

Geology, Water Quality and Aquatic Life in Malibu Creek: An Unusually Severe Example of Geologic Impacts*

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Abstract

This presentation provides an update to earlier work on geologic influences on water quality in Malibu Creek, one of California's saltiest creeks. Recent large-scale surveys of aquatic life and water quality in California and southern California streams in both natural and urban settings have enabled quantitative estimates of the relative influence of geologically-relevant factors on both stream chemistry and aquatic life in Malibu Creek. These estimates include not only general parameters such as overall salt levels (i.e. spec. conductance), but also estimates of the impact on aquatic life of specific major ions such as sulfate, phosphate, and nitrate. These factors and their impacts vary seasonally in Malibu Creek, as the watershed transitions each year from rain and surficial runoff dominated flows in winter (SC ~ 1,500 µS/cm) to groundwater-dominated flows (SC ~ 2,500 - 3000 µS/cm) from late spring through fall, timing that coincides with optimal physical factors (i.e. rising temperatures and insolation) for algal species adapted to or tolerant of the creek's unusually brackish water and sulfate levels (SO₄²⁻ > 500 mg/L), especially the green alga *Cladophora glomerata* and halophilic and eutrophilic diatoms. These geologically mediated water quality impacts also directly affect the creek's aquatic animal life, favoring benthic macroinvertebrate species tolerant of geologically-mediated water quality (i.e. high conductivity), and indirect impacts from algal-driven changes in physical habitat. Different geologies (i.e. Conejo volcanics vs biogenic marine shales and siltstones vs non-marine sedimentary exposures) dominate different tributary streams to Malibu Creek, providing a natural laboratory for separating the effects and relative influences of different geologies on the creek's water chemistry and aquatic life. In comparison to other California streams, Malibu Creek is best characterized as an outlier with respect to the magnitude of its geological impacts on water quality and the extent (taxonomically) of these impacts on its aquatic life.

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Pipers, D.Z., and C.M. Isaacs, 2001, The Monterey Formation: Bottom-water Redox Conditions and Photic-zone Primary Productivity, *in* C.M. Isaacs and J. Rullkötter (eds.), The Monterey Formation: From Rocks to Molecules, Columbia University Press, New York, p. 31-58.

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Geology, Water Quality and Aquatic Life in Malibu Creek: An Unusually Severe Example of Geologic Impacts

Randal Orton

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Geology → Water Quality → Aquatic Life



Santa Monica Basin

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

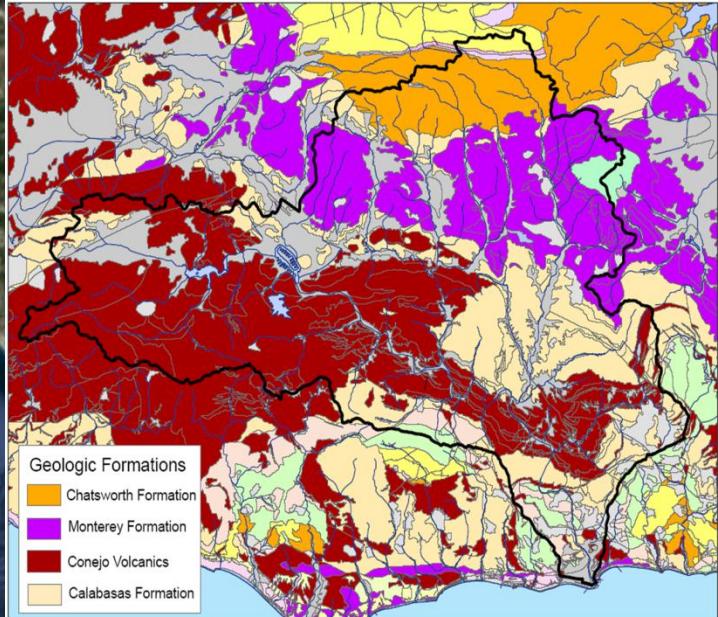
Data USGS

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Image Landsat

Imagery Date: 4/9/2013

33°58'46.50" N 118°38'51.47" W elev -537 ft



Dume Canyon

Santa Monica

Los Angeles

Santa Monica Canyon

Basin

Rancho Canyon



Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Data USGS

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Image Landsat

Imagery Date: 4/9/2013

33°58'46.50" N 118°38'51.47" W elev -537 ft

Torrance

Go

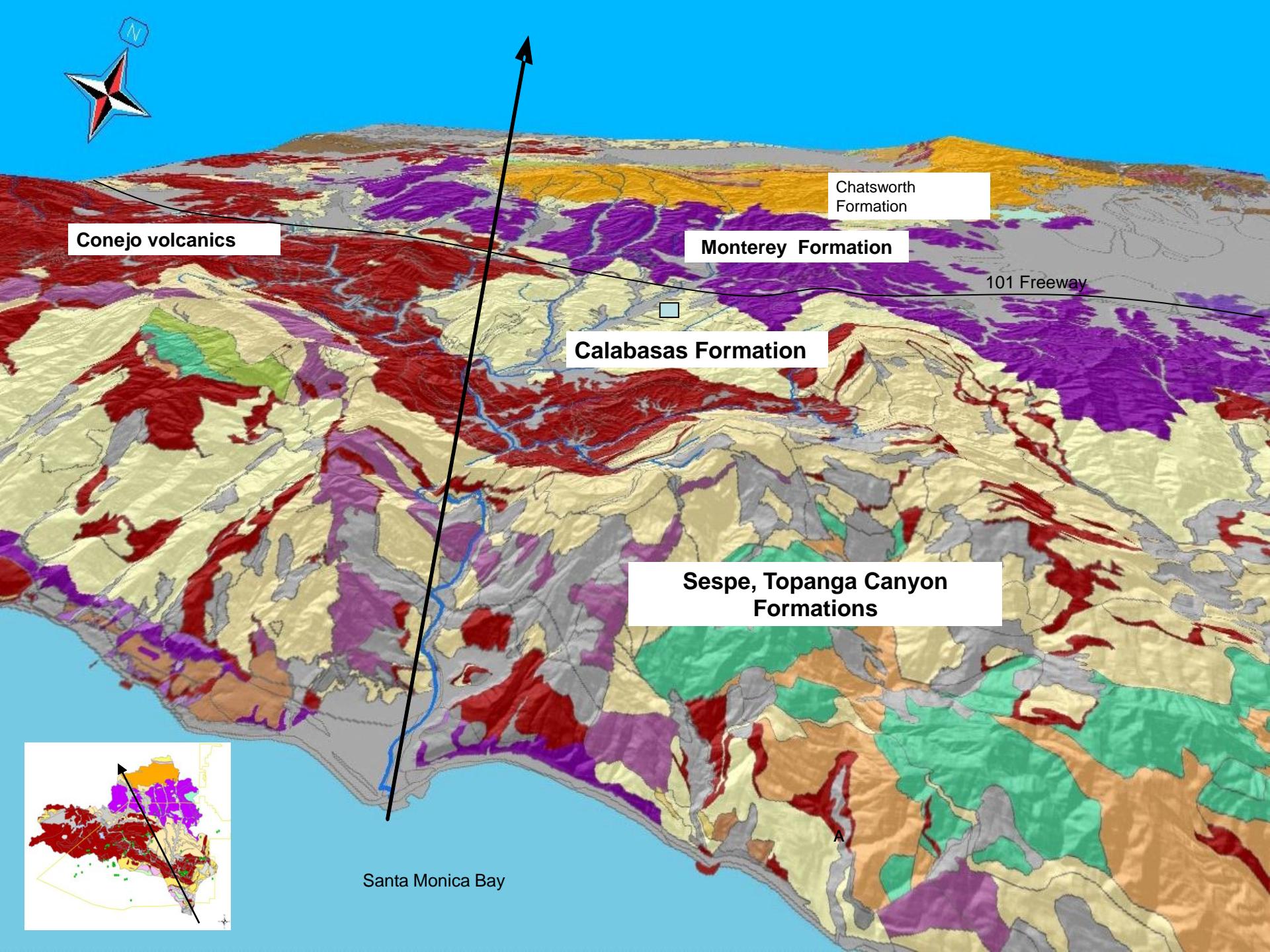
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- A geological map of the Malibu Creek watershed area, spanning parts of Ventura and Los Angeles counties. The map uses various colors to represent different rock units. A large purple area in the northwest is labeled 'Monterey / Modelo Fm.'. A black-outlined polygon covers the Malibu Creek watershed. Major freeways are labeled: '101 Freeway' running north-south, and '405 Freeway' running east-west. The 'Santa Monica Bay' is shown at the bottom. A legend in the top right corner identifies the purple color as 'Monterey / Modelo Fm.'.
- Malibu Creek watershed
 - Monterey / Modelo Fm.

Ventura Co.
Los Angeles Co.

101 Freeway

405 Freeway

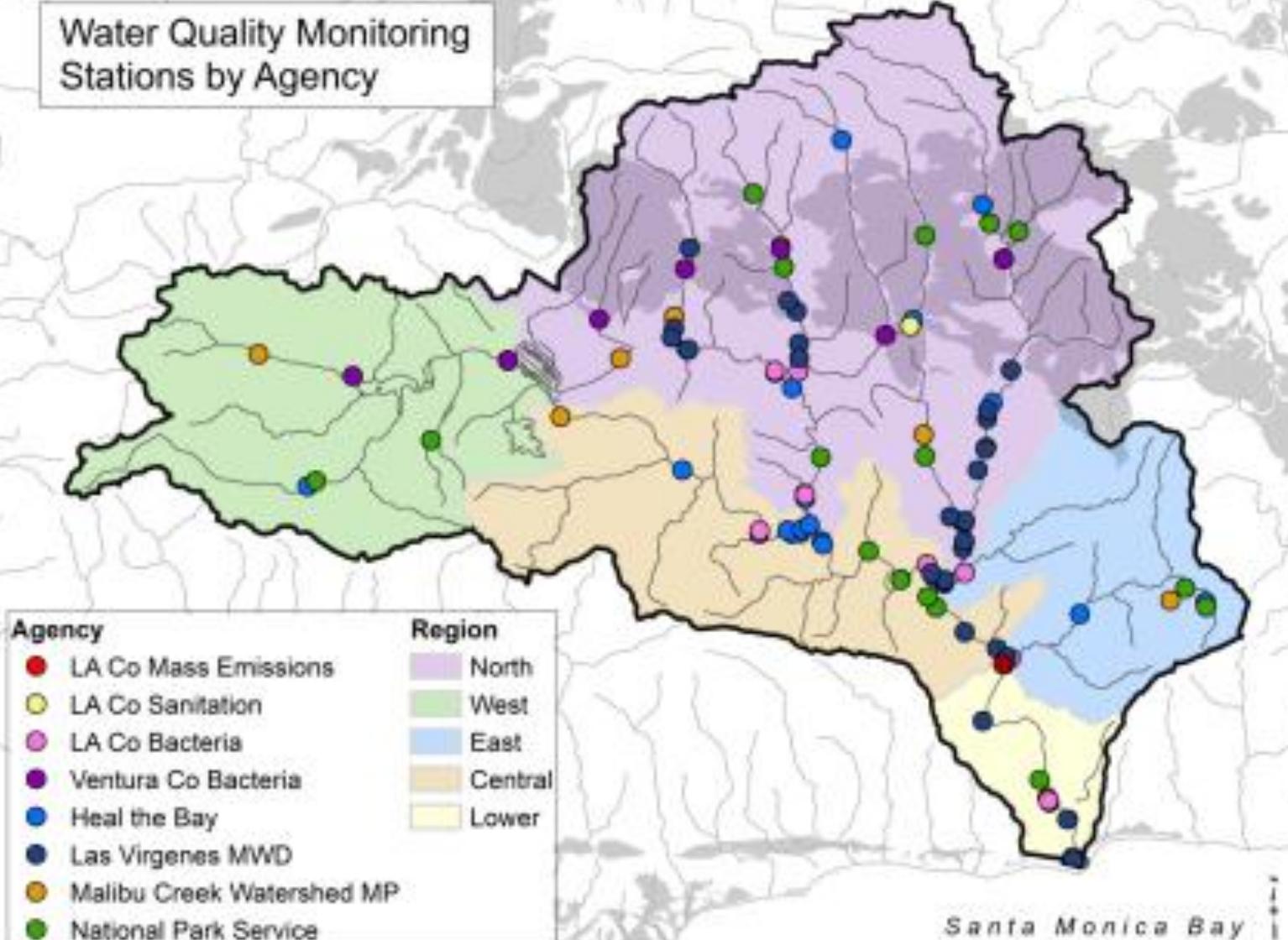
Santa Monica Bay



2

Water Quality

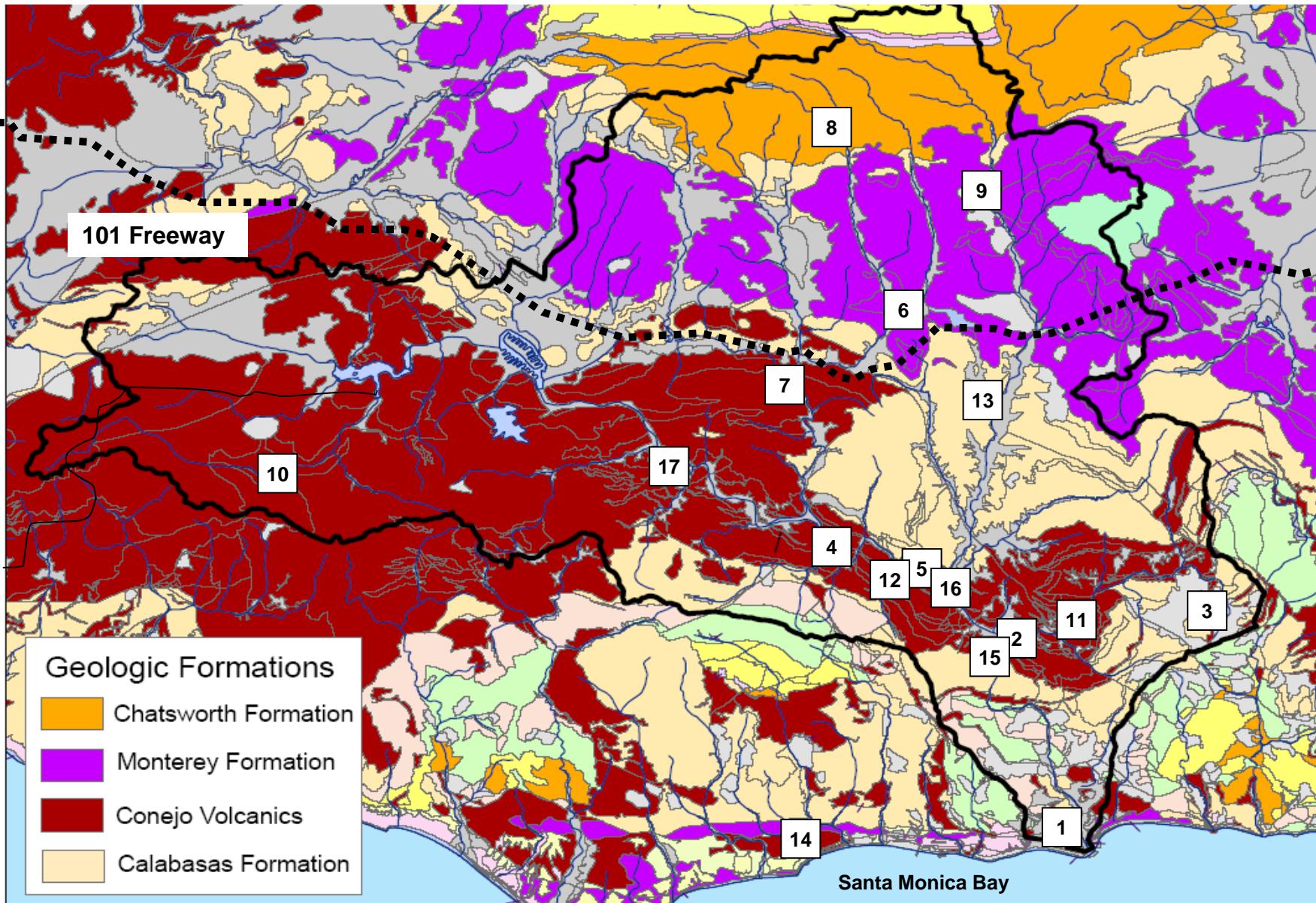
Water Quality Monitoring Stations by Agency

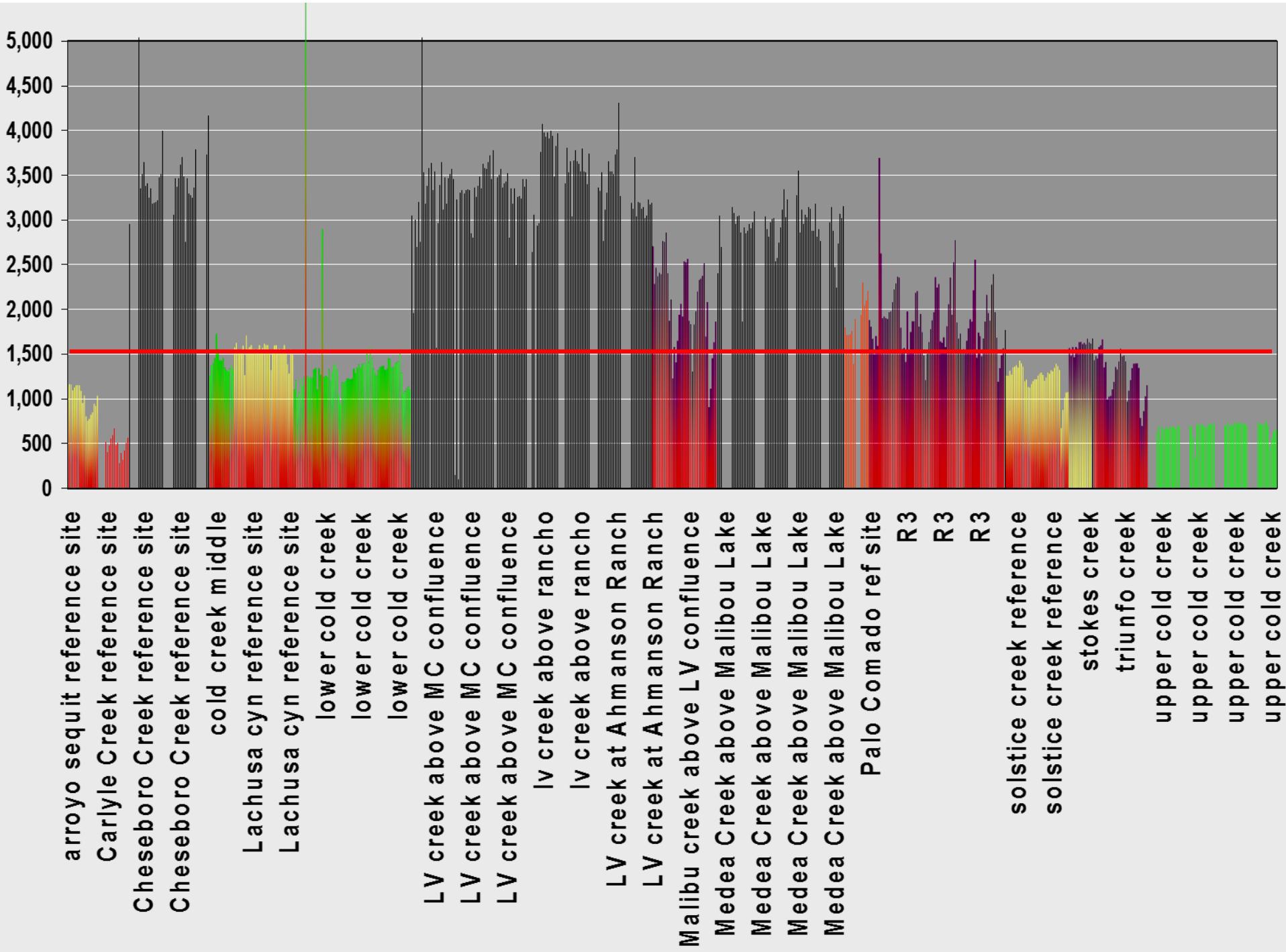


Show site info on Mouseover



Heal The Bay water quality sites





Elements enriched in Monterey Fm rock

(Issacs & Rullkötter, 2001)

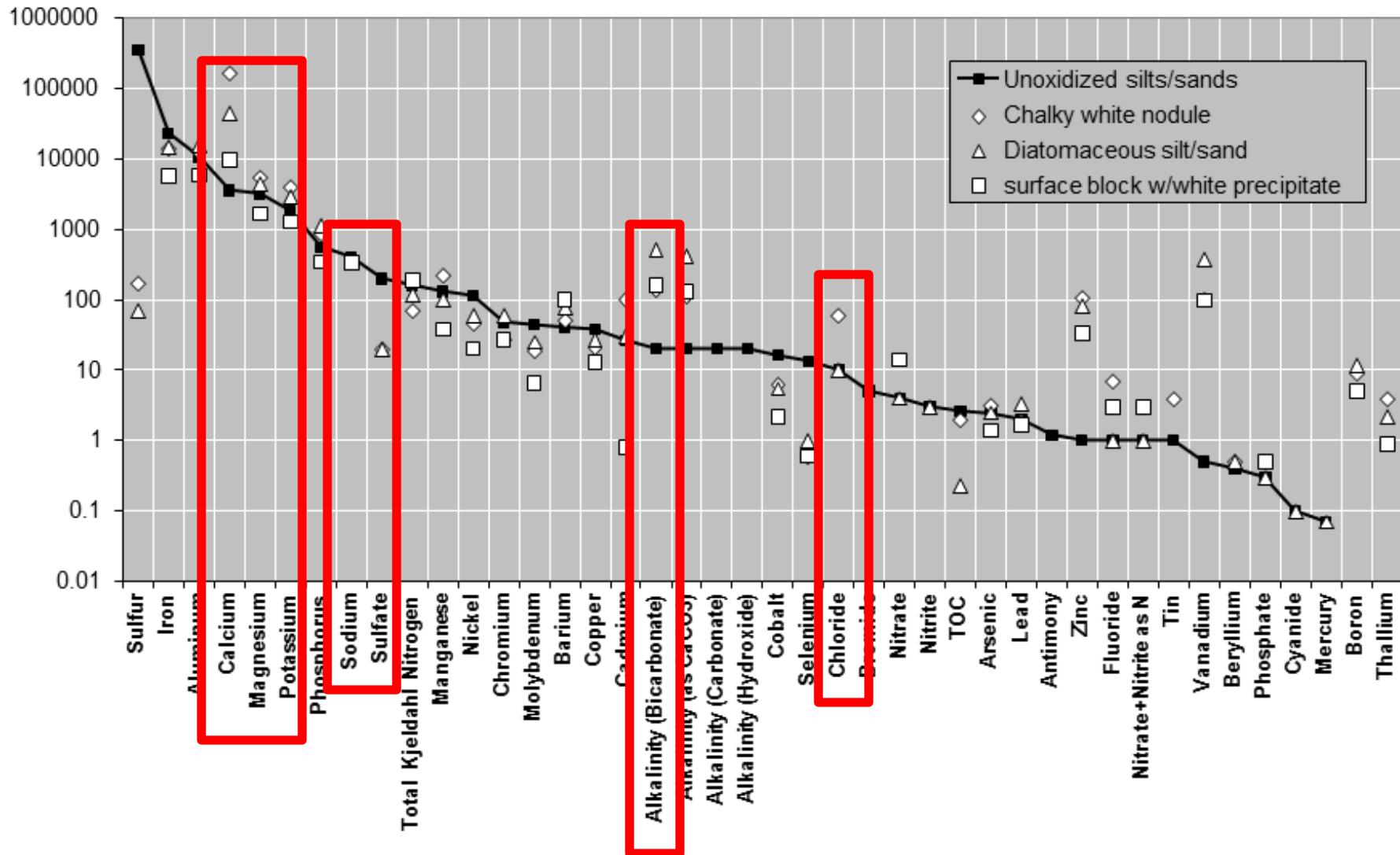
- Sulfate
- Chloride
- Phosphate
- Nitrogen
- Arsenic
- Boron
- Selenium
- Sodium
- Vanadium
- Silver
- Calcium
- Chromium
- Cadmium
- Aluminum
- Nickel
- Iron
- Copper
- Magnesium
- Lead
- Uranium
- Zinc

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Geology

Fig. 2. Composition of unoxidized silts/sands vs oxidized rock in freshly exposed Monterey Formation rock (ppm)

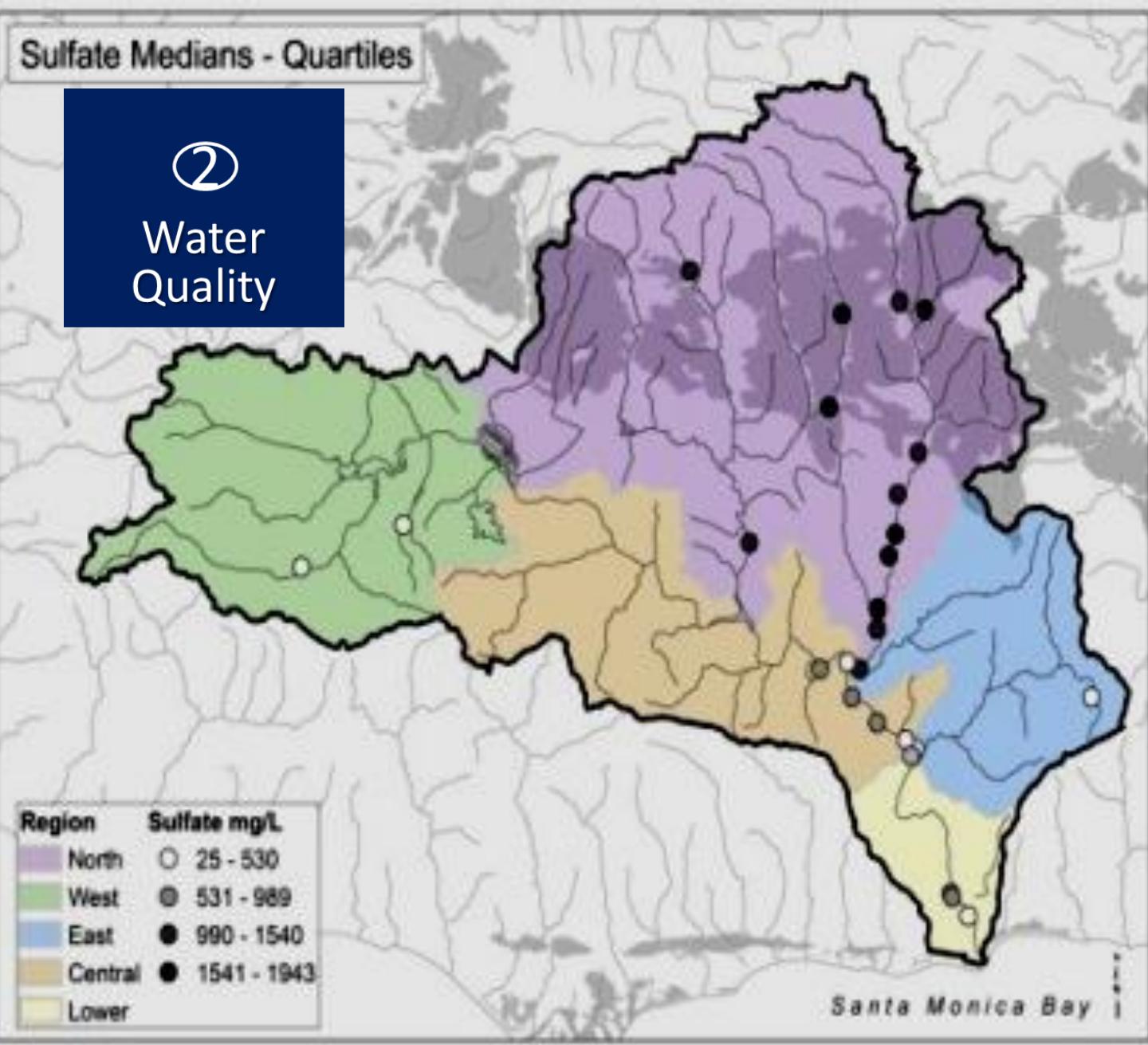
Note 10x-100x differences in sulfur, calcium, sulfate, Cd, alkalinity, Co, Se, chloride, nitrate, TOC, Zn, Fl, Tin, Va, Bo, Th

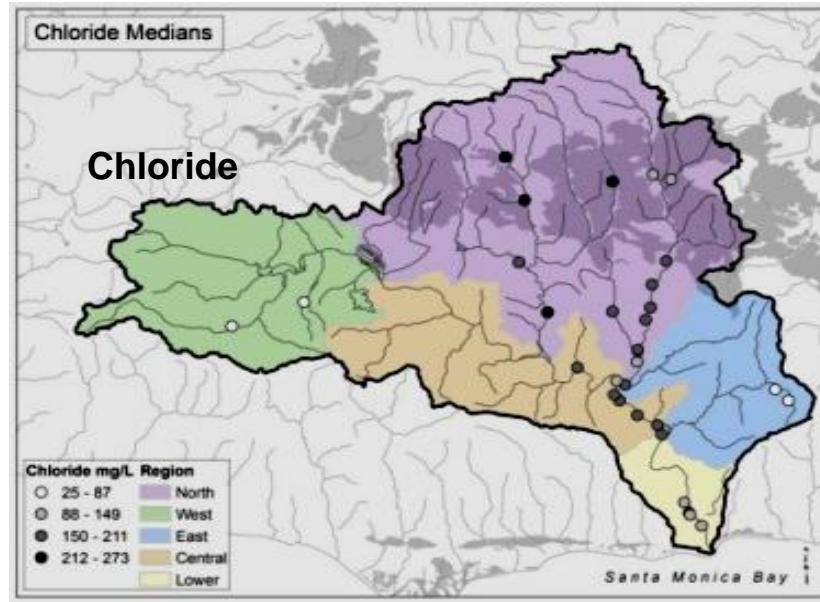
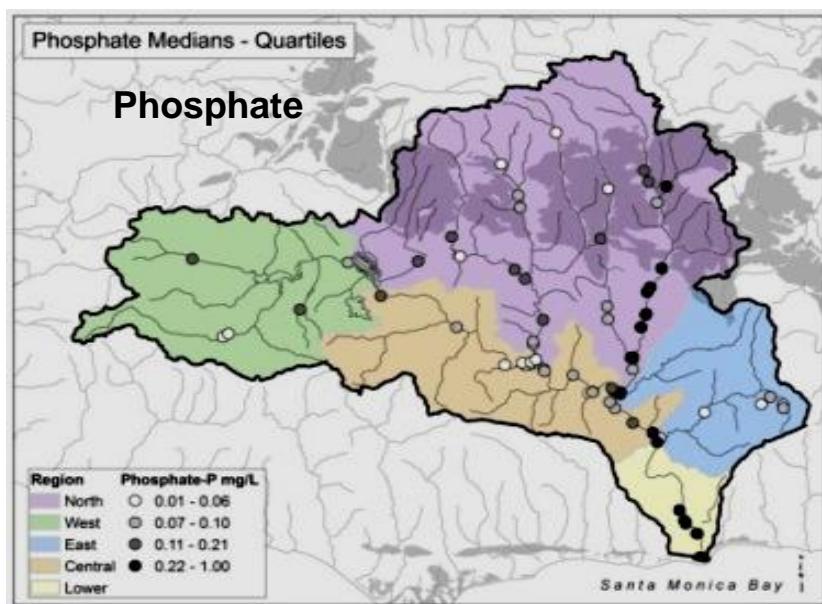
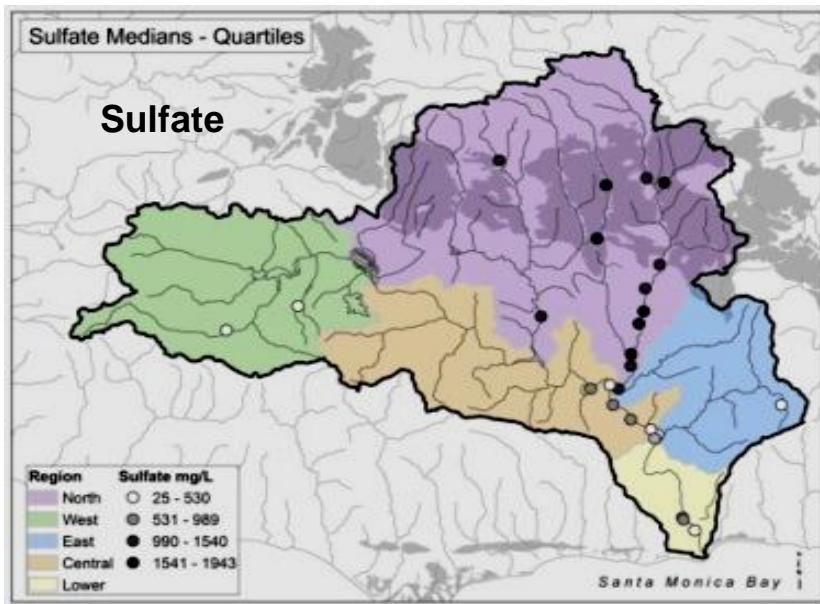


Sulfate Medians - Quartiles

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Water
Quality

Region	Sulfate mg/L
North	○ 25 - 530
West	◎ 531 - 989
East	● 990 - 1540
Central	● 1541 - 1943
Lower	





3" WATTS 709 DOUBLE CHECK
BACKFLOW DEVICE



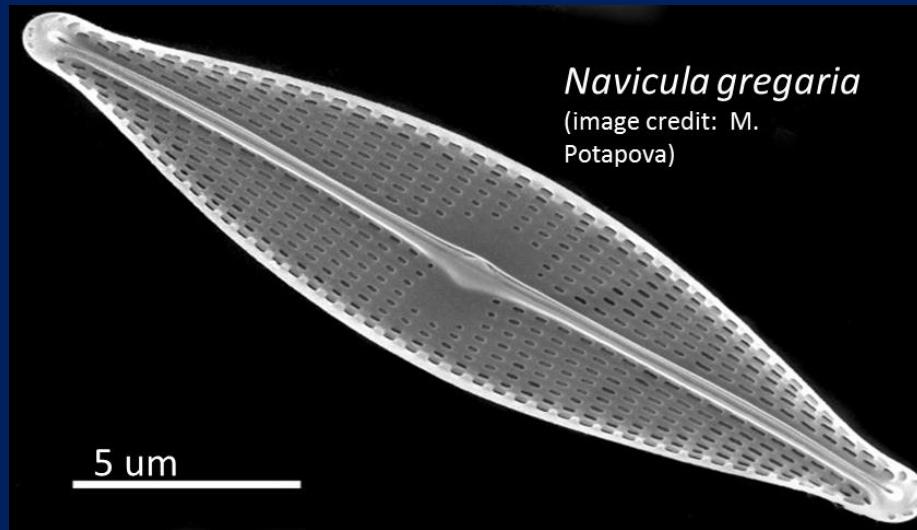


“The Extraction of Hidden Waters”

(Imbat Al-Miyah Al-Khafiyya)
Karaji, M. 1000.

Translation by Nadji, M. and R. Voigt (2008),
Exploration for Hidden Water by Mohammad
Karaji—The Oldest Textbook on Hydrology?
Groundwater, 10: 43-48.

Diatoms



3

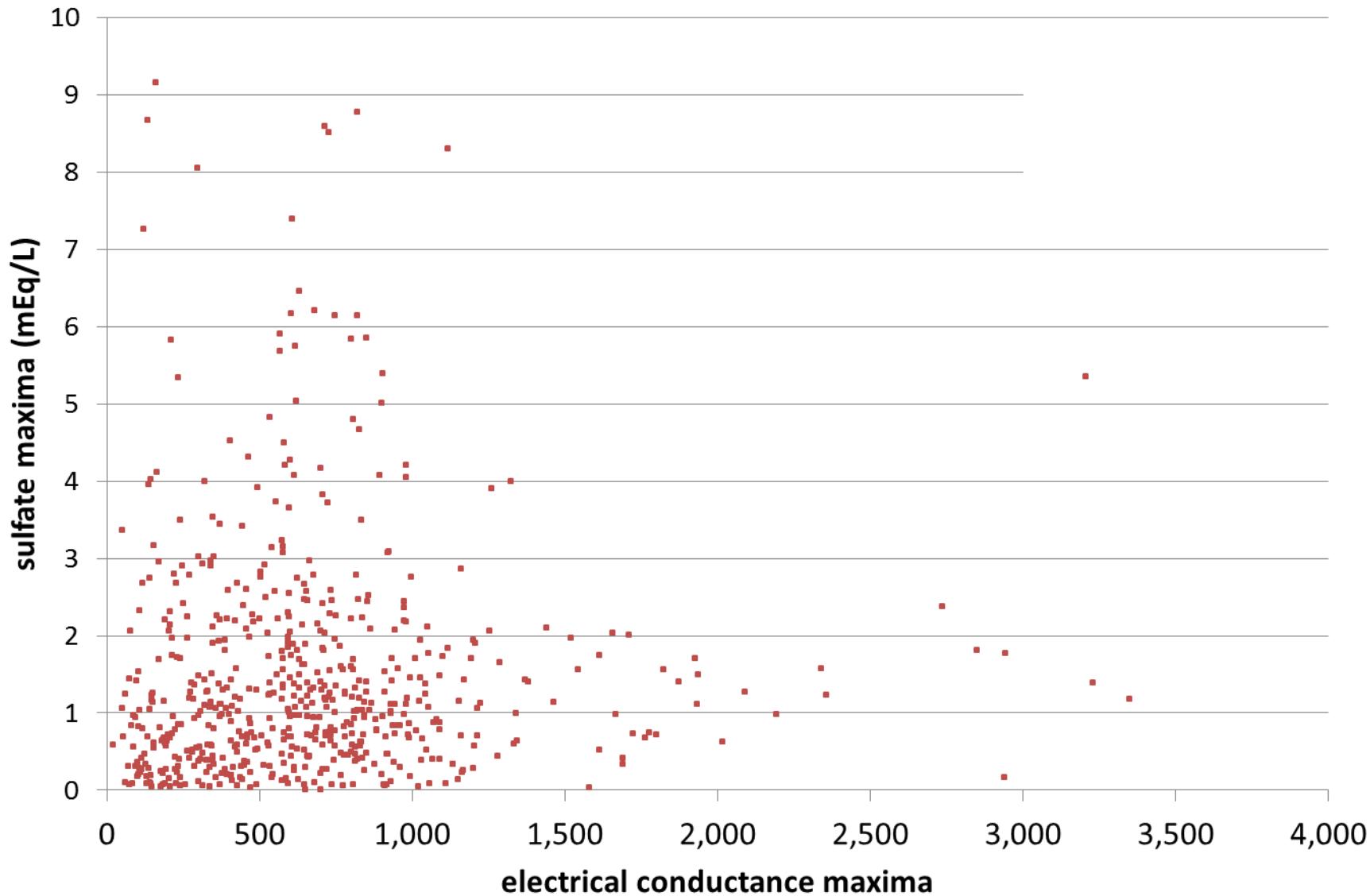
Aquatic Life

Diatoms in Malibu Creek

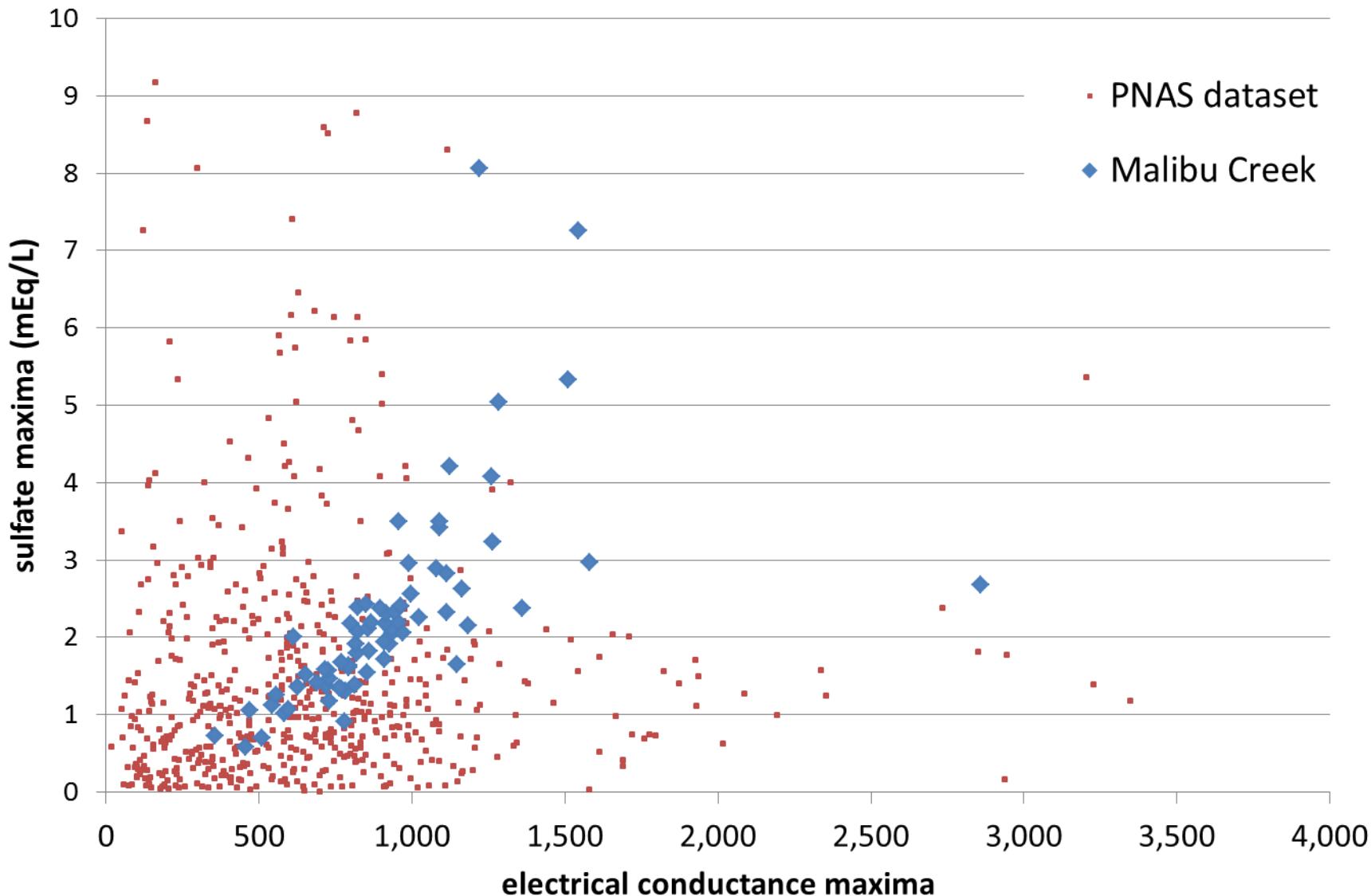
- 91 species identified by M. Potapova (PANS) from slides prepared by ABC Labs from 7 sites
- Two new species, one fairly common in the creek (*Fallacia* sp. nov.).
- **72 species (80%) have water quality preference data in NAWQA database**

MC species/Taxon Name	Occurrence	Conductivity optima and tolerance limits, mS/cm										Anion optima and tolerance limits (meq/L)										Cation optima and tolerance limits (meq/L)									
		Optimum	Low	High	Mg High	SO4 High	HCO3 + CC HCO3 + CC	HCO3 + CC Cl Optima	Cl Low	Cl High	SO4 Opti	SO4 Low	SO4 High	Ca Optima	Ca Low	Ca High	Mg Opti	Mg Low	Mg High	Na Opti	Na Low	Na High	K Optima	K Low	K High						
YES	Achnanthidium pyrenaicum (Hustedt) Kobayasi	526	211	97	456.00	1.36	0.58	1.42	0.56	3.63	0.12	0.04	0.37	0.17	0.05	0.58	1.11	0.47	2.65	0.48	0.17	1.36	0.16	0.05	0.48	0.03	0.02	0.07			
YES	Epithemia turgida (Ehrenberg) Kützing	127	227	101	508.00	1.95	0.70	1.91	0.87	4.16	0.10	0.03	0.38	0.16	0.04	0.70	1.33	0.59	3.03	0.59	0.18	1.95	0.18	0.05	0.70	0.04	0.02	0.10			
YES	Nitzschia bacillum Hustedt	4	176	87	355.00	1.05	0.72	1.93	1.32	2.82	0.36	0.11	1.19	0.11	0.02	0.72	1.72	1.08	2.75	0.33	0.11	1.05	0.38	0.12	1.22	0.02	0.00	0.09			
YES	Gomphonema mexicanum Grunow in Van Heurck	35	338	147	778.00	1.69	0.91	2.07	0.92	4.63	0.43	0.10	1.80	0.21	0.05	0.91	1.24	0.49	3.12	0.65	0.25	1.69	0.72	0.19	2.70	0.09	0.03	0.24			
YES	Geissleria decussis (Hustedt) Lange-Bertalot and Metzeltein	654	220	83	583.00	1.45	1.01	1.29	0.46	3.61	0.28	0.08	1.02	0.23	0.05	1.01	1.06	0.37	3.07	0.46	0.14	1.45	0.38	0.12	1.26	0.05	0.03	0.11			
YES	Encyonema silesiacum (Bleisch) Mann	564	197	83	468.00	1.17	1.05	1.23	0.47	3.24	0.13	0.02	0.72	0.26	0.06	1.05	1.05	0.41	2.67	0.42	0.15	1.17	0.29	0.09	1.01	0.03	0.01	0.08			
YES	Pseudostaurastrus brevistriata (Grunow in Van Heurck) Williams & Round	398	250	105	597.00	1.75	1.07	1.56	0.63	3.85	0.23	0.05	1.09	0.24	0.06	1.07	1.19	0.53	2.69	0.66	0.25	1.75	0.41	0.12	1.49	0.05	0.02	0.11			
YES	Partibellus protracta (Grunow) Witkowski, Lange-Bertalot and Metzeltein	38	235	102	541.00	1.44	1.13	1.56	0.70	3.44	0.27	0.06	1.16	0.29	0.08	1.13	1.22	0.57	2.61	0.58	0.23	1.44	0.47	0.16	1.38	0.05	0.02	0.11			
YES	Nitzschia minima Grunow	1672	319	140	729.00	1.85	1.17	1.71	0.63	4.62	0.35	0.10	1.27	0.31	0.08	1.17	1.44	0.55	3.74	0.64	0.22	1.85	0.44	0.14	1.40	0.06	0.03	0.12			
YES	Fragilaria vaucheriae (Kützing) Petersen	1201	209	79	555.00	1.33	1.26	1.07	0.37	3.13	0.18	0.03	0.96	0.28	0.06	1.26	0.97	0.34	2.74	0.44	0.15	1.33	0.35	0.10	1.18	0.04	0.02	0.10			
YES	Gomphonema truncatum Ehrenberg	122	333	142	783.00	2.10	1.30	1.89	0.65	5.50	0.42	0.10	1.85	0.35	0.09	1.30	1.63	0.62	4.28	0.71	0.24	2.10	0.52	0.16	1.70	0.05	0.02	0.13			
YES	Diadesmus confervaceus Kützing	324	318	132	769.00	1.61	1.34	1.46	0.50	4.31	0.61	0.18	2.05	0.33	0.08	1.34	1.29	0.48	3.46	0.56	0.20	1.61	0.76	0.24	2.44	0.08	0.03	0.20			
YES	Gyrosigma acuminatum (Kützing) Rabenhorst	215	390	200	762.00	2.48	1.35	2.36	1.02	5.45	0.42	0.18	1.00	0.45	0.15	1.35	1.85	0.84	4.07	1.02	0.42	2.48	0.58	0.25	1.33	0.07	0.04	0.13			
YES	Synedra ulna (Nitzsch) Ehrenberg	1311	252	102	627.00	1.64	1.36	1.44	0.51	4.02	0.28	0.06	1.27	0.30	0.07	1.36	1.26	0.48	3.31	0.55	0.19	1.64	0.42	0.13	1.42	0.05	0.02	0.11			
YES	Planothidium lanceolatum (Brébisson ex Kützing) Lange-Bertalot	1330	286	114	719.00	1.73	1.37	1.52	0.59	3.92	0.30	0.07	1.28	0.32	0.08	1.37	1.27	0.49	3.33	0.60	0.21	1.73	0.47	0.15	1.45	0.05	0.02	0.13			
YES	Gomphonema clavatum Ehrenberg	23	388	185	813.00	2.33	1.39	2.53	1.22	5.26	0.24	0.03	1.69	0.32	0.08	1.39	1.96	0.97	3.95	0.90	0.35	2.33	0.49	0.13	1.85	0.05	0.02	0.11			
YES	Melosira varians Agardh	1203	309	138	690.00	1.85	1.41	1.66	0.67	4.16	0.36	0.11	1.22	0.36	0.09	1.41	1.40	0.58	3.37	0.70	0.26	1.85	0.49	0.17	1.47	0.06	0.03	0.12			
YES	Staurosira construens (Ehrenberg) Williams & Round	344	312	134	728.00	2.07	1.47	1.99	0.87	4.53	0.26	0.05	1.32	0.35	0.08	1.47	1.52	0.69	3.36	0.80	0.31	2.07	0.48	0.13	1.84	0.05	0.02	0.15			
YES	Achnanthidium minutissimum (Kützing) Czernicki	2019	229	81	652.00	1.63	1.51	1.31	0.43	3.98	0.20	0.04	0.98	0.31	0.06	1.51	1.22	0.42	3.61	0.51	0.16	1.63	0.32	0.09	1.20	0.04	0.02	0.09			
YES	Nitzschia linearis (Agardh ex W. Smith) W. Smith	464	398	186	853.00	2.60	1.54	2.42	1.04	5.60	0.45	0.13	1.63	0.47	0.14	1.54	1.87	0.77	4.57	0.99	0.37	2.60	0.61	0.22	1.72	0.06	0.03	0.12			
YES	Nitzschia fonticola Grunow	472	316	137	726.00	2.01	1.57	2.05	0.95	4.45	0.45	0.11	1.89	0.44	0.12	1.57	1.66	0.79	3.49	0.80	0.32	2.01	0.64	0.18	2.24	0.06	0.02	0.15			
YES	Ctenophora pulchella (Raats ex Kützing) Williams & Round	66	342	163	706.00	1.39	1.58	0.86	0.27	2.74	0.67	0.18	2.41	0.53	0.18	1.58	1.18	0.53	2.62	0.57	0.24	1.39	0.70	0.22	2.22	0.06	0.03	0.13			
YES	Nitzschia amphibia Grunow	1456	400	201	794.00	2.01	1.60	2.26	1.06	4.80	0.51	0.15	1.75	0.45	0.12	1.60	1.87	0.89	3.94	0.81	0.33	2.01	0.69	0.22	2.16	0.07	0.03	0.16			
YES	Gomphonema parvulum (Kützing) Kützing	1898	284	101	794.00	1.81	1.63	1.33	0.40	4.48	0.39	0.10	1.53	0.34	0.07	1.63	1.21	0.40	3.71	0.55	0.17	1.81	0.53	0.15	1.92	0.06	0.03	0.14			
YES	Navicula salinarum Grunow	51	527	243	1146.00	3.18	1.65	2.25	0.88	5.74	1.32	0.44	4.00	0.68	0.28	1.65	1.90	0.80	4.53	1.16	0.43	3.18	1.24	0.43	3.56	0.08	0.04	0.14			
YES	Navicula germainii Wallace	975	339	149	769.00	2.01	1.67	1.80	0.71	4.55	0.50	0.15	1.67	0.42	0.11	1.67	1.50	0.57	3.91	0.71	0.25	2.01	0.67	0.22	2.01	0.07	0.04	0.13			
YES	Hippodonta capitata (Ehrenberg) Lange-Bertalot, Metzeltein & Witkowski	709	366	147	908.00	2.33	1.71	1.77	0.63	4.97	0.51	0.13	2.00	0.42	0.10	1.71	1.53	0.59	3.96	0.77	0.25	2.33	0.65	0.19	2.19	0.07	0.03	0.15			
YES	Sellaphora pupula (Kützing) Mereschkowsky	1064	342	143	820.00	1.80	1.79	1.74	0.64	4.72	0.42	0.11	1.65	0.42	0.10	1.79	1.52	0.58	3.98	0.65	0.23	1.80	0.64	0.19	2.09	0.07	0.03	0.15			
YES	Navicula libonensis Schoeman	16	537	336	859.00	2.86	1.82	2.32	0.95	5.62	0.38	0.11	1.39	0.32	0.06	1.82	1.84	0.97	3.48	0.73	0.19	2.86	0.57	0.12	2.71	0.06	0.03	0.12			
YES	Navicula cryptotesta Lange-Bertalot	1620	371	168	872.00	2.77	1.91	2.21	0.81	5.76	0.35	0.10	1.31	0.43	0.10	1.94	1.62	0.76	3.51	0.80	0.21	3.27	0.63	0.17	1.63	0.05	0.03	0.12			
YES	Conconeis placenta Ehrenberg	418	436	205	101	846.00	2.01	1.60	2.26	1.06	4.80	0.51	0.15	1.75	0.45	0.12	1.60	1.87	0.89	3.94	0.81	0.33	2.01	0.69	0.22	2.16	0.07	0.03	0.14		
YES	Navicula gregaria Donkin	1344	392	169	101	846.00	1.81	1.63	1.33	0.40	4.48	0.39	0.10	1.53	0.34	0.07	1.63	1.21	0.40	3.71	0.55	0.17	1.81	0.53	0.15	1.92	0.06	0.03	0.14		
YES	Epithemia soror Kützing	205	266	116	101	846.00	1.81	1.63	1.33	0.40	4.48	0.39	0.10	1.53	0.34	0.07	1.63	1.21	0.40	3.71	0.55	0.17	1.81	0.53	0.15	1.92	0.06	0.03	0.14		
YES	Hippodonta hippocastani (Ehrenberg) Hamilton	617	300	109	101	846.00	1.81	1.63	1.33	0.40	4.48	0.39	0.10	1.53	0.34	0.07	1.63	1.21	0.40	3.71	0.55	0.17	1.81	0.53	0.15	1.92	0.06	0.03	0.14		
YES	Fallicula pygmaea (Kützing) Stickle and Mann	533	469	228	101	846.00	1.81	1.63	1.33	0.40	4.48	0.39	0.10	1.53	0.34	0.07	1.63	1.21	0.40	3.71	0.55	0.17	1.81	0.53	0.15	1.92	0.06	0.03	0.14		
YES	Nitzschia frustulosa (Kützing) Grunow	1153	413	177	101	846.00	2.22	1.60	2.95	1.61	5.42	0.48	0.13	1.79	1.08	0.23	5.04	2.70	1.36	5.35	1.24	0.48	3.22	1.04	0.27	3.99	0.10	0.04	0.24		
YES	Cymatopleura solea (Brébisson) Smith	144	482	274	101	846.00	2.22	1.60	2.95	1.61	5.42	0.48	0.13	1.79	1.08	0.23	5.04	2.70	1.36	5.35	1.24	0.48	3.22	1.04	0.27	3.99	0.10	0.04	0.24		
YES	Nitzschia incospicua Grunow	1374	407	167	101	846.00	2.23	1.62	2.96	1.99	5.46	0.52	0.14	1.91	1.71	0.17	2.96	1.80	0.86	3.80	0.90	0.37	2.18	0.90	0.29	2.78	0.10	0.04	0.25		
YES	Tabularia fasciculata (Agardh) Williams and Round	109	719	181	285.00	3.31	2.57	1.80	0.69	4.72	1.29	0.26	6.50	0.60	0.13	2.67	1.69	0.69	4.15	1.17	0.41	3.31	1.47	0.37	5.86	0.09	0.03	0.23			
YES	Nitzschia microcephala Grunow	168	526	249	112.00	2.38	2.92	2.58	1.17	5.68	0.78	0.22	2.81	0.88	0.28	2.82	2.24	1.12	4.49	1.17	0.57	2.38	1.26	0.45	3.54	0.09	0.05	0.19			
YES	Amphora veneta Kützing	180	515	246	1079.00	2.26	2.88	2.90	1.53	5.48	0.89	0.24	3.30	0.79	0.22	2.88	2.39	1.16	4.95	0.98	0.43	2.26	1.47	0.48	4.49	0.11	0.05	0.22			
YES	Planothidium delicatulum (Kützing) Round et Bulktiyarova</																														

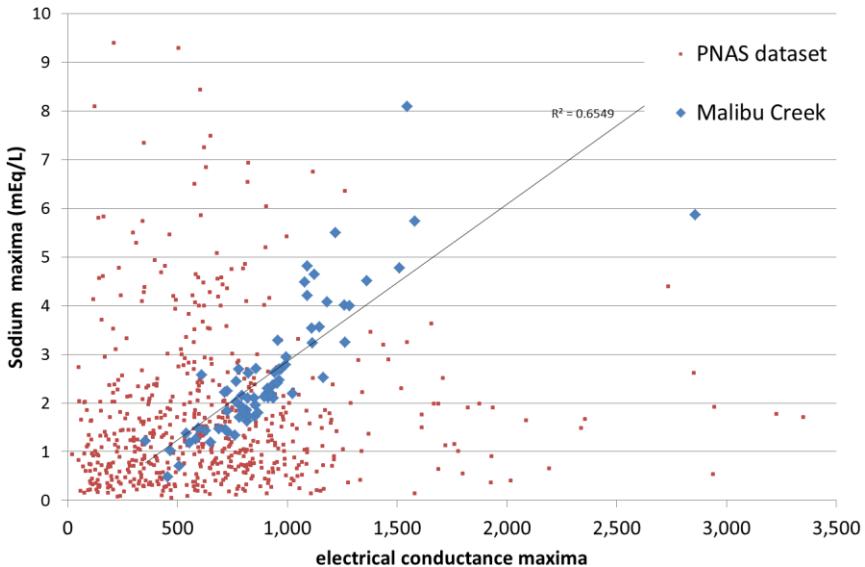
Sulfate vs electrical conductance maxima for 682 U. S. diatom species
(NAWQA dataset)



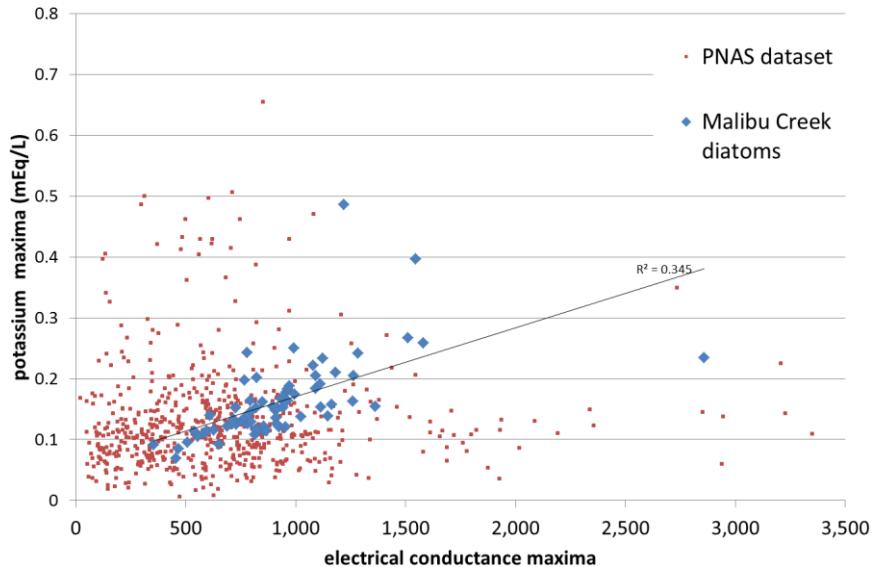
**Malibu Creek's diatom community nicely reflects the direct linkage
between the creek's high electrical conductance and sulfate (SO_4^{2-})**



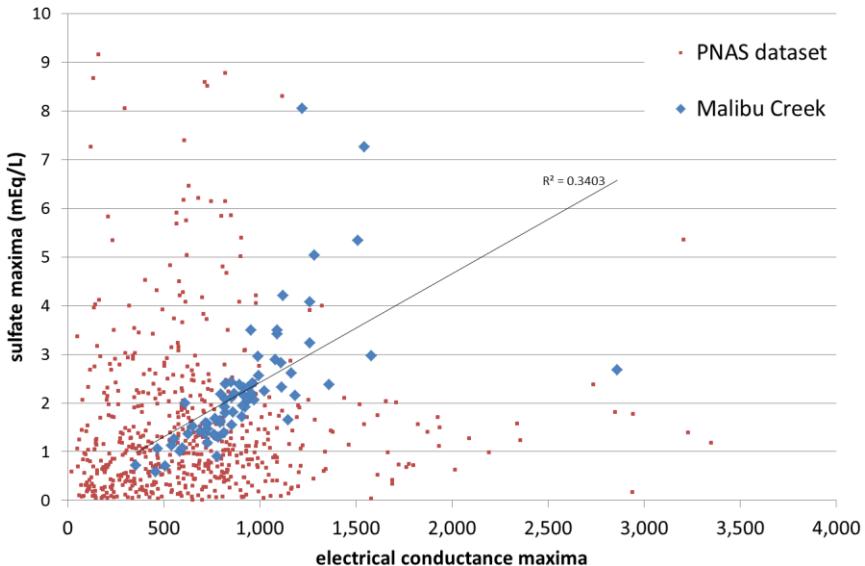
Malibu Creek's diatom community nicely reflects the direct linkage between the creek's high electrical conductance and sodium ions (Na^+)



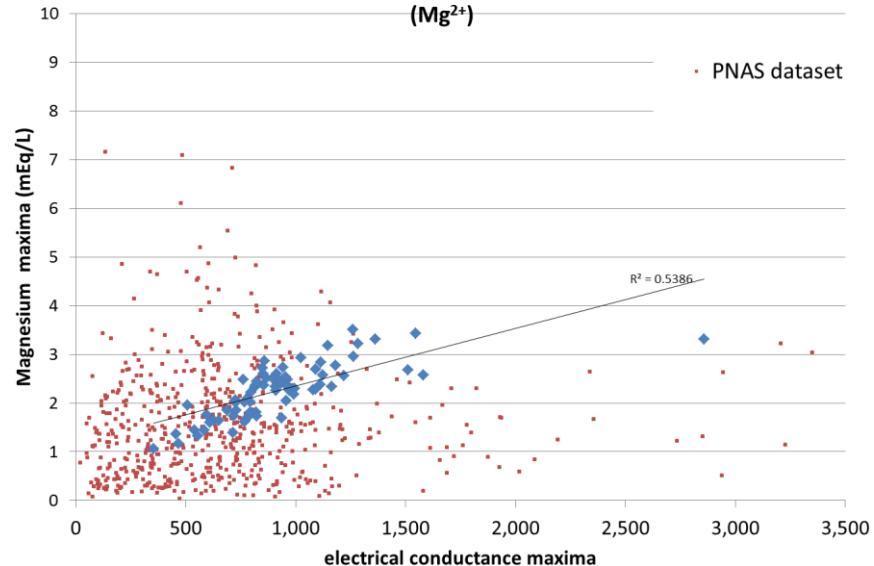
Malibu Creek's diatom community nicely reflects the direct linkage between the creek's high electrical conductance and potassium ions (K^+)



Malibu Creek's diatom community nicely reflects the direct linkage between the creek's high electrical conductance and sulfate (SO_4^{2-})



Malibu Creek's diatom community nicely reflects the direct linkage between the creek's high electrical conductance and magnesium ions (Mg^{2+})



Pleurosira laevis

("Malibu muck")

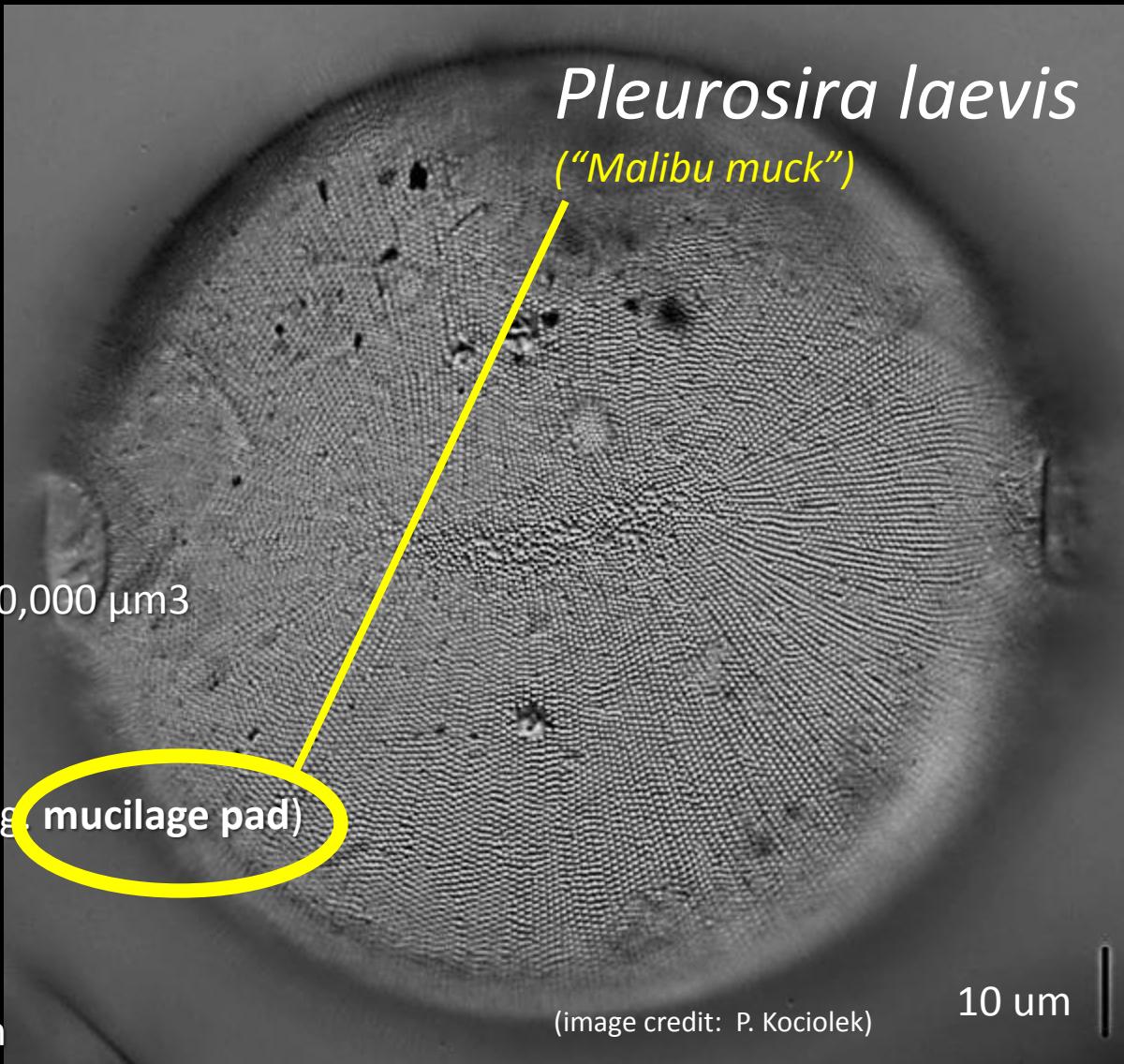
Size Range: 100,001-1,000,000 μm^3

Motility: non motile

Attachment: prostrate (e.g. **mucilage pad**)

Habitat: benthic

Colony: colonies common



(image credit: P. Kociolek)

10 μm





Macroalgae

Chain of causality – Classic eutrophication

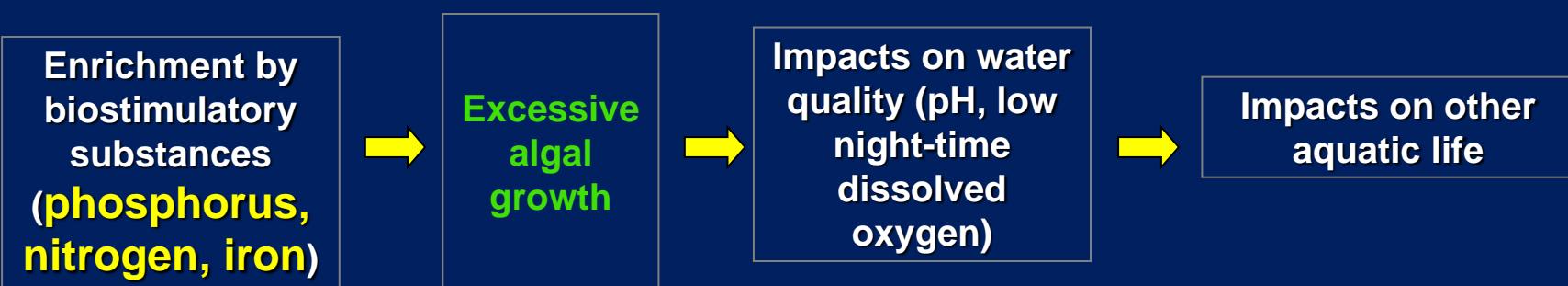
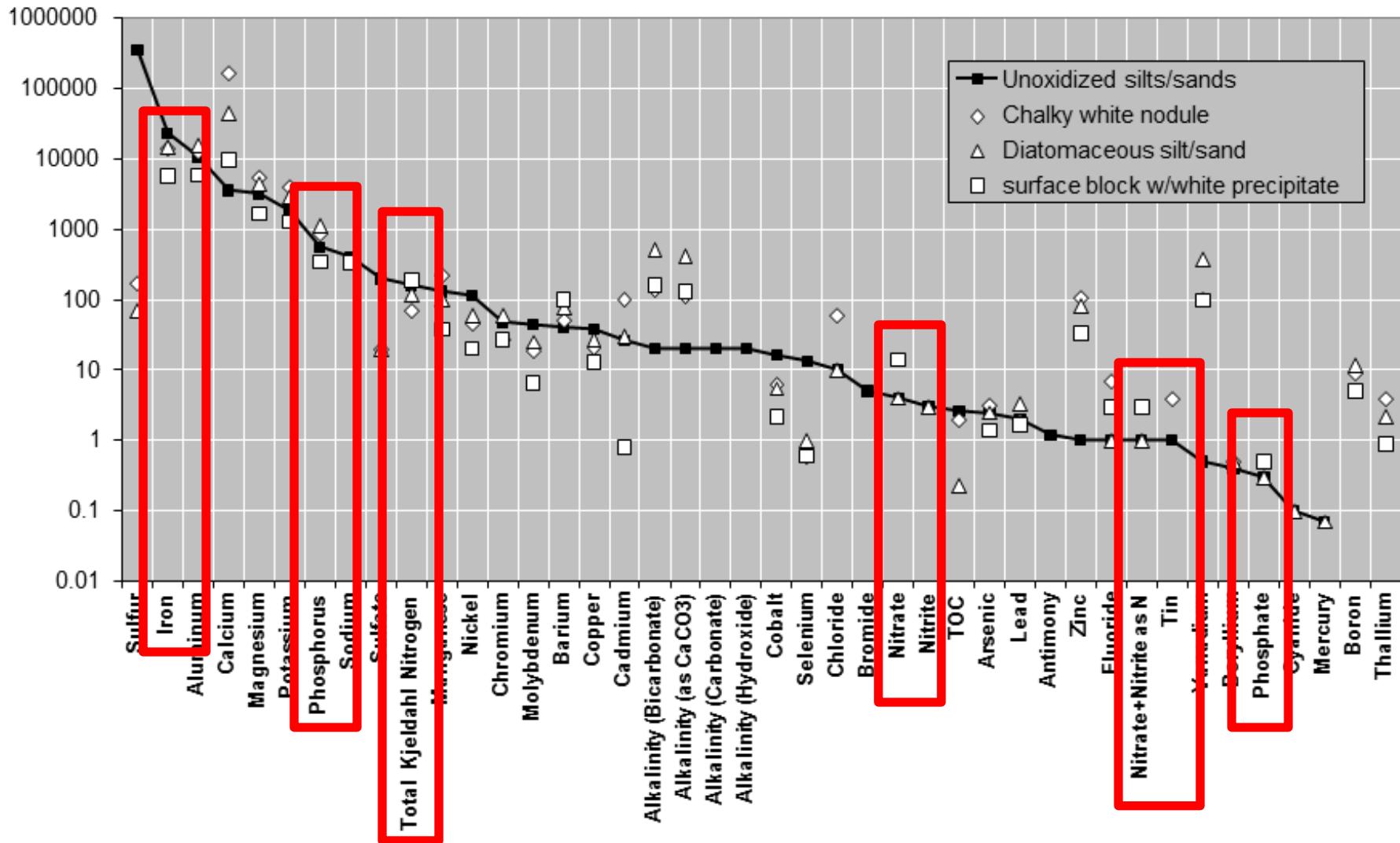


Fig. 2. Composition of unoxidized silts/sands vs oxidized rock in freshly exposed Monterey Formation rock (ppm)

Note 10x-100x differences in sulfur, calcium, sulfate, Cd, alkalinity, Co, Se, chloride, nitrate, TOC, Zn, Fl, Tin, Va, Bo, Th



New Zealand Periphyton Guideline:

Detecting, Monitoring and Managing Enrichment of Streams

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

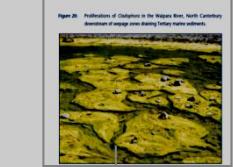
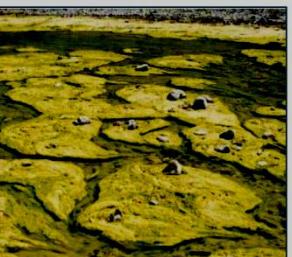
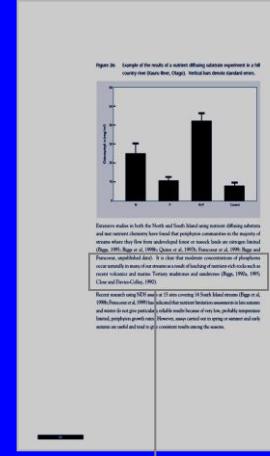
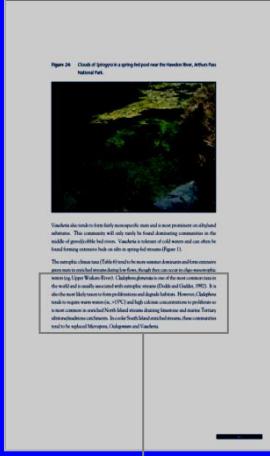


Figure 20: Proliferations of *Cladophora* in the Waipara River, North Canterbury downstream of seepage zones draining Tertiary marine sediments.



Biggs (2000) warns of natural eutrophication associated with nutrient-enriched marine Tertiary siltstones and andesitic volcanic rock 5 times in his seminal work on periphyton algae control.



situations. For example, people might want to have a particular section of a stream managed for recreational fishing, and for this to happen, it might be necessary to eliminate blooms of filamentous algae during summer. However, if the catchment includes a significant proportion of Tertiary marine siltstones which are rich in nutrients, this would be readily detected in the habitat classification. It would then be clear that filamentous algal growths are a natural product of the catchment conditions and clearly impossible to control.

waters (eg, Upper Waikato River). *Cladophora glomerata* is one of the most common taxa in the world and is usually associated with eutrophic streams (Dodds and Gudder, 1992). It is also the most likely taxon to form proliferations and degrade habitats. However, *Cladophora* tends to require warm waters (ie, >15°C) and high calcium concentrations to proliferate so is most common in enriched North Island streams draining limestone and marine Tertiary siltstone/mudstone catchments. In cooler South Island enriched streams, these communities tend to be replaced *Microspora*, *Oedogonium* and *Vaucheria*.

1993; Quinn et al, 1997a). However, it also needs to be clearly understood that a large degree of natural enrichment occurs through leachate from nutrient-rich rocks such as andesitic volcanics, Tertiary marine mudstones/sandstone, and limestone (Close and Davies-Colley, 1990; Biggs and Gerbeaux, 1993; Biggs, 1995). Indeed only small amounts of these rock types in a catchment can cause proliferations during low flows (Figure 20). Enriching

Francoeur, unpublished data). It is clear that moderate concentrations of phosphorus occur naturally in many of our streams as a result of leaching of nutrient-rich rocks such as recent volcanics and marine Tertiary mudstones and sandstones (Biggs, 1990a, 1995; Close and Davies-Colley, 1990).

Why Tertiary marine siltstone in the Malibu Creek watershed is so important for understanding its eutrophic

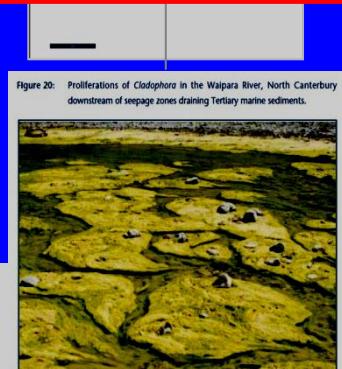
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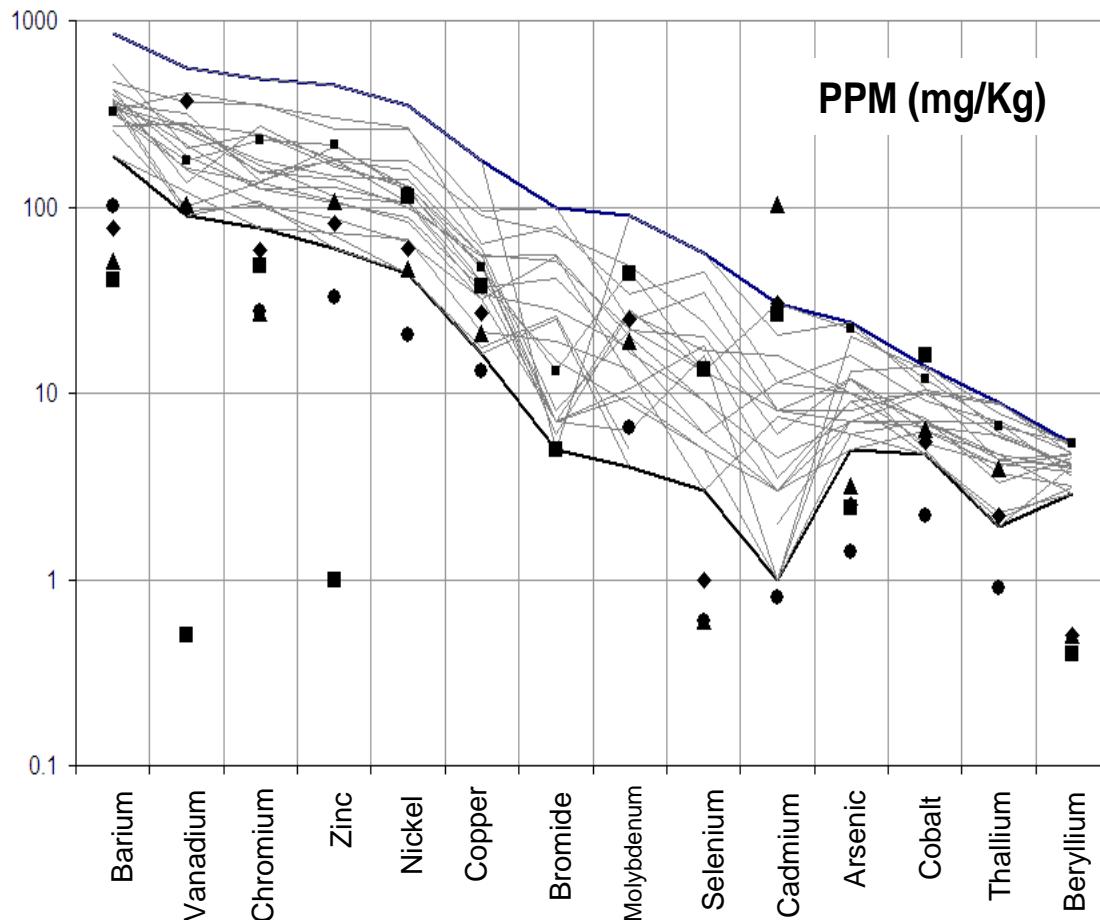


Elements enriched in Monterey Fm rock

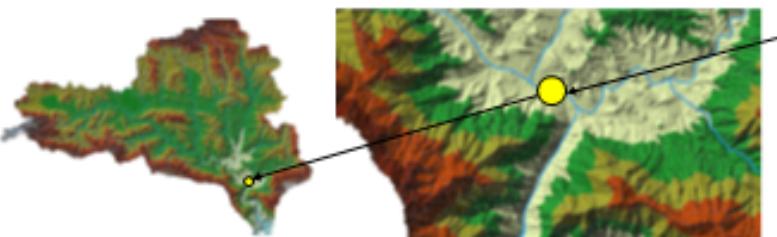
(Issacs & Rullkötter, 2001)

- Sulfate
- Chloride
- Phosphate
- Nitrogen
- **Arsenic**
- Boron
- **Selenium**
- **Sodium**
- **Vanadium**
- Silver
- Calcium
- Chromium
- Cadmium
- Aluminum
- Nickel
- Iron
- Copper
- Magnesium
- Lead
- Uranium
- Zinc

Fig. 3. Trace metal composition (ppm by weight) in MF rock from Malibu Creek watershed (dots) vs Santa Barbara County (lines) from Lion's Head & Naples Reef (from Pipers and Isaacs, 2001)



Dark lines = min. & max values for MF rock from S. Barbara Co., CA. Light grey lines = individual samples from same. Superimposed points = Local MF rock (\blacktriangle = Chalky white nodules; \bullet = surface block w/white precipitate; \blacksquare = siltstone; \lozenge = diatomaceous silt/sand)

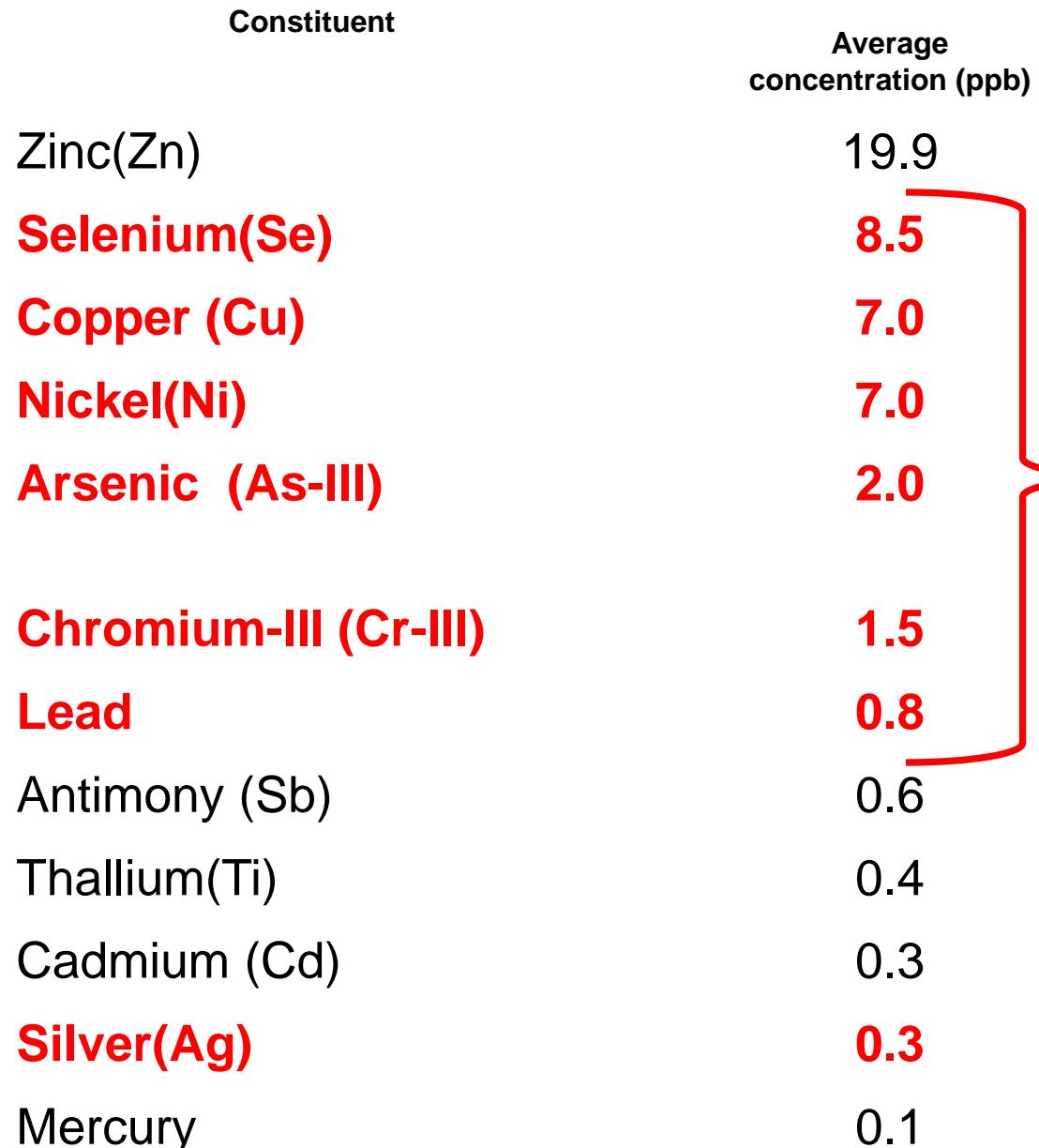


All of the data shown here are from Station R SWMC001U, located in upper Malibu Creek below its confluence with Triunfo Creek and Las Virgenes Creek and all upper watershed tributaries. Any pollution from point or non-point sources in the upper watershed must pass this station.

Metals and Organic Compounds

California Toxics Rule (CTR) test results upper Malibu Creek in Malibu Creek State Park (metals also shown)

	Volatile organic compounds	Semi-volatile organic compounds	Metals <small>(details next page)</small>	Pesticides
Date	19-03-02	19-03-02	19-03-02	19-03-02
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**Metals in Malibu Creek ranked by concentration
(L.A. County gaging station)**

Red = fish tissue levels exceed human consumption standards.



EAT AT YOUR OWN RISK

Geology, Water Quality and Aquatic Life in Malibu Creek: An Unusually Severe Example of Geologic Impacts

- Salts (sulfate, magnesium, chloride, calcium, sodium, bicarbonate)
- Algal nutrients (P, N, Fe)
- Metals



- Brackish “24/7”
- Legally undrinkable
- Too salty for most freshwater diatoms
- *Warm + salt + eutrophic*
= *Cladophora* heaven
- Don’t eat the fish

Acknowledgements - Data

Las Virgenes Municipal Water District

Triunfo Sanitation District

Heal The Bay Stream Team

National Park Service (SMMNRA)

Los Angeles Co. Flood Control District (Watershed Div.)

LVMWD.com – data, report

Acknowledgements



Jan Dougal
Gary Fields
Jacqy Gamble

California Dept. Water Resources

Coast Geological Society

Further info: Ortonrandal6@gmail.com