SWAMP
Surface Water Ambient Monitoring Program

Integrated Assessments: The Central Coast Healthy Watersheds Report Card

Karen R. Worcester, California Central Coast Water Board
David M. Paradies, Central Coast Ambient Monitoring Program

Our Vision for the Central Coast…

Healthy Watersheds

By 2025:

Healthy Aquatic Habitat - 80% of aquatic habitat is healthy; remaining 20% exhibit positive trends in key parameters

Proper Land Management - 80% of land is managed to maintain proper watershed functions; remaining 20% exhibit positive trends in key parameters

Clean Groundwater- 80 percent of ground water is clean, and the remaining 20 percent will exhibit positive trends in key parameters

AQUATIC LIFE GOAL: 80% of aquatic habitat is healthy; remaining 20% exhibit positive trends in key parameters

INTEGRATION OF:

I. Multiple data types into a report card assessment of "healthy aquatic habitat"

II. Site level data into a spatial assessment of whole watersheds

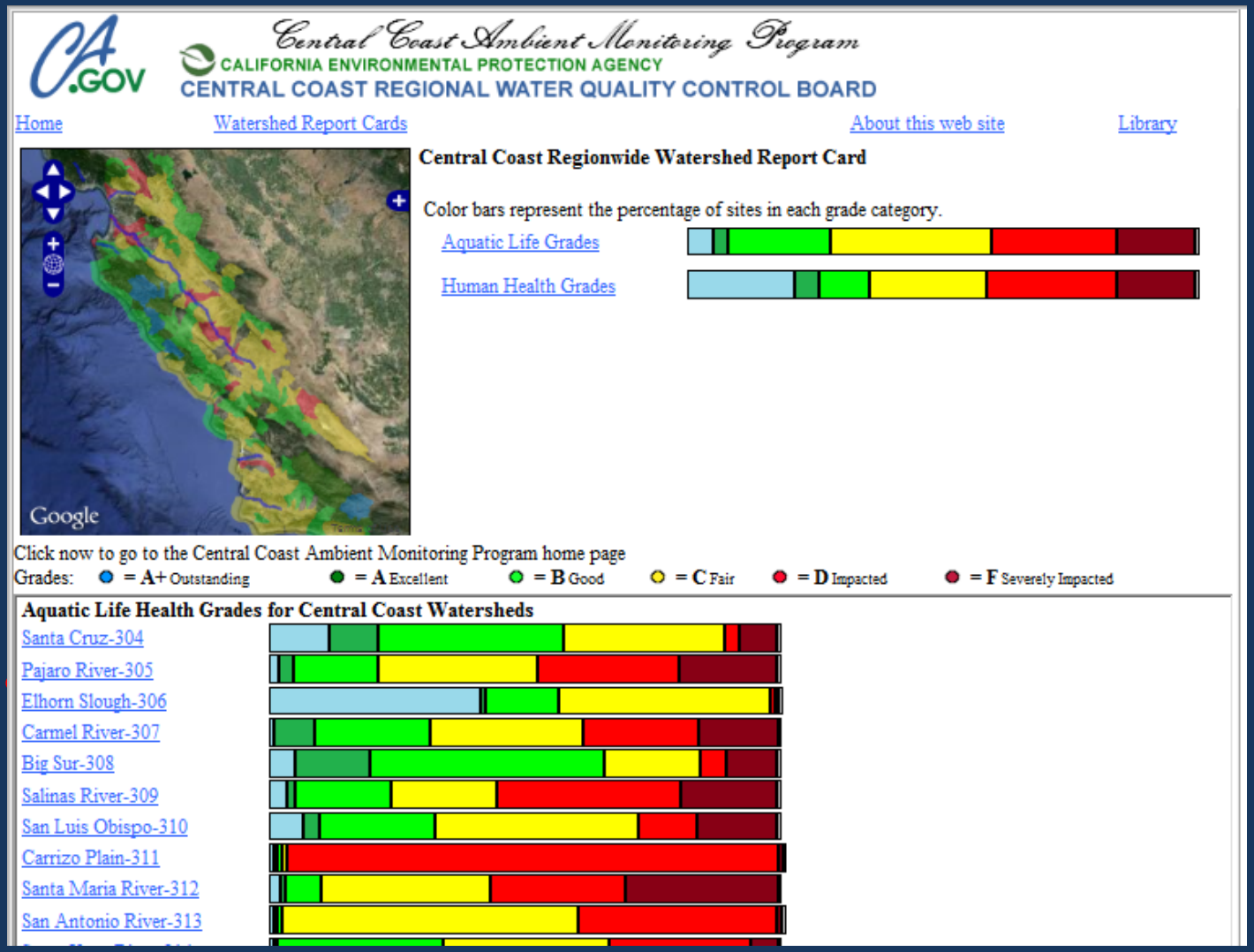
III. Trends in indices and trends in spatial areas (but not in this talk)

I. Integrating Multiple Data Types into a Watershed Health Report Card

Design Principles

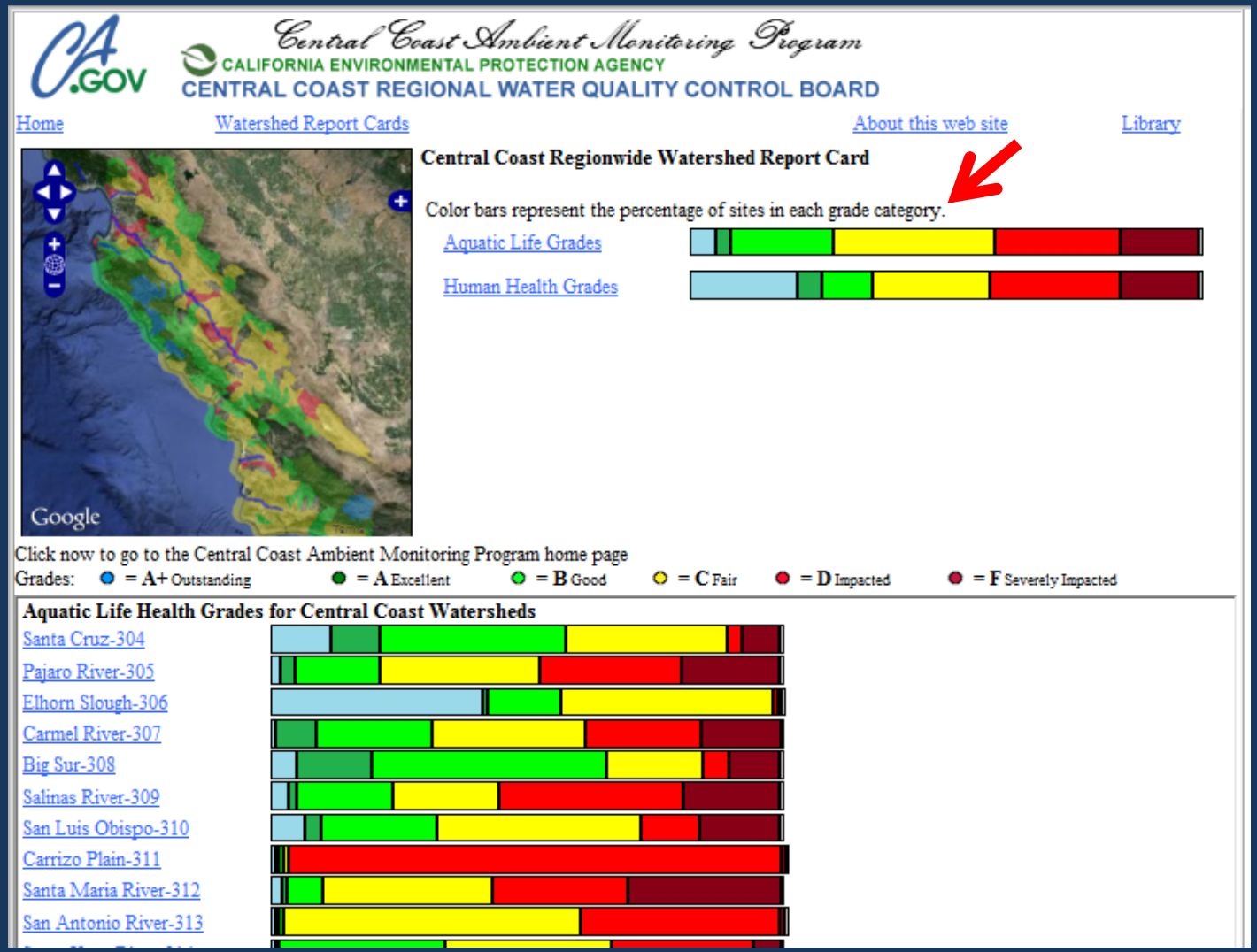
- User-friendly web environment
- Data from readily available sources
- Software rescores report card as data is updated
- Consistent, threshold-based scoring approach
- Health, not harm
- Drill down for detail

Healthy Watersheds Web Report Card



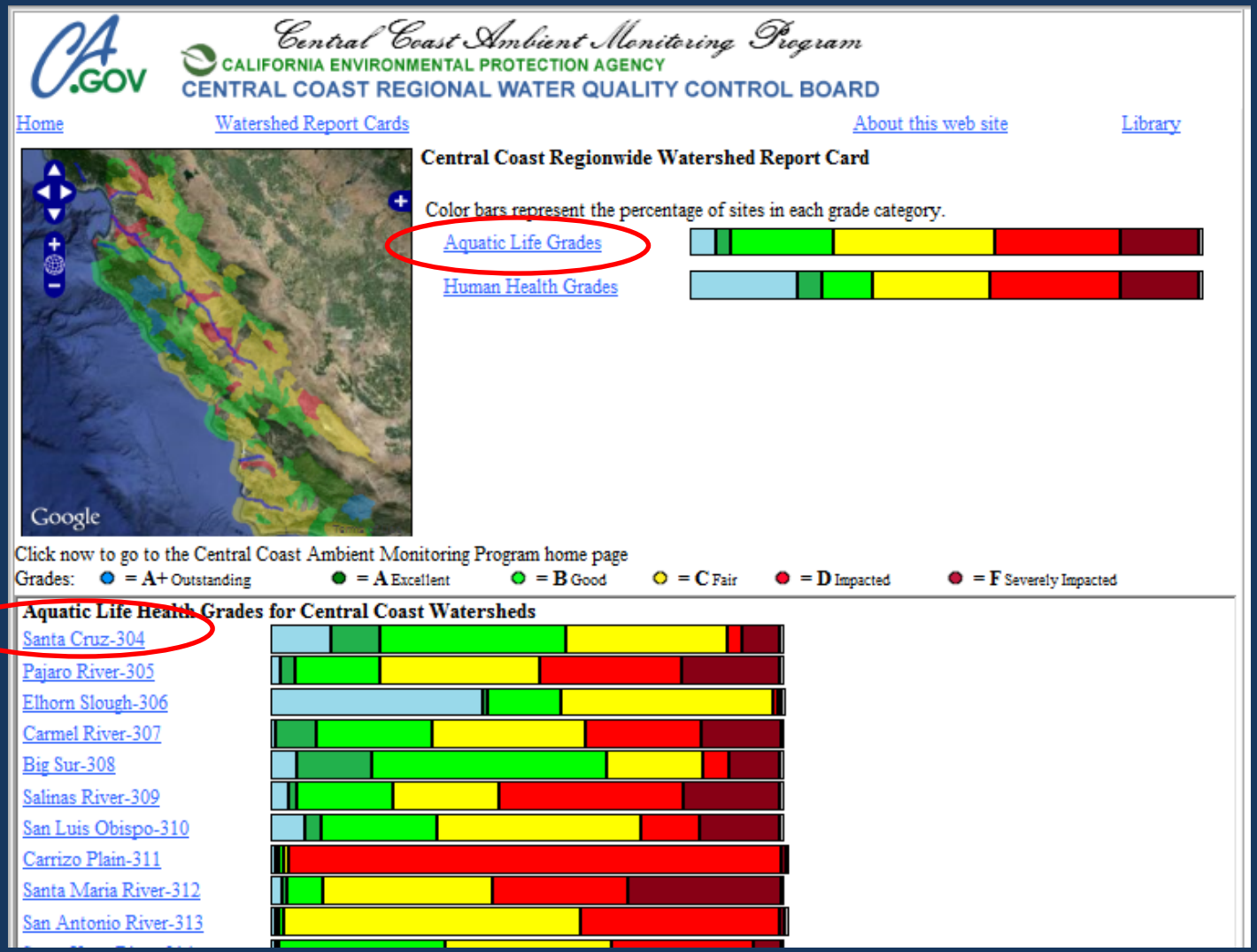
(not yet publically available)

Healthy Watersheds Web Report Card



(not yet publically available)

Healthy Watersheds Web Report Card



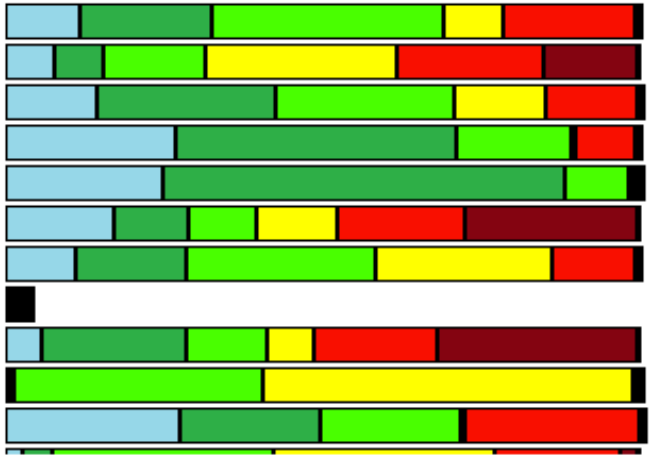
(not yet publically available)

CENTRAL COAST AMBIENT MONITORING PROGRAM

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD

Aquatic Life Health Grades for Central Coast Watersheds



Sturgeon Generals Warning: this web app is a very rough work in progress version.

Grades: ● = **A+** Outstanding ● = **A** Excellent ● = **B** Good ● = **C** Fair ● = **D** Impacted ● = **F** Severely Impacted

Aquatic Life Grades for Waterbodies in the Santa Cruz Watershed

Watersheds

Waterbody	Aquatic Life Grade	Aquatic Life Score
Aptos Creek	B	89
Arana Gulch Creek	B	85
Bear Creek(Santa Cruz County)	B	83
Boulder Creek	B	85
Branciforte Creek	A	92
Gazos Creek	D	61
Kings Creek	not yet	
Lompico Creek	B	86
Majors Creek (Santa Cruz County)	not yet	
San Lorenzo Estuary	B	84
San Lorenzo River	A	91

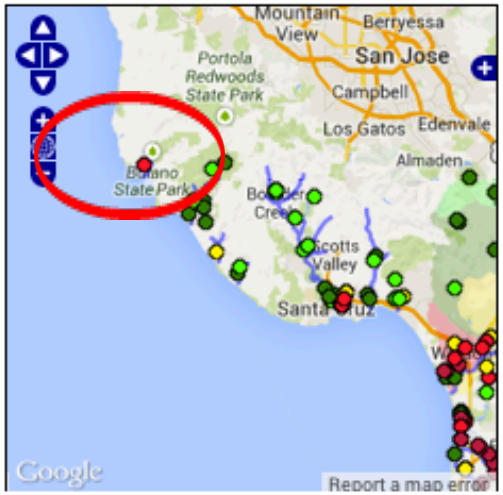
CENTRAL COAST AMBIENT MONITORING PROGRAM

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

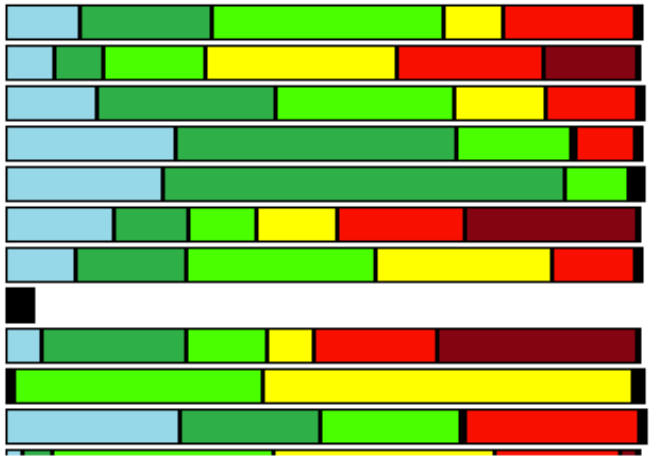
CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD

Wiki Work

Home | Central Coast Watershed Report Card | About this web site | Library | Data Navigator



Aquatic Life Health Grades for Central Coast Watersheds



Sturgeon Generals Warning: this web app is a very rough work in progress version.

Grades: ● = **A+** Outstanding ● = **A** Excellent ● = **B** Good ● = **C** Fair ● = **D** Impacted ● = **F** Severely Impacted

Aquatic Life Grades for Waterbodies in the Santa Cruz Watershed

Watersheds

Waterbody	Aquatic Life Grade	Aquatic Life Score
Aptos Creek	B	89
Arana Gulch Creek	B	85
Bear Creek(Santa Cruz County)	B	83
Boulder Creek	B	85
Branciforte Creek	A	92
Gazos Creek	D	61
Kings Creek	not yet	
Lompico Creek	B	86
Majors Creek (Santa Cruz County)	not yet	
San Lorenzo Estuary	B	84
San Lorenzo River	A	91

CENTRAL COAST AMBIENT MONITORING PROGRAM

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD

Aquatic Life Grades for Waterbodies in the Santa Cruz Watershed

Watersheds

Waterbody	Aquatic Life Grade	Aquatic Life Score
Aptos Creek	B	89
Arana Gulch Creek	B	85
Bear Creek(Santa Cruz County)	B	83
Boulder Creek	B	85
Branciforte Creek	A	92
Gazos Creek	D	61
Kings Creek	not yet	
Lompico Creek	B	86
Majors Creek (Santa Cruz County)	not yet	
San Lorenzo Estuary	B	84
San Lorenzo River	A	91
San Vicente Creek	A	92
Santa Cruz Harbor	D	60

Sturgeon Generals Warning: this web app is a very rough work in progress version.

Grades: = **A+** Outstanding = **A** Excellent = **B** Good = **C** Fair = **D** Impacted = **F** Severely Impacted

Aquatic Life Health Grades for Sites in the wb_id_280

Watersheds Waterbodies

Site	Site Name	Aquatic Life Grade	Aquatic Life Score
304GAZ	Gazos Creek Lagoon at Hwy 1	not yet	61

CENTRAL COAST AMBIENT MONITORING PROGRAM

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD

Wiki Work

Aquatic Life Grades for Waterbodies in the Santa Cruz Watershed

Watersheds

Waterbody	Aquatic Life Grade	Aquatic Life Score
Aptos Creek	B	89
Arana Gulch Creek	B	85
Bear Creek(Santa Cruz County)	B	83
Boulder Creek	B	85
Branciforte Creek	A	92
Gazos Creek	D	61
Kings Creek	not yet	
Lompico Creek	B	86
Majors Creek (Santa Cruz County)	not yet	
San Lorenzo Estuary	B	84
San Lorenzo River	A	91
San Vicente Creek	A	92
Santa Cruz Harbor	D	60

Sturgeon Generals Warning: this web app is a very rough work in progress version.

Grades: = **A+** Outstanding = **A** Excellent = **B** Good = **C** Fair = **D** Impacted = **F** Severely Impacted

Aquatic Life Health Grades for Sites in the wb_id_280

Watersheds Waterbodies

Site	Site Name	Aquatic Life Grade	Aquatic Life Score
304GAZ	Gazos Creek Lagoon at Hwy 1	not yet	61

CENTRAL COAST AMBIENT MONITORING PROGRAM

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD

Aquatic Life Grades for Waterbodies in the Santa Cruz Watershed

Watersheds

Waterbody	Aquatic Life Grade	Aquatic Life Score
Aptos Creek	B	89
Arana Gulch Creek	B	85
Bear Creek(Santa Cruz County)	B	83
Boulder Creek	B	85
Branciforte Creek	A	92
Gazos Creek	D	61
Kings Creek	not yet	
Lompico Creek	B	86
Majors Creek (Santa Cruz County)	not yet	
San Lorenzo Estuary	B	84
San Lorenzo River	A	91
San Vicente Creek	A	92
Santa Cruz Harbor	D	60

In the near future this map will change as you navigate this site.

Grades: = A+ Outstanding = **A** Excellent = **B** Good = **C** Fair = **D** Impacted = **F** Severely Impacted

Gazos Creek Lagoon at Hwy 1 (304GAZ)

Watersheds | Waterbodies | Sites

Aquatic Life	Conventional Analytes	Biostimulation	Benthics	Toxicity	Metals	Organic Chemicals	Hydrocarbons
D (61)	95	88			79	23	96

Human Health	Nitrogen Species	Salts	Pathogens	Metals	Organic Chemicals	Hydrocarbons	Groundwater
A (96)	98		85	100	100	100	

Auto text is incomplete. Lets explore drill down table work first. Also, syntax handlers (e.g. plural-singular, good site bad site) are not yet implemented.

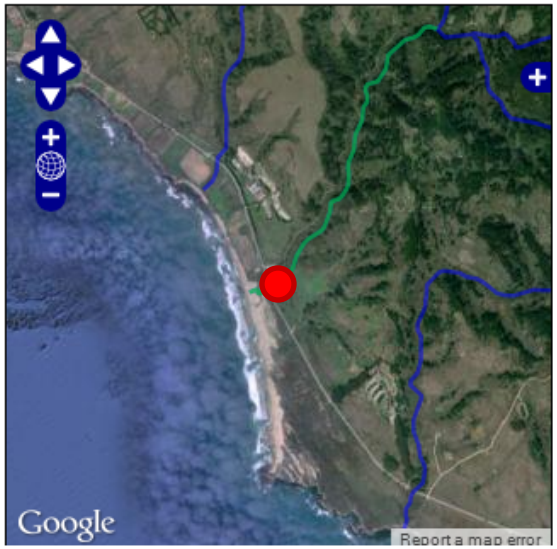
The Aquatic Health Grade of **D** (61) was based on scoring of ***n_analytes_aquatic_life analytes and ***n_samples individual tests. 0 conventional analytes were in poor or very poor condition. Other conventional analytes scored fair or better, with 9 in excellent or good condition. Of ***25 organic chemicals tested in water or sediment, ***5 were detected and ***2 scored poor or very poor; these were diazinon in water (2 samples) and chlorpyrifos in sediment (3 samples). No samples were collected for hydrocarbons. Of ***6 metals tested in water or sediment, ***6 were detected and ***2 scored poor or very poor; these were copper (5 total samples) and arsenic (3 samples). Benthic invertebrates scored ***D, and toxicity scored C overall, with ***invertebrates in sediment scoring lowest .

The Human Health Grade of **A** (96) was based on scoring of nitrogen and pathogen indicators in surface water only. Groundwater is not assessed at the level of the site. Nitrate scored ***C and exceeded the drinking water standard in ***4 of ***63 samples. Pathogen indicators scored ***B when evaluated relative to water body contact thresholds. ***3 analytes showed increasing concentrations over time; these include ***nitrate, ***turbidity, and ***diazinon. ***2 analytes showed decreasing concentrations over time; these include ***chlorophyll a and ***pH. No trends in loads were detected.

Central Coast Ambient Monitoring Program

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD



Gazos Creek Lagoon at Hwy 1 (304GAZ)

Watersheds Waterbodies Sites

*	Analyte	Units	Matrix	Min	Mean	Max	# Samples	Grade	Score	Threshold
●	Chlorfenvinphos	ug/l	water	0	0	0	1	A	100	0.028
●	Coumaphos	ug/l	water	0	0	0	1	A	100	0.0074
●	DDT, total	ug/kg dw	sediment	13.1	13.1	13.1	1	F	38	5.28
●	Dieldrin	ug/kg dw	sediment	0	0	0	1	A	100	2.85
●	Methyl Parathion	ug/kg dw	sediment	0	0	0	1	A	100	15.8

Grades: ● = **A+** Outstanding ● = **A** Excellent ● = **B** Good ● = **C** Fair ● = **D** Impacted ● = **F** Severely Impacted

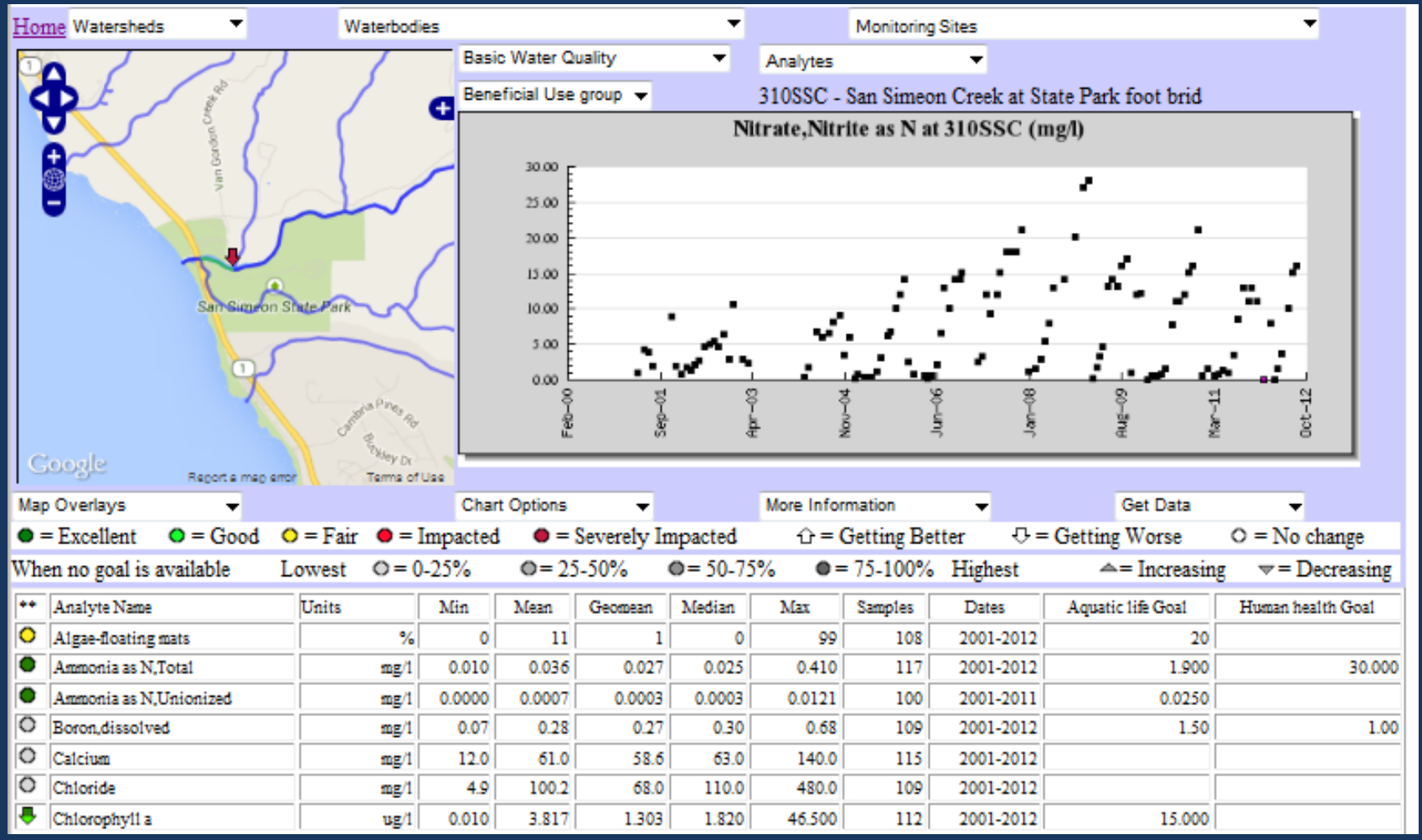
Gazos Creek Lagoon at Hwy 1 (304GAZ)

Watersheds Waterbodies Sites

Aquatic Life	Conventional Analytes	Biostimulation	Benthics	Toxicity	Metals	Organic Chemicals	Hydrocarbons
D (64)	95	92			47	38	

Human Health	Nitrogen Species	Salts	Pathogens	Metals	Organic Chemicals	Hydrocarbons	Groundwater
B (89)	99	72	83	100	100		

Report Card will connect to CCAMP Data Navigator to access data, maps, graphs, summary stats, trend analysis and other statistical tools



**	Analyte Name	Units	Min	Mean	Geomean	Median	Max	Samples	Dates	Aquatic life Goal	Human health Goal
○	Algae-floating mats	%	0	11	1	0	99	108	2001-2012	20	
●	Ammonia as N,Total	mg/l	0.010	0.036	0.027	0.025	0.410	117	2001-2012	1.900	30.000
●	Ammonia as N,Unionized	mg/l	0.0000	0.0007	0.0003	0.0003	0.0121	100	2001-2011	0.0250	
○	Boron,dissolved	mg/l	0.07	0.28	0.27	0.30	0.68	109	2001-2012	1.50	1.00
○	Calcium	mg/l	12.0	61.0	58.6	63.0	140.0	115	2001-2012		
○	Chloride	mg/l	4.9	100.2	68.0	110.0	480.0	109	2001-2012		
▼	Chlorophyll a	ug/l	0.010	3.817	1.303	1.820	46.500	112	2001-2012	15.000	

Scoring Approach

- Adapted from Canadian Water Quality Index (CCME)
- Magnitude and exceedance components
  - the Magnitude Exceedance Quotient or "MEQ"
- Follows report card paradigm

A	100	to	90	Excellent
B	90	to	80	Good
C	80	to	65	Fair
D	65	to	45	Poor
F	45	to	1	Very Poor

Also, Outstanding (A+) designation for "Blue Water Streams" that have an overall Index score of 95 or higher.

Canadian CCME Water Quality Index (WQI) has three factors

Factor 1: Scope

- % of variables that fail

Factor 2: Frequency (Exceedance)

- % of tests that fail

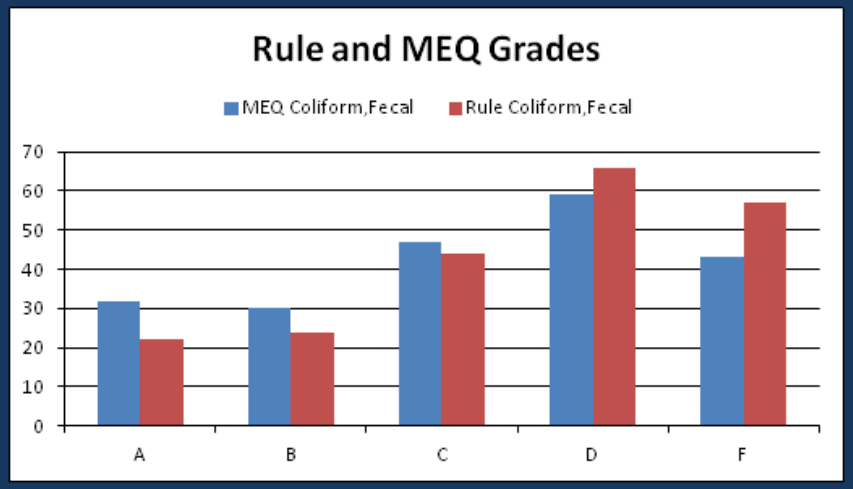
Factor 3: Amplitude (Magnitude)

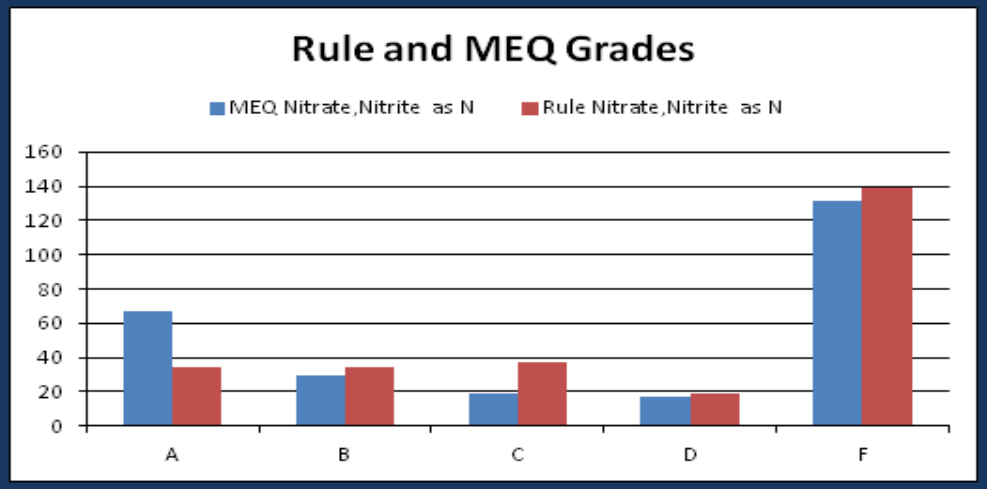
- *Magnitude of failed tests*

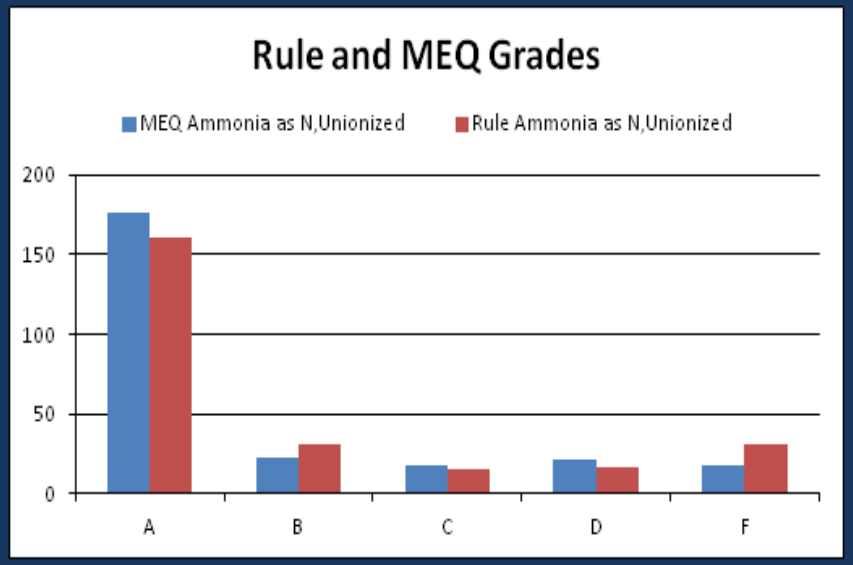
MEQ: modifications to CCME

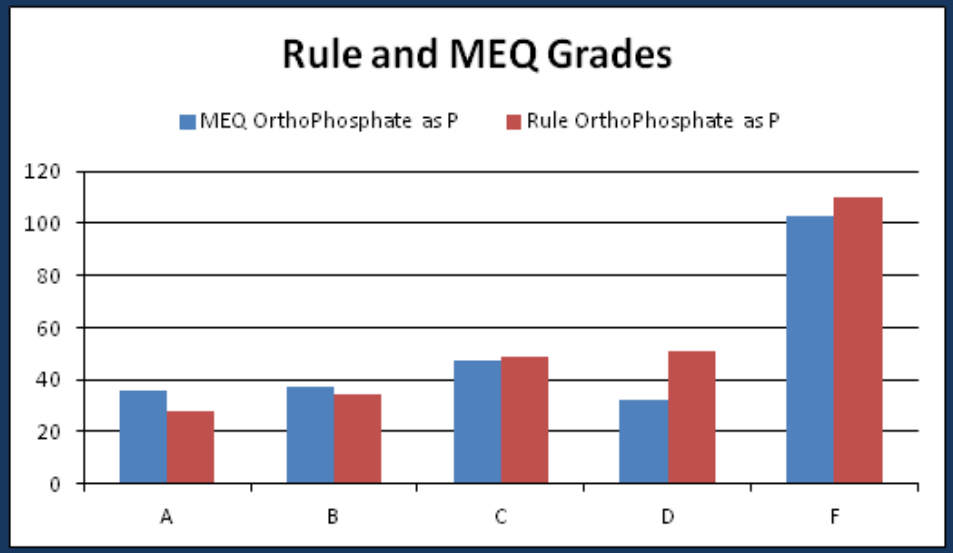
- Score all tests for magnitude, not just failed tests. (more differentiation of “good”)
- Eliminate scope term (percent of variables that fail) and use a different approach for aggregating parameters
- Special handling of some variables

We compared MEQ performance against an independent scoring approach

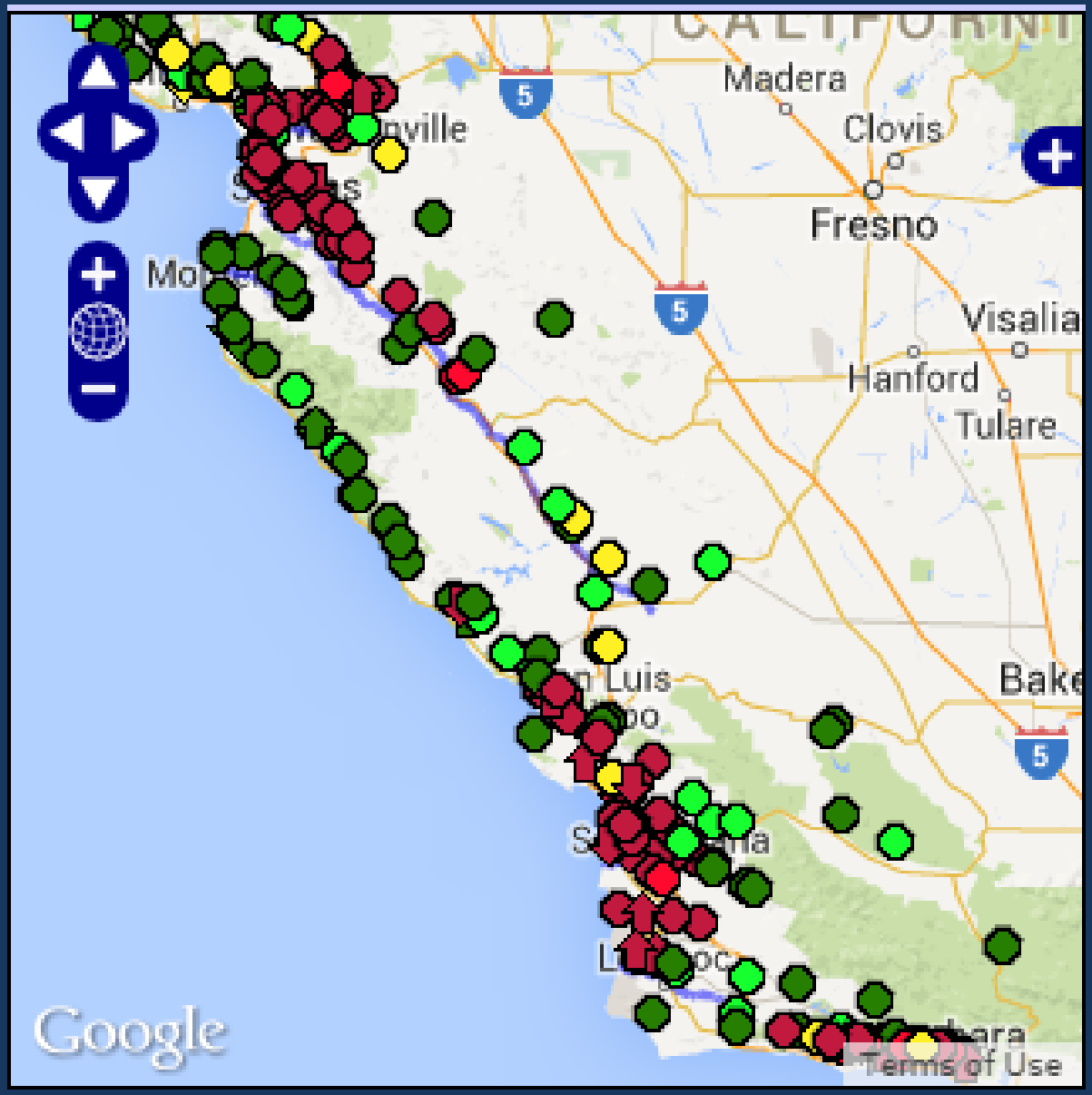








Scoring at site/analyte level….



Combining Measures into an Aquatic Life Index

Sub-Indices

- Conventional Analytes
- Toxicity
- Biostimulatory Risk
- Metals
- Organic Chemicals
- Biology
- Habitat

Aquatic Life Index

Conventional water quality

- pH departure
- Water temperature
- Nitrate - N
- Total and unionized ammonia
- Orthophosphate - P
- Total suspended solids
- Turbidity

Pesticides and other Organics

- sediment and water

Metals

- sediment and water

Biostimulation

- Oxygen departure
- Chlorophyll a (ug/L)
- % floating mats
- NNE oxygen deficit
- NNE predicted benthic chlorophyll biomass

Toxicity

- Algal cell growth
- Fish survival
- Fish growth
- Invert survival in water
- Invert reproduction in water
- Invert survival in sediment

Aquatic Life Index, cont.

Biology

- Benthic invertebrates
- Soft-bodied algae
- Periphyton
- Other? Fish, amphibians, etc…

Habitat (*stay tuned for Kevin and Ross's talk!)*

- Watershed-scaled riparian assessment using imagery analysis in combination with field measures (Central Coast Wetlands Group)
- CRAM

Aggregation of MEQ Scores into Indices

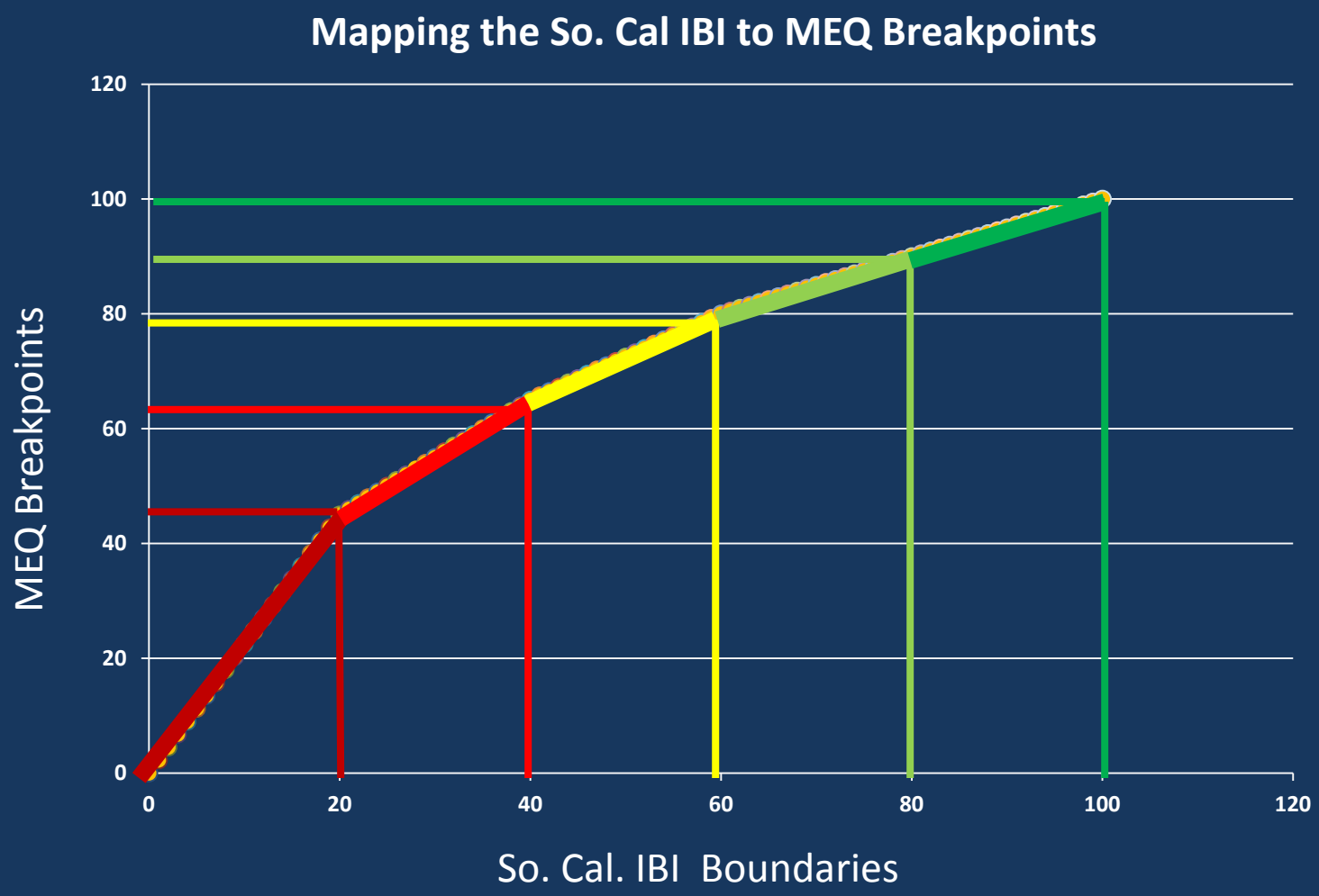
At the level of the Sub-Index

- Arithmetic Mean
- Geometric Mean
- Worst Score

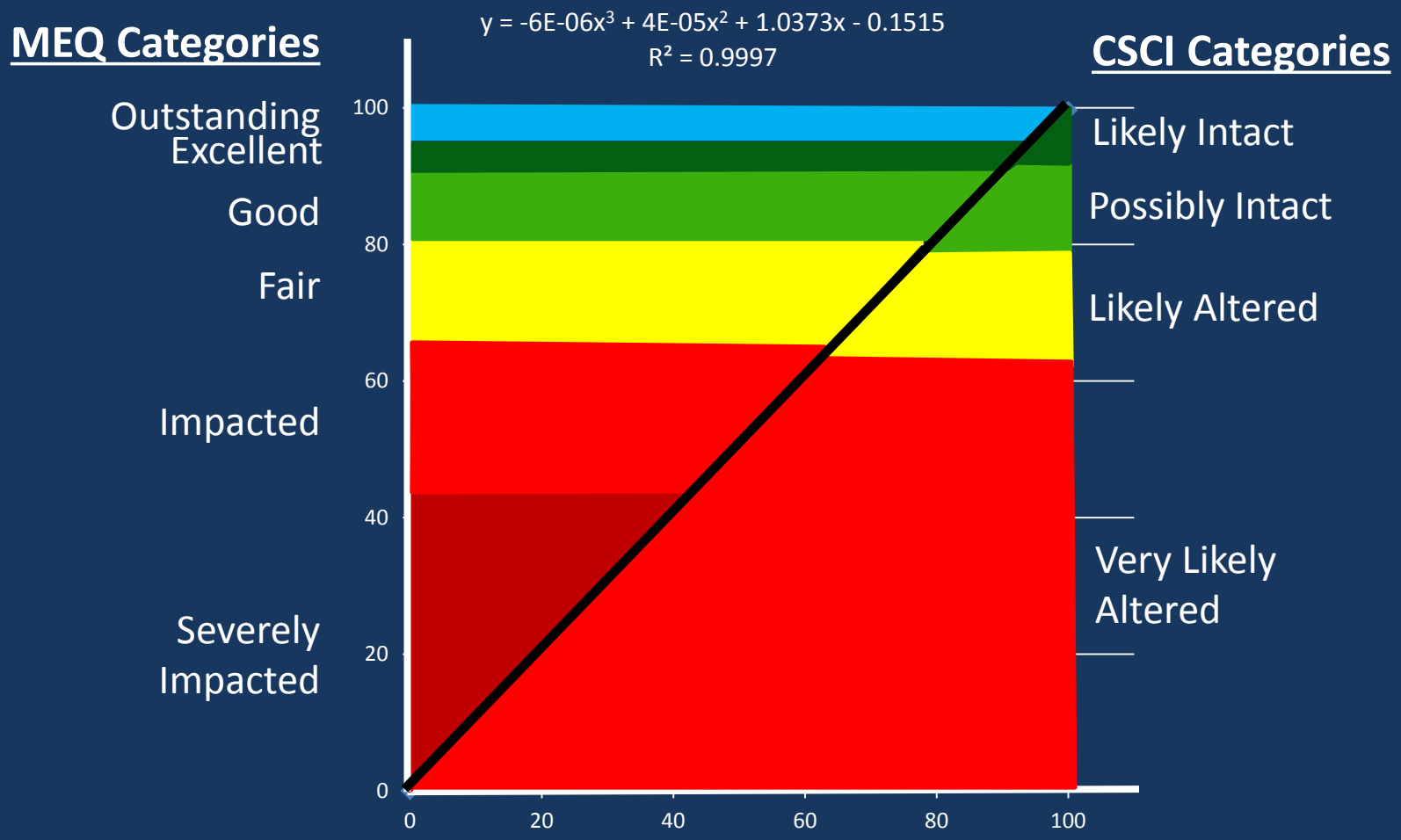
At the level of the Index (still in development)

- Geometric Mean
- Weighted Mean

Mapping multi-threshold scoring systems to MEQ



California Stream Condition Index (CSCI) breakpoints are very similar to CCME/MEQ



II. Integrating Site level data into a spatial assessment of whole watersheds

- Measured data overlaid on modeled data
- NHDPlus moves site scores upstream to reaches
- Land Use boundaries define spatial extent of scoring

Modeled data from California's recent Healthy Watersheds (CADMUS) Assessment

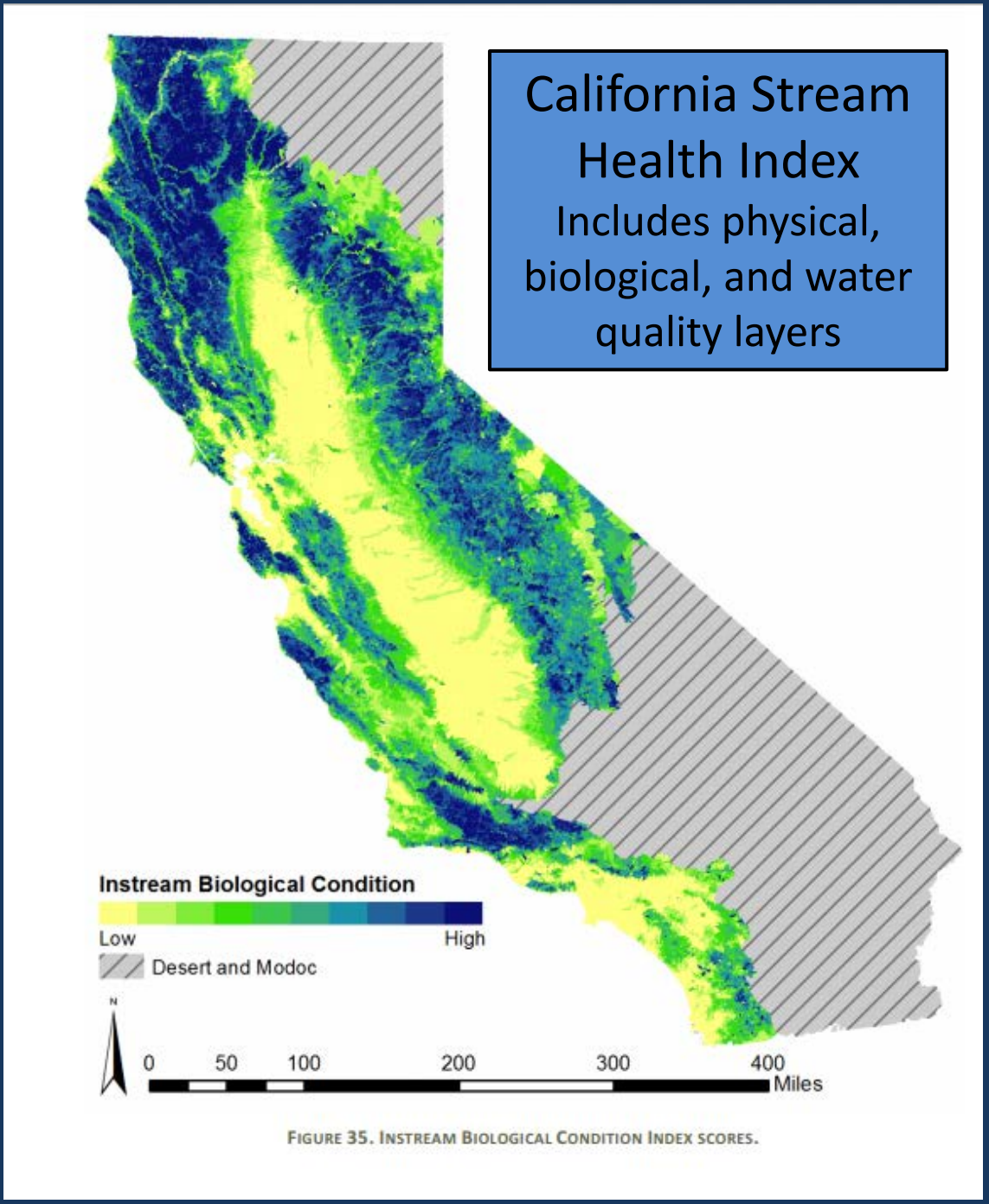
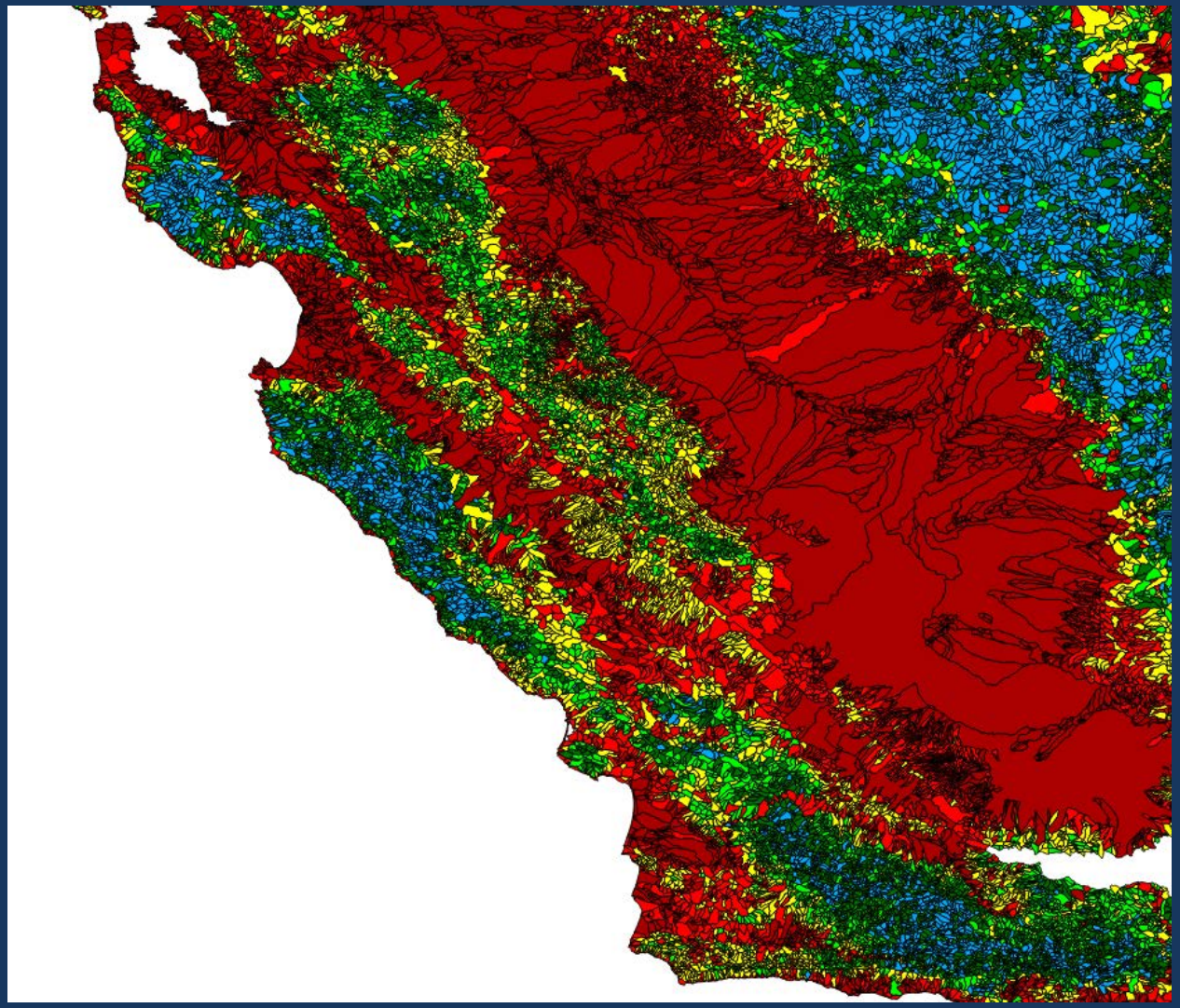
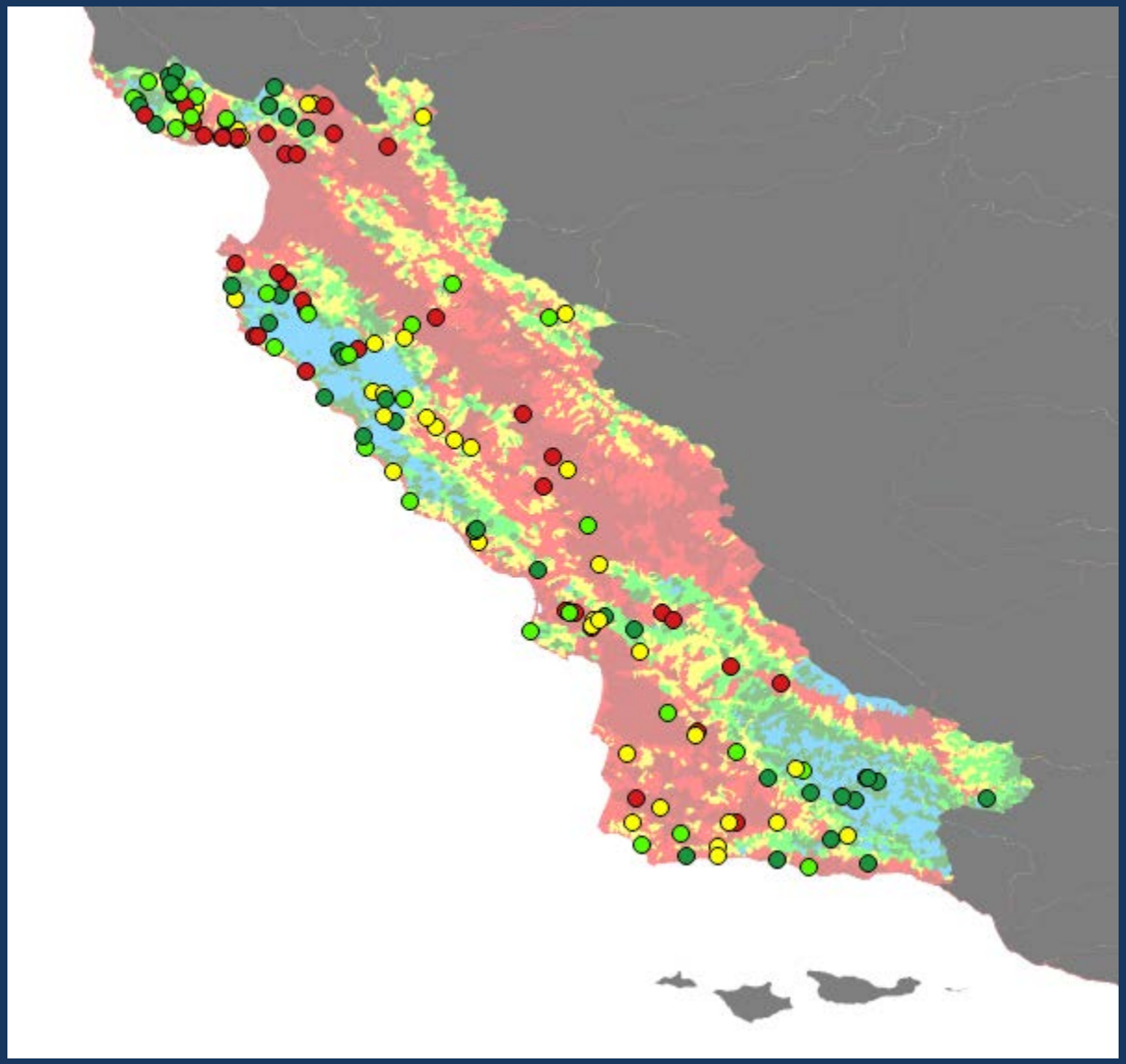


FIGURE 35. INSTREAM BIOLOGICAL CONDITION INDEX SCORES.

CADMUS Stream Health Index, using report card coloring paradigm



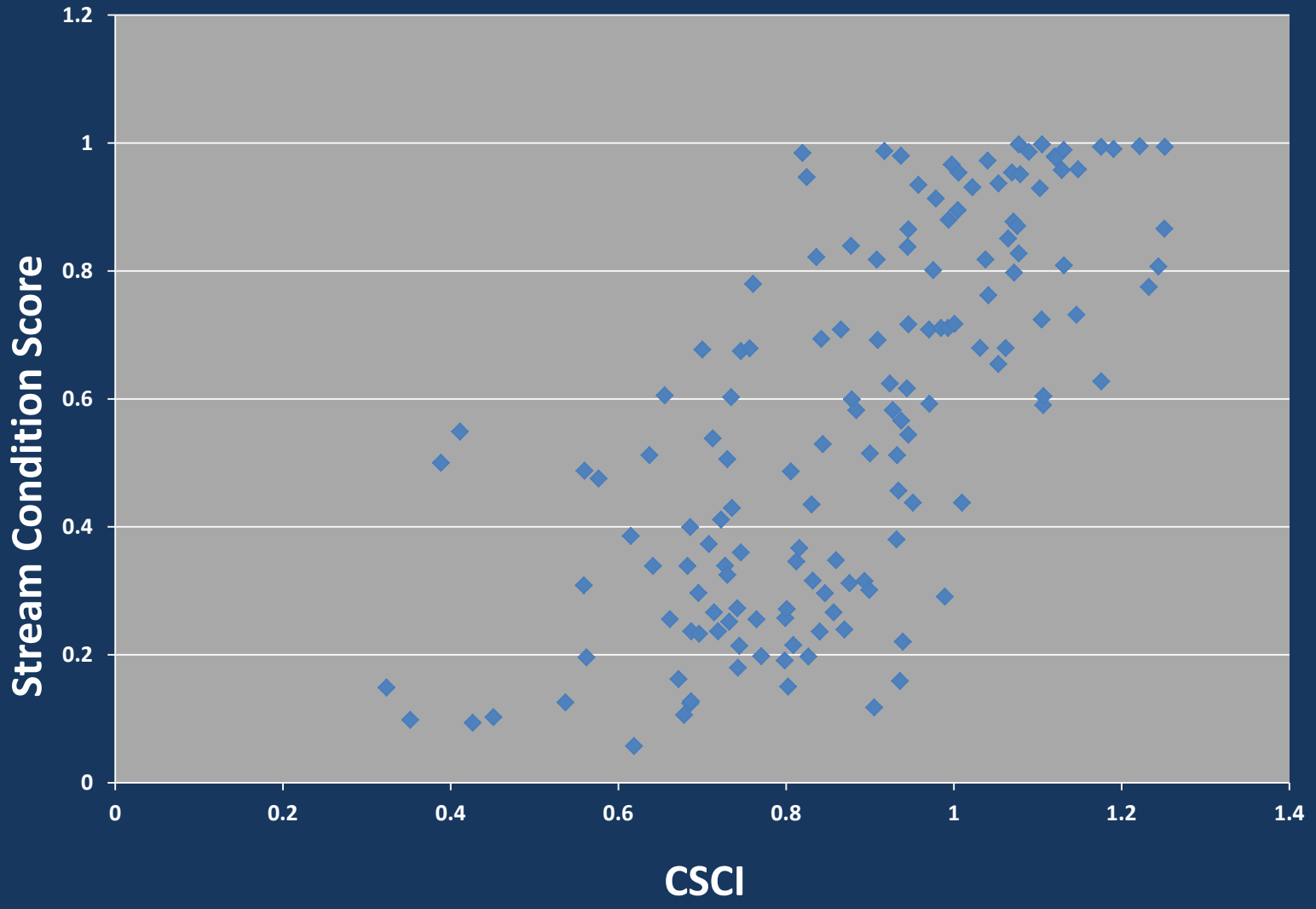
Central Coast CSCI site scores and CADMUS Stream Health



Mountain View
San Jose
La Honda
Campbell
Los Gatos
Santa Cruz
Monterey Bay
Google

Mountain View
San Jose
Campbell
Los Gatos
Santa Cruz
Monterey Bay
Google
Report a map error

Measured CSCI vs. Modeled Stream Health



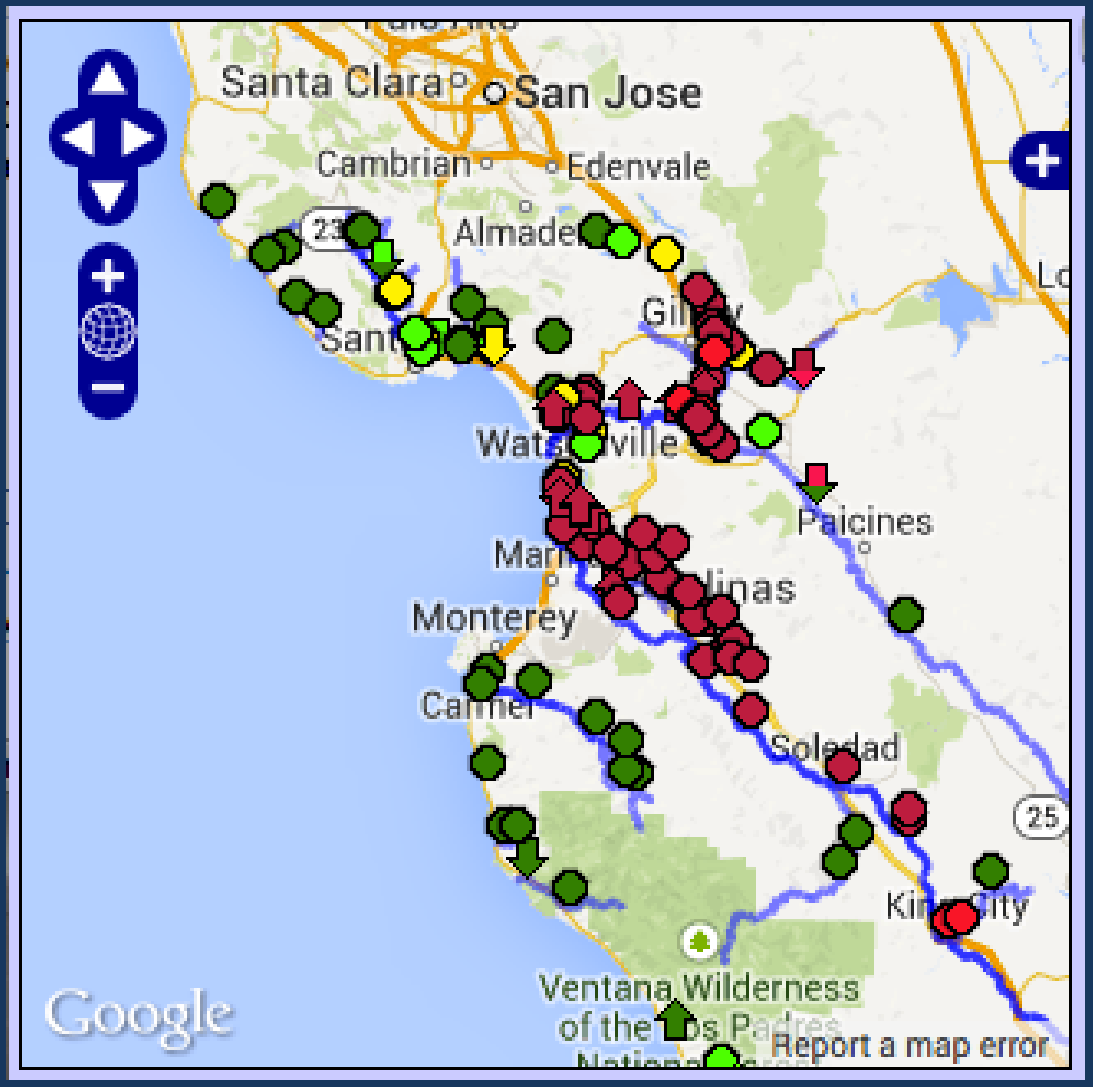
- We hope to have the Report Card ready in a first phase release for public use by Spring

- The State's Healthy Streams Workgroup would like to adapt this work for use in the "My Water Quality" Healthy Streams Portal

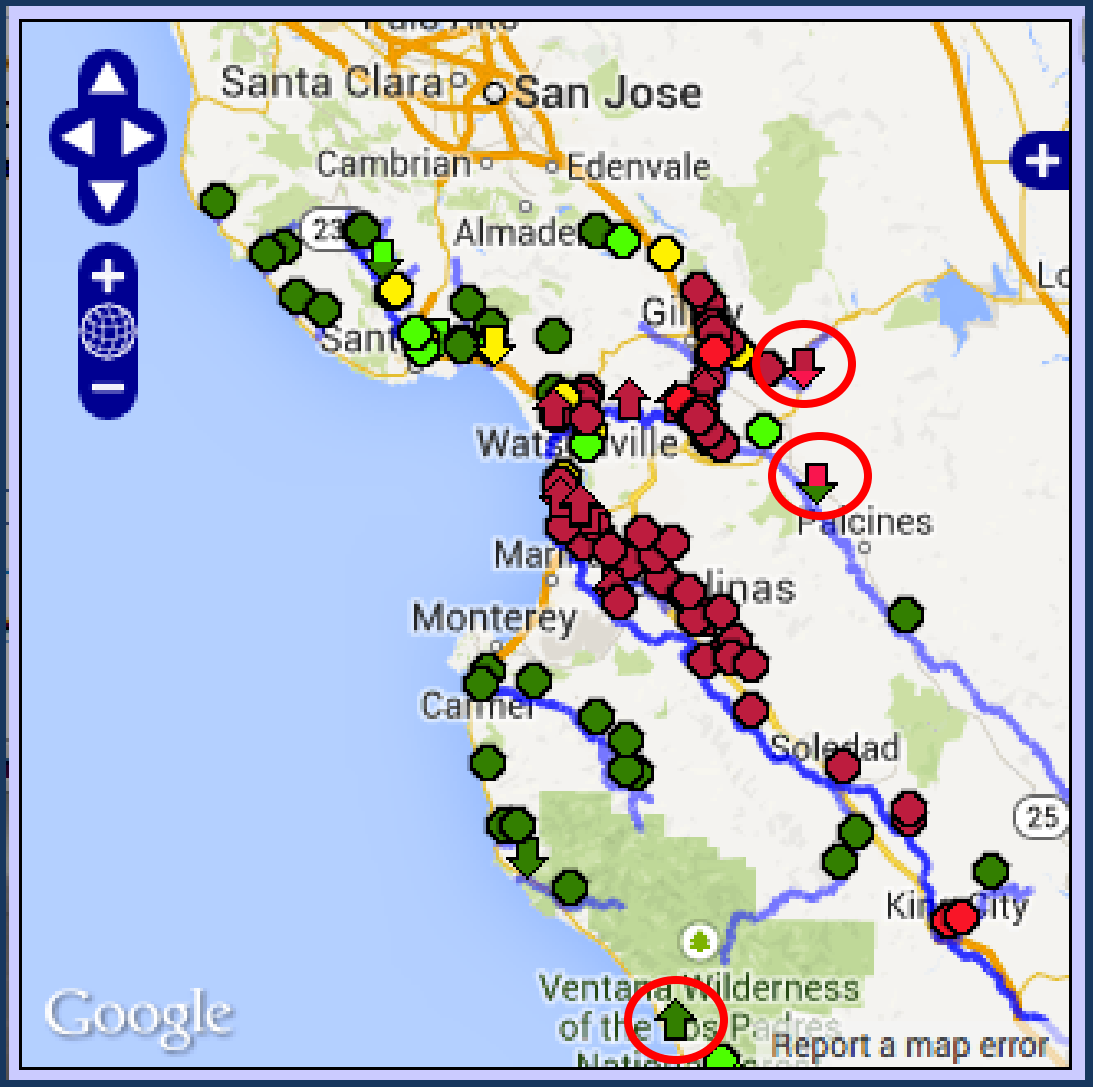
www.ccamp.org

III. Integrating trends in individual parameters at monitoring sites to trends in spatial areas

- Integrate trends from multiple analytes
- Associate site level trends with upstream reaches

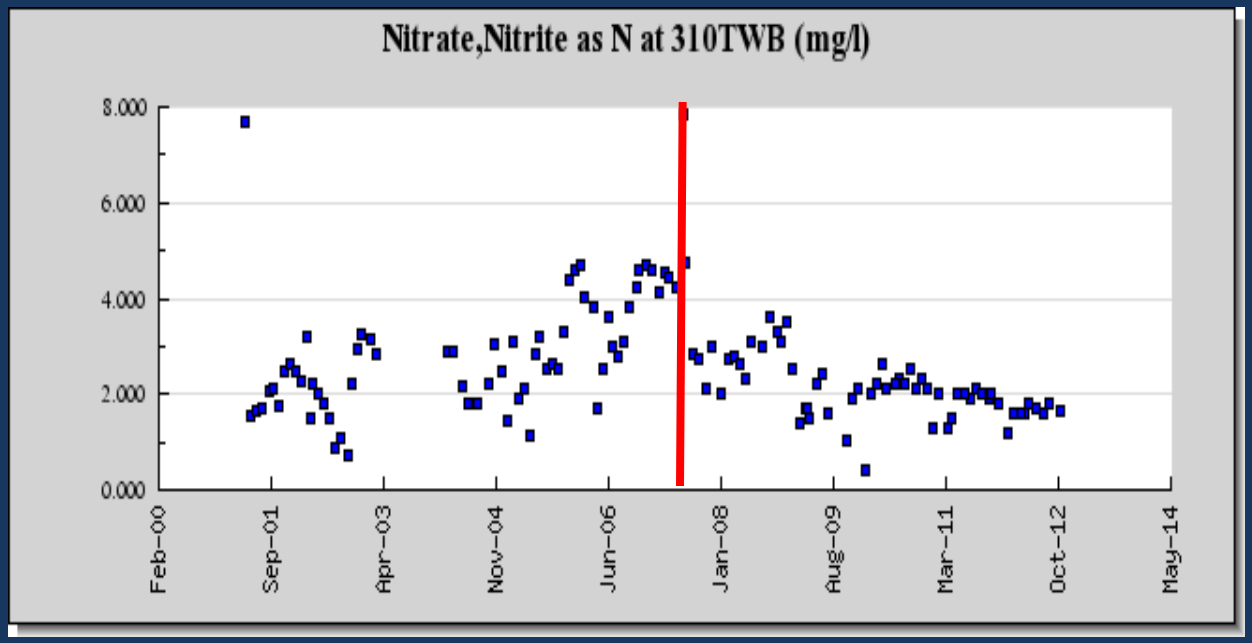


From our website: Nitrate in the Monterey Area



From our website: Nitrate in the Monterey Area (note arrow icons denoting change).

Change Point Analysis defines probable change points in a time series of data



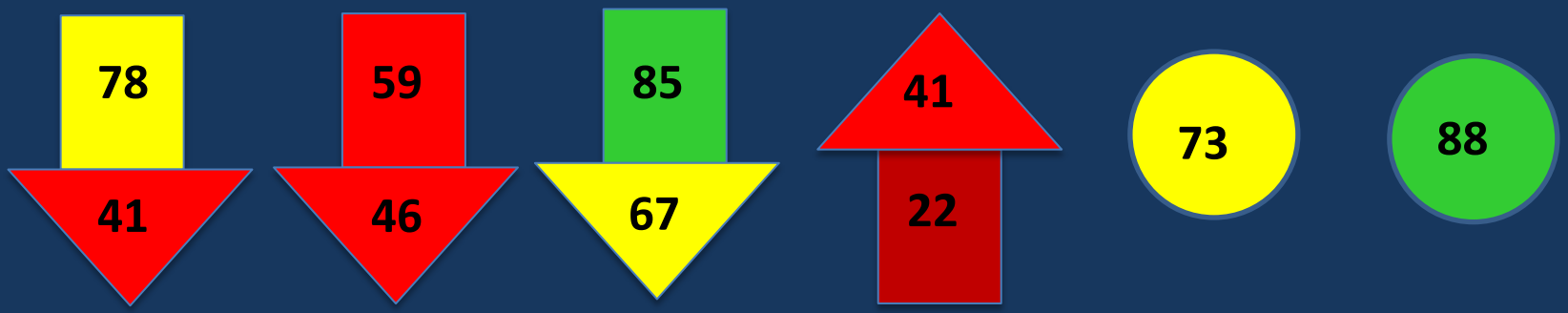
In this case, a treatment plant upgrade went online in May, 2007

Apply MEQ scoring to data on each side of Change Point to grade (color) two sections of arrow icon

We have found Change Point Analysis to be more useful than traditional trend analysis and are relying on it as our primary change scoring approach.

One Way to Aggregate Change Across Multiple Measures

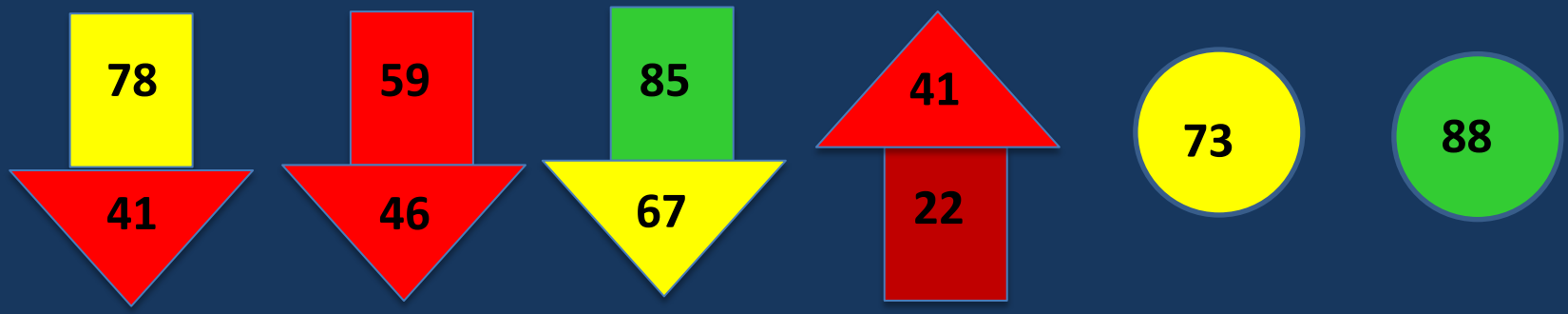
MEQ Grading Key			
A	100	to	90
B	90	to	80
C	80	to	65
D	65	to	40
F	45	to	1



Of six analytes that make up an index, 3 are getting worse, 1 is getting better and two show no change

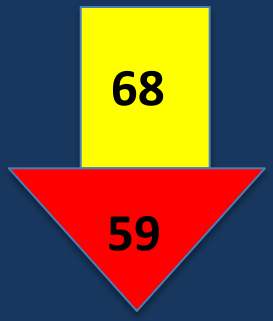
One Way to Aggregate Change Across Multiple Measures

MEQ Grading Key			
A	100	to	90
B	90	to	80
C	80	to	65
D	65	to	40
F	45	to	1



Before period: Mean (78 + 59 + 85 + 22 + 73 + 88) = 68

After period: Mean (41 + 46 + 67 + 41 + 73 + 88) = 59



At the level of the index, the site is getting worse