-Jul	5.0	3.5	4.4	1.4	3.7	7	7.5	3.3	5
2-Jul	5.0	3.3	4.4	4.1	3.4	6.7	7.1	3.4	5.2
3-Jul	5.0	3	3.6	3.7	3.3	6.7	6.7	3.6	5.4
4-Jul	5.0	3.7	3.5	3.6	3.3	7	6.4	3.8	5.7
5-Jul	5.0	2.6	3.5	3.6	3.3	6.8	6.3	4	5.6
6-Jul	5.0	2.2	3	3.3	3	6.8	6.5	3.1	5.4
7-Jul	5.0	2.2	2.8	3.3	2.8	6.5	6.4	2.9	5.3
8-Jul	5.0	2.2	3	3.6	2.9	6.8	6	2.3	5.9
9-Jul	5.0	2.7	2.8	3.9	2.9	6.7	5.7	2	5.9
10-Jul	5.0	3	2.7	3.9	2.8	7.2	5.2	3.9	5.8
11-Jul	5.0	3.4	2.9	4	2.5	6.1	6	2.2	5.8
12-Jul	5.0	3.6	2.8	3.9	2.5	5.5	5.9	4	5.6
13-Jul	5.0	3.8	2.6	3.9	2.4	7.1	6	3.8	5.4
14-Jul	5.0	3.8	2.5	3.9	2.3	7.2	6	3.9	5.3
15-Jul	5.0	3.6	2.2	3.6	1.5	7.5	6.1	3.9	5.3

Day	Objective	2001	2002	2003	2004	2005	2006	2007	2008
16-Jul	5.0	3.6	2.9	3.9	2.1	7.5	5.9	3.9	5.4
17-Jul	5.0	3.1	2.9	3.8	2.3	7.3	5.6	3.9	5.6
18-Jul	5.0	3	2.6	3.5	2.3	6.2	5.4	4	5.7
19-Jul	5.0	2.7	2.5	3	1.3	5.5	5.2	4.3	5.7
20-Jul	5.0	2.8	2.6	3.2	1.3	5.6	5.1	4.2	5.3
21-Jul	5.0	2.9	3	2.9	2.3	5.1	5	4.2	5.4
22-Jul	5.0	2.9	1.6	2.6	2.5	4.6	0	4	5.5
23-Jul	5.0	3.2	1.7	2.5	2.4	4.4	4.7	3.7	6.3
24-Jul	5.0	3.1	2.9	2.3	1.9	4.3	4.9	4.1	6.3
25-Jul	5.0	3.1	3.3	2.4	2.1	4.4	4.3	3.9	6.4
26-Jul	5.0	3.1	3.3	2.6	2.3	5.3	3.7	4	6
27-Jul	5.0	3.4	3.2	2.7	2.5	5.5	3.8	4	5.6
28-Jul	5.0	3	3.5	2.8	2.7	5.7	4.1	4	5.3
29-Jul	5.0	2.7	3.2	2.9	2.9	5.8	3.9	4.1	5.4
30-Jul	5.0	2.7	2.8	2.8	3	5.9	4	4.2	5.5
31-Jul	5.0	3.8	1.8	2.3	2.7	6	4.2	4.2	5.6
1-Aug	5.0	3.1	1.1	2.1	2.7	5.4	4.5	4.3	4.7
2-Aug	5.0	3.2	2.9	2.4	2.6	5.1	5.2	4.2	5.6
3-Aug	5.0	3.4	2.8	2.7	2.6	0.4	0	4.2	5.5
4-Aug	5.0	3.4	2.9	2.7	2.6	4.6	5.3	4.2	5.5
5-Aug	5.0	3.6	2.8	3	2.6	4.2	0	4.1	5.8
6-Aug	5.0	3.6	2.9	3	2.7	4.1	4.9	4.1	6.3
7-Aug	5.0	3.6	2.9	3.2	2.7	4	4.6	4.6	6.3
8-Aug	5.0	3.5	2.6	3.3	2.4	4.3	4.8	4.4	6.4
9-Aug	5.0	3.8	2.5	3.3	2.3	4.7	4.9	4.4	6.3
10-Aug	5.0	3.8	2.7	3.4	2.4	4.7	4.9	4.3	5.8
11-Aug	5.0	3.5	2.7	3.4	2.4	4.6	4.9	4.3	5.5
12-Aug	5.0	3.4	2.8	3.5	2.1	4.3	4.8	4.4	5
13-Aug	5.0	3.5	2.6	3.5	2.5	4.1	4.6	4.4	5.4
14-Aug	5.0	3.6	2.4	3.7	2.5	4	4.6	4.4	5.6
15-Aug	5.0	3.4	2.3	3.8	2.6	4	5.2	4.7	5.7
16-Aug	5.0	3.3	2.1	4.1	2.5	4.5	5.5	4.7	5.8
17-Aug	5.0	3.4	2.1	4.2	2.4	4.4	5.6	4.9	6
18-Aug	5.0	3.3	1.9	4.2	2.7	4.5	5.6	4.8	6.4
19-Aug	5.0	3.5	1.6	4.1	2.6	4.6	5.9	4.4	6.7
20-Aug	5.0	3.3	2	0	2.6	4.7	5.6	4.9	5.9
21-Aug	5.0	3.4	1.8	0	2.7	4.9	5.6	5.1	5.8
22-Aug	5.0	3.3	1.9	0	3.1	5.4	5.9	4.9	5.5
23-Aug	5.0	3.7	1.9	0	2.6	5.5	5.9	4.9	5.6
24-Aug	5.0	3.7	1.8	0	2.4	5.5	5.6	4.6	5.2
25-Aug	5.0	3.7	1.7	0	2.9	5.3	5.3	4.7	5.2
26-Aug	5.0	0	1.8	0	3	5.1	5.3	5	5.3
27-Aug	5.0	3.6	1.8	0	3.1	5	5	5.3	5.2
28-Aug	5.0	3.8	1.4	3.3	0	4.7	4.9	5.4	5.3
29-Aug	5.0	3.5	1.4	3.2	2.7	4.7	6	1.7	5.4
30-Aug	5.0	3.3	1.4	1.3	0	5.2	5.7	1.7	5.7
31-Aug	5.0	3	2.1	1.2	3	5.2	5.8	4.6	6
1-Sep	5.0	2.8	1.6	1.2	2.9	4.7	5.7	4.2	6.8
2-Sep	5.0	3.1	1.3	1.1	2.9	4.8	0	5.3	7
3-Sep	5.0	3.4	0.9	0	3	4.6	5.7	5.3	6.9
4-Sep	5.0	3.7	2.5	0	2.9	5	6.2	4.6	7.1

Day	Objective	2001	2002	2003	2004	2005	2006	2007	2008
5-Sep	5.0	4.1	2.5	2.7	2.4	5.4	2.2	4.7	7
6-Sep	5.0	4.3	2.5	2.4	2.4	5.8	6.5	4.6	6.7
7-Sep	5.0	4.6	2.7	2.4	2.3	5.7	0	4.7	6.4
8-Sep	5.0	4.6	2.6	2.4	2.3	5.4	0	4.7	5.9
9-Sep	5.0	4.7	2.8	2.8	1.9	5.2	5.9	4.7	5.8
10-Sep	5.0	4.7	3.1	2.9	1.3	5.3	5.7	4.8	5.7
11-Sep	5.0	4.4	3.6	3	1.3	5.2	5.7	4.9	5.4
12-Sep	5.0	4.3	3.8	3	1.3	4.7	7.2	4.9	5.3
13-Sep	5.0	4.1	3.9	3.4	1.5	4.3	7	4.8	5.3
14-Sep	5.0	4	3.9	3.8	2.4	4.8	6.1	4.8	5.3
15-Sep	5.0	3.9	3.8	4	2.4	4.9	6.2	4.8	5.3
16-Sep	5.0	3.9	1.7	4.1	2.2	5.1	6.2	5.1	5.3
17-Sep	5.0	4.1	4	4.5	2.1	5.2	6.2	0	5.7
18-Sep	5.0	4	3.6	4.9	2.4	5.2	6.1	5.7	6.2
19-Sep	5.0	4	3.5	4.8	2.4	5	6.1	5.8	6.5
20-Sep	5.0	3.9	2.9	4.9	2	5.2	6.4	6	6.6
21-Sep	5.0	3.9	2.5	5	2.1	5.2	6.4	5.9	6.7
22-Sep	5.0	3.8	2.3	5.3	2	4.9	6.5	5.8	6.8
23-Sep	5.0	3.7	2.3	5.5	2.7	4.6	6.8	5.7	6.8
24-Sep	5.0	3.8	2.5	5.3	2.3	4.6	6.8	5.7	7.1
25-Sep	5.0	4.2	2.5	5.3	2.4	4.5	7	6.1	7
26-Sep	5.0	4.5	2	5.1	2.7	4.6	7.1	6.2	2.7
27-Sep	5.0	4.7	1.5	5	2.9	5	0	6.1	7
28-Sep	5.0	4.8	1.4	5.8	3.1	5.4	6.9	5.9	6.6
29-Sep	5.0	4.9	1.1	6.2	3.4	5.6	6.8	6.2	6.2
30-Sep	5.0	4.7	1.3	6.4	3.4	5.7	6.7	6.5	5.9
1-Oct	6.0	4.9	1.8	6.1	3.6	5.1	6.6	6.4	5.6
2-Oct	6.0	5	2.9	6.1	3.7	5	6.5	6.2	5.5
3-Oct	6.0	4.9	2.8	6.2	3.9	5.2	7.1	6.3	5.3
4-Oct	6.0	4.9	2.7	6.1	4.4	5.5	7.2	6.3	5.1
5-Oct	6.0	4.6	2.5	6.5	4.7	5.9	7.6	6.3	5
6-Oct	6.0	4.6	2.5	6.8	4.8	6.2	7.1	6.9	5
7-Oct	6.0	4.8	0	6.9	4.9	6.6	7.2	7.2	5
8-Oct	6.0	5.1	5.5	6.9	4.7	6.7	7.2	7.1	5.1
9-Oct	6.0	5.6	6.2	6.9	4.7	7.2	7.2	7	5.4
10-Oct	6.0	6.4	5.5	6.8	4.8	7.2	7.2	7	6.2
11-Oct	6.0	6.8	5.2	6.8	4.3	7.2	7.3	7.1	6.8
12-Oct	6.0	6.8	5.1	7	4.4	6.2	7.3	0	7
13-Oct	6.0	6.5	5	7.3	4.6	6.1	7.7	7.2	7.2
14-Oct	6.0	6.1	5.6	7.6	4.8	6.9	7.6	7.4	7.6
15-Oct	6.0	6.1	6.5	6.5	4.9	6.8	7.6	7.1	7.8
16-Oct	6.0	6.4	6.8	8.2	4.7	7	7.6	6.6	8.2
17-Oct	6.0	5.9	7.3	8.4	4.1	6.9	7.8	6.5	8.3
18-Oct	6.0	5.8	7.4	8.4	3.9	6.9	8	6.3	8.2
19-Oct	6.0	5.3	7.7	8.3	3.9	6.9	7.9	4.9	8.2
20-Oct	6.0	6.1	8.1	8.1	4.1	6.4	7.9	7.6	8.1
21-Oct	6.0	6.9	8.6	7.5	5.5	6.8	7.8	8.9	8
22-Oct	6.0	7.1	8.3	7.1	5.6	6.9	7.8	9.3	8.1
23-Oct	6.0	7.4	7.3	7.1	6	6.8	7.7	8.8	8.2
24-Oct	6.0	7.3	7	7.2	0	6.8	7.9	8.3	8.6
25-Oct	6.0	7.2	7.2	7.3	6	6.8	8	8.4	9

Day	Objective	2001	2002	2003	2004	2005	2006	2007	2008
26-Oct	6.0	6.7	7.2	7.5	6.5	7.1	8.2	4.6	8.1
27-Oct	6.0	7.8	7	7.7	6.8	7	8.3	10	9.5
28-Oct	6.0	7.9	7.3	7.8	6.8	7.2	8.3	9.9	9.1
29-Oct	6.0	4.1	7.3	7.9	6.6	7.1	8.4	9.7	8.7
30-Oct	6.0	7.7	7.3	8.1	6.5	7.3	8.5	9.3	8.3
31-Oct	6.0	7.7	7.4	8	6.8	7.3	8.8	9.1	7.9
1-Nov	6.0	7.8	7.4	7.9	7.2	7.3	9	9.1	7.4
2-Nov	6.0	7.7	7.3	8	7.2	7.3	9	9.1	7
3-Nov	6.0	7.3	7.1	8.2	7.4	7.3	8.7	9.2	6.8
4-Nov	6.0	7.5	7.4	8.4	7.1	7.2	8.6	9.1	6.8
5-Nov	6.0	7.6	7.7	8.4	7.4	7.3	8.1	8.9	6.8
6-Nov	6.0	7.6	7.9	8.5	7.2	7.3	7.7	8.9	6.8
7-Nov	6.0	7.7	8.2	8.5	7	7.2	7.7	9	6.9
8-Nov	6.0	7.6	8	8.6	7	7.6	7.6	9.1	6.9
9-Nov	6.0	7.6	6.4	8.3	6.3	7.5	7.9	9	6.9
10-Nov	6.0	7.7	5.8	7.8	5.9	7.3	8.3	8.8	7.2
11-Nov	6.0	7.6	5.4	8.2	5.6	7.1	8.3	8.5	7.1
12-Nov	6.0	7.1	4.6	8	5.4	6.9	8.4	8.2	7.2
13-Nov	6.0	6.5	5.3	7.4	6	6.9	8.2	7	7.2
14-Nov	6.0	5.6	5.3	6.9	6	6.7	8.2	6	7.2
15-Nov	6.0	5.5	5.4	6.8	5.7	6.4	8.3	6.3	7.1
16-Nov	6.0	7.1	5.4	6.5	5.5	7.2	8.3	6.2	7
17-Nov	6.0	7.1	5.2	6.2	5.3	7	8	9.6	6.9
18-Nov	6.0	7.2	5	6.9	5	6.9	7.5	7.8	6.8
19-Nov	6.0	7	4.8	6.7	4.8	6.5	7.2	6.6	6.7
20-Nov	6.0	7.2	4.6	6.5	4.6	6.4	7.2	7	6.8
21-Nov	6.0	7	4.5	6.5	4.7	6.2	8	7	7
22-Nov	6.0	7.1	4.4	6.6	4.7	6.1	7.9	7.1	7
23-Nov	6.0	7.1	4.1	6.7	4.7	5.7	7.8	7.3	7.1
24-Nov	6.0	7.3	4.1	6.7	4.5	5.4	7.8	7.3	7.1
25-Nov	6.0	7.8	4	6.6	4.5	5.3	7.8	7	7.1
26-Nov	6.0	1.6	3.8	6.6	4.5	5.3	7.9	7.1	7.1
27-Nov	6.0	7.1	3.7	6.6	4.5	5.3	7.8	7.2	7
28-Nov	6.0	3.4	3.6	6.6	5.3	5.2	7.7	6.9	7.1
29-Nov	6.0	7.6	3.4	6.6	5.5	5.3	7.9	7.3	7.1
30-Nov	6.0	7.3	3.3	6.5	5.4	5.6	8.2	7.5	7.1
1-Dec	5.0	7.2	3.1	6.4	5.3	5.5	8.4	7.6	7
2-Dec	5.0	7.5	3.1	6.5	5.1	6	8.5	7.9	7.1
3-Dec	5.0	7.5	3.1	6.6	5.2	5.9	8.6	8.1	6.5
4-Dec	5.0	6.4	2.9	5.5	5.1	5.8	0	8.3	6.5
5-Dec	5.0	7.2	3	6.6	5	5.6	8.6	8.1	6.6
6-Dec	5.0	7	2.8	6.6	4.7	5.4	7.7	0	6.7
7-Dec	5.0	6.8	2.8	6.8	5.6	5.2	8.5	8	6.7
8-Dec	5.0	6.3	2.8	6.7	6	5.1	8.6	8.2	6.8
9-Dec	5.0	6.5	2.7	6.8	5.8	5	8.6	8.2	7.4
10-Dec	5.0	6.5	2.5	6.9	5.6	5	8.5	8.1	7.5
11-Dec	5.0	6.6	2.5	6.7	5.3	5	8.5	8.4	7.5
12-Dec	5.0	6.6	2.4	6.9	5.1	4.9	8.5	8	7.6
13-Dec	5.0	6.5	3	0.9	4.8	5	8.5	8.2	7.7
14-Dec	5.0	4.9	4.4	0.8	4.3	5	8.1	8	8
15-Dec	5.0	4.7	5	0.5	3.8	5.1	7.9	8	8.4

Day	Objective	2001	2002	2003	2004	2005	2006	2007	2008
16-Dec	5.0	4.8	1.9	4	3.5	5.1	7.9	7.8	8.5
17-Dec	5.0	4.9	1.9	6.8	3.1	5	7.6	7.7	8.6
18-Dec	5.0	7.3	3.5	6.6	2.9	5.2	7.6	8.2	8.8
19-Dec	5.0	7	4.2	6.5	2.6	6.6	7.6	7.9	9.1
20-Dec	5.0	7.2	4.5	6.4	2.5	6.4	7.6	8.2	9.2
21-Dec	5.0	6.9	4.7	6.4	2.9	6.2	7.7	8.6	9.2
22-Dec	5.0	7.2	4.7	6.4	2.9	6	7.9	8.3	9.4
23-Dec	5.0	5.4	4.8	6.3	2.9	6	8.3	8.3	9.4
24-Dec	5.0	6.7	5	6.5	2.9	6.6	8.3	8.3	9.5
25-Dec	5.0	6.6	5	6.7	3	6.7	8.6	8.6	9.7
26-Dec	5.0	6.4	5	6.6	3	6.9	8.8	8.7	9.8
27-Dec	5.0	6.3	5.4	6.1	3.6	7.2	8.9	8.8	9.7
28-Dec	5.0	6.4	5.4	5.8	4.7	7.5	9.9	8.9	9.9
29-Dec	5.0	6.7	5.6	6.3	4.1	8	10.1	8.9	9.9
30-Dec	5.0	6.8	5.4	7.4	4.9	8.6	10.1	8.8	9.9
31-Dec	5.0	6.3	6	7.4	4.7	9.2	10	9.2	9.7

APPENDIX F:
AERATION FACILITY WEEKLY REPORTS, May 2008 - October 2008

The Aeration Facility provides weekly reports for the Department of Water Resources. Reports are available at the Bay-Delta Office and the Bay-Delta web page.[1] Reports are available for May 30, 3008 through October 17, 2008.

1. May 30, 2008

With dissolved oxygen levels approaching 5.0 mg/l, the Aeration Facility may be operated the week of June 2nd. Due to an electronic component failing in Pump A, the facility will be operated at only 50% capacity. Pump A should be back in operation the week of June 9th once the contractor makes the necessary repairs.

2. June 6, 2008

The Aeration Facility was not operated during the week ending June 6th. With dissolved oxygen levels continuing to approach 5.0 mg/l, the Aeration Facility may be operated the week of June 9th. Due to an electronic component failing in Pump A, the facility may be operated at only 50% capacity. Pump A should be back in operation sometime during the week once necessary repairs are completed.

3. June 13, 2008

With dissolved oxygen levels approaching 5.0 mg/l, the Aeration Facility may be operated this coming week. Pump A was repaired so the system is back to full capacity.

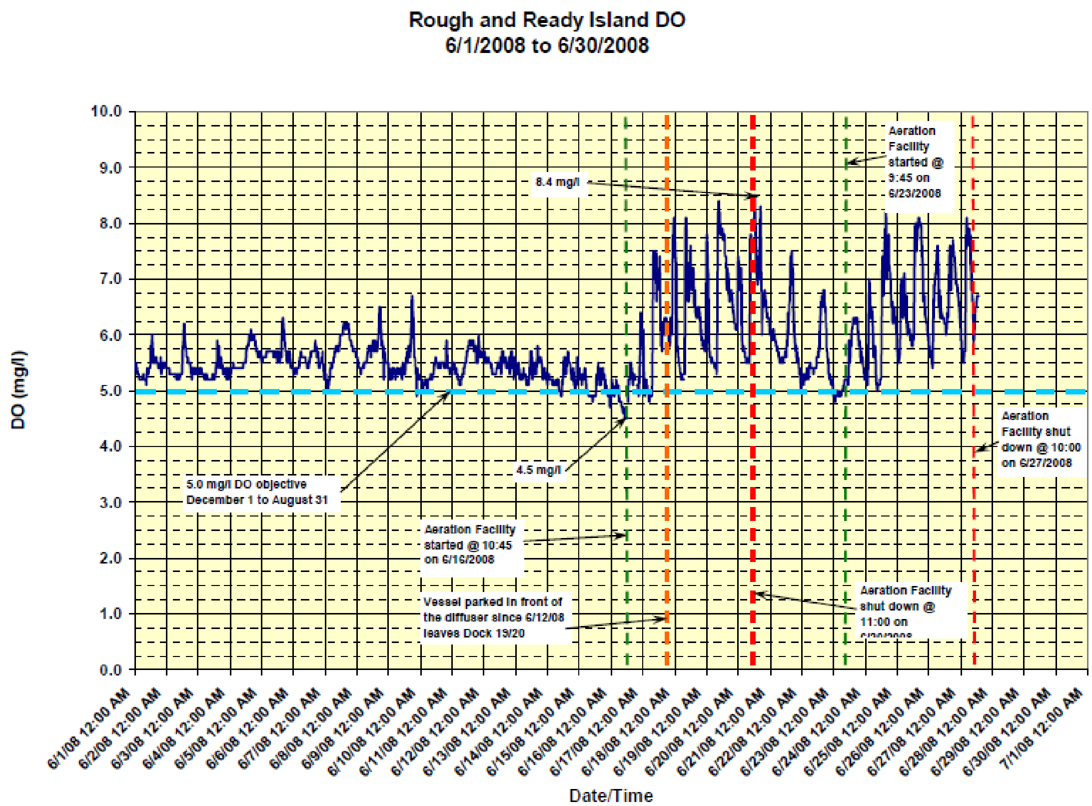
4. June 20, 2008

With dissolved oxygen (DO) levels beginning to drop below 5.0 mg/l last weekend, the Aeration Facility was turned on Monday, June 16, 2008 at about 10:45 a.m to begin the first of several planned on/off pulse tests. The system was operated at full capacity with oxygenated water with a DO level in the upper 30 mg/l range. Water was discharged into the Stockton Deep Water Ship Channel for four full days ending Friday, June 20, 2008 at about 10:45 a.m. The system will be off for the weekend and will likely be turned back on Monday, June 23, 2008 at 9:00 a.m.

[1] All reports area available at http://baydeltaoffice.water.ca.gov/sdb/af/weekly/weekly.cfm

5. June 27, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on Monday, June 23, 2008 at about 9:45 a.m. The system was operated at full capacity with oxygenated water with a dissolved oxygen (DO) level in the upper 30 mg/l range. Water was discharged into the Stockton Deep Water Ship Channel (DWSC) for four full days ending Friday, June 27, 2008 at about 10:00 a.m. The system will be off for the next three days and will be turned back on Monday, June 30, 2008 at about 9:00 a.m. Below is a draft plot of the DO readings from the Rough and Ready Island station during June 2008. As we compile and analyze data from the four additional DO sensors in the DWSC we will share that information in future updates.



6. July 3, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on Monday, June 30, 2008 at about 9:45 a.m. The system was operated at full capacity with oxygenated water with a dissolved oxygen (DO) level in the upper 30 mg/l range. Water was discharged into the Stockton Deep Water Ship Channel (DWSC) for three full days ending Thursday, July 3, 2008 at about 12:45 p.m. for Pump B and 3:00 p.m. for Pump

A. The system will be off for the next four days and will be turned back on Monday, July 7, 2008 at about 9:00 a.m. In addition, the efficiency of an updated oxygen injector will be tested Monday.

7. July 11, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on Monday, July 7, 2008 at about 9:30 a.m. The system was operated at full capacity with oxygenated water with a dissolved oxygen (DO) level in the upper 30 mg/l range. Water was discharged into the Stockton Deep Water Ship Channel for four full days ending Friday, July 11 2008 at about 10:00 a.m. The system will be off for the next three days and will be turned back on Monday, July 14, 2008 at about 9:00 a.m.

8. July 18, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on Monday, July 14, 2008 at about 9:45 a.m. The system was operated at full capacity with oxygenated water with a dissolved oxygen (DO) level in the upper 30 mg/l range. Water was discharged into the Stockton Deep Water Ship Channel for four full days ending Friday, July 18 2008 at about 9:30 a.m. The system will be off for the next three days and will be turned back on Monday, July 21, 2008 at about 9:00 a.m.

9. July 25, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on Monday, July 21, 2008 at about 9:45 a.m. The system was operated at full capacity with oxygenated water with a dissolved oxygen (DO) level in the upper 30 mg/l range. Water was discharged into the Stockton Deep Water Ship Channel for four full days ending Friday, July 25 2008 at about 9:45 a.m. The system will be off for the next three days and will be turned back on Monday, July 28, 2008 at about 9:00 a.m.

10. August 1, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on Monday, July 28, 2008 at about 9:45 a.m. The system was operated at full capacity with oxygenated water with a dissolved oxygen (DO) level in the upper 30 mg/l range. Water was discharged into the Stockton Deep Water Ship Channel for four full days ending Friday, August 1, 2008 at about 10:15 a.m. In addition, a test was conducted on Wednesday, July 30, 2008 to feed oxygen at a lower pressure to measure if higher oxygen transfer efficiencies could be attained. Results are still being analyzed. Thus far, the maximum efficiency achieved has been in the low 60% range. An efficiency of 80% is hoped to be achieved through additional optimization testing. The system will be off for the next three days and will be turned back on Monday, August 4, 2008 at about 9:30 a.m.

11. August 8, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on Monday, August 4, 2008 at about 9:45 a.m. The system was operated at full capacity with oxygenated water with a dissolved oxygen (DO) level in the upper 30 mg/l range. Water was discharged into the Stockton Deep Water Ship Channel for four full days ending Friday, August 8, 2008 at about 10:00 a.m. In addition, dye tests and longitudinal surveys were completed to measure the dilution of oxygen from the diffuser and to measure the tidal movement and spreading of the dye. Additional surveys will be conducted next week.

Preliminary results from last week's efficiency testing at a lower oxygen supply pressure show efficiencies increased slightly to the mid 60% range. Additional testing will be done to continue to increase the oxygen transfer efficiency. The system will be off for the next three days and will be turned back on Monday, August 11, 2008 at about 9:30 a.m.

12. August 15, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on Tuesday, August 12, 2008 at about 11:30 a.m. The system is being operated at full capacity with oxygenated water with a dissolved oxygen (DO) level in the upper 30 mg/l range. The pulse operation will be increased from 4 days to 7 days to evaluate the benefit of three additional days of continuous operation. The system will be shut down on Tuesday, August 19, 2008 at approximately 11:30 a.m and is planned to be off for 7 days.

In addition, dye tests and longitudinal surveys were completed to measure the dilution of oxygen from the diffuser and to measure the tidal movement and spreading of the dye.

13. August 22, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on last Tuesday, August 12, 2008 at about 11:30 a.m and turned off Tuesday, August 19, 2008 at about

11:15 a.m. The system will be off for 7 days and turned back on next Tuesday, August 26, 2008 at approximately 11:30 a.m and is planned to operate for 7 days.

14. August 29, 2008

As a part of ongoing pulse tests, the Aeration Facility was turned on Tuesday, August 26, 2008 at about 11:00 a.m. and will run for 7 days. The system is being operated with oxygenated water with a dissolved oxygen (DO) level in the middle 30 mg/l range. The Aeration Facility will be turned off on Tuesday, September 2, 2008 at about 11:00 a.m. The system will then be off for 7 days and turned back on Tuesday, September 9, 2008.

15. September 2, 2008

A change has been made to the operation schedule for the Aeration Facility. Rather than shutting down today, the system will operate through Friday, September 5, 2008 at about 11:00 a.m. This will allow us to analyze a 10-day operation cycle. A longitudinal survey will be made after the system is turned off. The system will then be off for 10 days and turned back on Monday, September 15, 2008.

16. September 12, 2008

As a part of on-going pulse operations, the Aeration Facility will be turned back on Tuesday, September 16, 2008 at about 9:00 a.m. discharging a dissolved oxygen (DO) level in the mid 30 mg/l range. With the system being off for the last 10 days, natural DO levels are currently being observed which are below the 6.0 mg/l TMDL. The response of increasing DO levels to above the current TMDL will be monitored during the planned 7 day operation. The system will run until September 23, 2008.

17. September 19, 2008

As a part of on-going pulse operations, the Aeration Facility was turned back on Tuesday, September 16, 2008 at about 10:00 a.m. discharging a dissolved oxygen (DO) level in the mid 30 mg/l range. The system will operate for 10 days, shutting down on Friday, September 26, 2008 at about 10:00 a.m. The 10 day operation will allow longitudinal surveys at the high-high tide to be conducted after 2, 4, 6, 8, and possibly 10 days to further monitor the spatial effects on DO in the Stockton Deep Water Ship Channel. Longitudinal surveys have already been performed after 2, 4, 6, 8, and 10 days for the low-low tide.

18. September 26, 2008

As a part of on-going pulse operations, the Aeration Facility was turned off Friday, September 26, 2008 at about 10:00 a.m. after 10 days of operation. The system will be off for 10 days and started back up on Monday, October 6, 2008. Additional longitudinal surveys to monitor the spatial effects on DO in the DWSC will be performed after the system is off. Flows in the San Joaquin River at Vernalis are scheduled to increase beginning Wednesday, October 1, 2008 to meet water quality objectives for fish and wildlife beneficial uses. It appears the Head of Old River Barrier is scheduled to be installed next week.

19. October 3, 2008

The Aeration Facility was turned off Friday, September 26, 2008 at about 10:00 a.m. after 10 days of operation. The system was scheduled to be off for 10 days and started back up on Monday, October 6, 2008. The system will tentatively remain off for another week so that the effects of increased flows to meet water quality objectives in the San Joaquin River as well as the installation of the Head of Old River Barrier can be observed. The Head of Old River Barrier should be fully installed sometime next week. An update will be provided when the Aeration Facility is turned back on.

20. October 17, 2008

The Aeration Facility has been off since Friday, September 26, 2008. With dissolved oxygen (DO) levels in the Stockton Deep Water Ship Channel well above the water quality objective of 6.0 mg/l, the system will remain off. The effects of increased flows to meet water quality objectives in the San Joaquin River as well as the installation of the Head of Old River Barrier that was completed on Thursday, October 16, 2008 should keep DO levels up. If DO levels decrease to the water quality objective level, the system will be turned back on for additional testing. An update will be provided when that occurs.