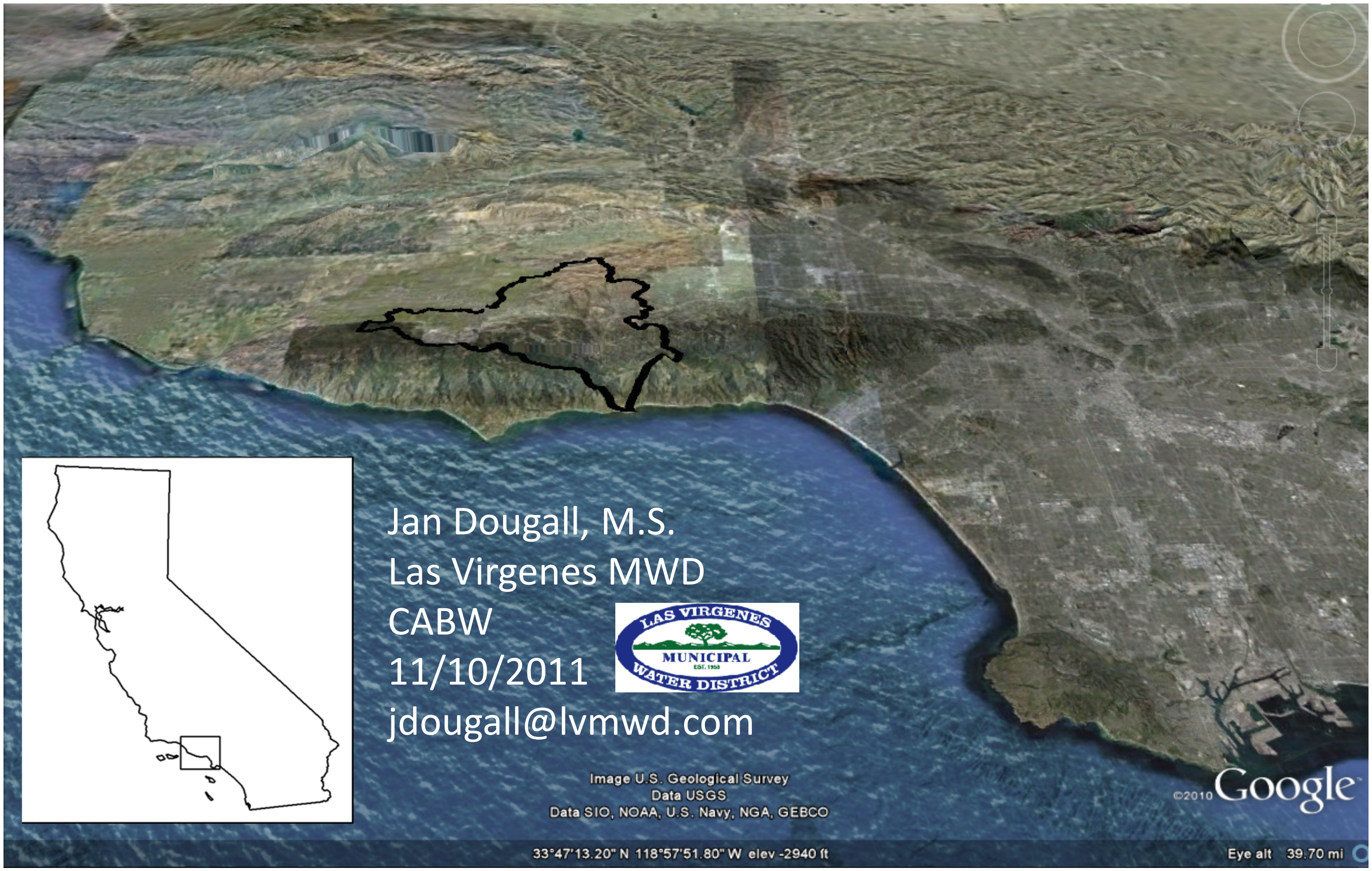
Malibu Creek watershed as an outlier on Water Quality and Macroinvertebrate IBI Scores



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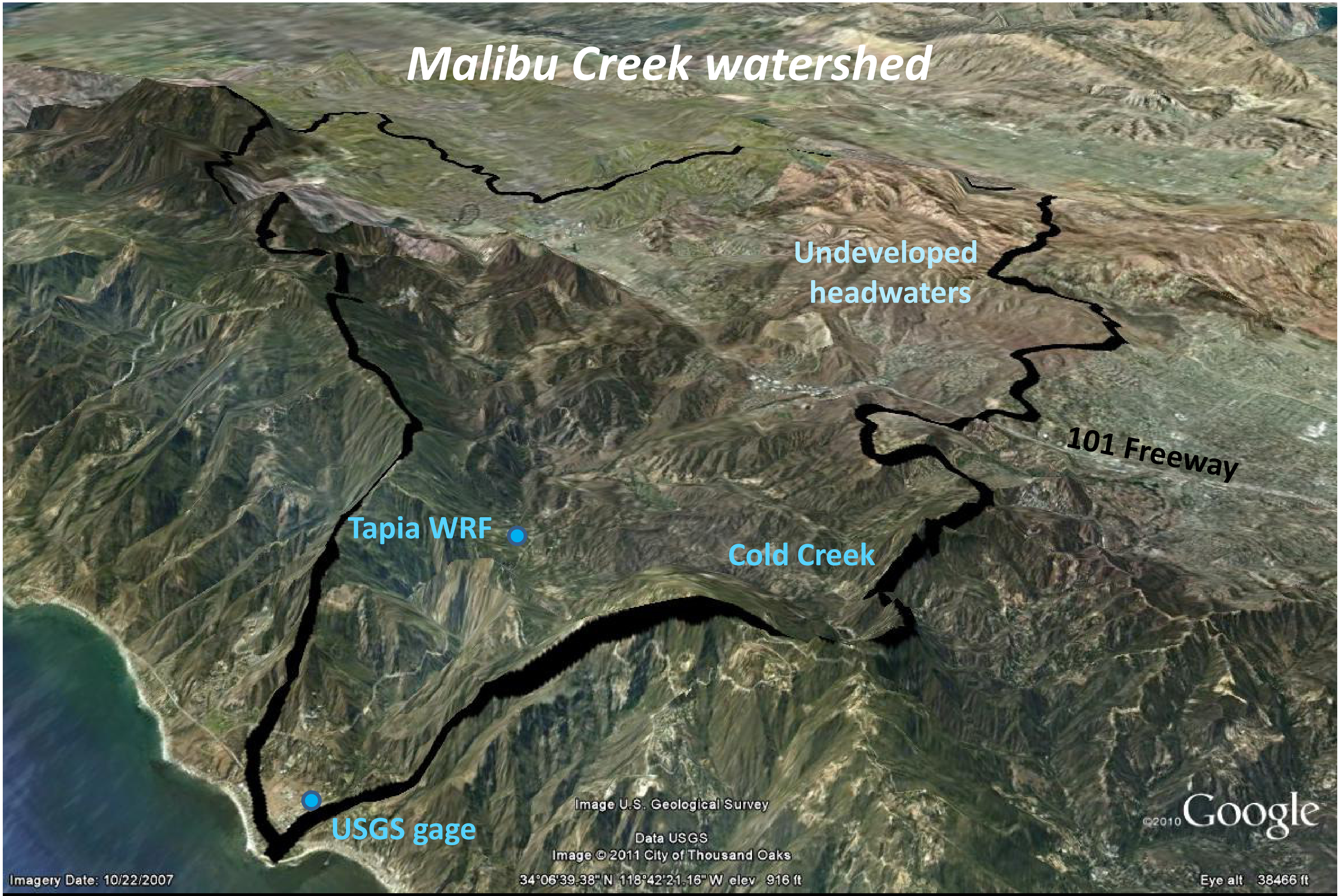
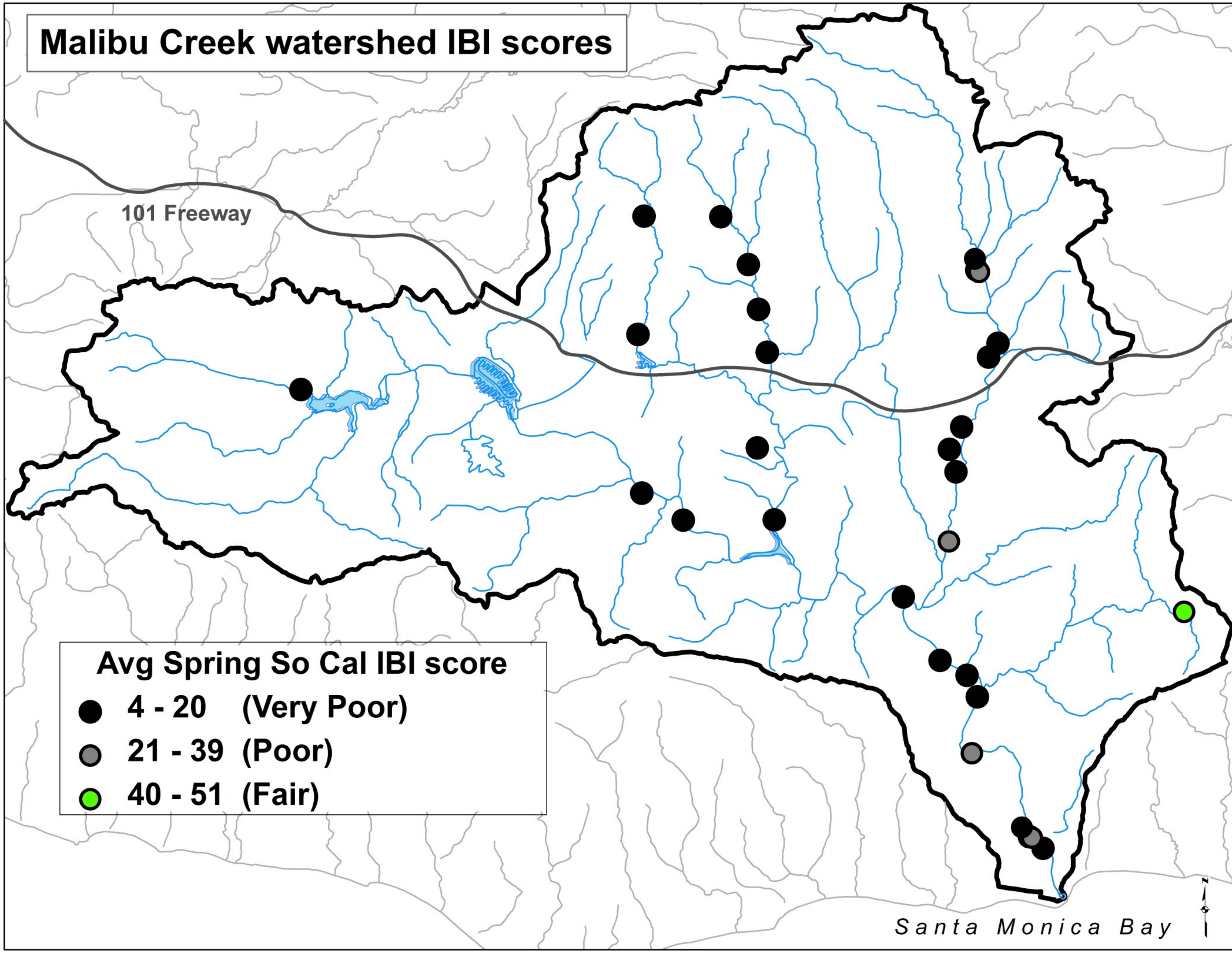
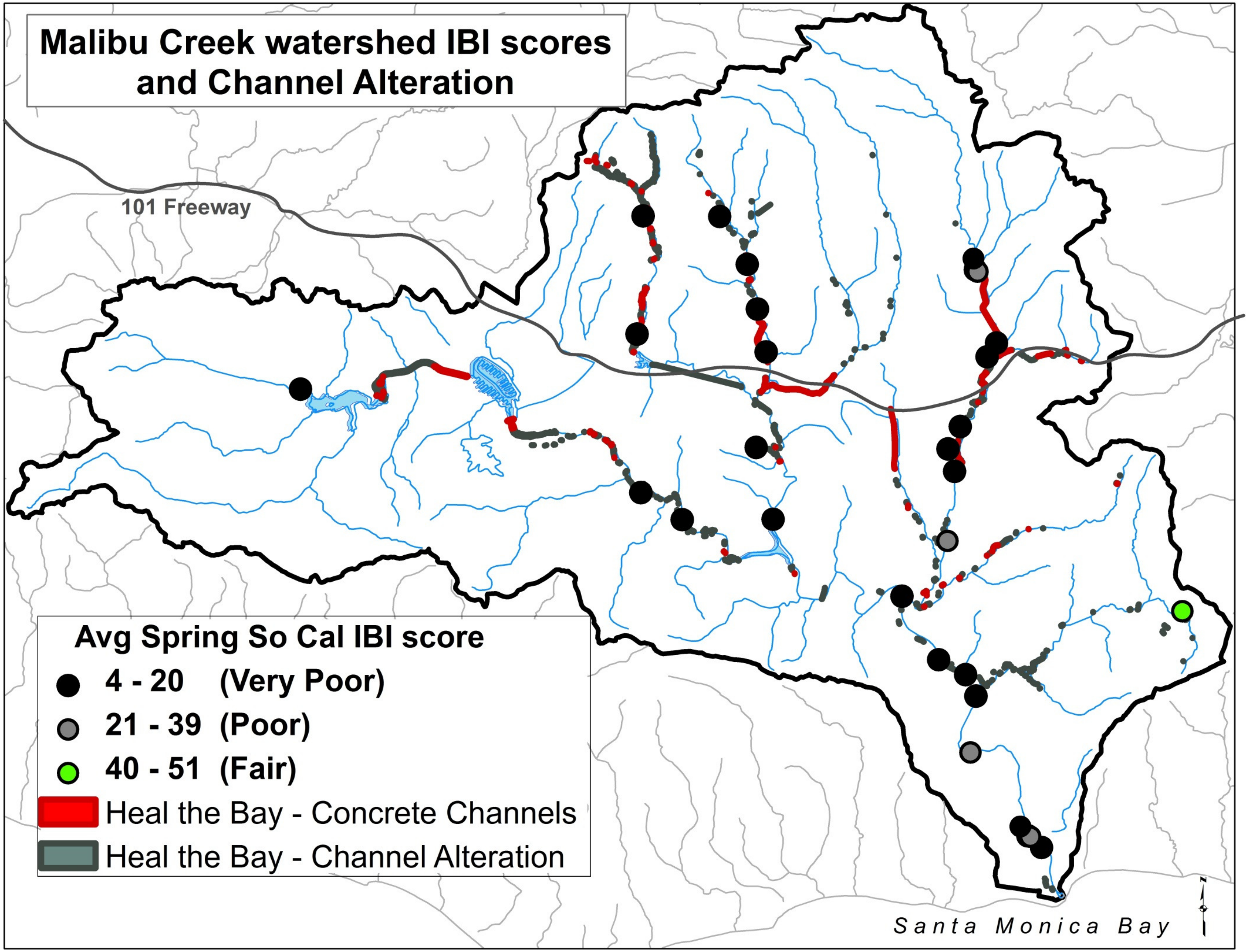
Outline

1. Malibu Creek watershed has five 303(d) listings for Benthic Macroinvertebrate Bioassessments
   - The EPA must establish a TMDL by March 24, 2013, so will select their own criteria and target
2. Causes of impairment could be
   - hydromodification,
   - mineral water quality from geologic sources,
   - man-made pollutants, or
   - Seasonality of flow
3. How can anthropogenic effects be distinguished from natural?

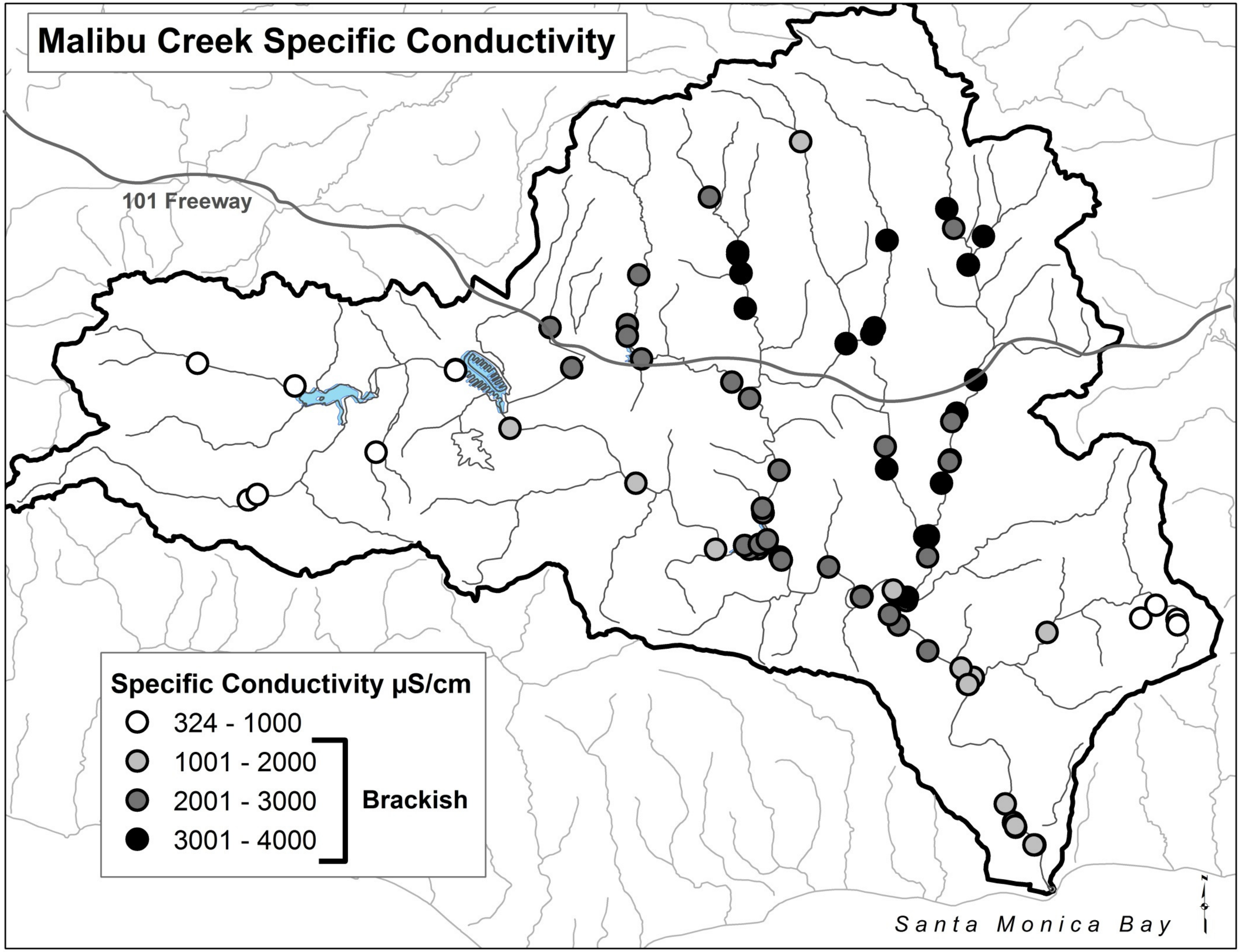

Malibu Creek watershed
Undeveloped headwaters
101 Freeway
Tapia WRF
Cold Creek
USGS gage
Image U.S. Geological Survey
Data USGS
Image © 2011 City of Thousand Oaks
Imagery Date: 10/22/2007
34°06'39.38" N 118°42'21.16" W elev 916 ft
Eye alt 38466 ft
©2010 Google



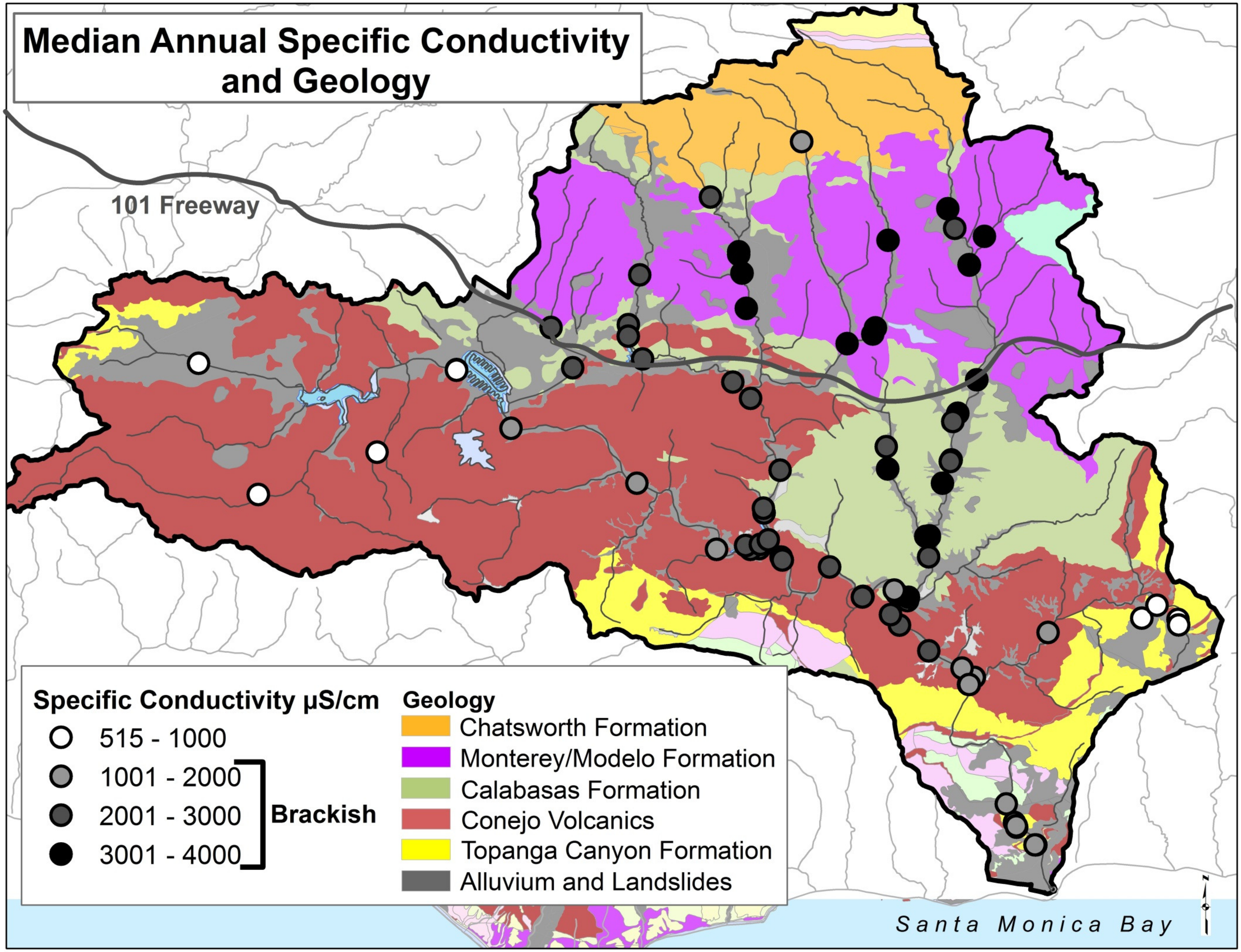
Malibu Creek watershed IBI scores
101 Freeway
Avg Spring So Cal IBI score
4 - 20 (Very Poor)
21 - 39 (Poor)
40 - 51 (Fair)
Santa Monica Bay



Malibu Creek watershed IBI scores and Channel Alteration
101 Freeway
Avg Spring So Cal IBI score
4 - 20 (Very Poor)
21 - 39 (Poor)
40 - 51 (Fair)
Heal the Bay - Concrete Channels
Heal the Bay - Channel Alteration
Santa Monica Bay



Malibu Creek Specific Conductivity
101 Freeway
Specific Conductivity µS/cm
324 - 1000
1001 - 2000
2001 - 3000
3001 - 4000
Brackish
Santa Monica Bay



Median Annual Specific Conductivity and Geology
101 Freeway
Specific Conductivity µS/cm
515 - 1000
1001 - 2000
2001 - 3000
3001 - 4000
Brackish
Geology
Chatsworth Formation
Monterey/Modelo Formation
Calabasas Formation
Conejo Volcanics
Topanga Canyon Formation
Alluvium and Landslides
Santa Monica Bay

Hazardous Trace Elements in Petroleum Source Rocks

Monterey Formation

The major petroleum source rock of California, the Miocene Monterey Formation is widely regarded as one of the world's classic petroleum source rocks and the origin of most of the oil in California's giant oil fields.

http://energy.cr.usgs.gov/TraceElements/monterey.html

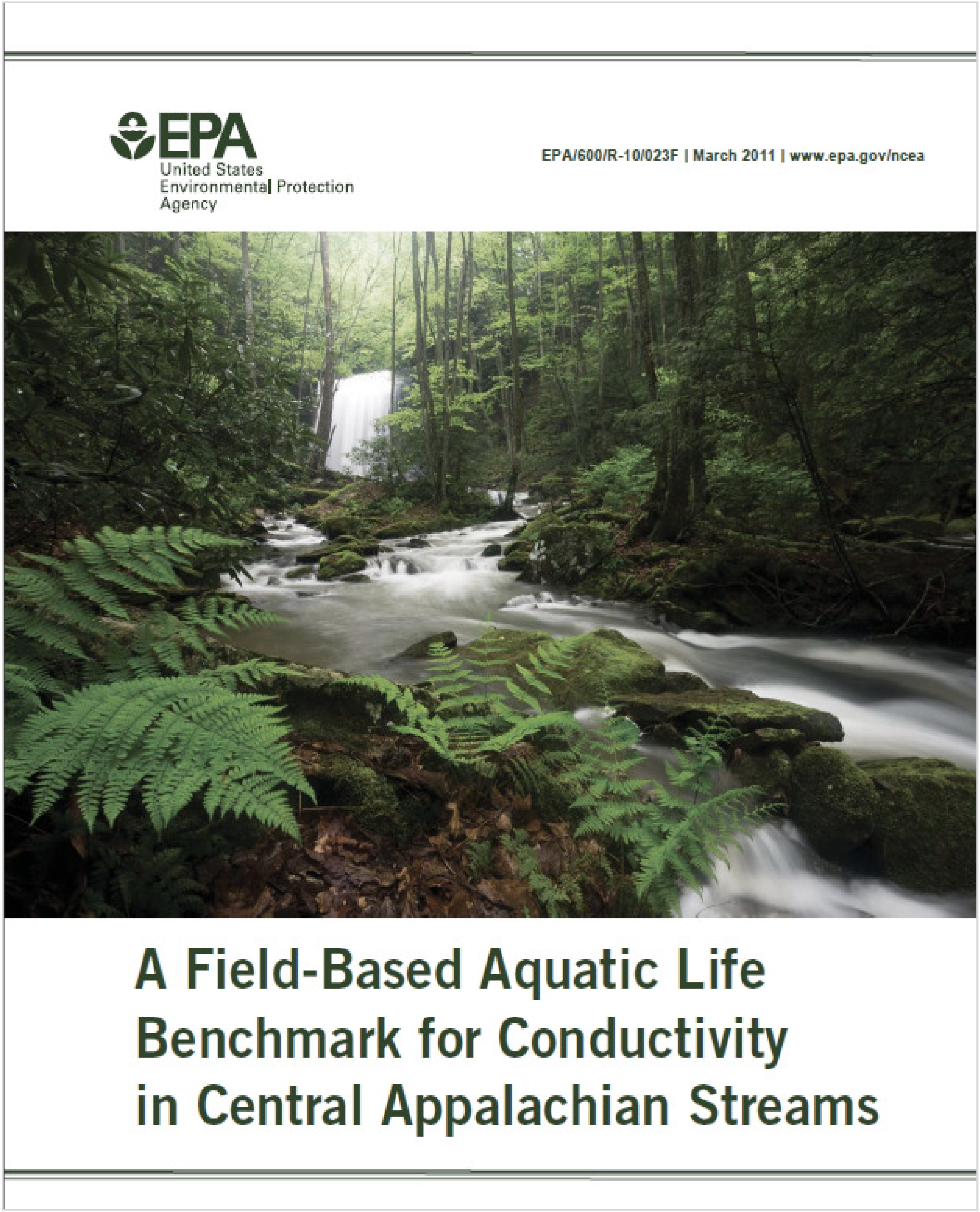
Element	Average Shale (WSA)*	Organic-carbon-rich Monterey Formation*	Relative Enrichment Factor
Silver	0.07	2.1	30
Bromine	4	75	19
Cadmium	0.3	16.5	55
Chromium	90	310	3
Copper	45	103	2
Molybdenum	2.6	38.5	15
Nickel	68	267	4
Antimony	1.5	10.3	7
Selenium	***0.6***	***30.5***	***51***
Uranium	3.7	20.8	6
Vanadium	130	564	4
Zinc	95	335	4

Mean Range Number of samples	EPA Mined Sites	EPA Unmined Sites	Malibu Creek watershed	Malibu Northern tributaries	Malibu Lower Creek
Specific Cond. (µS/cm)	**1023** 159-2540 27	**62** 34-133 10	**2362** 66-9240 2,397	**3046** 71-9240 1,203	**1916** 750-3690 285
Potassium (mg/L)	**9.9** (3-19) 13	**1.6** (1.3-2) 7	Only collected in North	**9.4** (2.0-23.8) 97	No Data
Bicarbonate alkalinity (mg/L)	**183** (10.7-501.8) 13	**20.9** (6.1-3.5) 7	Only collected in North	**454** (250-1000) 97	No Data
Magnesium (mg/L)	**122.4** (28-248) 13	**4.3** (2.3-7) 7	Only collected in North	**172** (104-234) 78	No Data
Chloride (mg/L)	**4.6** (<2.5-11) 13	**2.8** (<2.5-4) 7	**159** (20-325) 395	**188** (92-325) 149	**146** (78-196) 114
Sulfate (mg/L)	**695.5** (155-1520) 13	**16** (11-21.6) 7	**949** (16-2300) 358	**1524** (901-2300) 124	**609** (264-2050) 108

EPA Study:

Downstream effects of mountaintop coal mining: comparing biological conditions using family and genus level macroinvertebrate bioassessment tools **Pond et al. (2008)**

Mount et al. (1997) reported relative major ion toxicity as **K > HCO3 ≈ Mg > Cl > SO4**

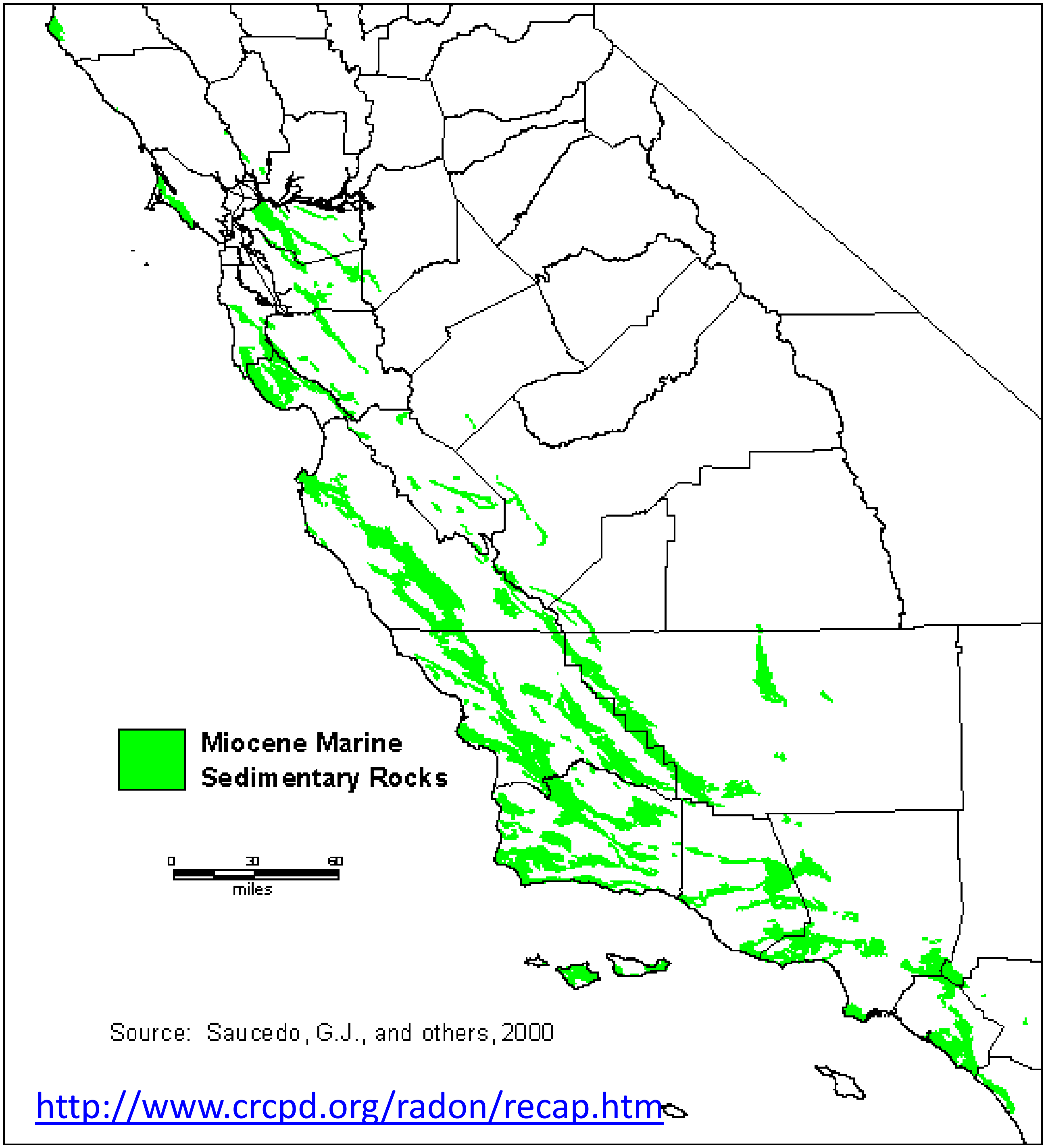

EPA United States Environmental Protection Agency

EPA/600/R-10/023F | March 2011 | www.epa.gov/ncea

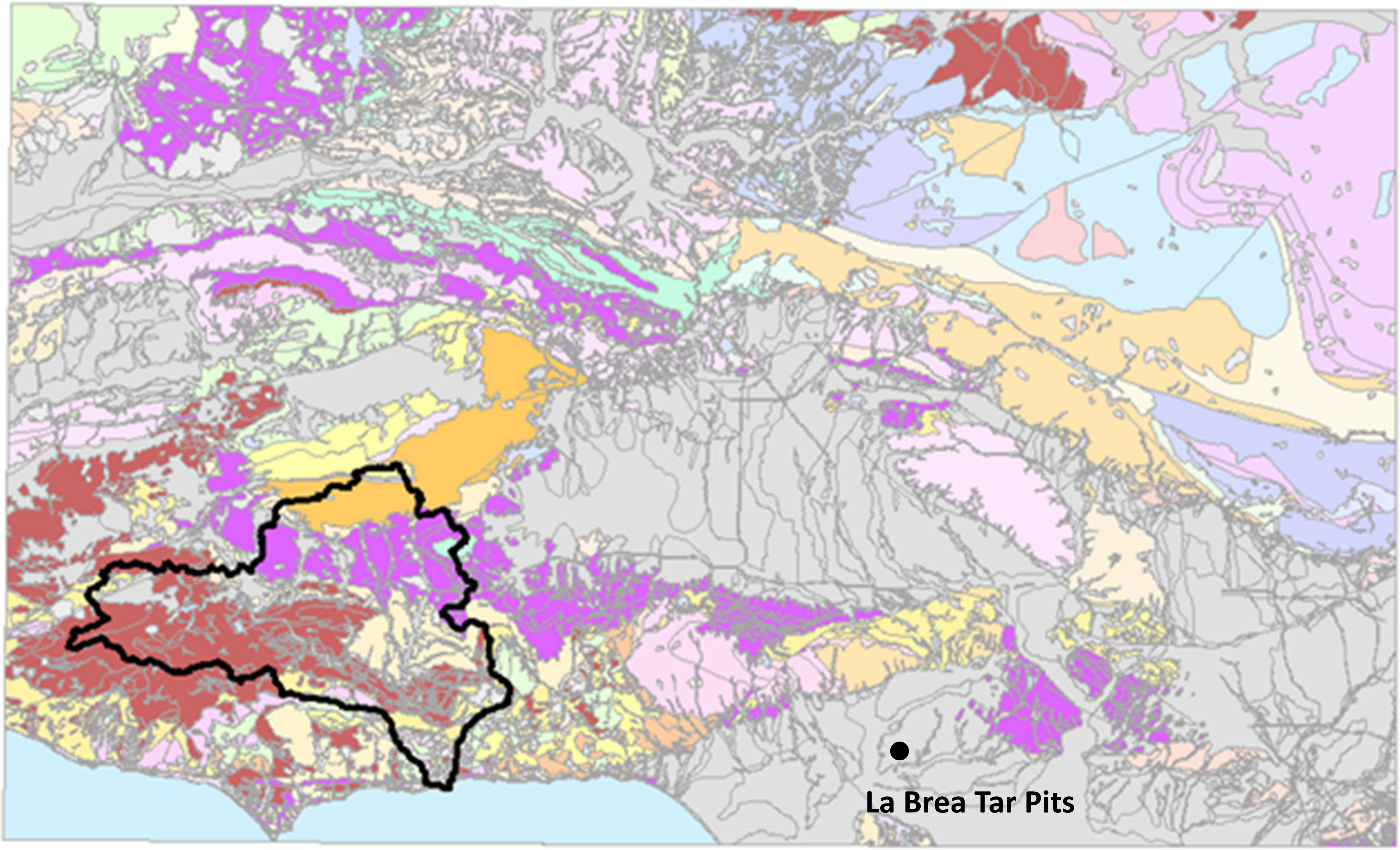
A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams

“The chronic aquatic life benchmark value for conductivity derived from all-year data from West Virginia is 300 µS/cm.”

http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=233809



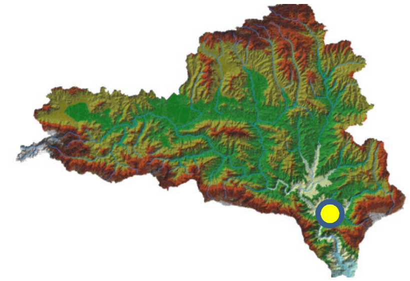
http://www.crcpd.org/radon/recap.htm



7.5% of the L.A. area has surface geology that may be enriched: Monterey, Modelo, Puente and Rincon Formations

http://pubs.usgs.gov/of/2005/1019/

California Toxics Rule (CTR) test results

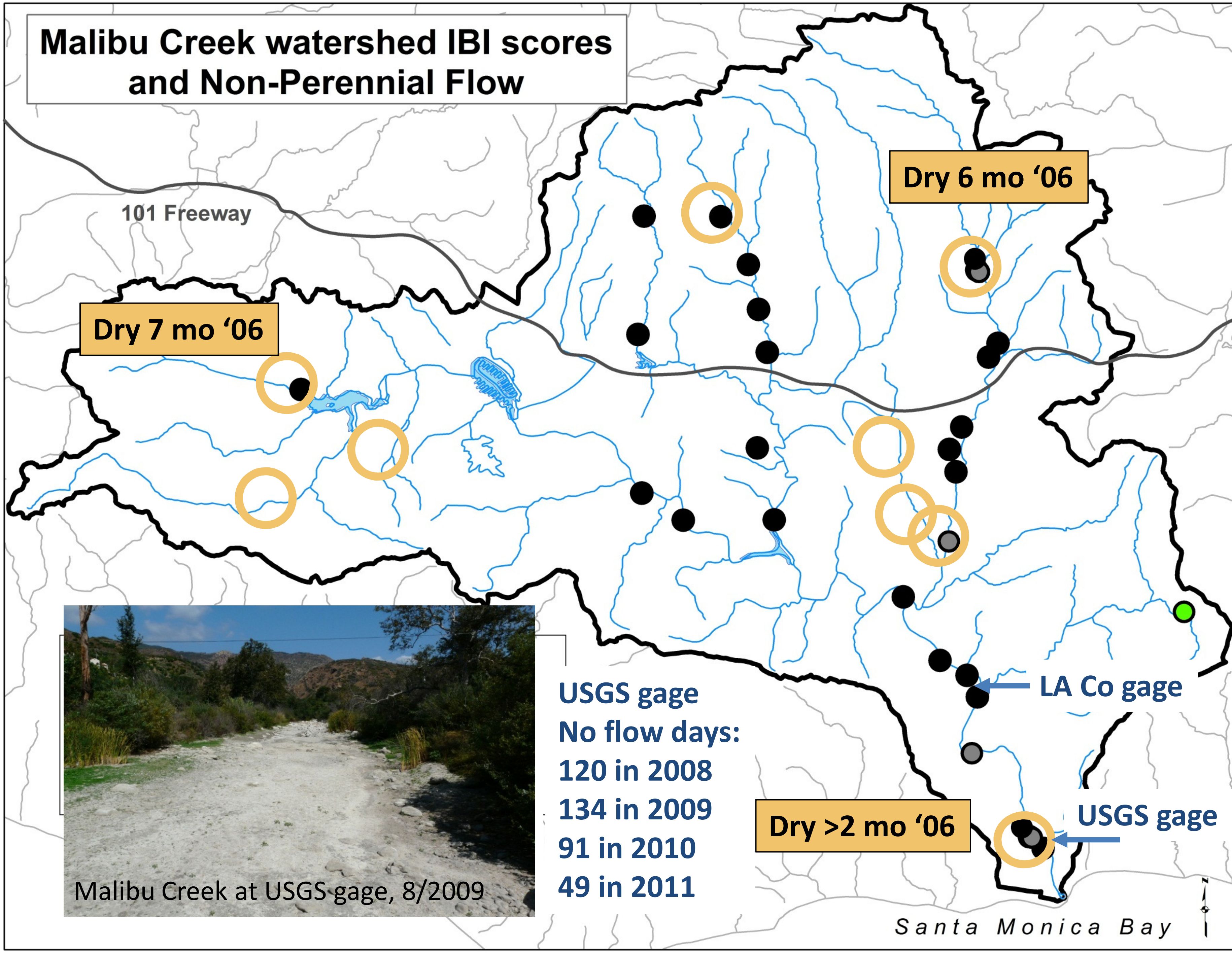


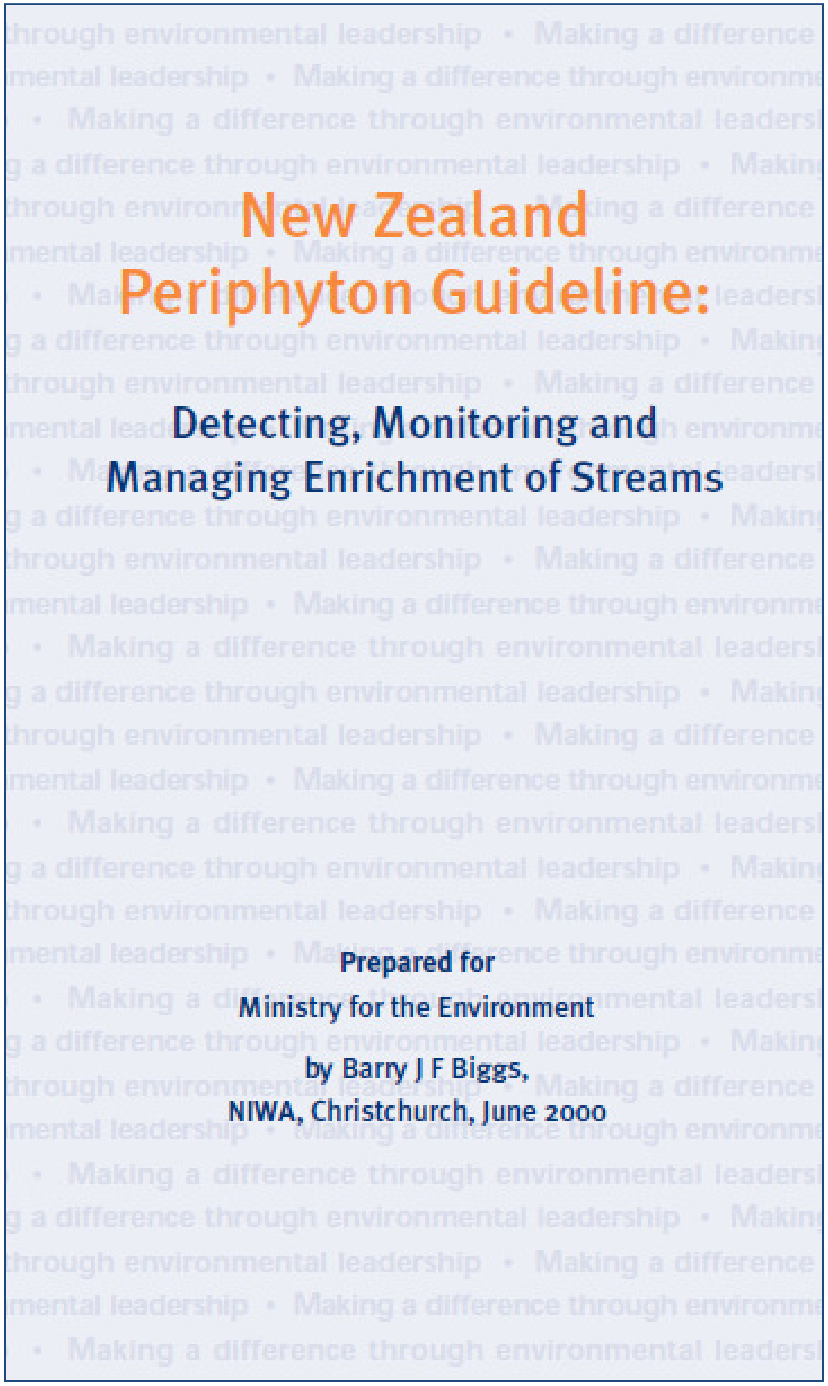
Detected Not Detected

Volatile organic compounds | Semi-volatile organic compounds | Metals | Pesticides

Pollutant ID	Constituent	US EPA Method Used	MDL (µg/L)	07-19-01	08-02-01	09-20-01	10-09-01	11-13-01	12-11-01	01-22-02	02-12-02	03-12-02	04-16-02	05-07-02	06-04-02	07-09-02	08-07-02	09-10-02	10-08-02	11-05-02	12-03-02
VOLATILE POLLUTANTS			Season →																		
34496	1,1 Dichloroethane	8260B	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34501	1,1 Dichloroethylene		0.28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34506	1,1,1 Trichloroethane		0.26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34511	1,1,2 Trichloroethane		0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34516	1,1,2,2 Tetrachloroethane		0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34536	1,2 Dichlorobenzene		0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32103	1,2 Dichloroethane		0.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34541	1,2 Dichloropropane		0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34566	1,3 Dichlorobenzene		0.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34561	1,3 Dichloropropylene		0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34571	1,4 Dichlorobenzene		0.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34210	Acrolein		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34215	Acrylonitrile		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34030	Benzene		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32104	Bromoform		0.41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34413	Methyl Bromide		0.32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32102	Carbon Tetrachloride		0.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34301	Chlorobenzene		0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34306	Chlorodibromo-methane		0.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85811	Chloroethane		0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32106	Chloroform		0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32101	Dichlorobromo-methane		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34418	Methylene Chloride		0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78113	Ethylbenzene		0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34475	Tetrachloroethylene		0.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34010	Toluene		0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34549	1,2-Trans Dichloroethylene		0.21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39180	Trichloroethylene		0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39175	Vinyl Chloride		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEMI – VOLATILE POLLUTANTS																					
34526	Benzo (a) Anthracene	8270C	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34536	1,2 Dichlorobenzene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34346	1,2 Diphenylhydrazine		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34551	1,2,4 Trichlorobenzene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34566	1,3 Dichlorobenzene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34571	1,4 Dichlorobenzene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34586	2 Chlorophenol		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34601	2,4 Dichlorophenol		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34606	2,4 Dimethylphenol		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34616	2,4 Dinitrophenol		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34611	2,4 Dinitrotoluene		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34624	2,4,6 Trichlorophenol		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34626	2,6 Dinitrotoluene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34591	2-Nitrophenol		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34576	2-Chloroethyl vinyl ether		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34581	2-Chloronaphthalene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34631	3,3' Dichlorobenzidine		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34230	Benzo (b) Fluoranthene		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3-Methyl-4-Chlorophenol		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3615	2-Methyl-4,6-Dinitrophenol		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34646	4-Nitrophenol		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34636	4-Bromophenyl phenyl ether		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34641	4-Chlorophenyl phenyl ether		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34205	Acenaphthene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34200	Acenaphthylene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34220	Anthracene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39120	Benzidine		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34247	Benzo (a) Pyrene		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34521	Benzo (g,h,i) Perylene		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34242	Benzo (k) Fluoranthene		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34278	Bis (2-Chloroethoxyl) methane		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34273	Bis(2-Chloroethyl) ether		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34283	Bis(2-Chloroisopropyl) ether		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39100	Bis(2-Ethylhexyl) phthalate		0.5	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
34292	Butyl benzyl phthalate		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34320	Chrysene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39110	di-n-Butyl phthalate		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34596	di-n-Octyl phthalate		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34556	Dibenzo(a,h)-anthracene		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34336	Diethyl phthalate		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34341	Dimethyl phthalate		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34376	Fluoranthene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34381	Fluorene		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34386	Hexachloro-cyclopentadiene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39700	Hexachlorobenzene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39702	Hexachlorobutadiene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34396	Hexachloroethane		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34403	Indeno(1,2,3,cd)-pyrene		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34408	Isophorone		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34433	N-Nitrosodiphenyl amine		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34438	N-Nitrosodimethyl amine		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34428	N-Nitroso-di-n-propyl amine		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34696	Naphthalene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34447	Nitrobenzene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39032	Pentachlorophenol		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34461	Phenanthrene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34694	Phenol		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34469	Pyrene		0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INORGANICS																					
948	Asbestos	100.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1097	Antimony (Sb)	200.8	0.43	0	0	0	0.9	0.8	0.6	0.8	0.6	0.7	0	0.6	0.7	0	0.6	0	0.8	0	0.8
1000	Arsenic (As-III)		0.05	2.1	2	0	3	2	0	0	0	0	0	0	2	2	0	2	0	3	0
1012	Beryllium (Be)		0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1027	Cadmium (Cd)		0.04	0	0	0.2	0.7	0.8	0.3	0.2	0.4	0.3	0	0.3	0	0.5	0	0.2	0.3	0.2	0.4
1033	Chromium-III (Cr-III)		0.14	0	0	1.2	2	3	1	1	1	3	2	0	1	0	2	1	0	3	1
1119	Copper (Cu)		0.08	2.7	11.1	1.2	4	11	4	5	4	7	5	5	4	6	4	4	13	21	14
1051	Lead		0.03	0	0	0	0.9	1.5	0.3	0.7	0.4	0.5	0.3	0.2	0	3.6	0.4	0.2	0	1.5	2
1067	Nickel(Ni)		0.04	6.8	7.3	0	8	10	6	5	6	11	9	5	5	5	7	7	8	10	8
1147	Selenium(Se)		0.13	11	11	0	13	7	10	0	10	10	6	8	11	7	7	10	10	12	6
1077	Silver(Ag)		0.17	0	0	0.9	0.62	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1059	Thallium(Ti)		0.01	0	0	0	0.4	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0.4
1092	Zinc(Zn)		0.4	3.6	22	2.8	39	30	20	40	10	20	20	10	0	10	0	10	20	60	20
1032	Chromium VI (Cr-VI)	218.6	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71900	Mercury	245.1	0.05	0	0	0	0	0.01	0	0	0.04	0.01	0	0	0	0.01	0.01	0	0.1	0	0
720	Cyanide(CN)	335.2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PESTICIDES																					
39310	4,4'-DDD	8081A	0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39320	4,4'-DDE		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39300	4,4'-DDT		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78428	Alpha-Endosulfan		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39336	Alpha-BHC		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39330	Aldrin		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34356	Beta-Endosulfan		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39338	beta-BHC		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39350	Chlordane		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34198	delta-BHC		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39380	Dieldrin		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34351	Endosulfan Sulfate		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39390	Endrin		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34366	Endrin Aldehyde		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39410	Heptachlor		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39420	Heptachlor Epoxide		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39340	gamma-BHC		0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4166	PCB 1016		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4166	PCB 1221		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4166	PCB 1232		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4166	PCB 1242		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4166	PCB 1248		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4166	PCB 1254		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4166	PCB 1260		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39400	Toxaphene		0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82698	TCDD	8280A				0			0												

Malibu Creek watershed IBI scores and Non-Perennial Flow





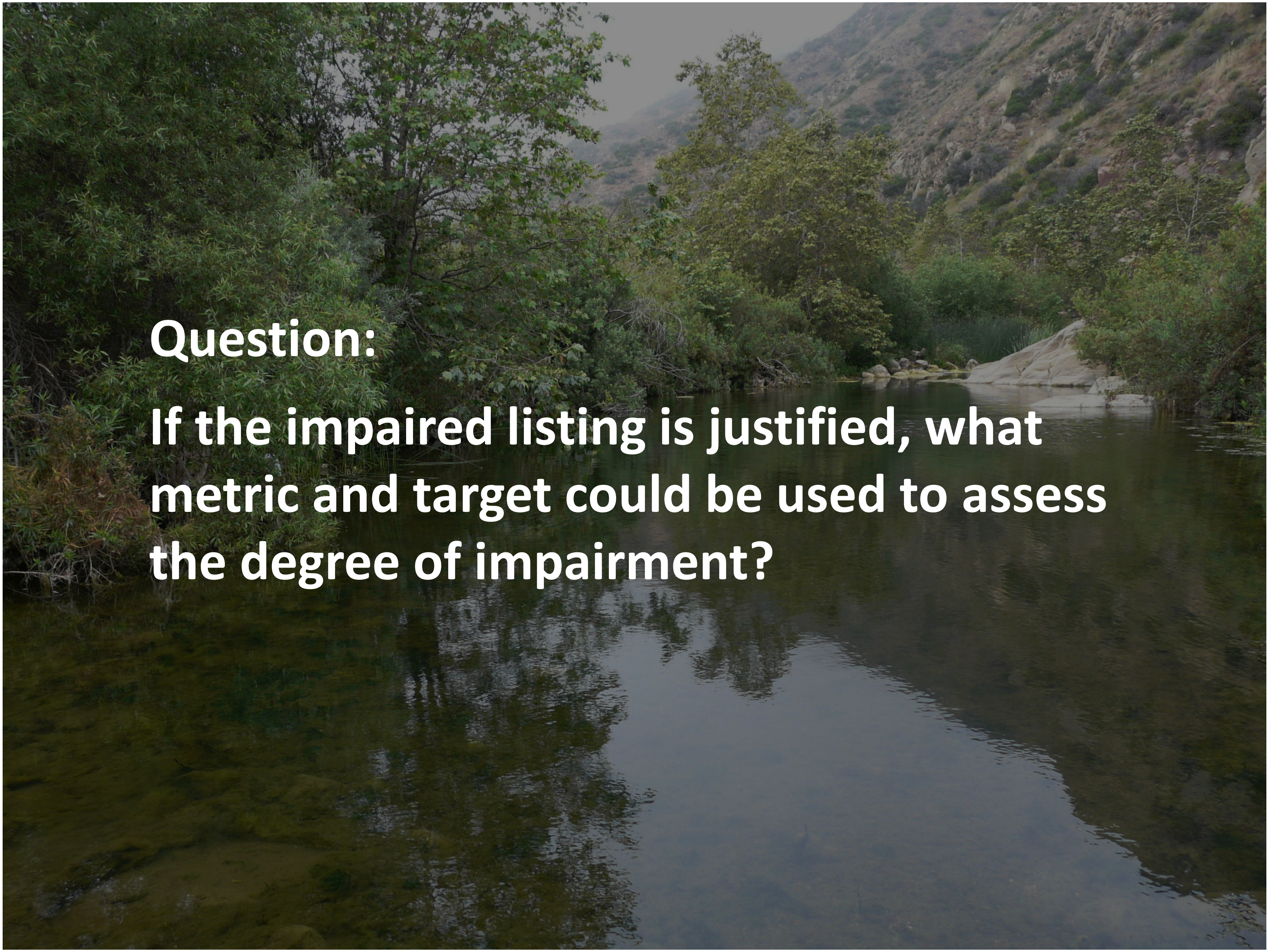
New Zealand Periphyton Guideline:

Detecting, Monitoring and Managing Enrichment of Streams

Prepared for
Ministry for the Environment
by Barry J F Biggs,
NIWA, Christchurch, June 2000

p. 53 … a large degree of natural enrichment occurs through leachate from nutrient rich rocks such as … Tertiary marine … siltstone … Indeed only small amounts of these rock types in a catchment can cause proliferations during low flows.

Figure 20: Proliferations of *Cladophora* in the Waipara River, North Canterbury downstream of seepage zones draining Tertiary marine sediments.


Question:
If the impaired listing is justified, what metric and target could be used to assess the degree of impairment?

WATER QUALITY IN THE MALIBU CREEK WATERSHED - CURRENT STATUS

Source: California Integrated §303(d) Report (2010)

	POLLUTANT / IMPAIRMENT →	Algae*	Ammonia	Eutrophic*	Nutrients (Algae)*	Odor*	Scum/Foam-unnatural*	Organic Enrichment/Low Diss. Ox.*	Coliform Bacteria	Indicator Bacteria	Viruses (enteric)	Swimming Restrictions	Trash	Benthic Community Effects	Benthic-Macroinvertebrate Bioassessments*	Chloride*	DDT (Dichlorodiphenyltrichloroethane)	Fish Barriers (Fish Passage)	Invasive Species	Lead	Mercury	Mercury (tissue)	PCBs	pH	Sedimentation/Siltation	Selenium*	Specific Conductivity*	Sulfates*	Total Listings per Creek
	Proposed Regulatory Remedies →	NUTRIENT TMDL							BACTERIA TMDL				TRASH TMDL	TMDLs PENDING															
STREAMS	Las Virgenes Creek				x		x	x	x				x		x				x						x	x			9
STREAMS	Lindero Creek Reach 1	x					x		x				x		x				x							x			7
STREAMS	Lindero Creek Reach 2	x					x		x				x													x			5
STREAMS	Malibu Creek				x		x		x				x		x			x	x						x	x		x	10
STREAMS	Medea Creek Reach 1	x							x				x												x	x			5
STREAMS	Medea Creek Reach 2	x							x				x		x				x						x	x			7
STREAMS	Palo Comado Creek								x																				1
STREAMS	Stokes Creek								x																				1
STREAMS	Triunfo Canyon Creek Reach 1																			x	x				x				3
STREAMS	Triunfo Canyon Creek Reach 2														x					x	x				x				4
LAKES	Lake Lindero	x		x		x							x			x										x	x		7
LAKES	Lake Sherwood	x	x	x				x														x							5
LAKES	Malibou Lake	x		x				x																					3
LAKES	Westlake Lake	x	x	x				x												x									5
BEACH	Malibu Beach									x							x												2
BEACH	Malibu Lagoon Beach (Surfrider)								x								x						x						3
LAGOON	Malibu Lagoon			x					x		x	x		x										x					6
	Total listings in the watershed	8	2	5	2	1	4	4	10	1	1	1	7	1	5	1	2	1	4	3	2	1	1	1	6	7	1	1	83

* Probable natural source (Monterey Formation)

Extra slide: Regulatory Context

1997 – EPA sued for failure to implement TMDLs in LA Region

1998 - Federal Consent Decree – 92 pollutant - water body combinations scheduled for TMDLS

2009 – Benthic Macroinvertebrate listing for Malibu Creek added to the 303(d) list

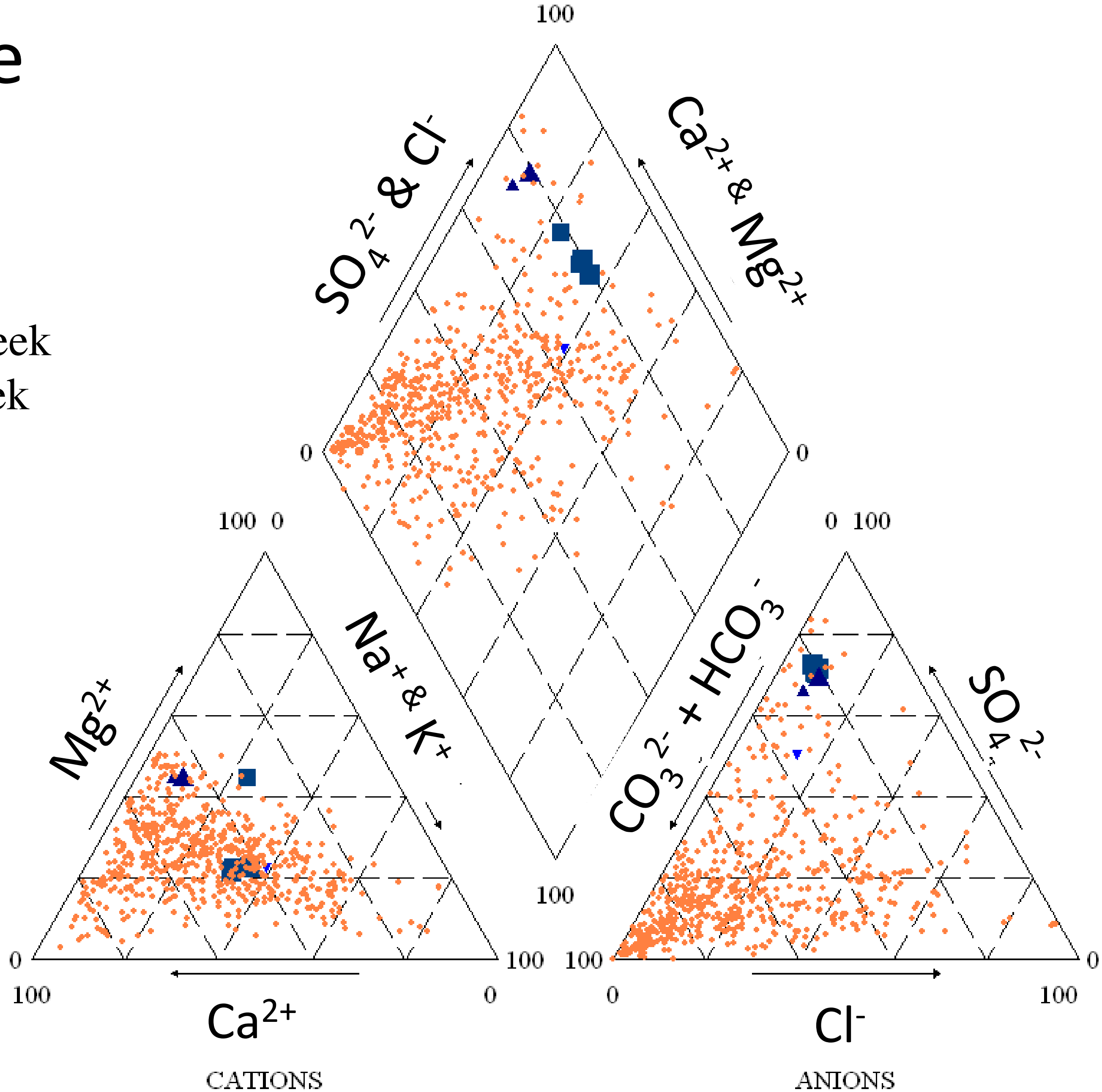
2010 – Consent Decree amended with deletions and additions, including:

- Malibu Creek Benthic Macroinvertebrate Bioassessments
- Malibu Creek Sedimentation and Siltation

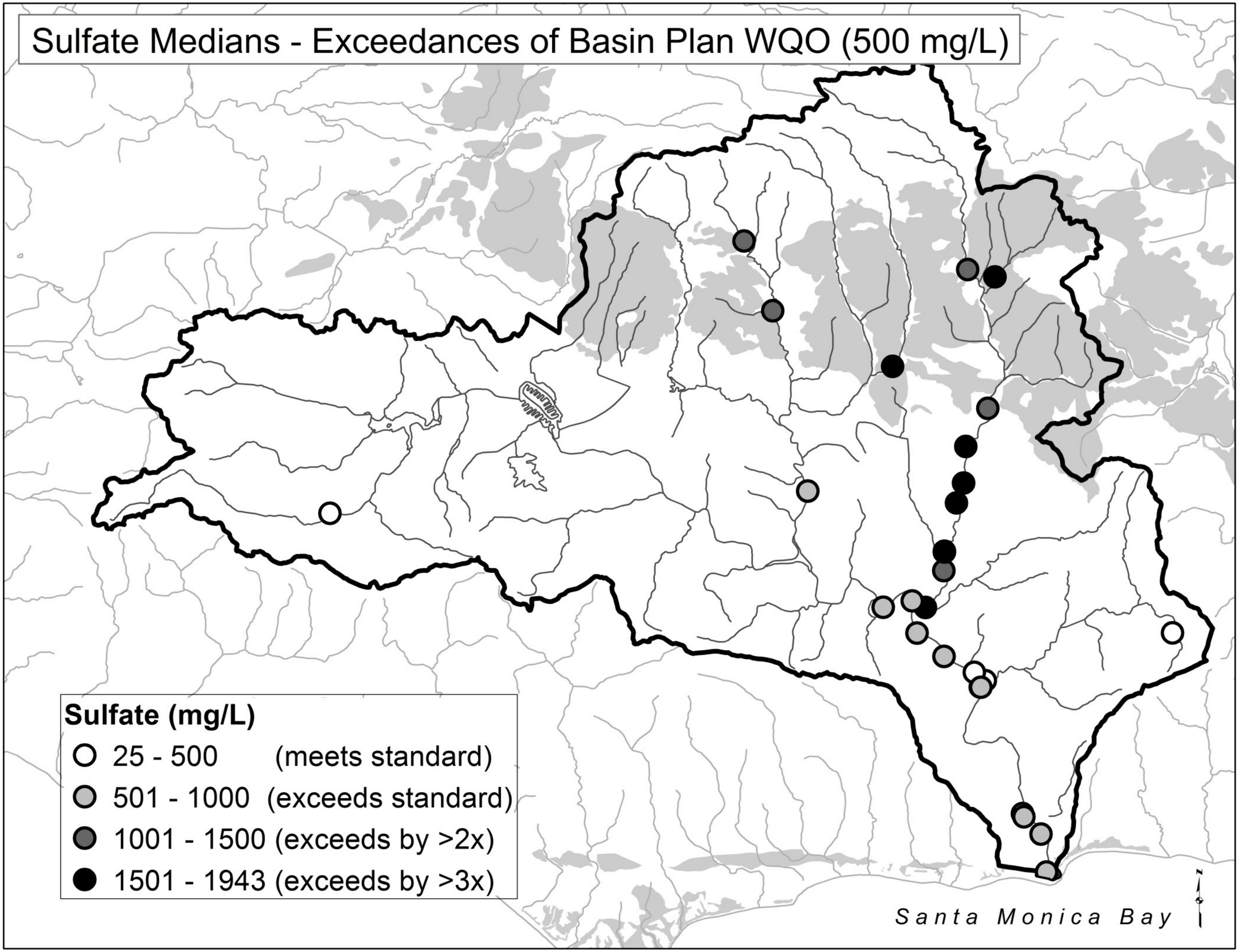
March 24, 2013 – EPA's TMDL implementation deadline

Ion Balance

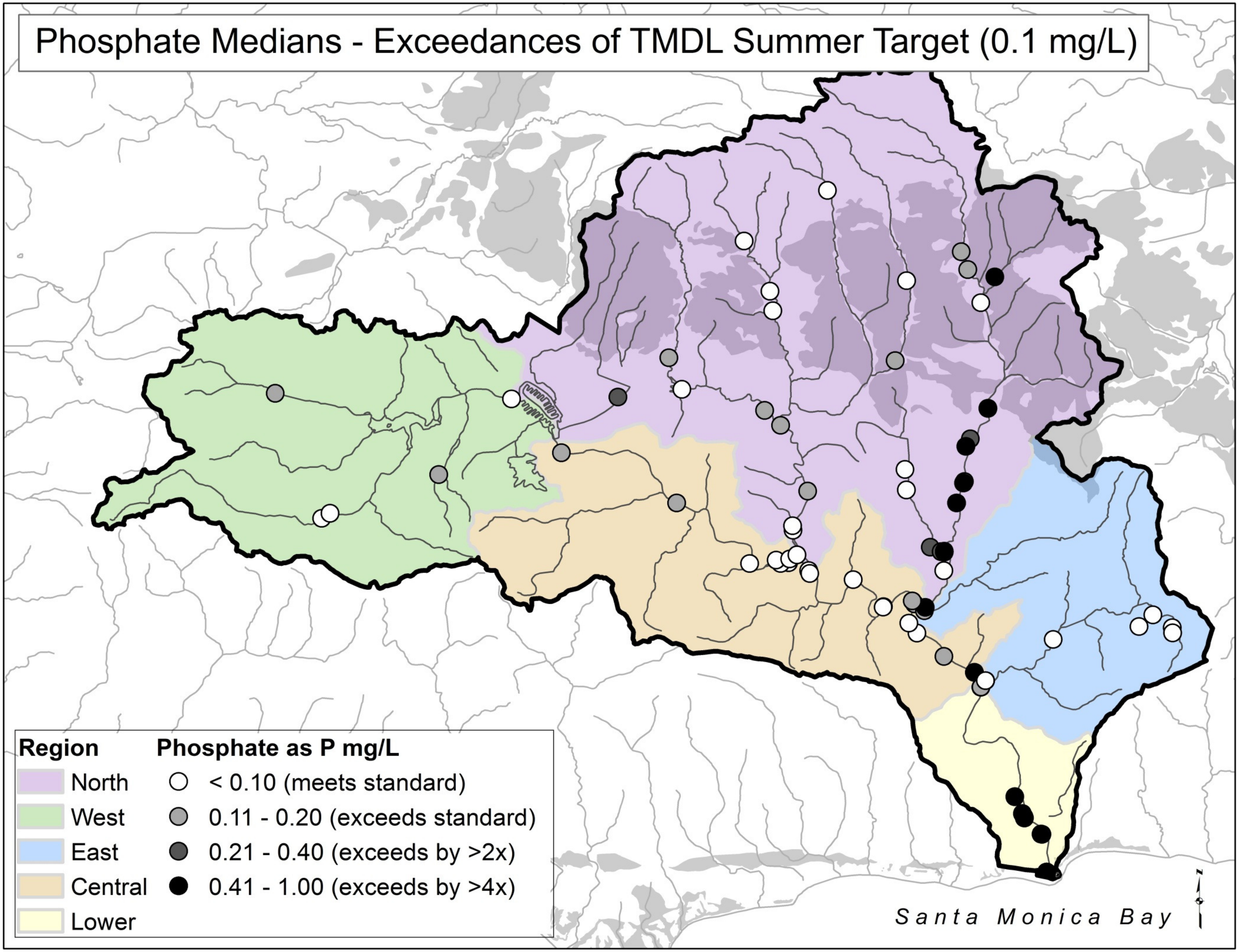
Key
NAWQA data
Las Virgenes Creek
Cheeseboro Creek
Malibu Creek



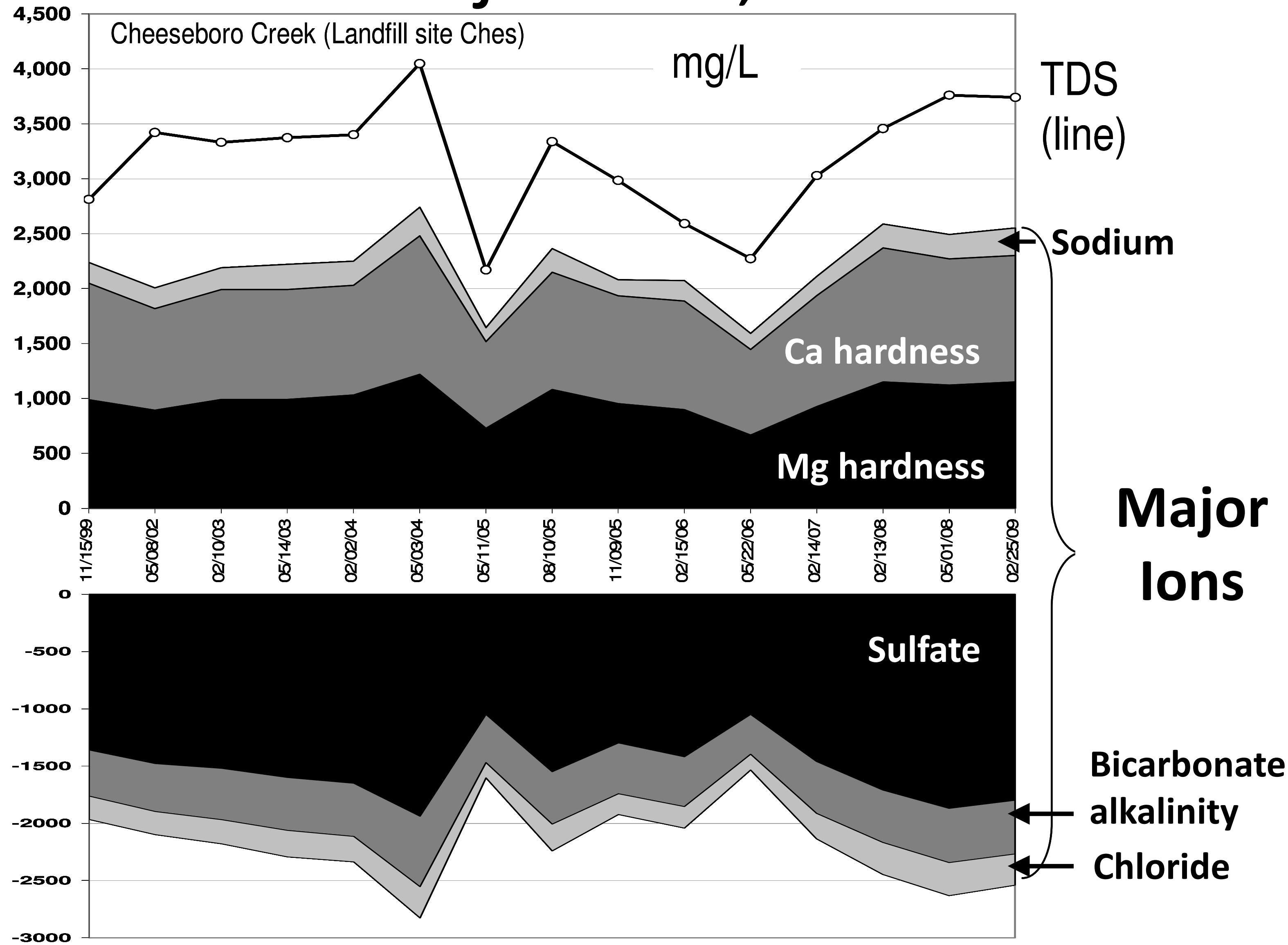
http://infotrek.er.usgs.gov/nawqa_map/

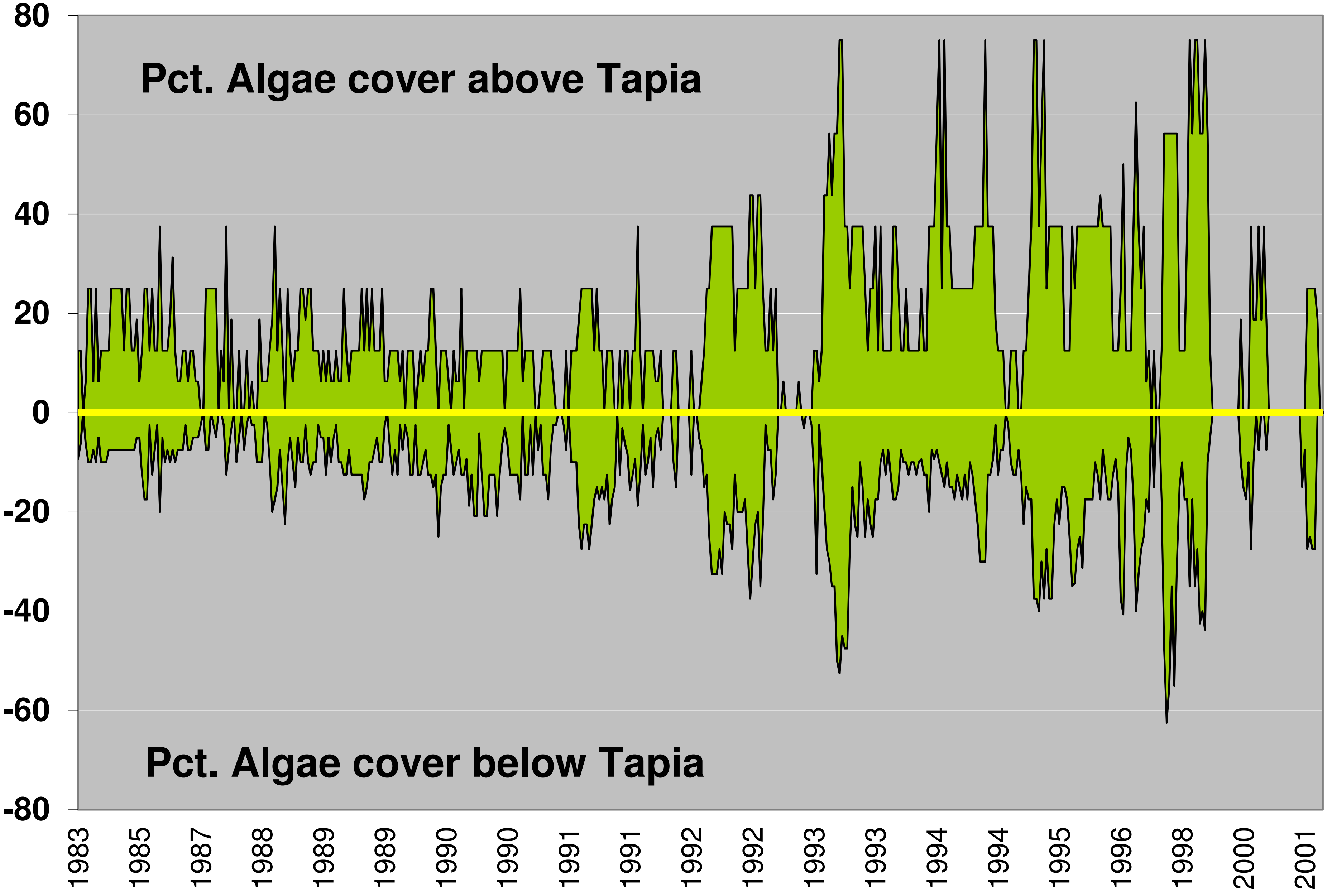


Sulfate Medians - Exceedances of Basin Plan WQO (500 mg/L)
Sulfate (mg/L)
25 - 500 (meets standard)
501 - 1000 (exceeds standard)
1001 - 1500 (exceeds by >2x)
1501 - 1943 (exceeds by >3x)
Santa Monica Bay
N

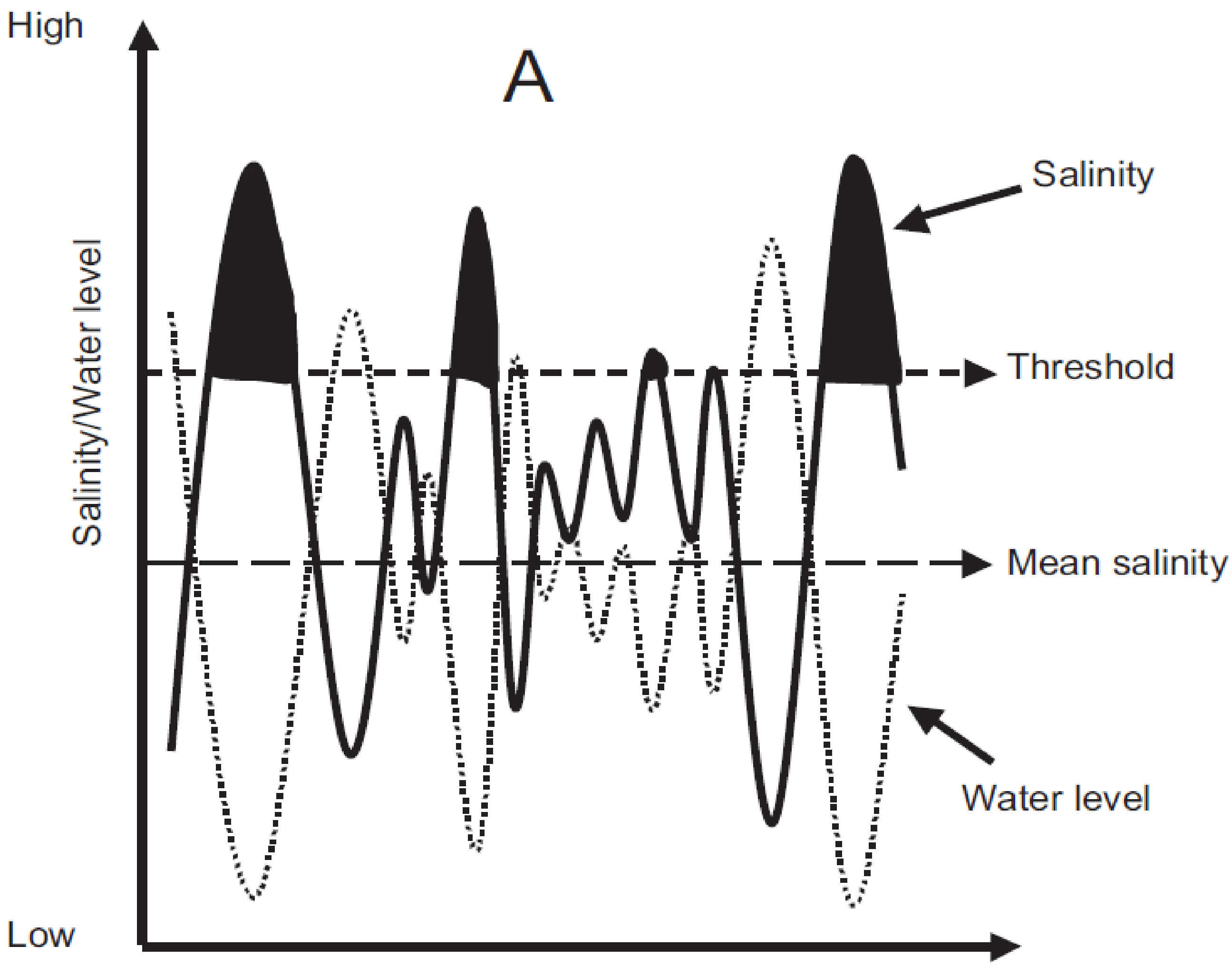

Phosphate Medians - Exceedances of TMDL Summer Target (0.1 mg/L)
Region
North
West
East
Central
Lower
Phosphate as P mg/L
< 0.10 (meets standard)
0.11 - 0.20 (exceeds standard)
0.21 - 0.40 (exceeds by >2x)
0.41 - 1.00 (exceeds by >4x)
Santa Monica Bay

Why are SC and TDS so high?
Extra slide: Major ions, Cheseboro site





Pct. Algae cover above Tapia
Pct. Algae cover below Tapia
80
60
40
20
0
-20
-40
-60
-80
1983
1985
1987
1988
1989
1989
1990
1990
1991
1991
1992
1992
1993
1993
1994
1994
1995
1996
1998
2000
2001



Nielsen et al. (2003) Effects of increasing salinity on freshwater ecosystems in Australia

"aquatic biota will be adversely affected as salinity exceeds 1000 mg/L (1500 µS/cm)" – citing Hart et al. 1991