A Central Coast Water Quality Report Card For Healthy Watersheds

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What do water quality managers and decision-makers need from their data?

- Where is the problem?
- What is causing the problem?
- What land uses are associated with the problem?
- Where are our best places, that need to be protected?
- Where are places that could be enhanced or improved?
- Are things getting better or worse? Where??

We can answer these types of questions in an assessment report

But can we answer them with an online tool that updates as the data does??

We can…!

CENTRAL COAST AMBIENT MONITORING PROGRAM
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD

Wiki Work

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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 .

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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

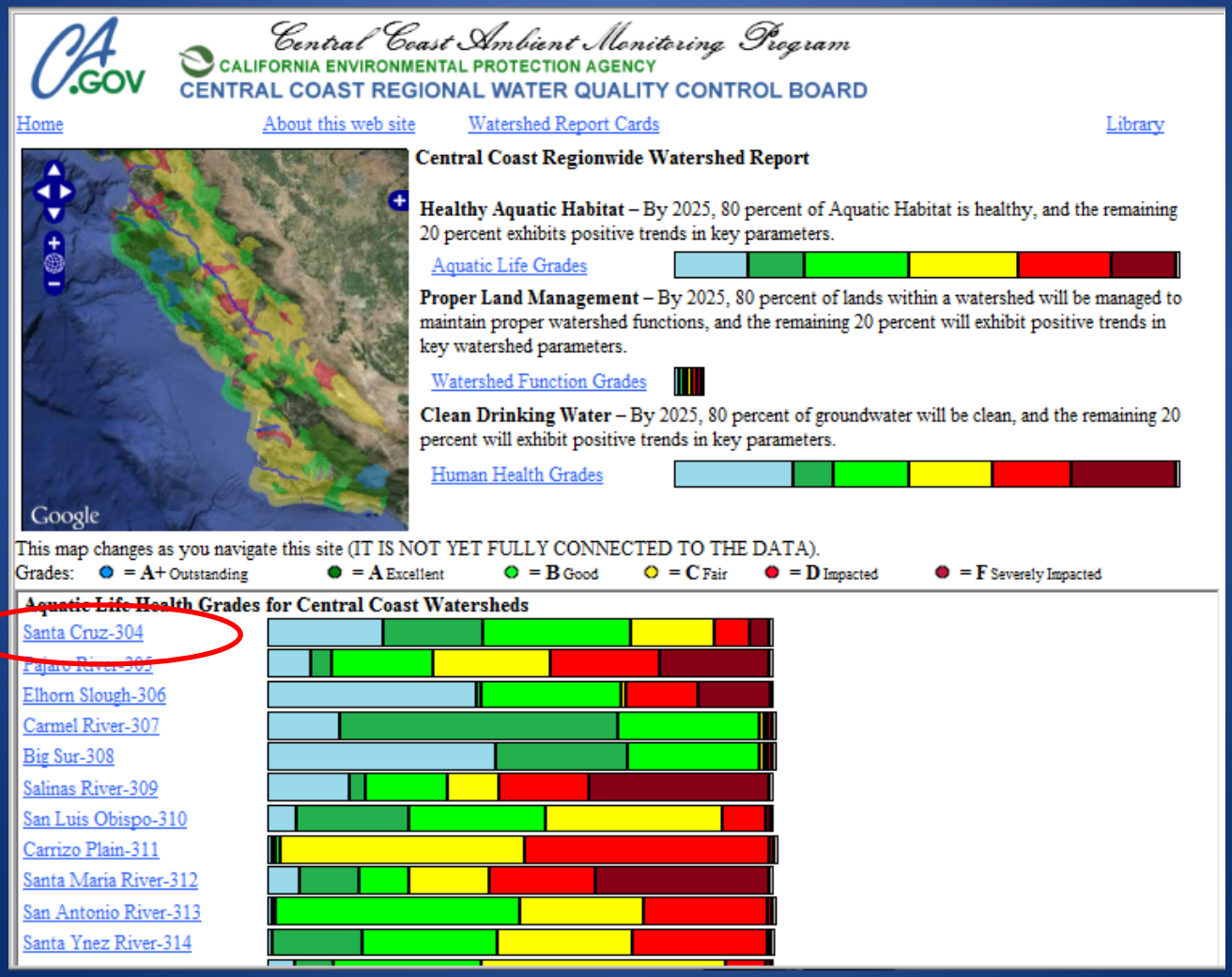
To assess our goals we needed to characterize both status (health) and change

- Multi-metric approach
- Measured and modeled data
- Consistent, threshold-based scoring approach
- Status and change at different scales
  - Analyte and multi-metric scales
  - Site, waterbody, and watershed scales

General principles

- Help the user answer Where, Why, What?
- Data from readily available online sources
- Data of documented quality
- Transparency of methods
- Drill down for detail
- Staff-maintained technical content via wikis

Healthy Watersheds Web Report Card, publically available later this year



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Central Coast Regionwide Watershed Report

Healthy Aquatic Habitat – By 2025, 80 percent of Aquatic Habitat is healthy, and the remaining 20 percent exhibits positive trends in key parameters.

Aquatic Life Grades

Proper Land Management – By 2025, 80 percent of lands within a watershed will be managed to maintain proper watershed functions, and the remaining 20 percent will exhibit positive trends in key watershed parameters.

Watershed Function Grades

Clean Drinking Water – By 2025, 80 percent of groundwater will be clean, and the remaining 20 percent will exhibit positive trends in key parameters.

Human Health Grades

This map changes as you navigate this site (IT IS NOT YET FULLY CONNECTED TO THE DATA).

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

Aquatic Life Health Grades for Central Coast Watersheds

Santa Cruz-304
Pajaro River-305
Elhorn Slough-306
Carmel River-307
Big Sur-308
Salinas River-309
San Luis Obispo-310
Carrizo Plain-311
Santa Maria River-312
San Antonio River-313
Santa Ynez River-314

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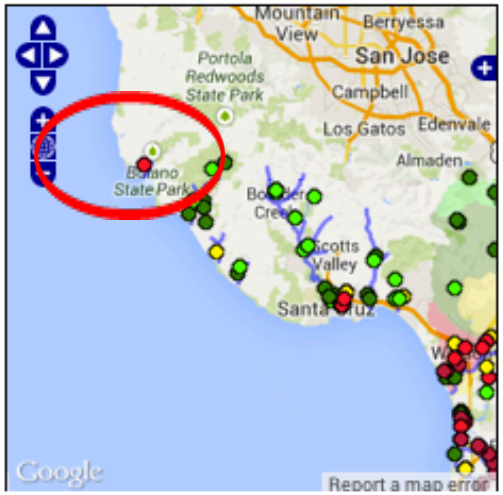
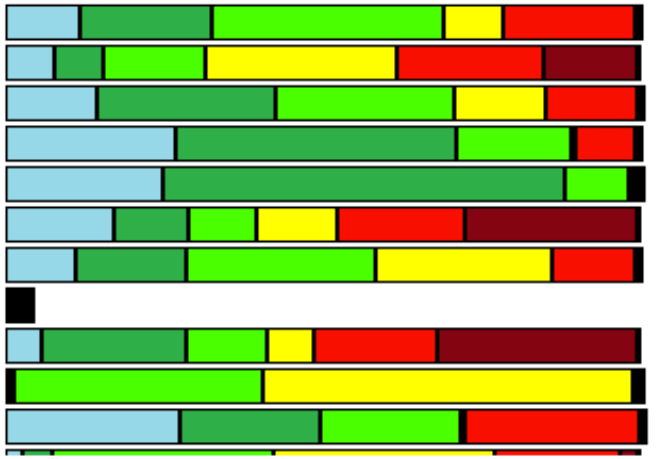


Aquatic Life Health Grades for Central Coast Watersheds



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

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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

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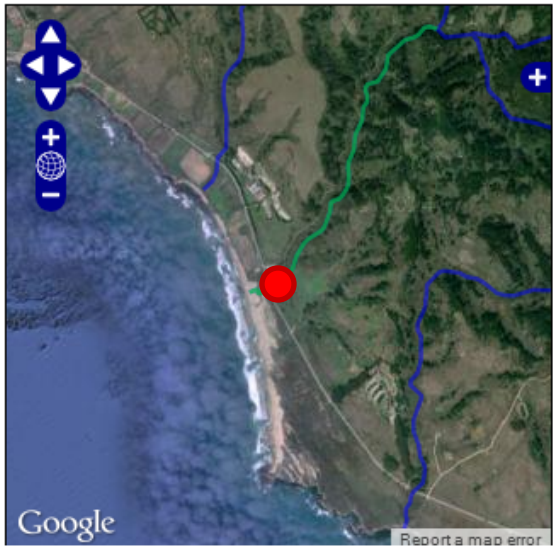

Gazos Creek Lagoon at Hwy 1 (304GAZ)

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

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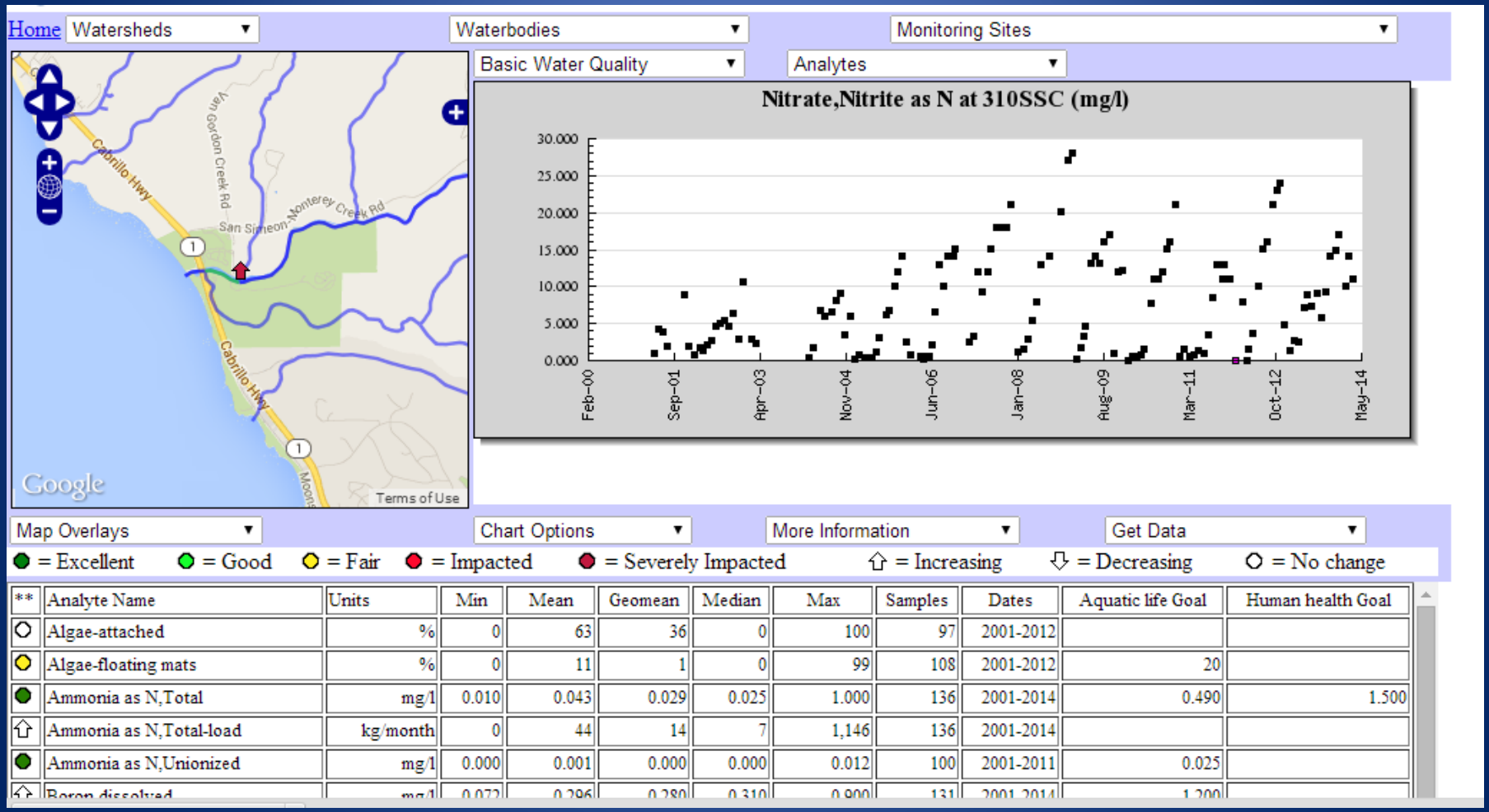
D (64)	95	92			47	38	

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

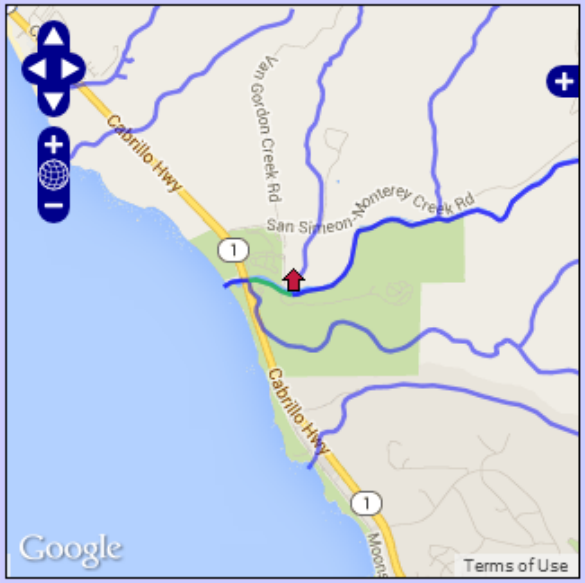
Report Card will connect to CCAMP Data Navigator to access data, maps, graphs, summary stats, trend analysis and other statistical tools

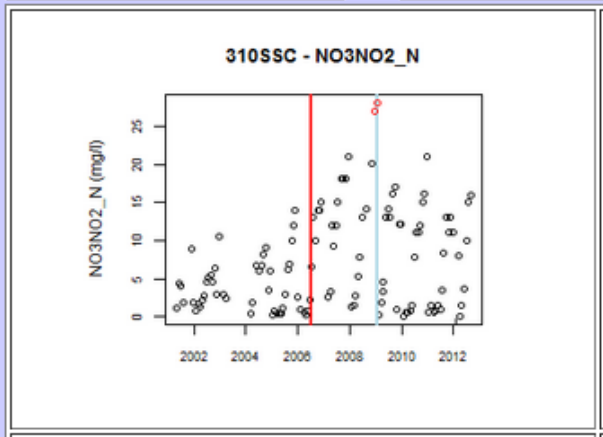


**	Analyte Name	Units	Min	Mean	Geomean	Median	Max	Samples	Dates	Aquatic life Goal	Human health Goal
○	Algae-attached	%	0	63	36	0	100	97	2001-2012		
○	Algae-floating mats	%	0	11	1	0	99	108	2001-2012	20	
●	Ammonia as N,Total	mg/l	0.010	0.043	0.029	0.025	1.000	136	2001-2014	0.490	1.500
⇧	Ammonia as N,Total-load	kg/month	0	44	14	7	1,146	136	2001-2014		
●	Ammonia as N,Unionized	mg/l	0.000	0.001	0.000	0.000	0.012	100	2001-2011	0.025	
⇧	Boron,dissolved	mg/l	0.072	0.296	0.280	0.310	0.900	131	2001-2014	1.200	

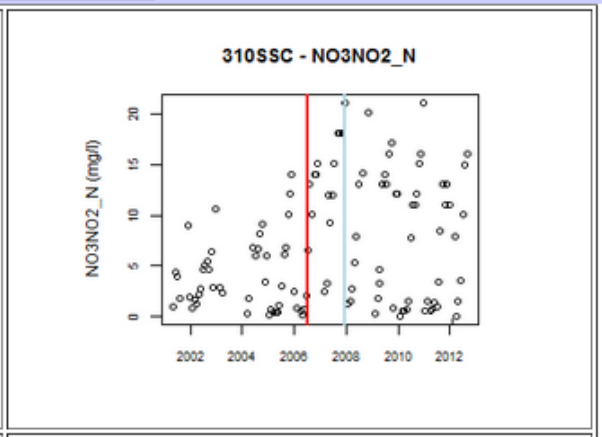
Change analysis at San Simeon Creek

Home | Watersheds | Waterbodies | Monitoring Sites | Basic Water Quality | Analytes





Unusual events (outliers) shown in red



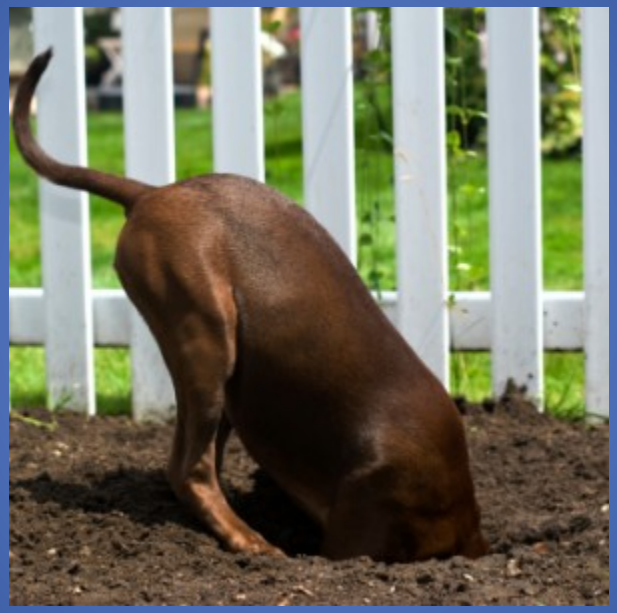
Assessment excluding unusual events

Map Overlays | Chart Options | More Information | Get Data

● = Excellent ● = Good ● = Fair ● = Impacted ● = Severely Impacted ⇧ = Increasing ⇩ = Decreasing ○ = No change

*	Analyte	Units	Change	Trend	Date of Change	Before	After	% Change
⇧	Ammonia as N,Total-load (NH3_N_LOAD)	mg/l	Increasing	Decreasing	Dec 06 2004	12.1	23.6	95%
⇧	Boron,dissolved (BORON_DIS)	mg/l	Increasing	No trend	May 14 2013	0.28	0.36	29%
⇧	Chloride (CHLORIDE)	mg/l	Increasing	Increasing	Mar 28 2012	95	161	69%
⇧	Chlorophyll a (CHLORA)	ug/l	Increasing	Increasing	Apr 09 2009	2.1	3.2	52%
⇩	Chlorophyll a-load (CHLORA_LOAD)	ug/l	Decreasing	Increasing	Feb 01 2011	3765	929	-75%
○	Coliform,ecoli-load (ECOLI_LOAD)	mpn/100 ml	No change	Decreasing				0%
○	Coliform,fcoli-load (FCOLI_LOAD)	mpn/100 ml	No change	Decreasing				0%

Digging into the details…



Setting Chemical Thresholds in Sediment and Water

Our system is designed to allow selection of different thresholds for different purposes

Threshold Selection

- Various sources
  - Marshack (2014) water quality goals
  - US EPA Aquatic life benchmarks
  - New USGS health-based screening levels
  - Canadian Water Quality Goals
  - Scientific literature
- Tiered selection criteria
  - Adopted standards
  - Recommended guidelines
  - Scientific literature
- Software supported threshold selection

Threshold selections and underlying algorithms have been peer reviewed by several experts and are currently being finalized

Scoring Approach

- Adapted from Canadian Water Quality Index (CCME)
- Magnitude and exceedance components
- “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

We are also designating Outstanding (A+) for “Blue Water Streams” that score Excellent across all measures.

Indices of Health

Human Health Index

Drinking water

- Nitrogen species
- Salts
- Metals
- Organic Chemicals

Water Contact

- Pathogens

Aquatic Life Index

- Conventional Analytes
- Toxicity
- Bioassessment
- Biostimulatory Risk
- Metals
- Organic Chemicals

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.

Habitat Scoring (future)

- Regionally-scaled riparian assessment using imagery analysis in combination with field measures (Central Coast Wetlands Group)
- Physical habitat measures from bioassessment sampling
- CRAM

Biology

- Benthic invertebrates
- Algae
- Other biological measures as available

Human Health Index

DRINKING WATER

Nitrogen Species

- Nitrate
- Ammonia
- Nitrite

Salts

- Boron
- Chloride
- Sodium
- TDS

Pesticides and other Organics

- Sediment and water

Metals

- Sediment and water

WATER CONTACT

Pathogens

- *E. coli*
- Fecal coliform

Aggregating scores into an sub-index

Different combining approaches are used for different types of parameters

- Mean average
- Harmonic Mean
- Worst score

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(310TWB) Watersheds Waterbodies Sites

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○	Oxygen,Dissolved-departure	mg/l	water	0	0.19	1.33	494	C	76	0.5
●	Water Temperature-departure	degrees c	water	0	0	0	493	A	100	3
↓	Ammonia as N,Unionized	mg/l	water	0.0001	0.002	0.04	107	A	95	0.025
↓	Ammonia as N,Total	mg/l	water	0.01	0.05	0.36	124	A	95	0.49
↓	Nitrate,Nitrite as N	mg/l	water	0.42	2.55	7.83	125	F	14	1
↓	OrthoPhosphate as P	mg/l	water	0.15	0.41	1.06	125	F	11	0.13
●	pH departure	-log[h+]	water	0	0.002	0.7	492	A	99	0.1
●	Suspended Solids,Total	mg/l	water	0.5	17.7	1000	245	A	96	30
●	Turbidity	ntu	water	0	15.6	1490	131	A	96	25

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(310TWB) Watersheds Waterbodies Sites

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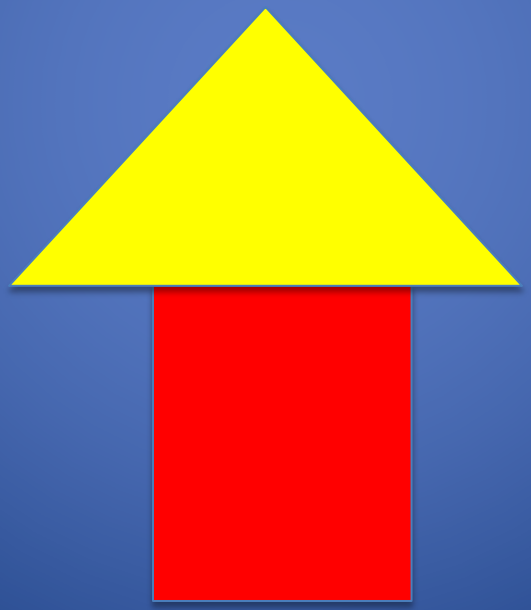
F (43)	68	87	17		47		

Human Health	Nitrogen Species	Salts	Pathogens	Metals	Organic Chemicals	Hydrocarbons	Groundwater
B (81)	86	66	79	99			

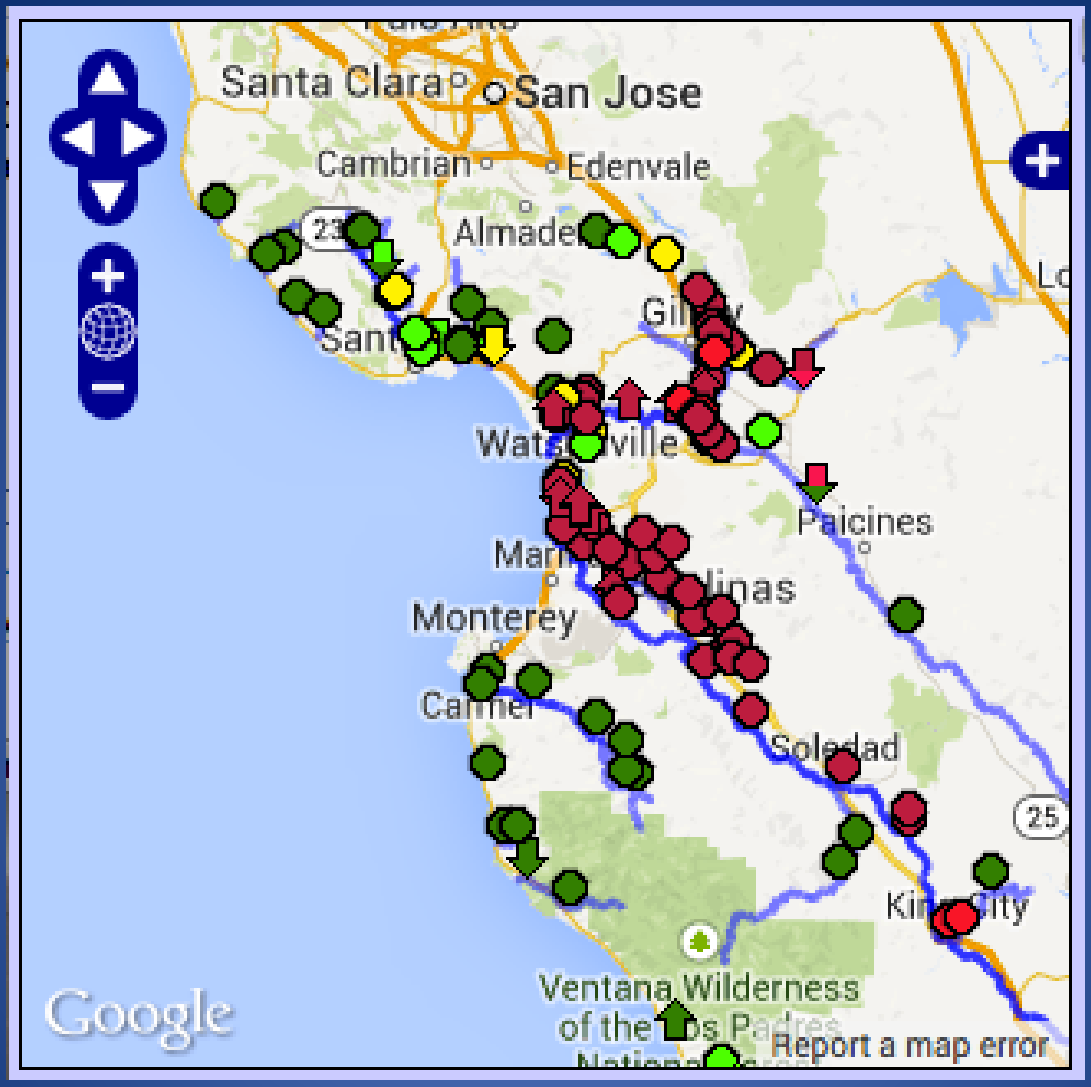
Scoring Change



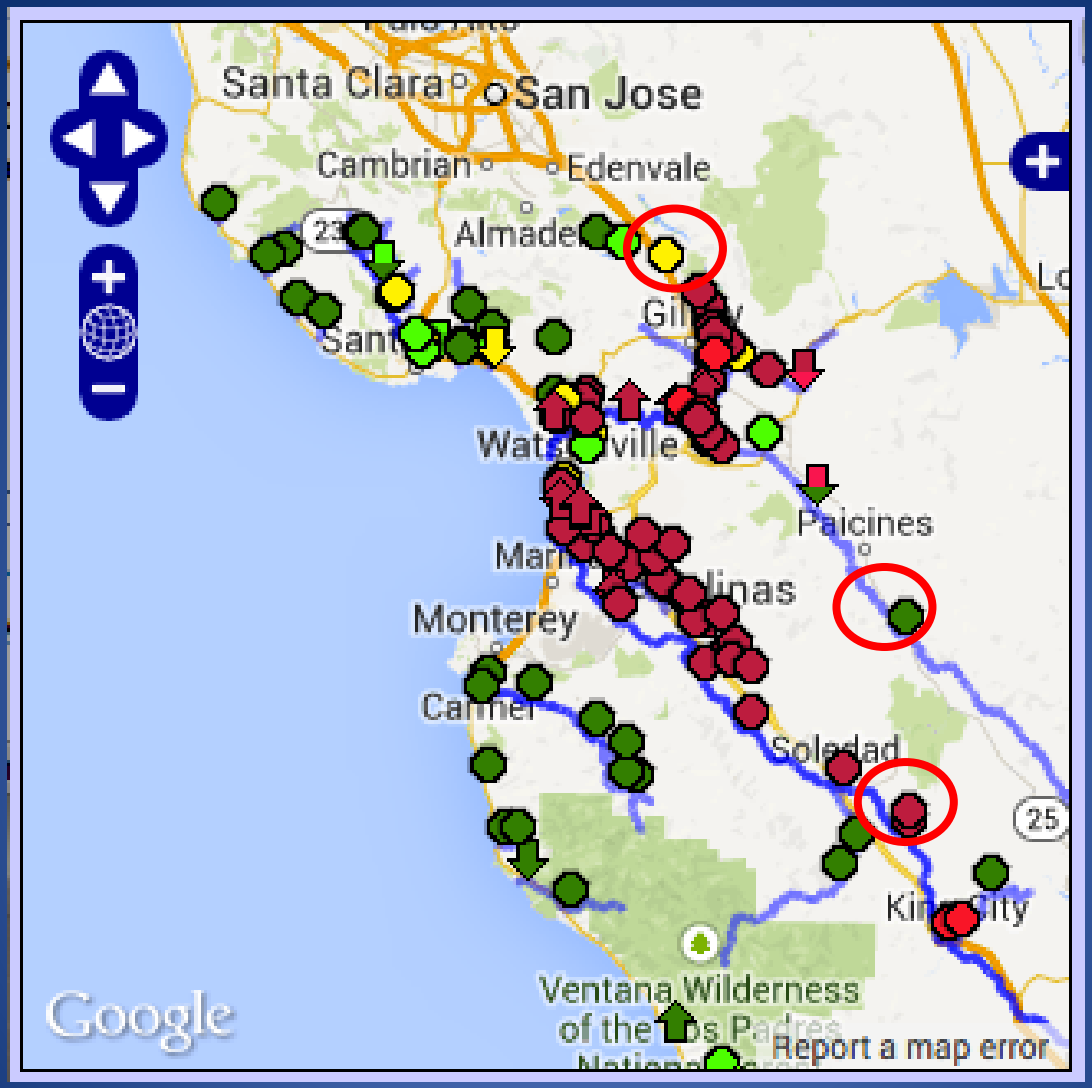
Why is this important?

For our region, it allows us to address the change component in our Vision goals:

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



From our website: Nitrate in the Monterey Area



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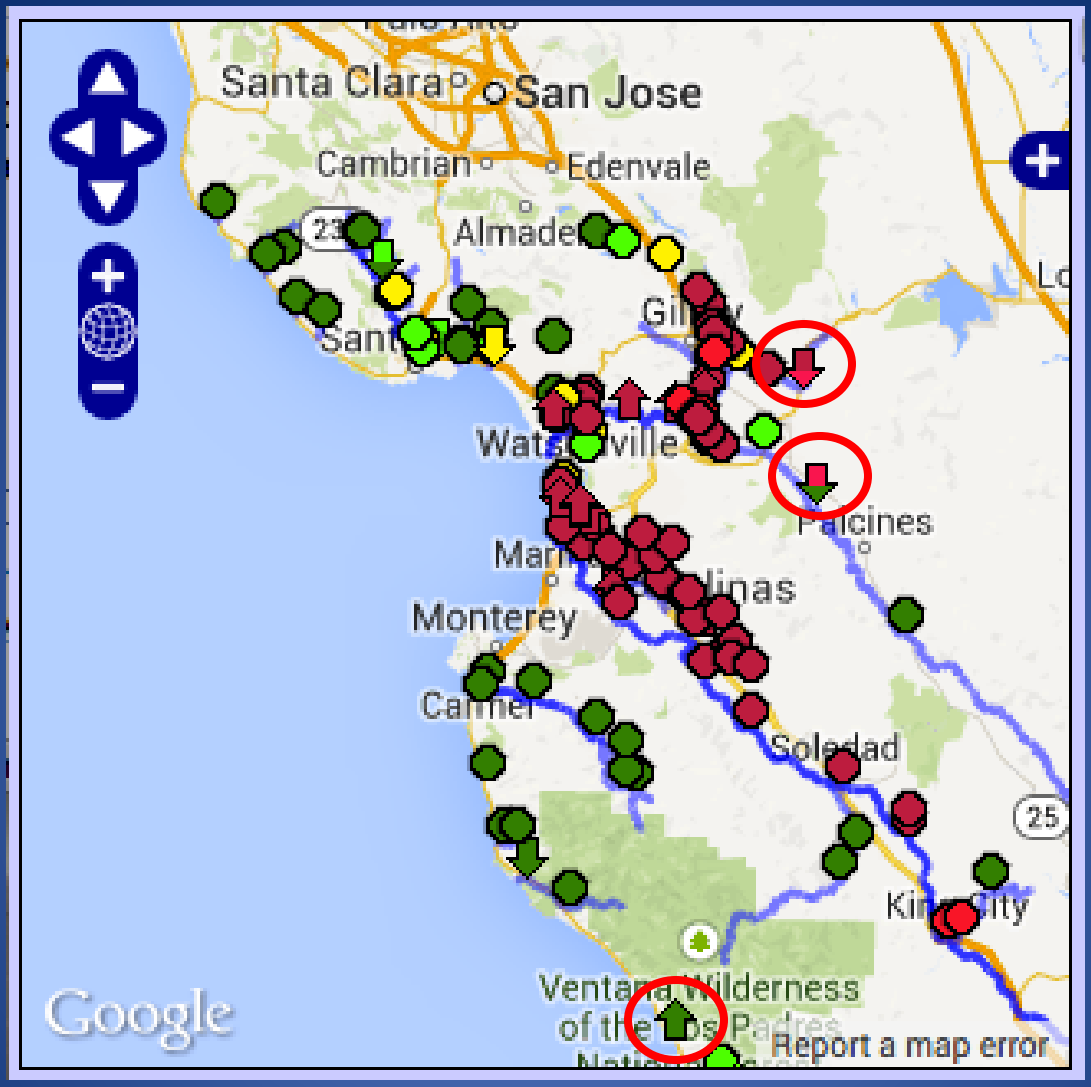
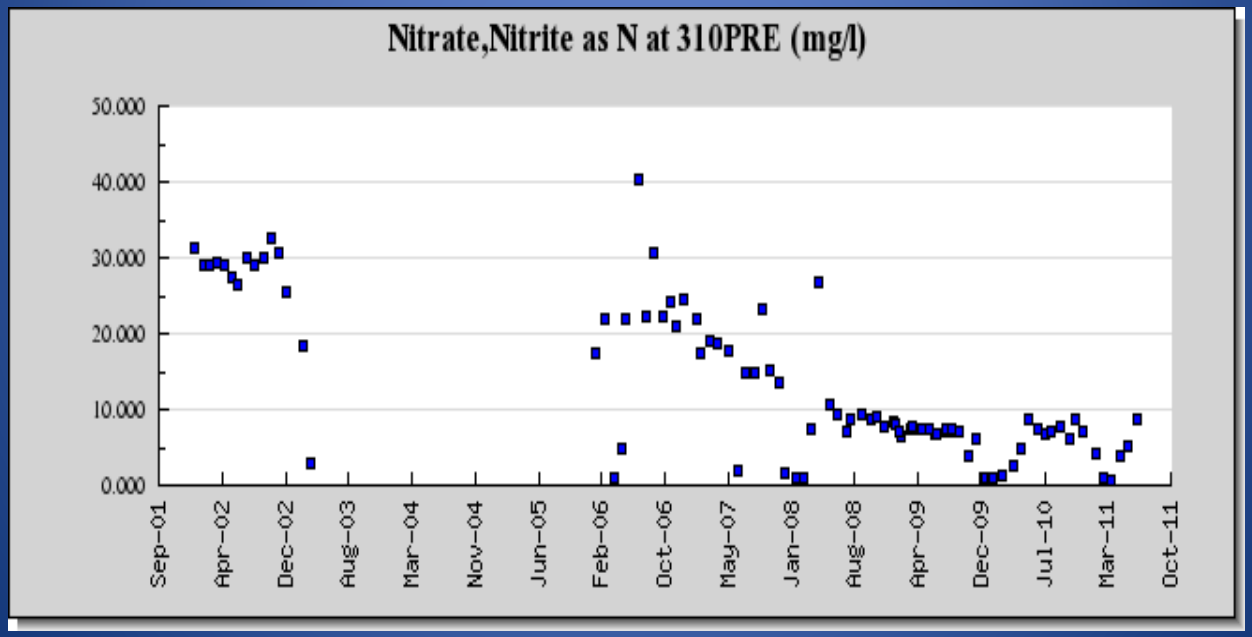


From our website: Nitrate in the Monterey Area (note arrow icons denoting change).

We look at change in two ways:

Kendall Trend Analysis



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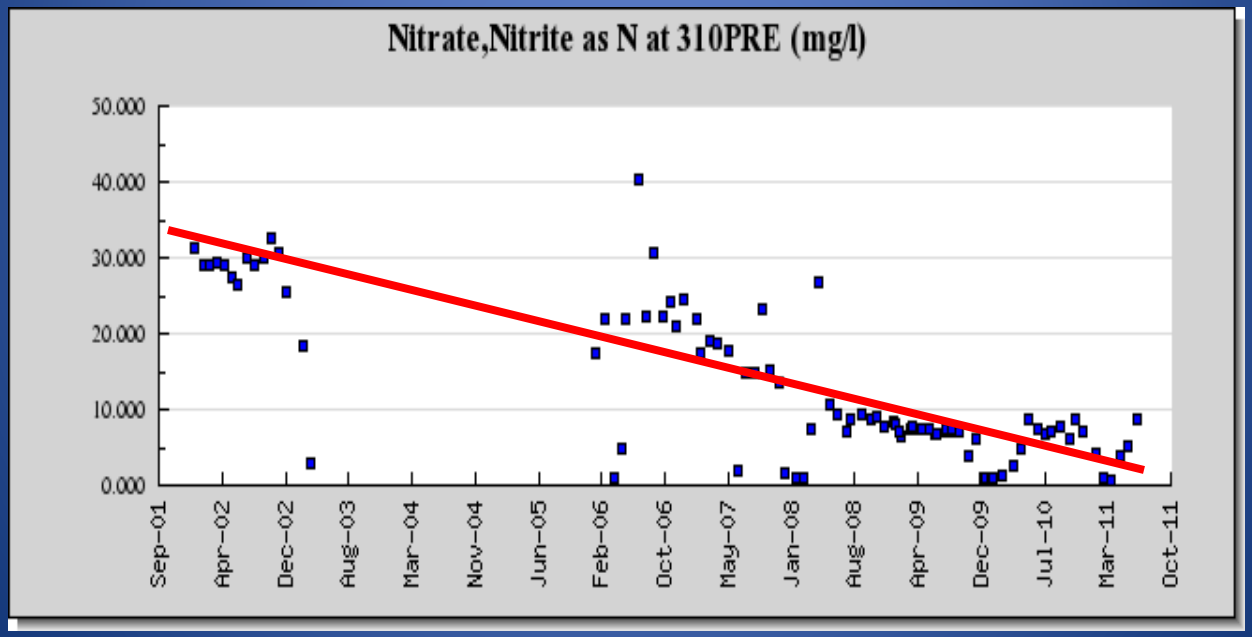

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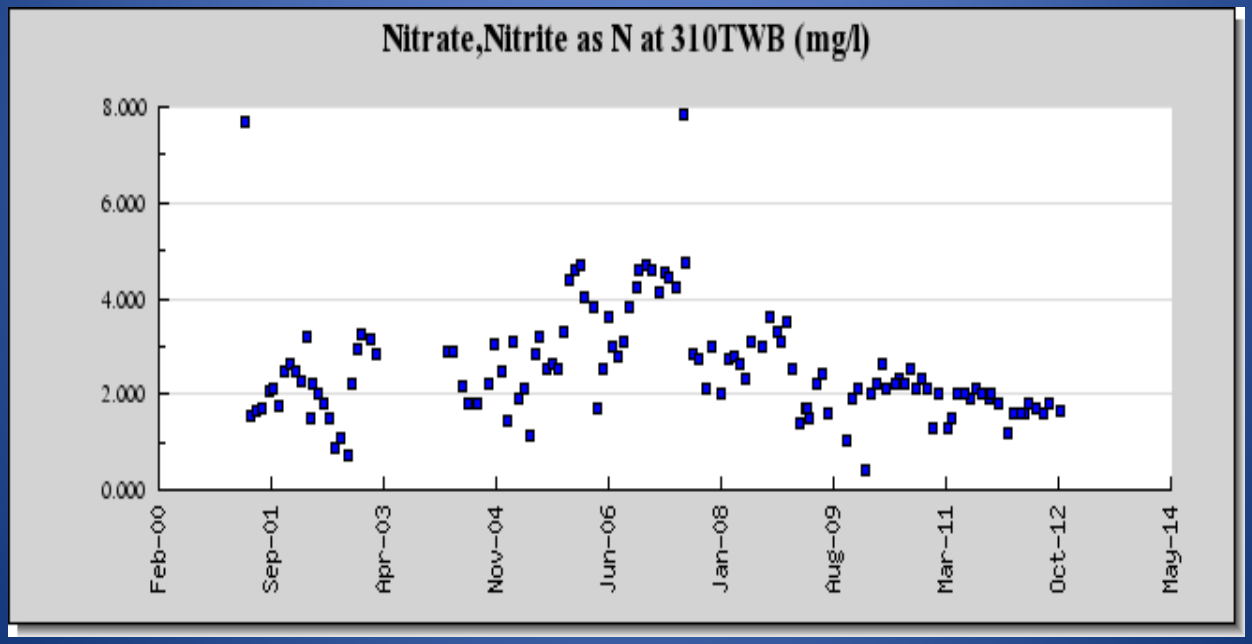
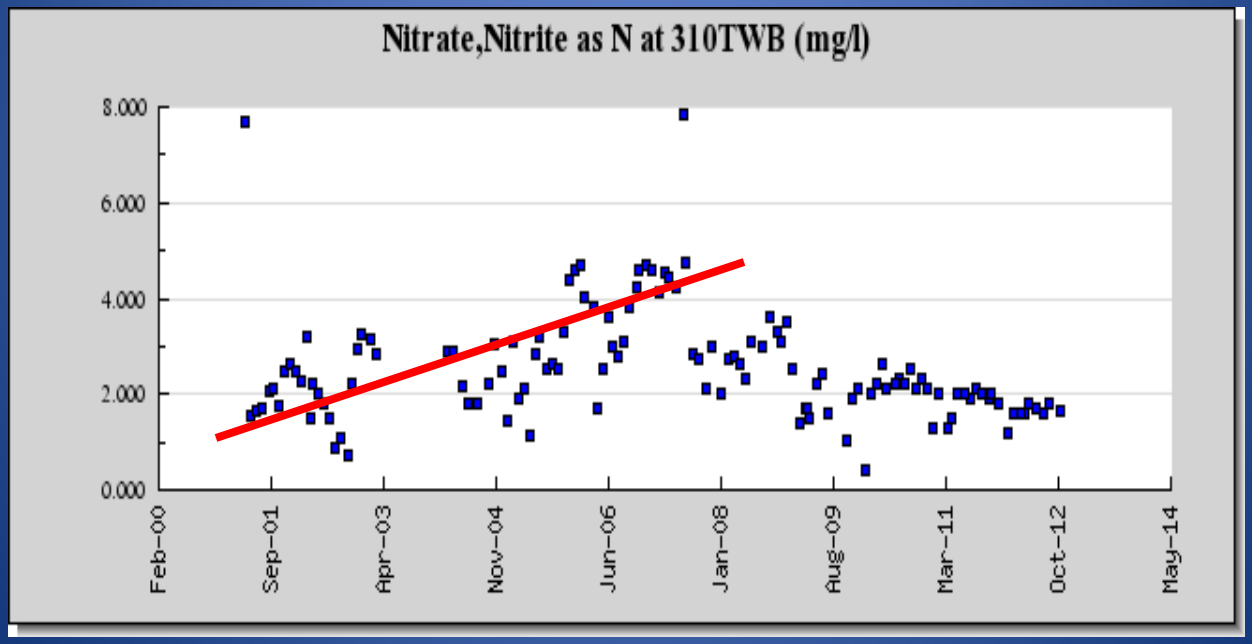
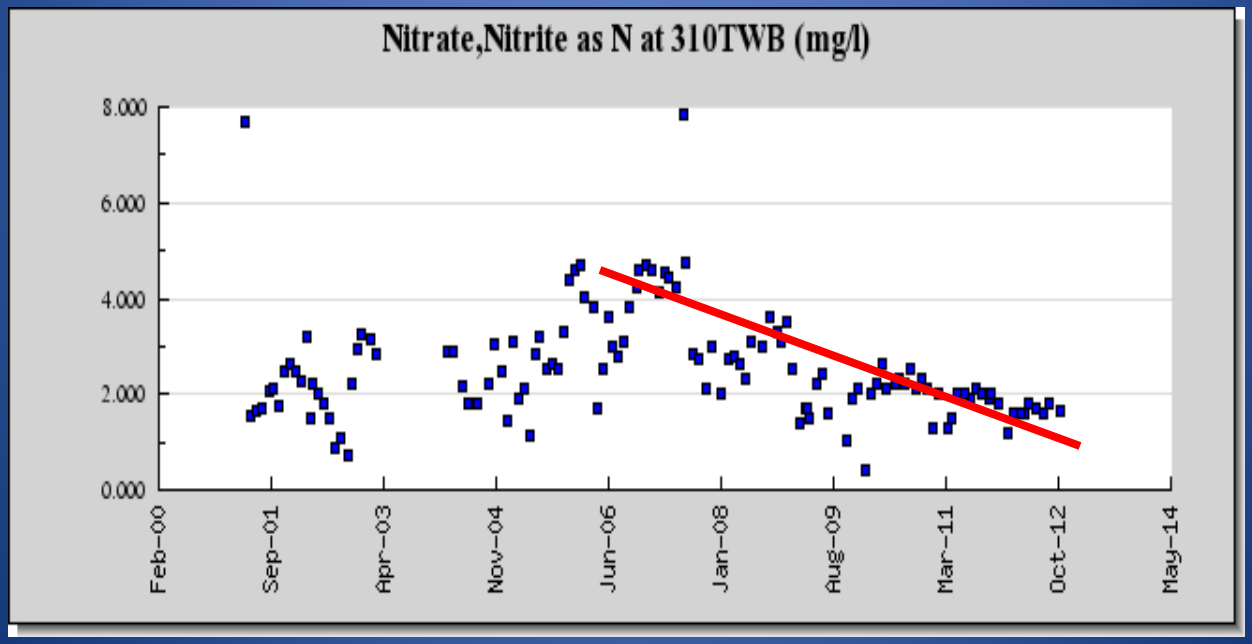


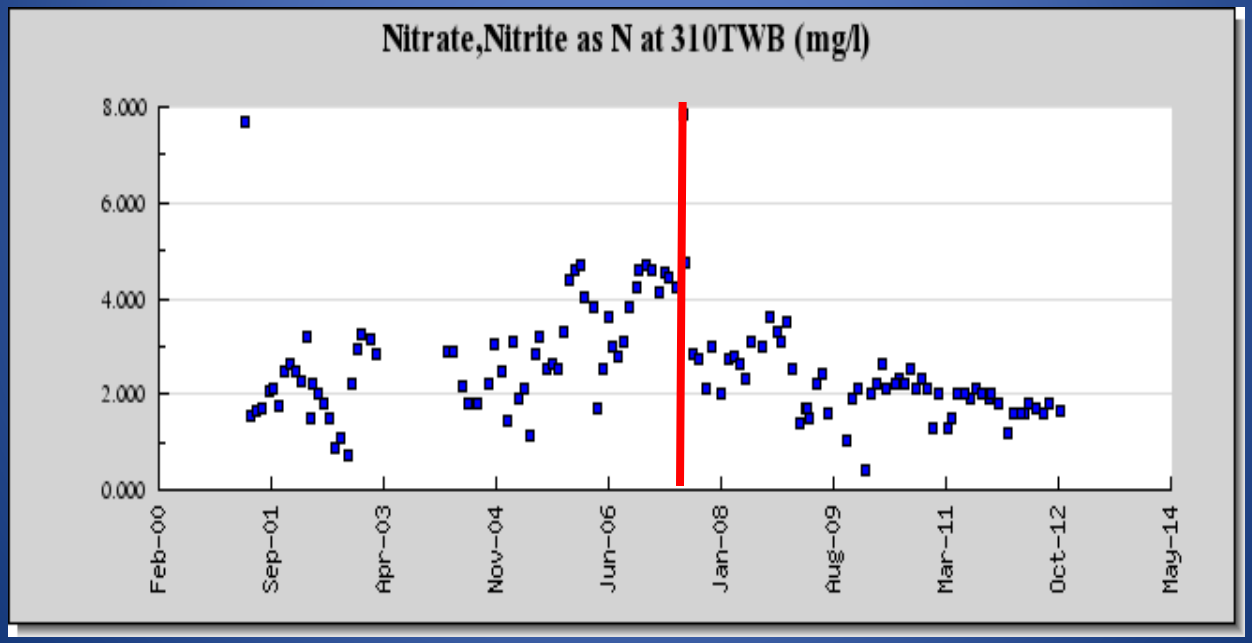
Some change doesn't fit a straight line:



Some change doesn't fit a straight line:

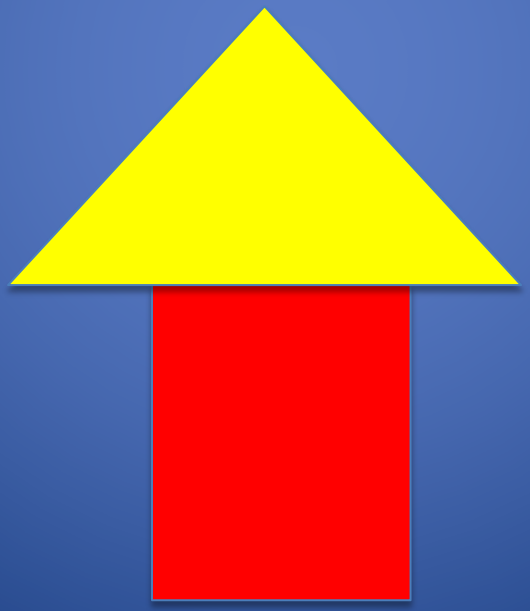


Change Point Analysis defines probable change points in a time series of data



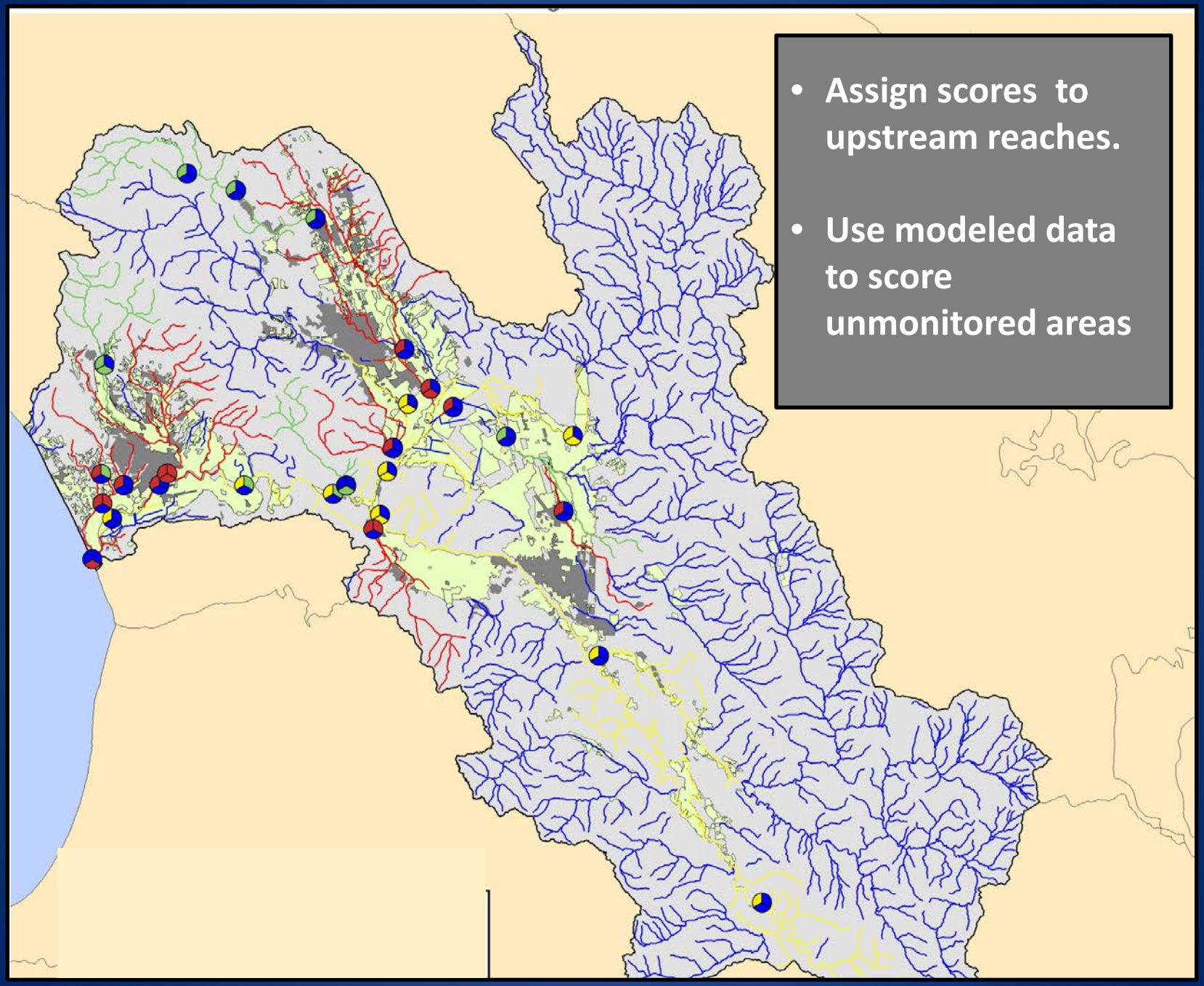
In this case, a treatment plant upgrade went online in May, 2007

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



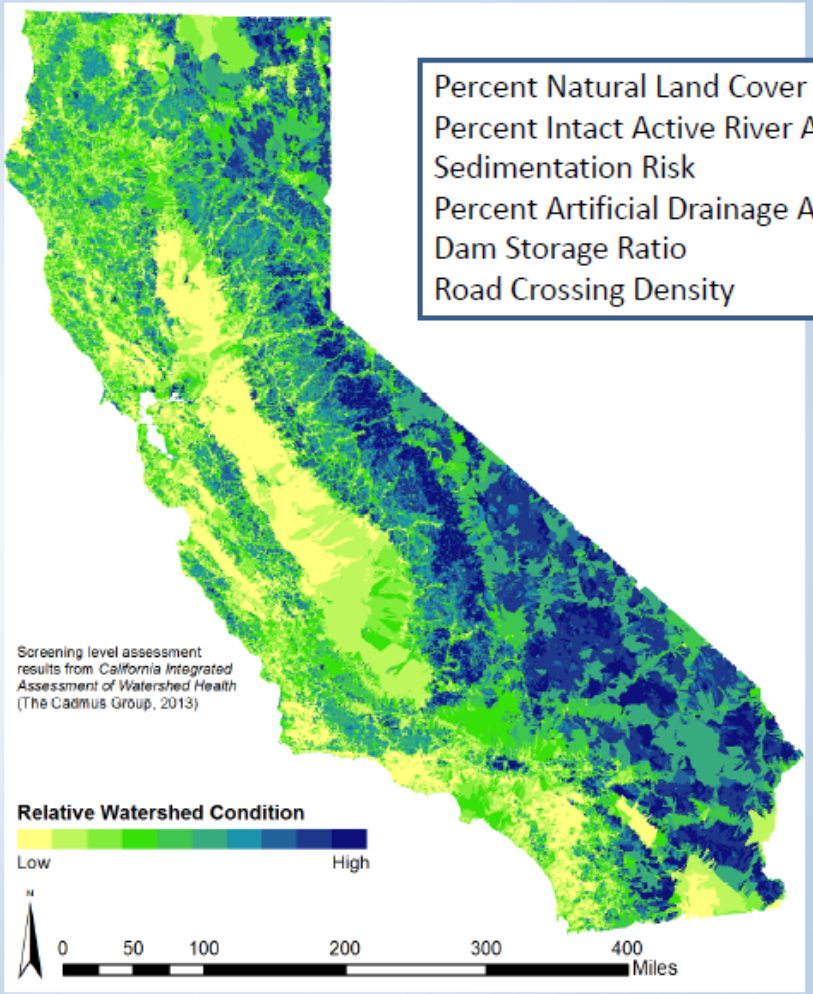
Scoring whole watersheds

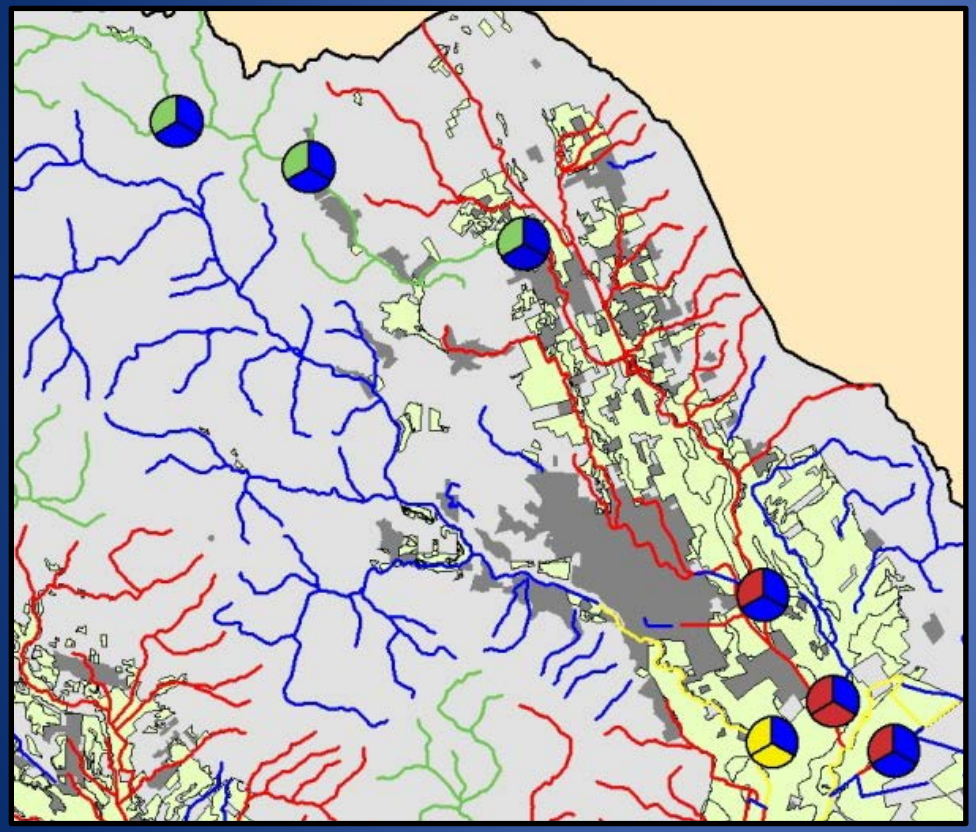
(currently in progress)


• Assign scores to upstream reaches.
• Use modeled data to score unmonitored areas

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

Relative Watershed Condition Index





Scoring Reaches

NHD reach network allows site scores to travel upstream to next site or a land use boundary

Next Steps

- Public release of Data Navigator in September.
- Methods manual to the SWAMP program for peer review this fall.
- Public release of Phase 1 of the Central Coast Healthy Watersheds Report Card this winter

Phase 2 of the Healthy Watersheds Report Card

- Add linked groundwater data from GeoTracker to Human Health Goal
- Address Goal 2 related to watershed function and land management
  - Pesticide applications
  - Impervious surfaces
  - Ag program metrics
  - Stormwater program metrics
  - etc.

Adoption of our software in a state-wide framework?

- Software is open source and is available for use by others
- We have provided Moss Landing Regional Data Center with Regional versions of the Data Navigator
- State Board has expressed interest in adopting Data Navigator for broader use in association with CEDEN
- The Council's Healthy Streams workgroup has expressed interest in adopting the Report Card for broader use in the Healthy Streams web portal

What is CCAMP OpenWater?

CCAMP OpenWater is…

…An Internet-based **Open Source Software Toolkit** focused on water quality and quantity assessment and visualization.

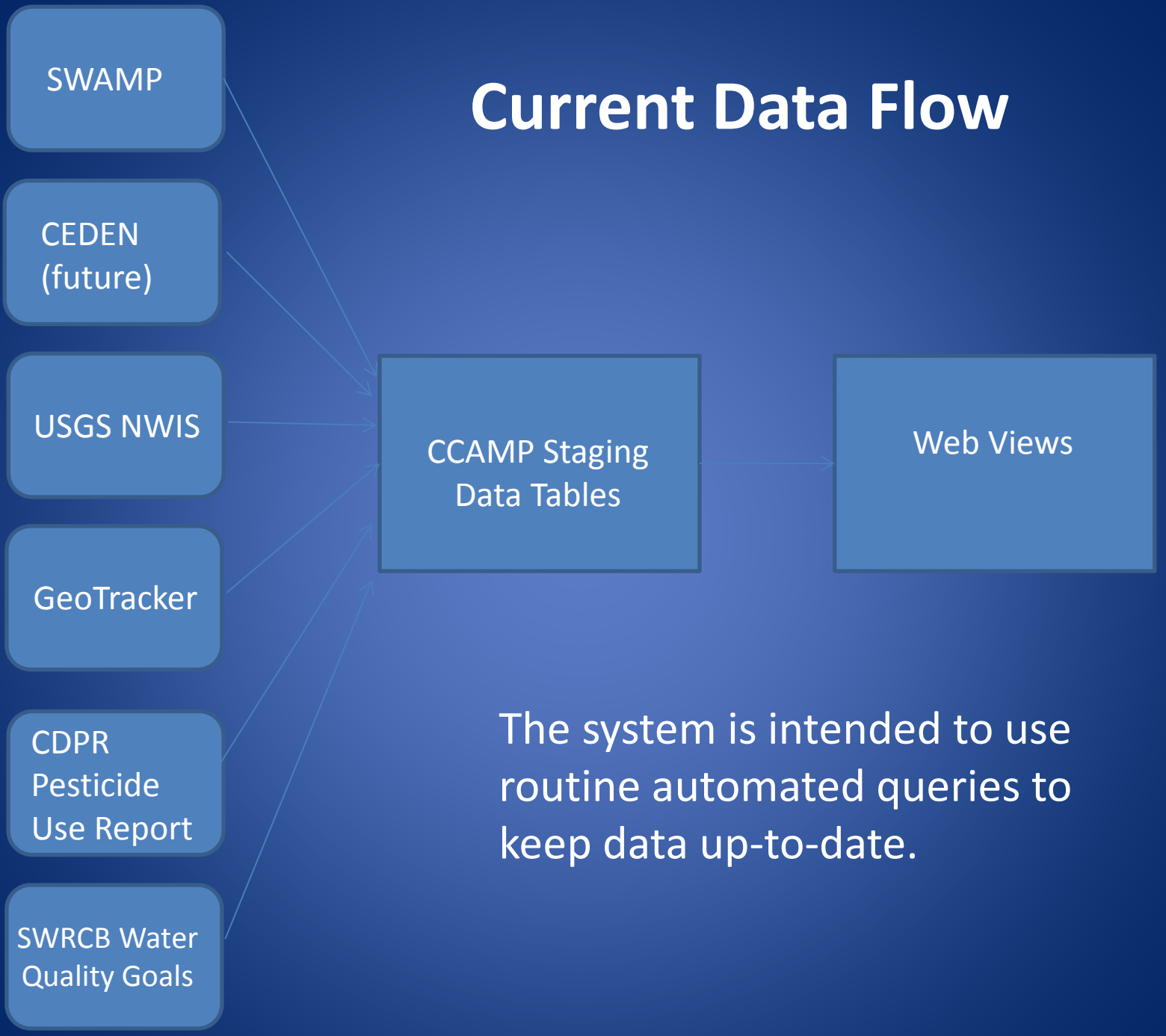
- Multi-server environment
- Scheduled data mining from multiple databases
- Data grooming
- Statistical Analysis
- Data visualization tools

"If I can't picture it, I can't understand it." (Albert Einstein)

Why Open Source?

- Reduces system development failure risk
- Provides access to international community of code developers and standards
- Empowers agency staff, users, and development partners
- Avoids pre-committing the State and others to licensing agreements with sole source commercial vendors

Current Data Flow



The system is intended to use routine automated queries to keep data up-to-date.

Data Grooming

- Synonym dictionaries
- Analyte name standardization
- Units of measurement standardization
- Quality assurance data filtering
- Handling of duplicates

GeoSpatial processing and linking

- Automated linking of monitoring sites to GIS layers
- Handling GIS layer idiosyncrasies
- Linking of land use and other datasets to sites
  - Pesticide use characterization
  - Land Cover characterization
  - Flow and Load estimation

Geospatial Framework

- National Hydrography Dataset Plus
- National Watershed Boundary Dataset
- National Land Cover Dataset
- Public Land Survey System Boundaries
- Bulletin 118 Groundwater Basin Boundaries
- California Healthy Watersheds (CADMUS)