Managing for Water Sustainability in an Uncertain Future

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Presentation to the California Water Quality Monitoring Council,
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with

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Council for Watershed Health & SAWPA

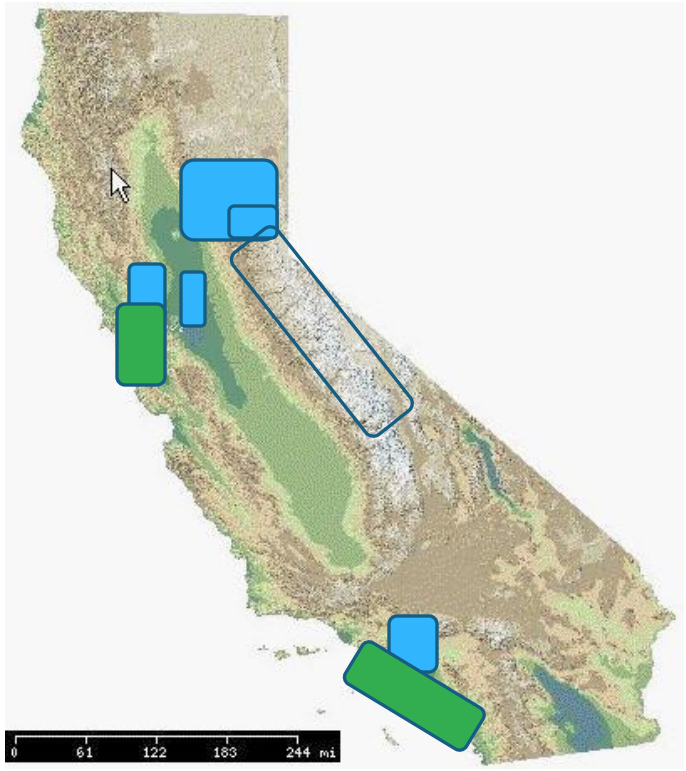
Pacific Institute, Sacramento River Watershed Program, Napa County, and South Yuba River Citizens League

indicators.ucdavis.edu

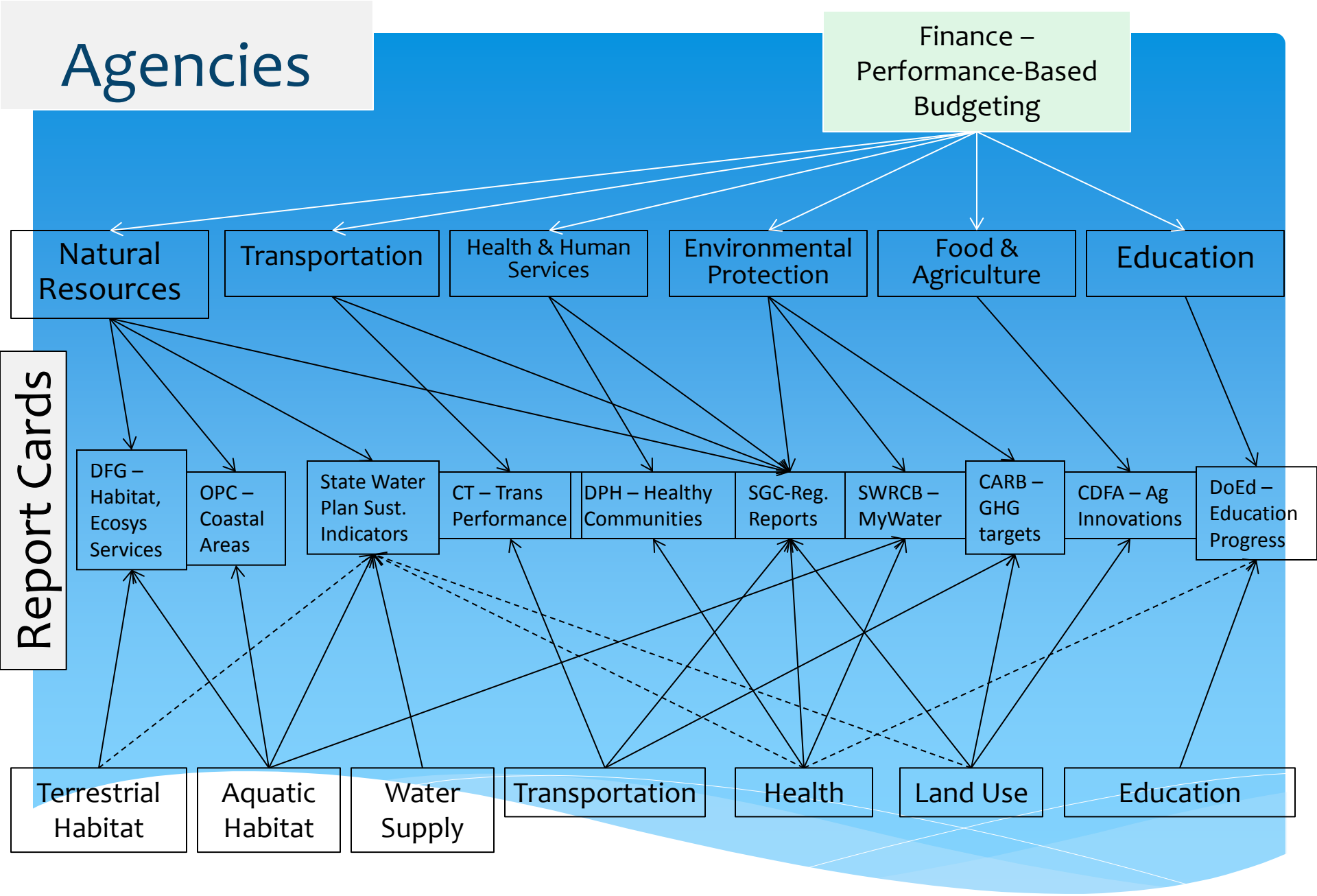
Previous Work with Indicators

* SF Bay Score Card (bay.org)
* Beach Report Card (brc.healthebay.org)
* Ski Resort Report Card (SNA et al.)
* SGC Regional Reports (SGC.ca.gov)

* Caltrans (CTP), CA Dept Education (SARC), CDPH (HCI)
* CalFire (FRA), CDFW (CWAP)



Agencies

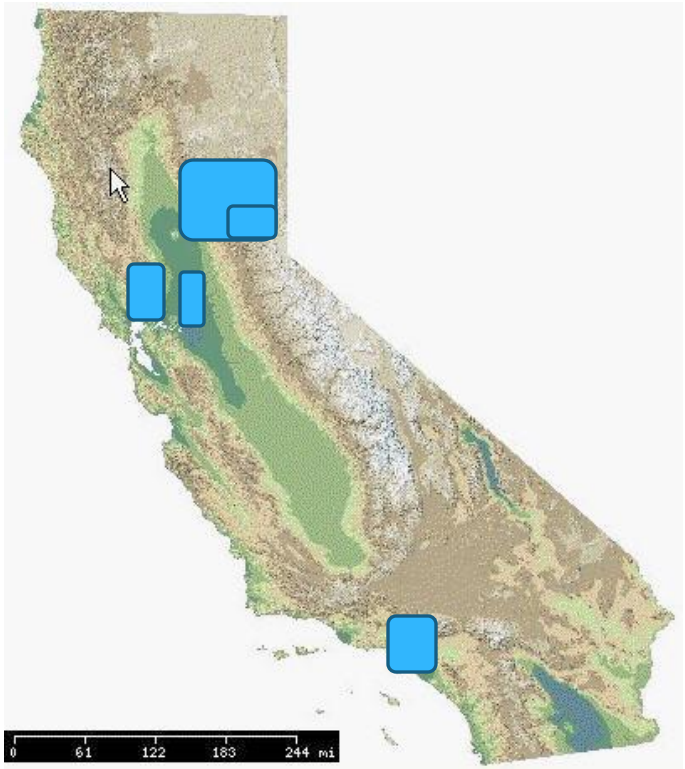


Domains of Concern

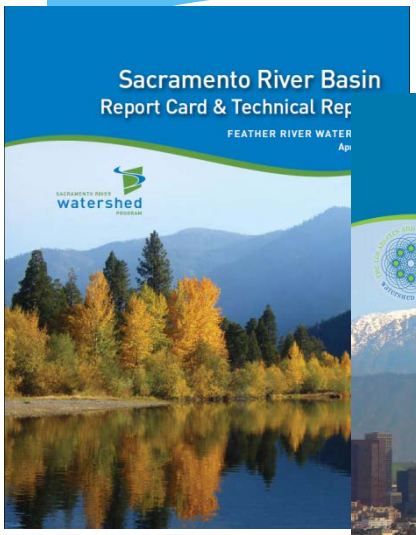
My Previous Work with Sustainability Indicators

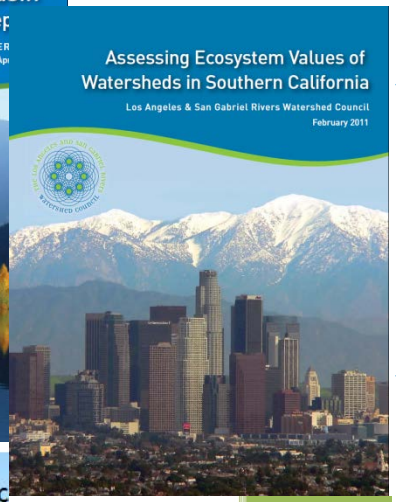
* Measuring whole system condition and performance
* Consistent with global literature, while breaking new ground

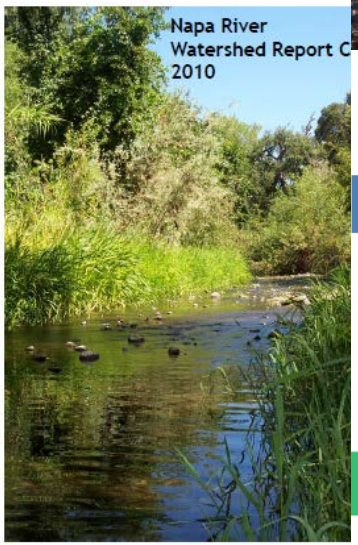
* Test cases in Yuba River, Lower Sacramento River, Feather River, Napa River, and Los Angeles River

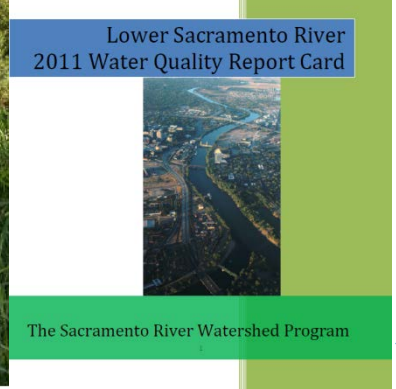


Report Cards









Goals	Icon	Objectives
A. Maintain and improve water quality and supply to sustainably meet the needs of natural and human communities		1) Protect receiving waters from pollution to comply with current and future water quality regulations
		2) Maintain water quality for healthy aquatic systems*
		3) Protect the quality of drinking water supplies
		4) Maintain and restore natural stream flows for aquatic and riparian communities*
		5) Maintain water supplies to meet human needs within the watershed
B. Protect and enhance native aquatic and terrestrial species, especially sensitive and at-risk species and natural communities		1) Protect and enhance native fish populations, including anadromous fish*
		2) Protect and enhance bird populations
		3) Protect and enhance amphibian populations
		4) Protect and enhance mammal populations*
		5) Protect and enhance native invertebrate communities*
		6) Discourage and reduce invasive, non-native species
C. Protect and enhance landscape and habitats structure and processes to benefit ecosystem and watershed functions		1) Protect and enhance riparian habitat quality
		2) Protect and enhance wetland habitat quality
		3) Protect and enhance aquatic habitat connectivity*
		4) Protect and enhance terrestrial habitat connectivity*
		5) Maintain and restore stream geomorphic processes
		6) Optimize primary production and nutrient cycling to support aquatic and terrestrial communities* (for N)
		7) Manage land-uses to reduce impacts on aquatic and terrestrial habitats
D. Maintain and restore natural disturbance processes that balance benefits for natural and human communities		1) Reduce high severity fire frequency; encourage natural fire regimes that support native communities*
		2) Reduce flood risk to human communities; encourage natural flood processes that support native communities*
		3) Reduce greenhouse gas emissions and encourage activities to adapt to climate change
E. Maintain and improve the social and economic conditions, including benefits from healthy watersheds	 	1) Protect and enhance wildlife friendly agricultural practices*
		2) Improve grazing management
		3) Encourage sustainable land use practices
		4) Improve community economic status in balance with watershed condition*
		5) Improve community relationship with watershed processes
		6) The watershed supports sustainable social practices
		7) Support and improve human uses associated with watershed condition*
		8) To have widespread community awareness and deep civic engagement in the protection and improvement of watersheds*

Goals	Measurable Objective	Indicators	Sub-Watershed Condition Score (0 – 100) ENFF	NFF	MFF	LF	NY	MY	SY	DC	LY	UB	LB	Trend	Confidence
Water quality and supply for natural and human communities	Water quality for aquatic health	Water temperature, algae, mercury in fish	73	75	38	50	53	47	39	35	13	40	61		medium-high
	Maintain natural stream flows	Current flow vs. historical flow	69	n/a	n/a	54	n/a	n/a	n/a	63	40	60	41	n/a	medium
Protect and restore native animals and plants	Native birds	Bird species richness	100	n/a	100	100	100	100	100	n/a	100	100	100		medium
	Protect native aquatic communities	Land disturbance, aquatic insects, fish	69	64	69	61	66	69	62	47	55	61	82		high
Protect and enhance habitats, ecosystems, and watersheds	Protect aquatic connections	Barriers to aquatic organism movement	77	82	76	82	82	76	79	69	77	67	79	n/a	medium-high
	Protect landscape connections	Barriers to wildlife movement	23	81	44	5	54	27	100	5	11	14	2	n/a	high
	Maintain natural production and nutrient cycles	Carbon storage and sequestration, nitrogen loads	88	93	63	94	93	89	93	48	96	91	96		medium
Maintain and restore natural disturbance	Restore natural fire regimes	Fire frequencies compared to expected frequency	2	9	14	39	2	3	4	12	15	0	4		medium
	Encourage natural flooding, while protecting people	Floodplain access	n/a	n/a	n/a	43	n/a	n/a	n/a	n/a	70	n/a	38	n/a	low
Improve social and economic conditions & benefits from healthy watersheds	Enhance wildlife-friendly agriculture	Pesticide use and organic agriculture	100	99	100	51	n/a	98	100	100	17	100	62		medium-high
	Improve community economic status	Poverty measure	49	52	54	34	64	32	40	73	35	70	61		high

Table E.1 — How well are we meeting goals and objectives for the Feather River watershed?

Goals	Measurable Objective	Condition	Trend	Confidence
Water quality and supply for natural and human communities	Water quality for aquatic health	51	↔	Medium-high
	Maintain natural stream flows	55	n/a	Medium
Protect and restore native animals and plants	Native birds	100	↔	Medium
	Native invertebrates	46	↔	High
	Native fish	49	↔	High
	Agricultural/urban development	90	n/a	Medium
Protect and enhance habitats, ecosystems, and watersheds	Protect aquatic connections	77	n/a	Medium-high
	Protect landscape connections	33	n/a	High
	Maintain natural production and nutrient cycles	82	↓	Medium
Maintain and restore natural disturbance	Restore natural fire regimes	9	↔	Medium
	Encourage natural flooding, while protecting people	50	n/a	Low
Improve social and economic conditions & benefits from healthy watersheds	Enhance wildlife-friendly agriculture	83	↑	Medium-high
	Improve community economic status	51	↓	High

Table 4 – The Arroyo Seco Report Card

Goal	Indicators	Condition	Trend	Confidence
To sustainably manage local water supplies for human and natural communities.	Per capita water use	94	Not Assessed	High
	Healthy Surface Waters	60	Not Assessed	Moderate
	Rain reaching groundwater	59	Not Assessed	Moderate
To have widespread community awareness and deep civic engagement in the protection and improvement of watersheds.	Local Government Action	44	Not Assessed	Moderate
To conserve and restore a diversity of native habitats to support fish and wildlife.	Presence of Native Wildlife	59	Not Assessed	Moderate
	Protected Native Habitats	60	Not Assessed	High
	Habitat Intactness	57	Not Assessed	High
To restore or simulate natural disturbance processes that balance benefits for human and natural communities.	Storm Flow Pattern	55	Not Assessed	Moderate/High
	Wildfire Pattern & Intensity	75	↔	High
To meet human needs and enhance the quality of life by improving the conditions of watersheds and their ecosystems.	Aquatic Recreation	82	Not Assessed	Moderate
	Vegetated Residential Area	83	Not Assessed	Moderate
	Equitable Park Access	55	Not Assessed	Moderate
	Overall Score:	**65.25**		

Analytical details

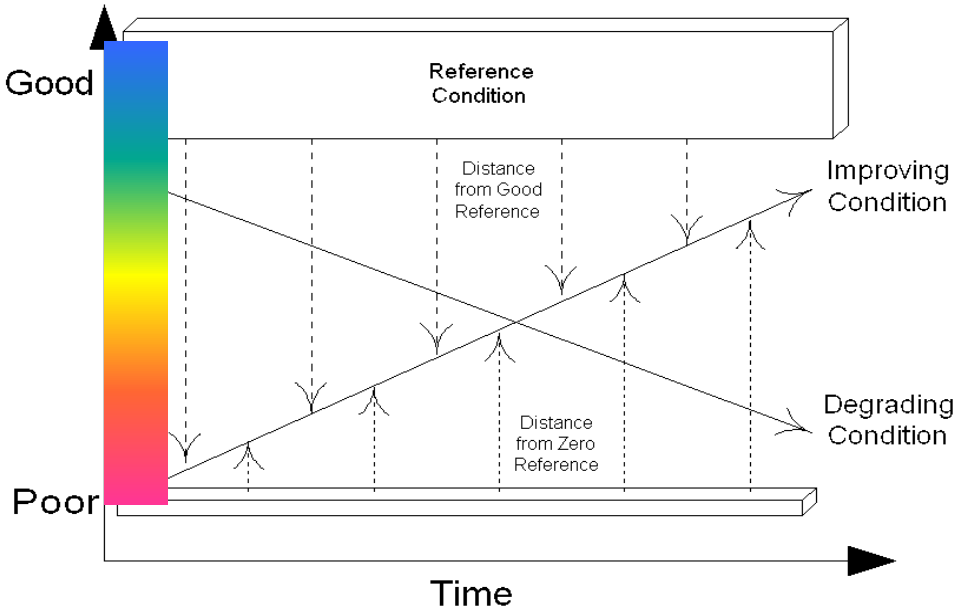
Quantitative targets must be defined, existing distance to target is then measured for each metric or indicator on a 0-100 scale.

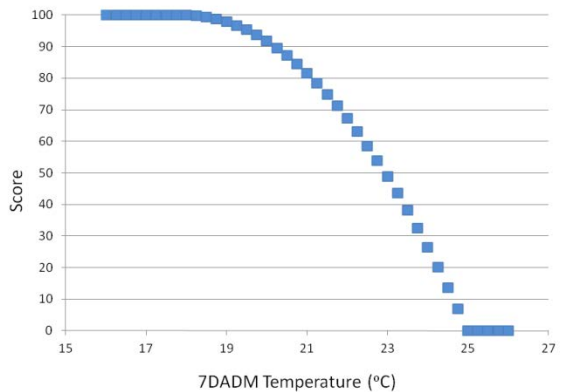
Spatially co-located sites are compared and potentially lumped. Typically, scores are derived from raw data at the resolution of the raw data, then lumped to a sub-watershed reporting scale

Trends analysis primarily using Mann-Kendall, Seasonal Kendall, Regional Kendal. Sen slope estimation

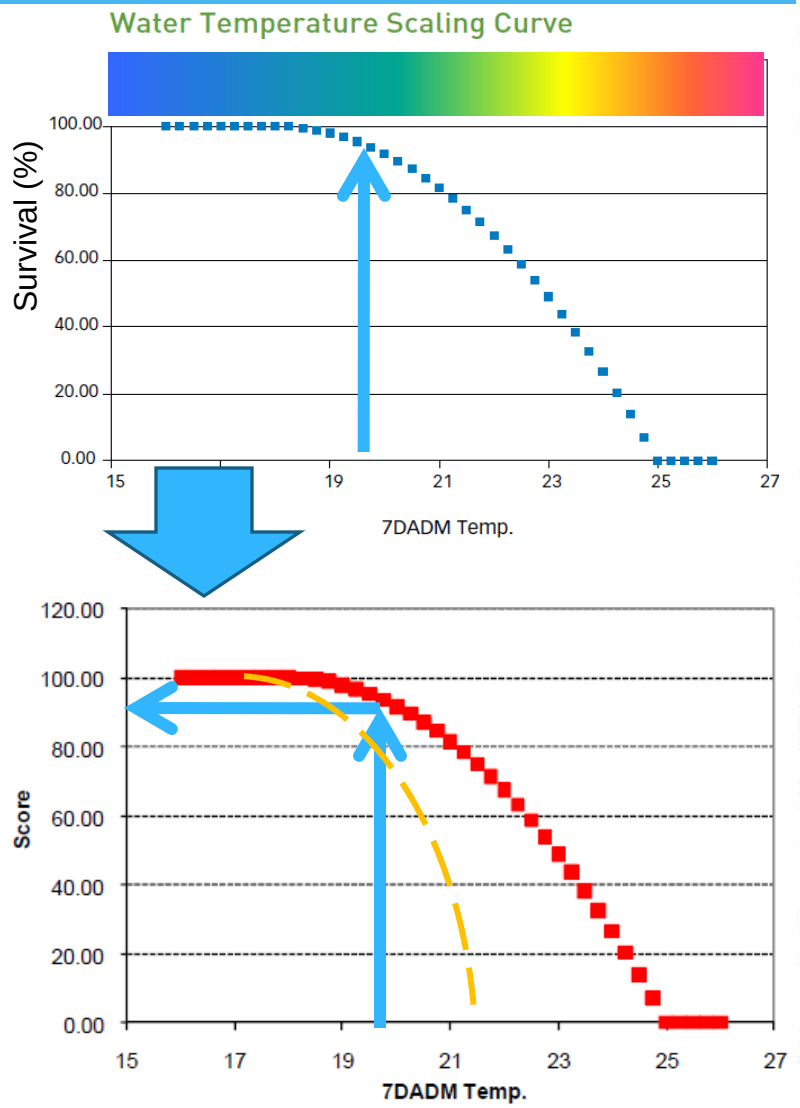
Confidence is based upon quantitative estimates (e.g., standard deviation of the mean) and qualitative determinations of certainty about the indicators themselves, the data quality and relevance to the indicator

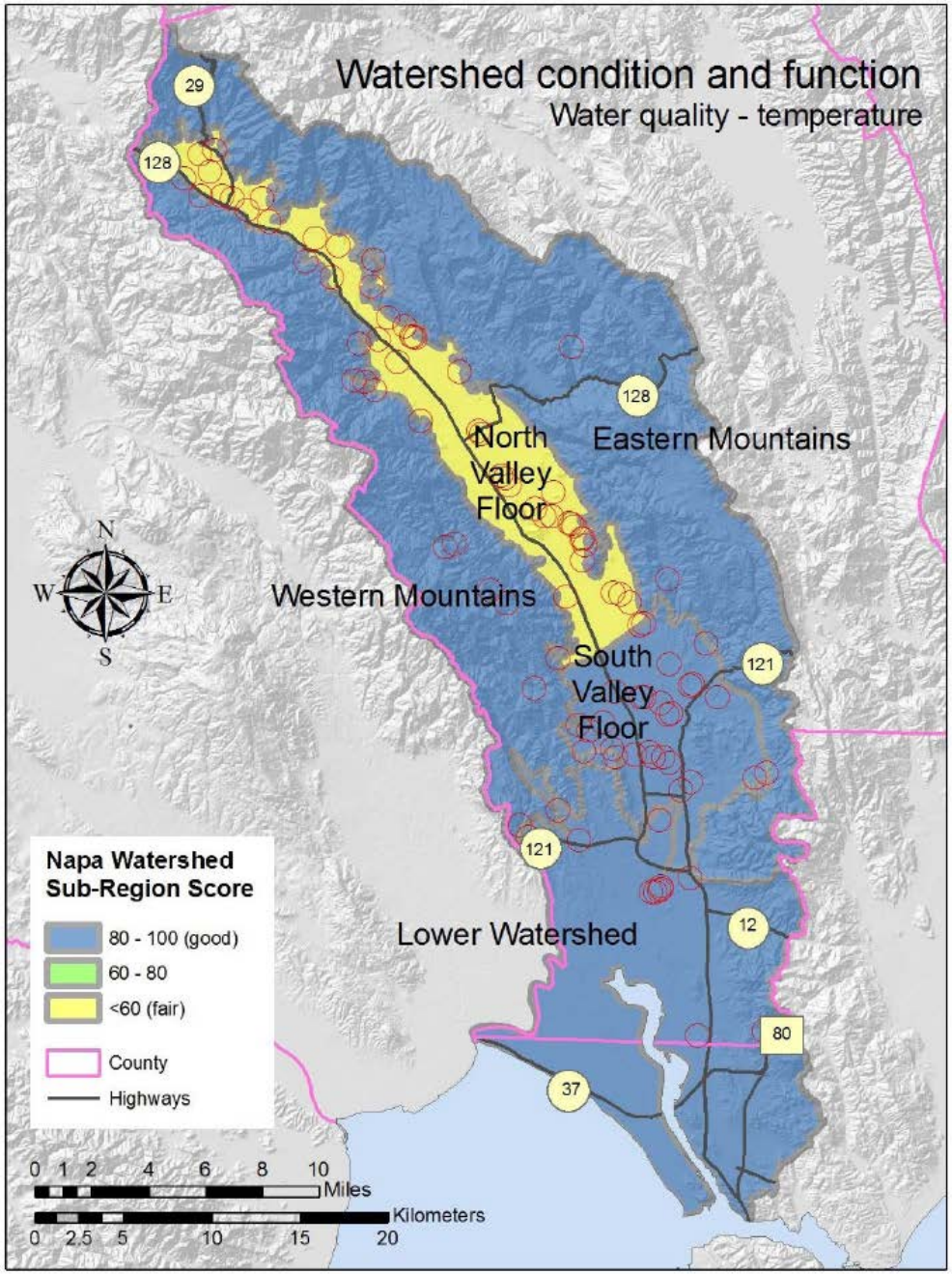
Scoring: "Distance to target" or axiological normalization*

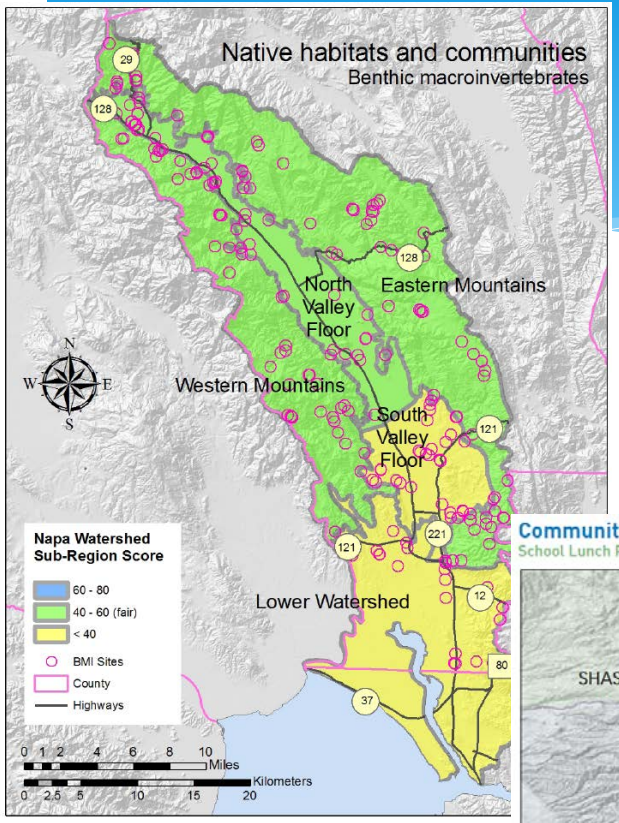


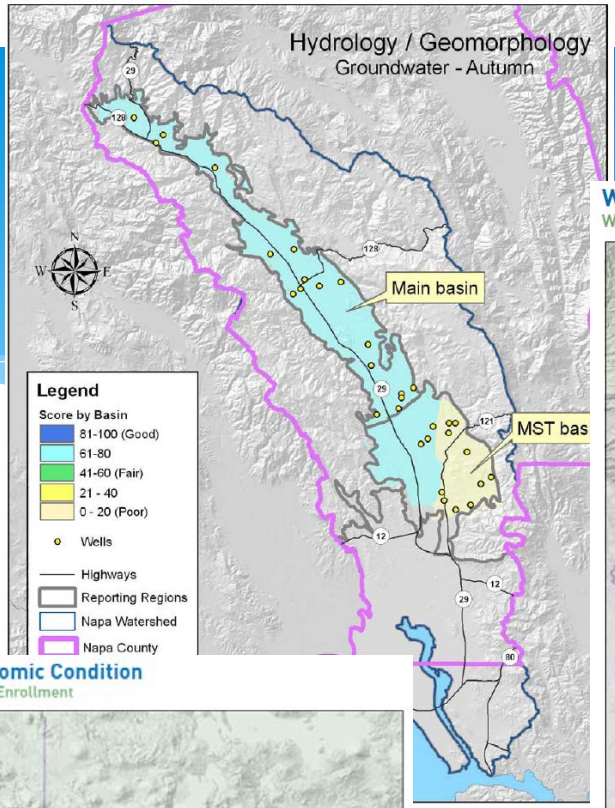


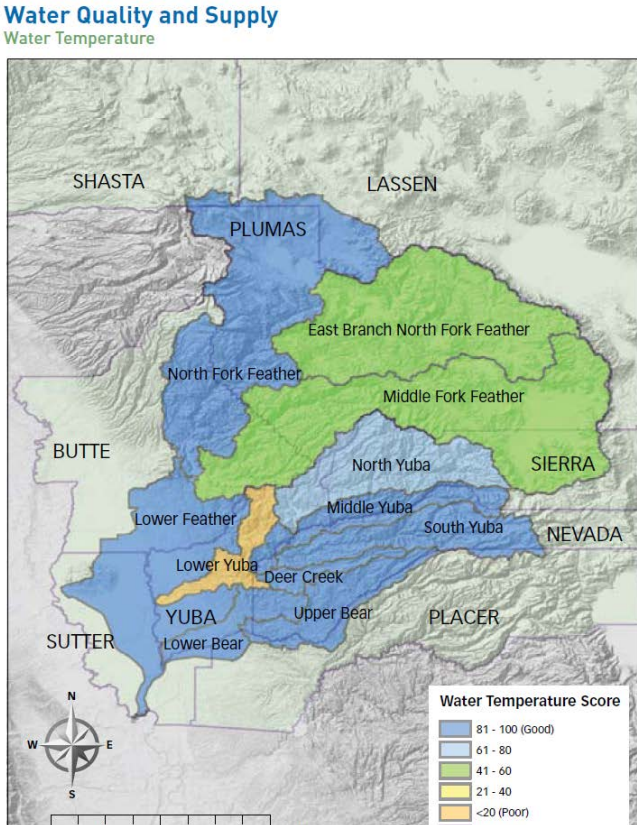
* Compare with (1) empirical normalization where min and max value in study area are used to set range (HWI), or (2) statistical normalization where values are standard deviations from mean, or (3) comparison to one reference (typical), or (4) no normalization (typical)

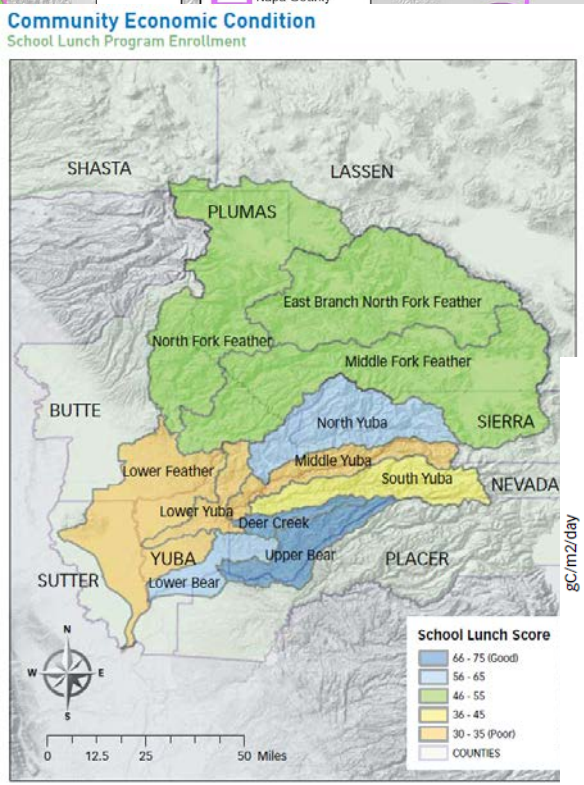

Water Temperature Scaling Curve
Survival (%)
100.00
80.00
60.00
40.00
20.00
0.00
15
19
21
23
25
27
7DADM Temp.
Score
120.00
100.00
80.00
60.00
40.00
20.00
0.00
15
17
19
21
23
25
27
7DADM Temp.

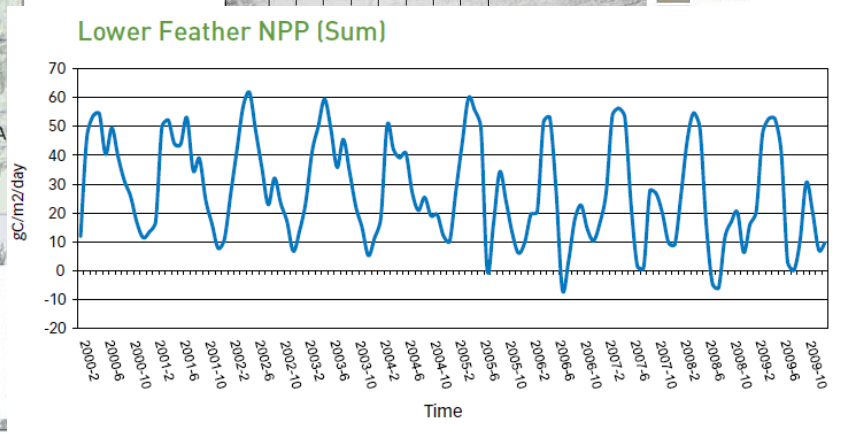

Watershed condition and function
Water quality - temperature
29
128
128
North Valley Floor
Eastern Mountains
Western Mountains
South Valley Floor
121
121
12
80
37
N
W
E
S
Napa Watershed Sub-Region Score
80 - 100 (good)
60 - 80
<60 (fair)
County
Highways
Lower Watershed
0 1 2 4 6 8 10
Miles
0 2.5 5 10 15 20
Kilometers


Native habitats and communities
Benthic macroinvertebrates
North Valley Floor
Eastern Mountains
Western Mountains
South Valley Floor
Lower Watershed
Napa Watershed Sub-Region Score
60 - 80
40 - 60 (fair)
< 40
BMI Sites
County
Highways
Miles
Kilometers


Hydrology / Geomorphology
Groundwater - Autumn
Main basin
MST bas
Legend
Score by Basin
81-100 (Good)
61-80
41-60 (Fair)
21 - 40
0 - 20 (Poor)
Wells
Highways
Reporting Regions
Napa Watershed
Napa County


Water Quality and Supply
Water Temperature
SHASTA
LASSEN
PLUMAS
East Branch North Fork Feather
North Fork Feather
Middle Fork Feather
BUTTE
North Yuba
SIERRA
Lower Feather
Middle Yuba
South Yuba
NEVADA
Lower Yuba
Deer Creek
YUBA
Upper Bear
PLACER
SUTTER
Lower Bear
Water Temperature Score
81 - 100 (Good)
61 - 80
41 - 60
21 - 40
<20 (Poor)


Community Economic Condition
School Lunch Program Enrollment
SHASTA
LASSEN
PLUMAS
East Branch North Fork Feather
North Fork Feather
Middle Fork Feather
BUTTE
North Yuba
SIERRA
Lower Feather
Middle Yuba
South Yuba
NEVADA
Lower Yuba
Deer Creek
YUBA
Upper Bear
PLACER
SUTTER
Lower Bear
School Lunch Score
66 - 75 (Good)
56 - 65
46 - 55
36 - 45
30 - 35 (Poor)
COUNTIES
Miles


Lower Feather NPP (Sum)
gC/m2/day
Time

* Examples

Whole system reporting

Goals	Measurable Objective	Condition	Trend	Confidence
Water quality and supply for natural and human communities	Water quality for aquatic health	51	↔	Medium-high
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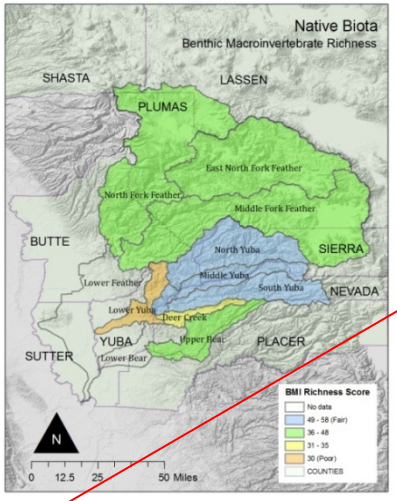
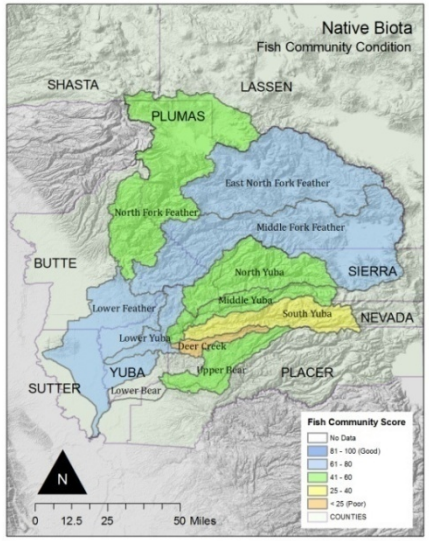
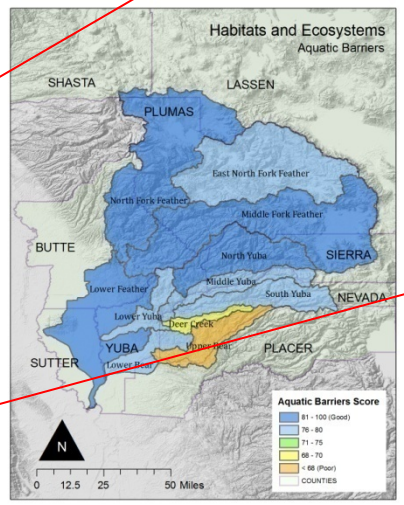
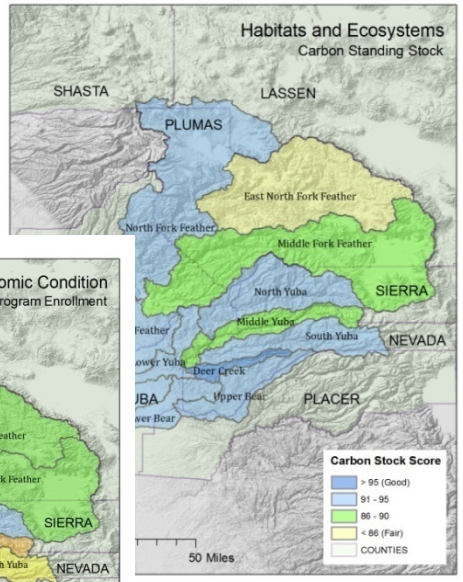
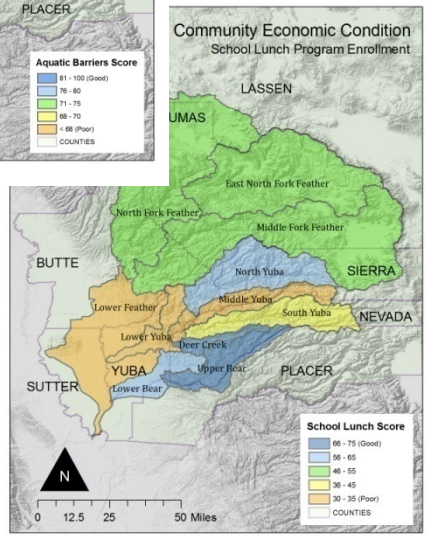
	Protect landscape connections	33	n/a	High
	Maintain natural production and nutrient cycles	82	↓	Medium
Maintain and restore natural disturbance	Restore natural fire regimes	9	↔	Medium
	Encourage natural flooding, while protecting people	50	n/a	Low
Improve social and economic conditions & benefits from healthy watersheds	Enhance wildlife-friendly agriculture	83	↑	Medium-high
	Improve community economic status	51	↓	High











Web reporting

Table E.1 — How well are we meeting goals and objectives for the Feather River watershed?

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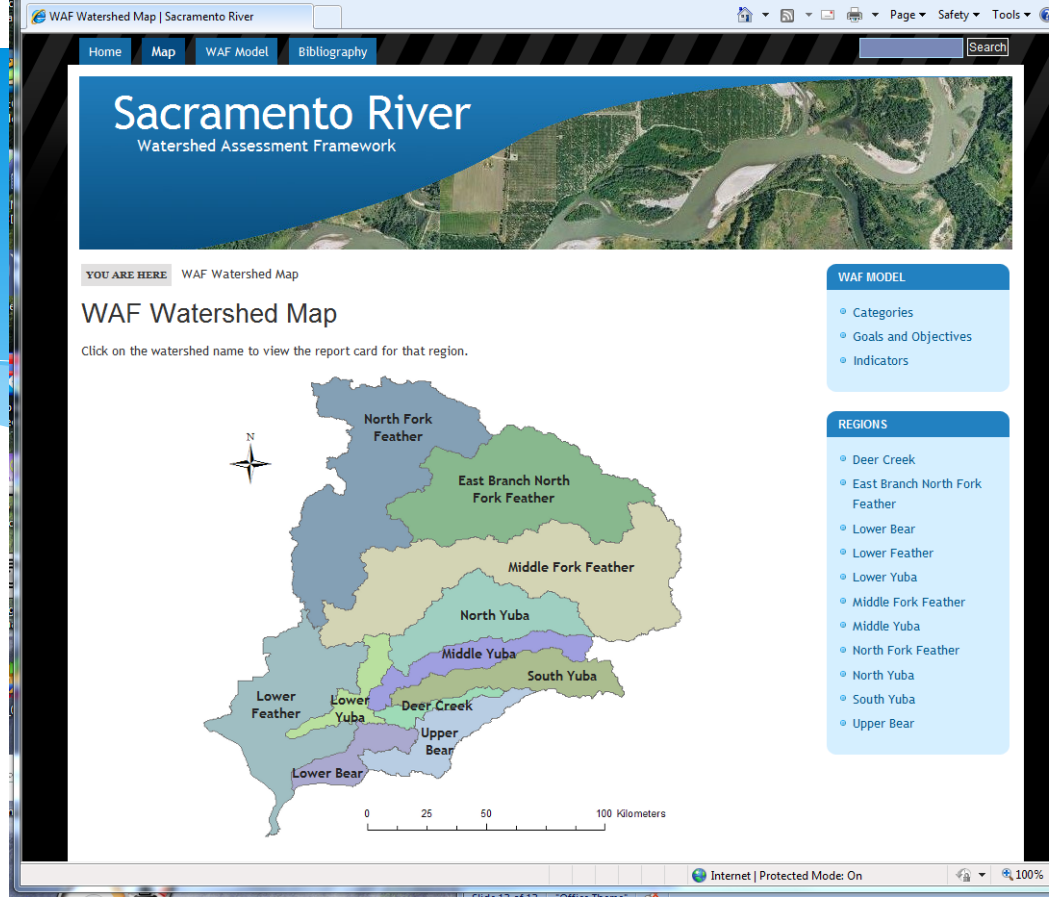
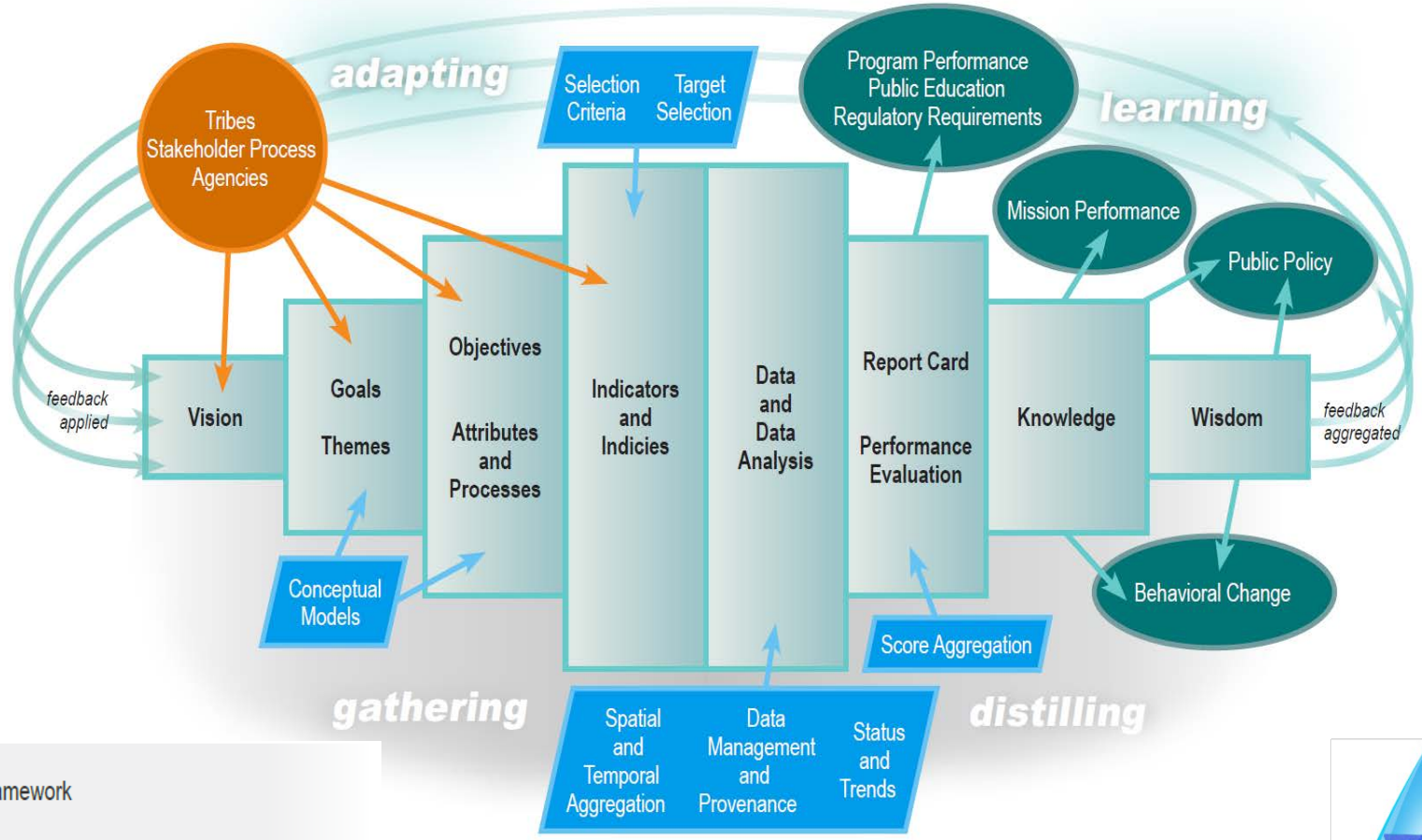


http://ice.ucdavis.edu/waf/

Trend Analysis

There was a statistically significant upward trend in school lunch program enrollment over the 22-year period ($p < 0.001$), with a 1.0% increase per year. This significant increase in enrollment was true of both Napa County and Solano County schools. In Napa, the increase in enrollment was 0.6% per year and in Solano, 1.6% per year. **Forty-two of the watershed's 87 schools individually increased in enrollment ($p < 0.05$), with 41 showing no statistically-significant change, and 4 Napa County schools showing a decrease in enrollment.**

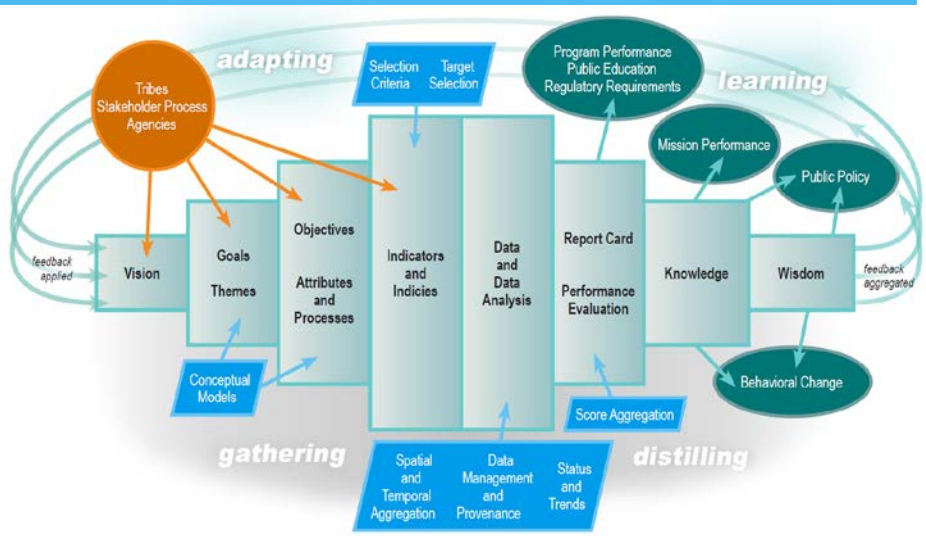
Next Stage: California Water Plan Update 2013 Water Sustainability Indicator Framework



State and Region Pilots

* State project was advised by Water Plan staff, members of the Inter-Agency Steering Committee, the Public Advisory Committee, and the Tribal Advisory Committee
* Pilot was a result of partnership with Santa Ana Watershed Project Authority and Council for Watershed Health
* Associated with the "One Water One Watershed 2.0" process

Themes/categories/domains



* Water Supply Reliability
* Water Quality
* Ecosystem Health
* Social Benefits and Equity
* Adaptive and Sustainable Management

CA Water Sustainability Goals

California Water Plan Update 2013

Goal 1. Manage and make decisions about water in a way that integrates water availability, environmental conditions, and community well-being for future generations.

Goal 2. Improve water supply reliability to meet human needs, reduce energy demand, and restore and maintain aquatic ecosystems and processes.

Goal 3. Improve beneficial uses and reduce impacts associated with water management.

Goal 4. Improve quality of drinking water, irrigation water, and in-stream flows to protect human and environmental health.

Goal 5. Protect and enhance environmental conditions by improving watershed, floodplain, and aquatic condition and processes.

Goal 6. Integrate flood risk management with other water and land management and restoration activities.

Goal 7. Employ adaptive decision-making, especially in light of uncertainties, that support integrated regional water management and flood management systems.

Sustainability Indicators: California

Indicator Name	Sustainability Goals
Aquatic Fragmentation	5
Baseline Water Stress	1,2
California Stream Condition Index	5
CalEnviroScreen-Groundwater Threats	4
Geomorphic Condition	5,6
Groundwater Quality-Nitrate	4
Groundwater Stress	2
Historical Drought Severity	2,5
Historical Flooding	6
Interannual variability	2,5,7
Native Fish Species	5
Public Perceptions of Water	7
Return Flows	2,3
Threats to Amphibians	5
Upstream Protected Lands	2,4
Upstream Storage	2,3
Water Footprint	1,2,7
Water Quality Index	4
Water Use and Availability	2

State pilot indicators and indices and corresponding Sustainability Goals. 19 of 120 indicators in the Water Plan Sustainability Indicators Framework

SAWPA Water Sustainability Goals

SAWPA One Water One Watershed 2.0

Goal 1: Maintain reliable and resilient water supplies and reduce dependency on imported water

Goal 2: Manage at the watershed scale for preservation and enhancement of the natural hydrology to benefit human and natural communities

Goal 3: Preserve and enhance the ecosystem services provided by open space and habitat within the watershed

Goal 4: Protect beneficial uses to ensure high quality water for human and natural communities

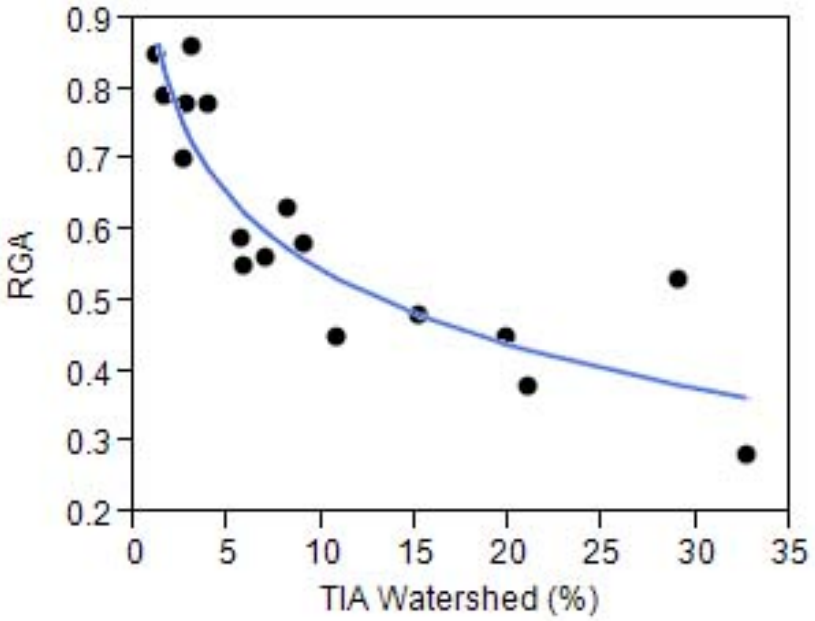
Goal 5: Accomplish effective, equitable and collaborative integrated watershed management in a cost-effective manner

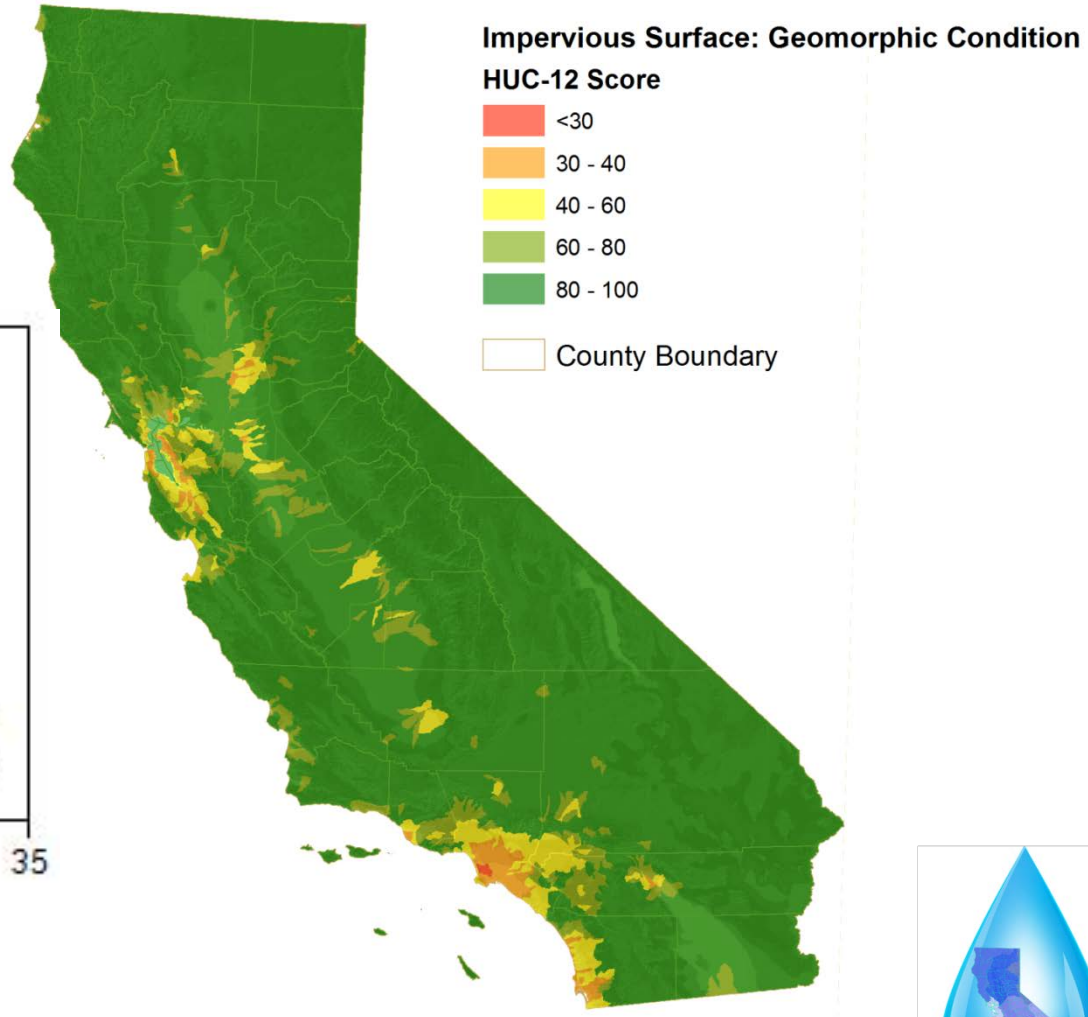
Sustainability Indicators: SAWPA

Indicator Name	SAWPA OWOW 2.0 Sustainability Goal
Proportion of Water Use from Imported and Recycled Sources	1
Water Use (per capita)	1
Local Water Supply Reserves	1
Adoption of Sustainable Water Rates	1
Water Availability and Stress (WRI Aqueduct 2.0)	1
Annual Water Resource Energy Use Relative to Rolling Average	1
Stream Network with Natural Substrate Benthos	2
Impervious Surface: Water Quality Index and Geomorphic Condition	2,4
Coastal Impacts from Sea Level Rise	3,5
Aquatic Habitat Fragmentation	2
Open Space for Recreation	3
Invasive Species and Native Landscapes	3
Area with Restoration Projects and Conservation Agreements	3
Exceedance of Water Quality Objectives in Watershed	4
Exceedance of Groundwater Salinity Standards	4
Exceedance of Water Quality Objectives at Discharge	4
Exceedance of Water Quality Objectives at Recreation Sites	4
Biological Condition Index	3,5
OWOW (Stakeholder-Community) Participation	5

Scoring: Example impervious surfaces and geomorphic/flooding processes

National Land Cover Database 2006

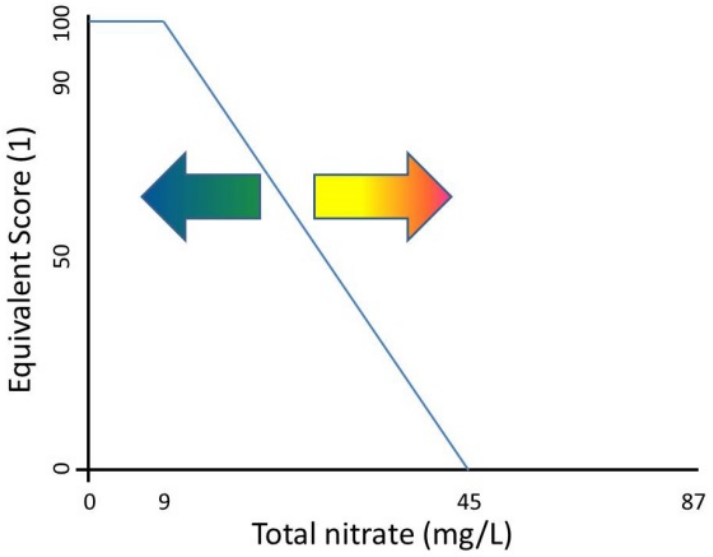


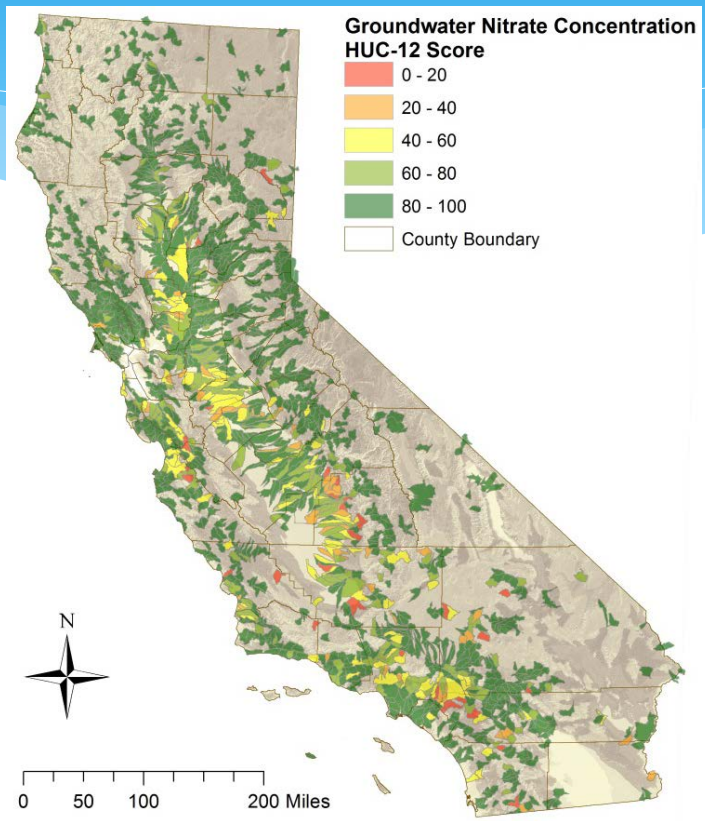


Adapted from Fitzgerald et al (2012).

Scoring: Changing the scoring model

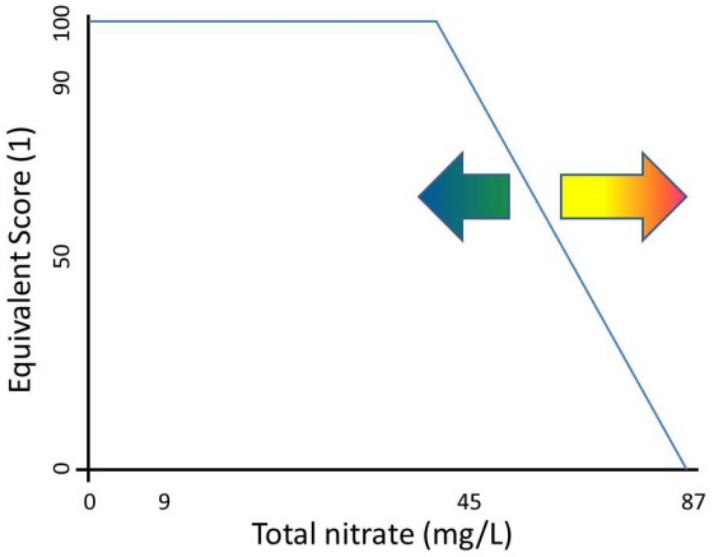
Nitrate concentration less than or equal to the background nitrate concentration in groundwater in the Central Valley (9 mg/L; Harter et al., 2012) receive a score of 100. Nitrate concentrations greater than 45 mg/L (MCL) receive a score of 0.

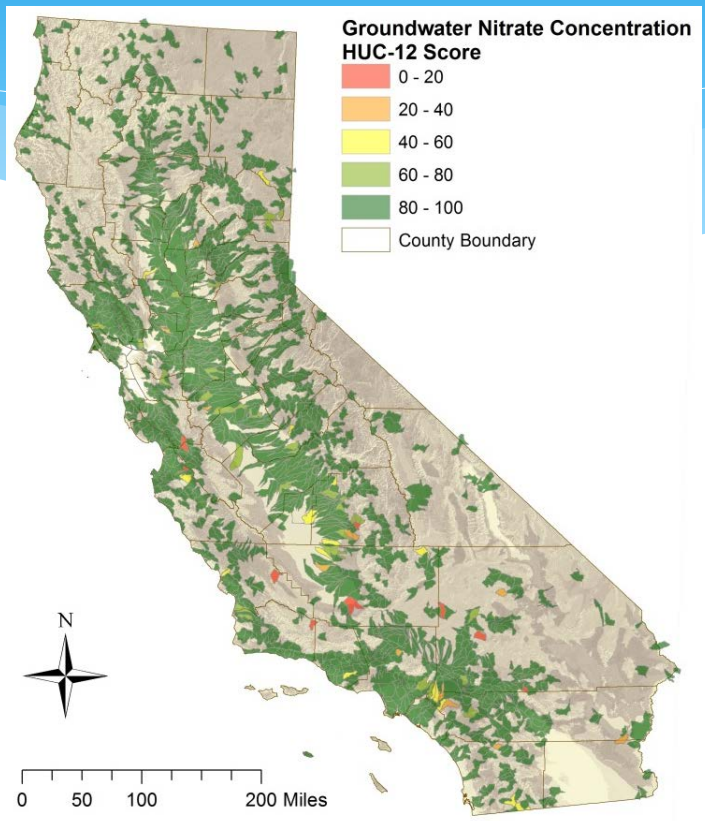




Scoring: Changing the scoring model

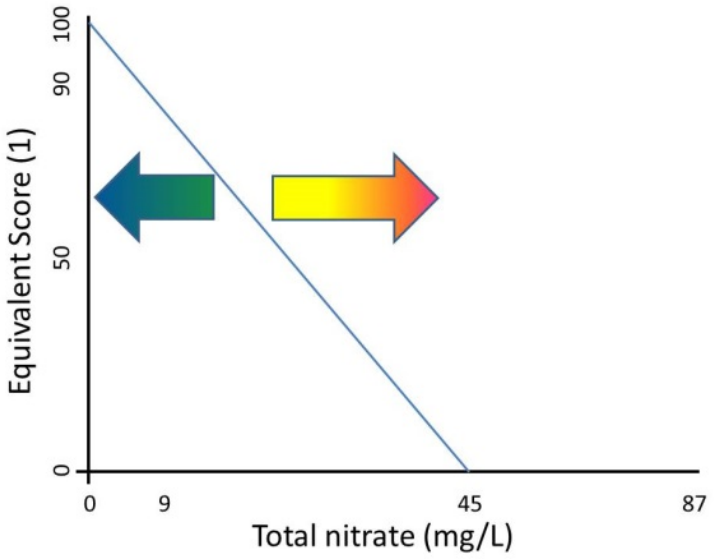
Nitrate concentrations less than the MCL receive a score of 100 and concentrations >45 mg/L up to the mean of all groundwater samples in California's water supply wells in 2012 (87 mg/L; score = 0) receive scores proportional to concentration.

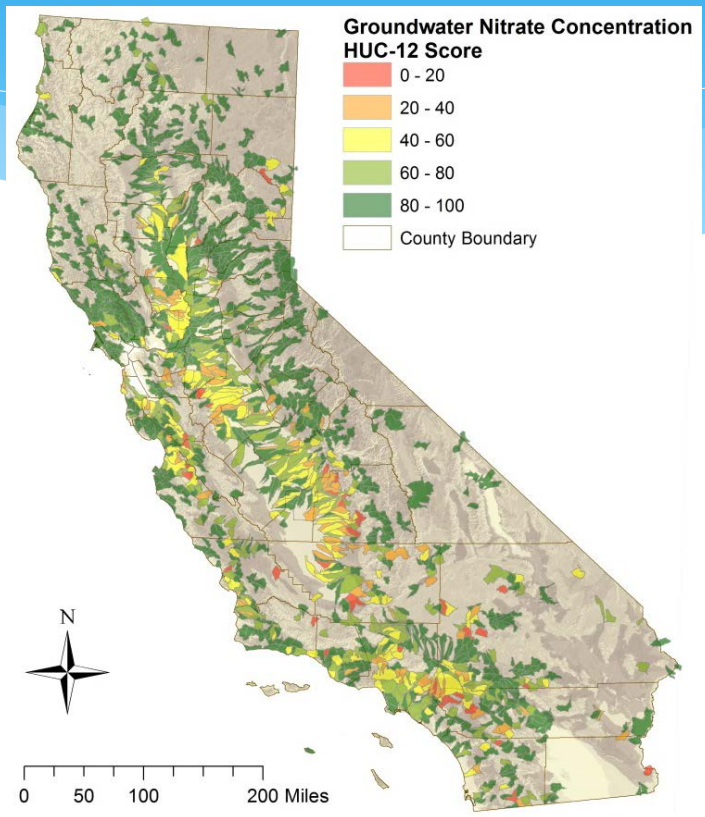




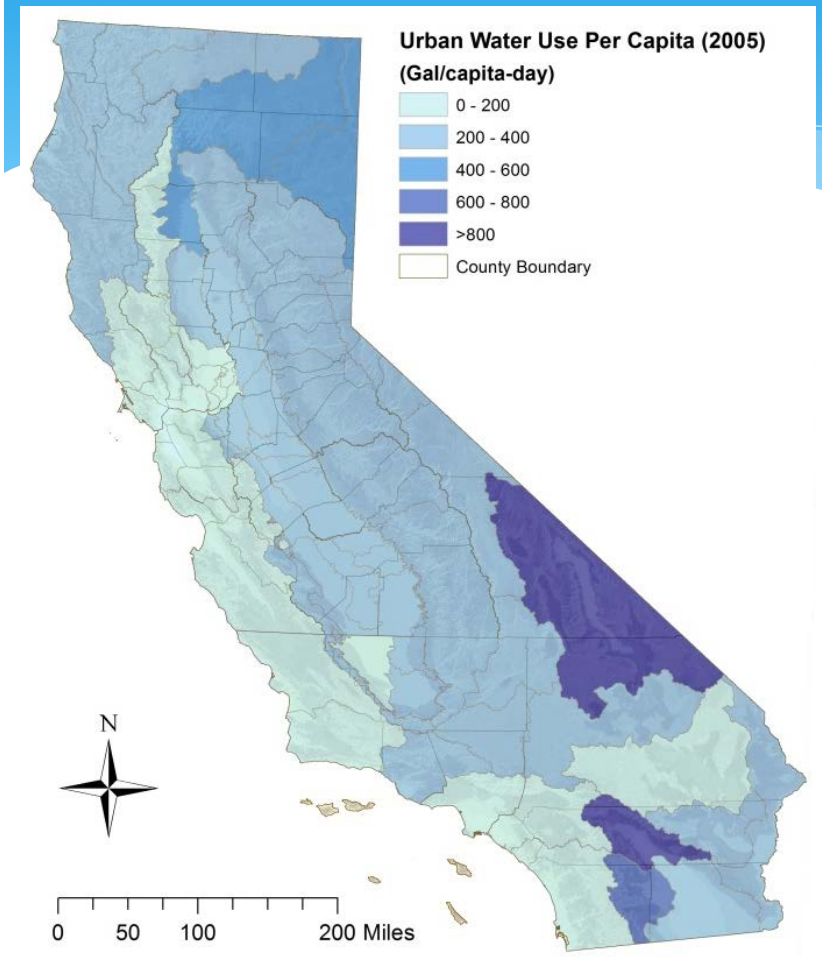
Scoring: Changing the scoring model

Nitrate concentration of 0 mg/L gets a score of 100, concentrations above the MCL receive a score of 0, and intermediate concentrations receive proportionally intermediate scores.

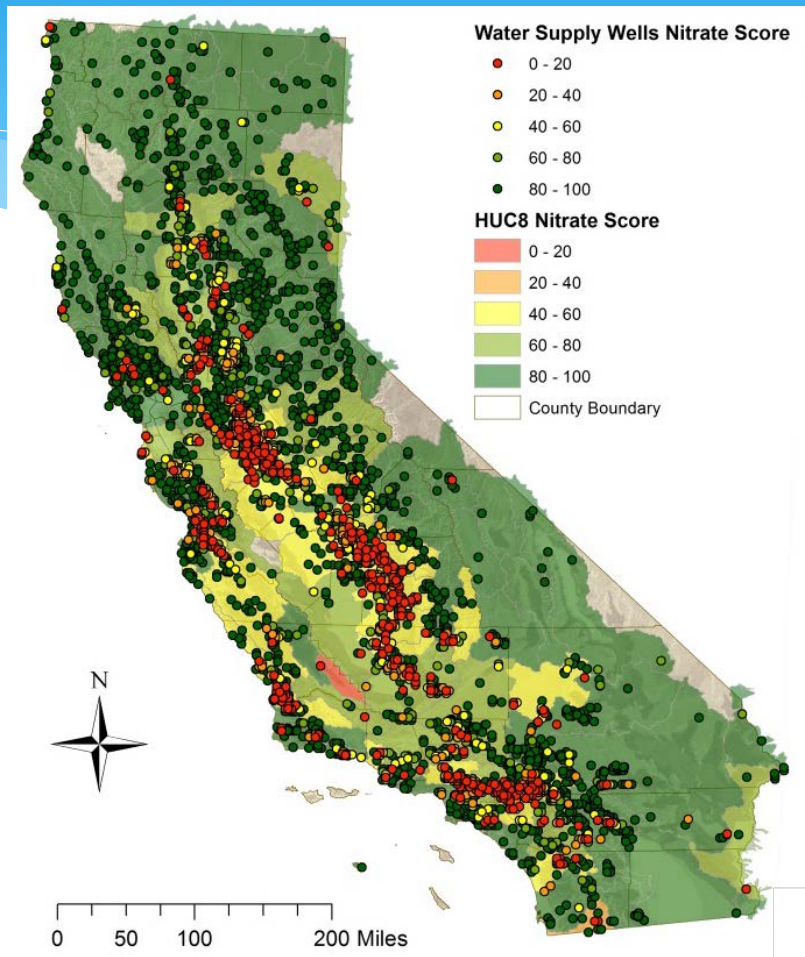




Sample Findings: California

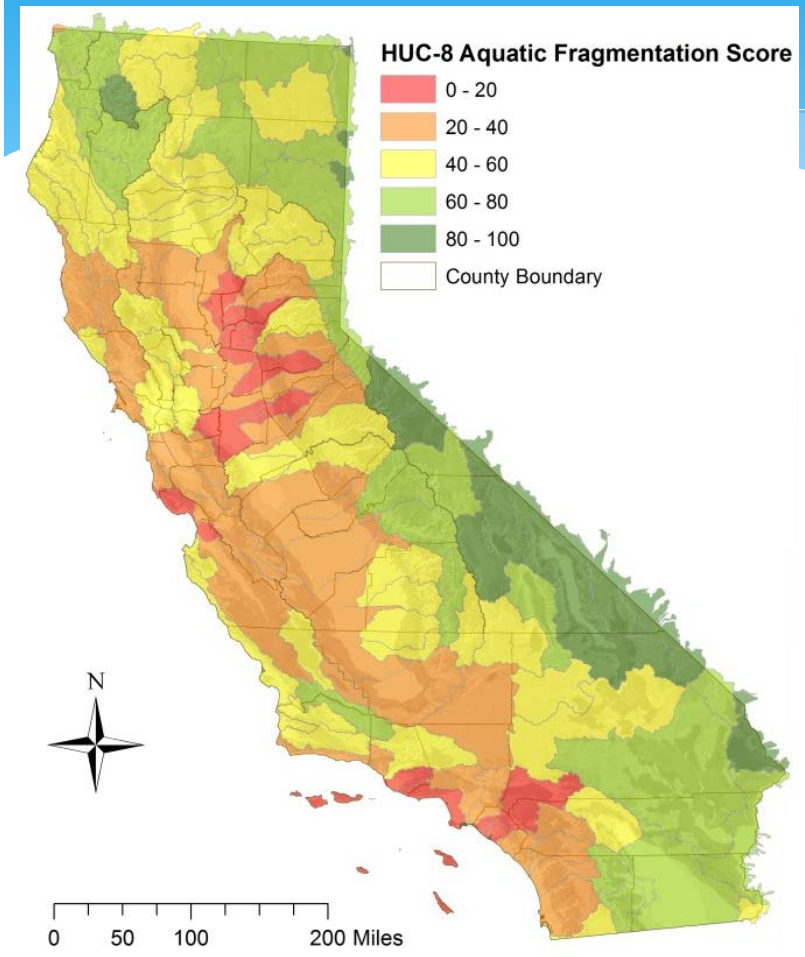


Water use by DWR planning area

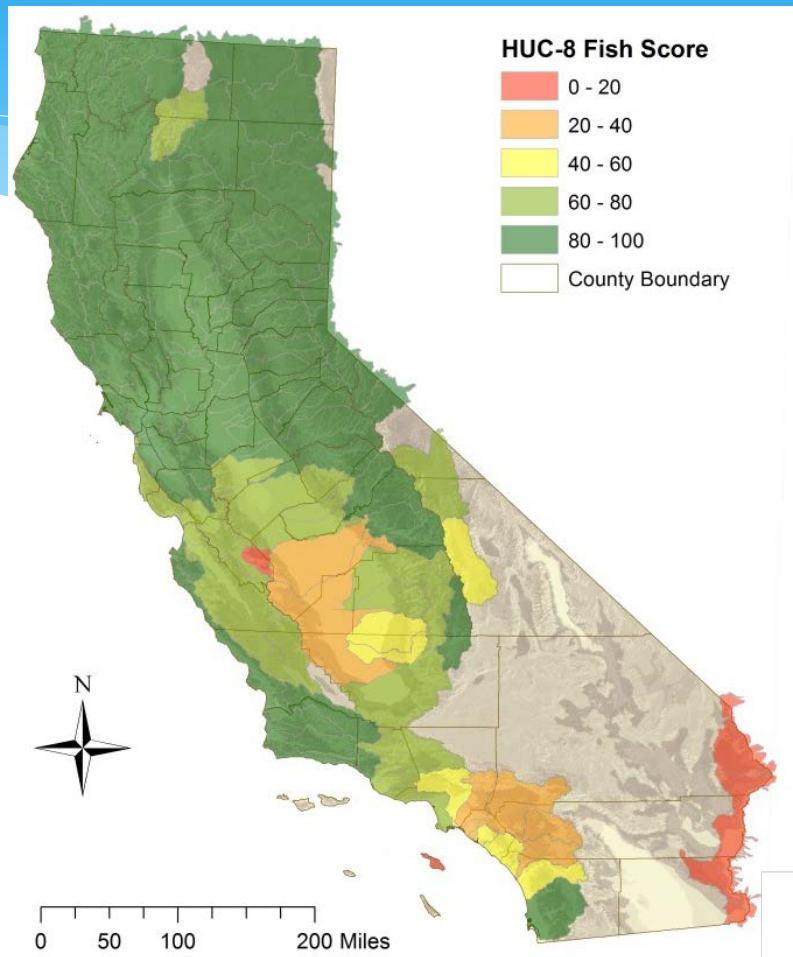


Water supply wells affected by contamination

Sample Findings: California



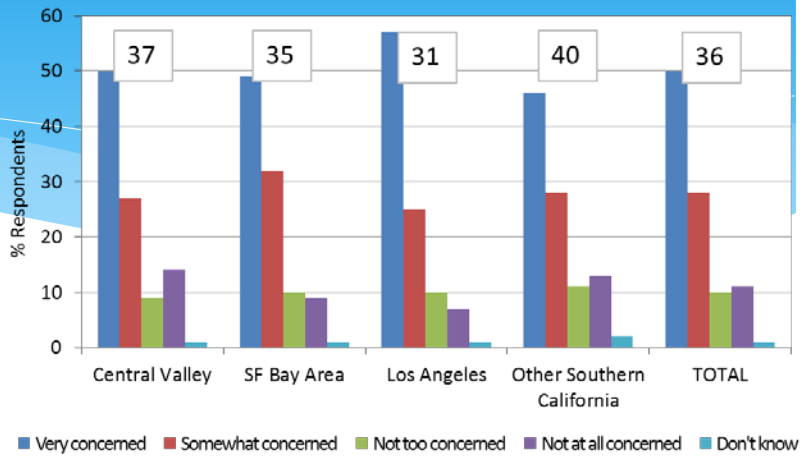
Aquatic fragmentation from road-stream crossings



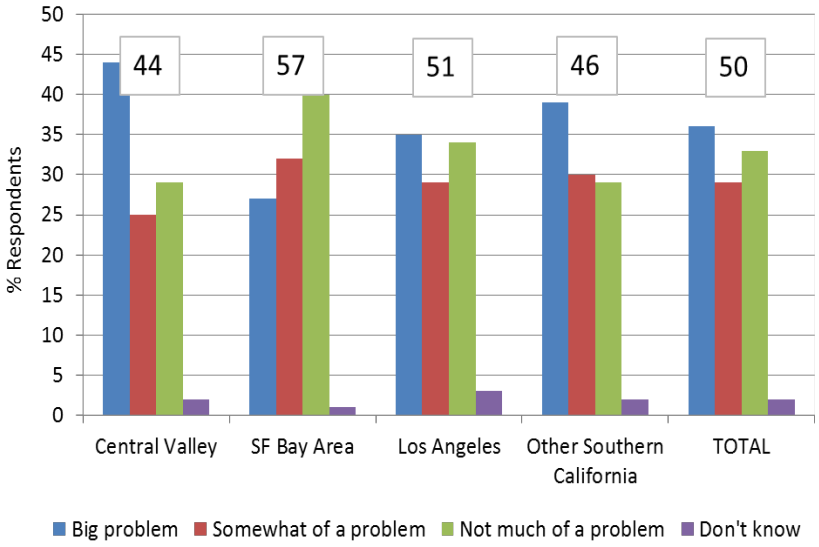
Current presence of native fish species relative to historic presence.

Findings: Public views on water systems and investments

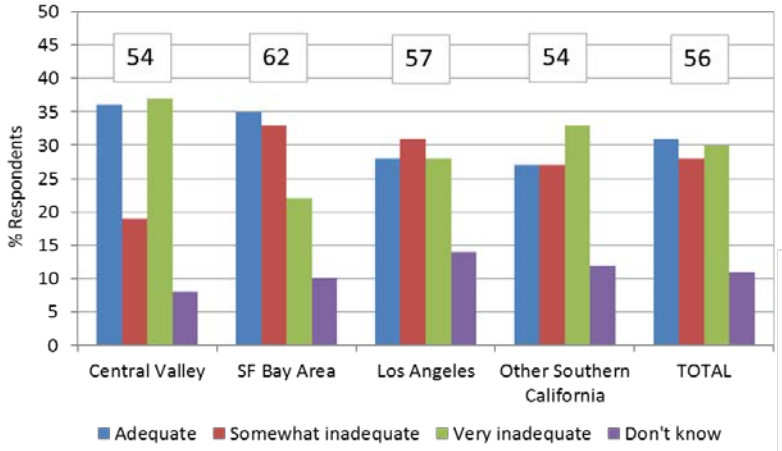
Public Perception of Effects of Climate Change on Future Water Supplies (July 2011, sample = 4,580)



Public Perception by Region of Seriousness of Threats to the Public Water Supply (December 2012, sample = 7,315)

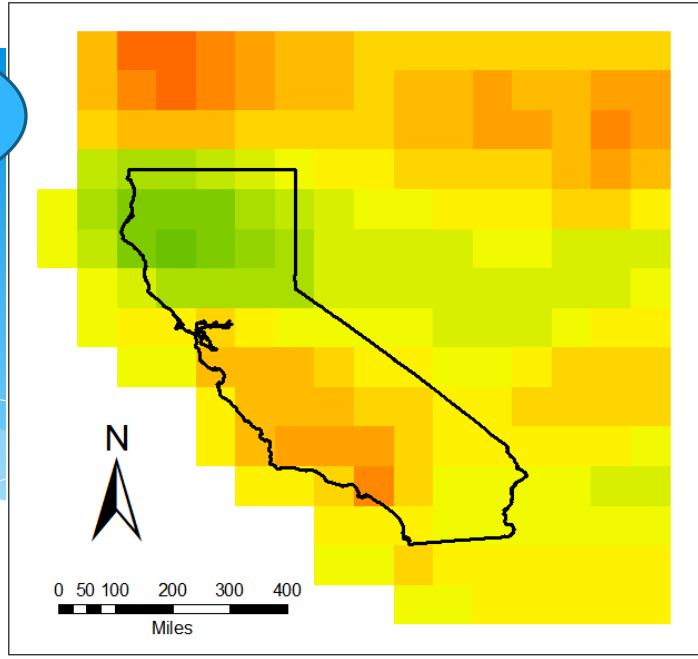


Public Perception of Security of Future Water Supplies (December 2009, sample = 1,825)

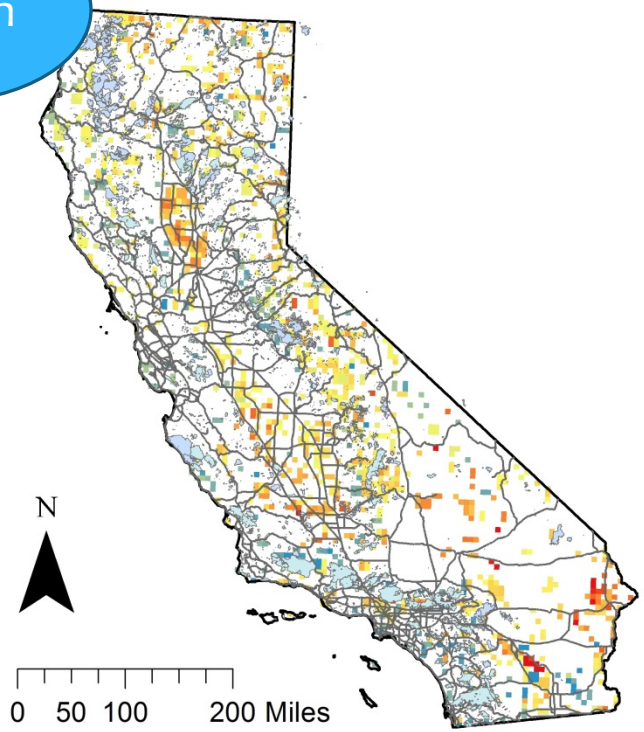


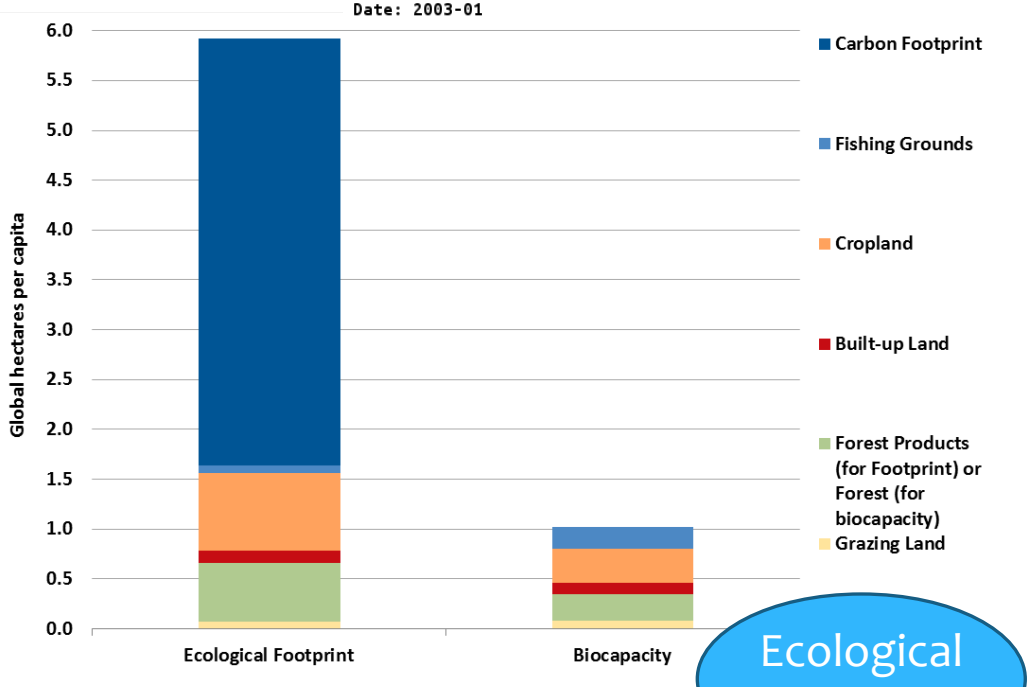
Data Source: Public Policy Institute of California

Groundwater-GRACE



Plant Growth Index



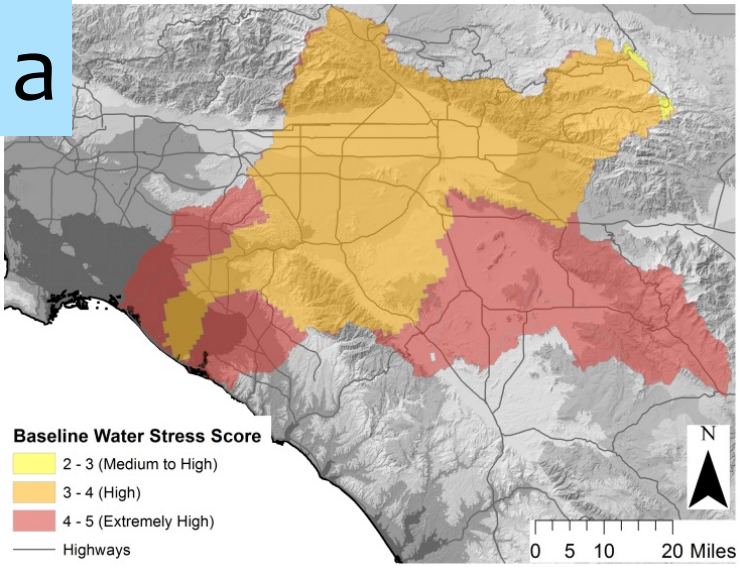


Ecological Footprint

Data Sources: JPL, Global Footprint Network, CSUMB-NASA/AMES

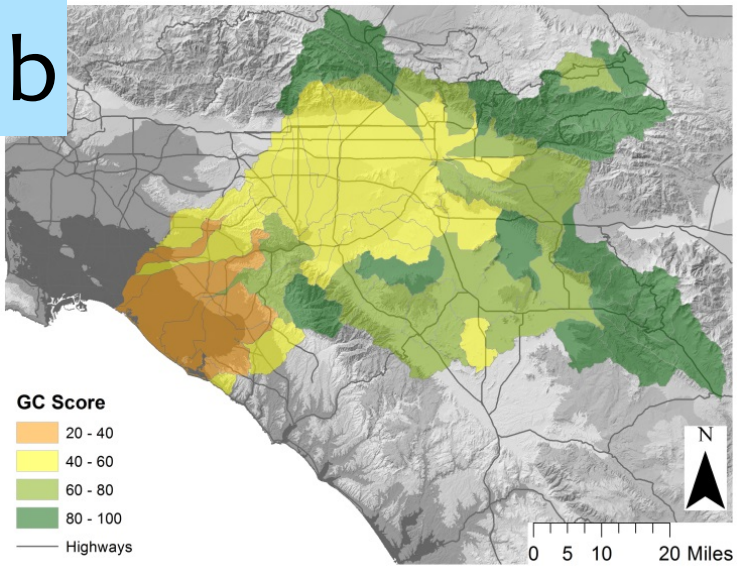
Sample Findings: SAWPA

a

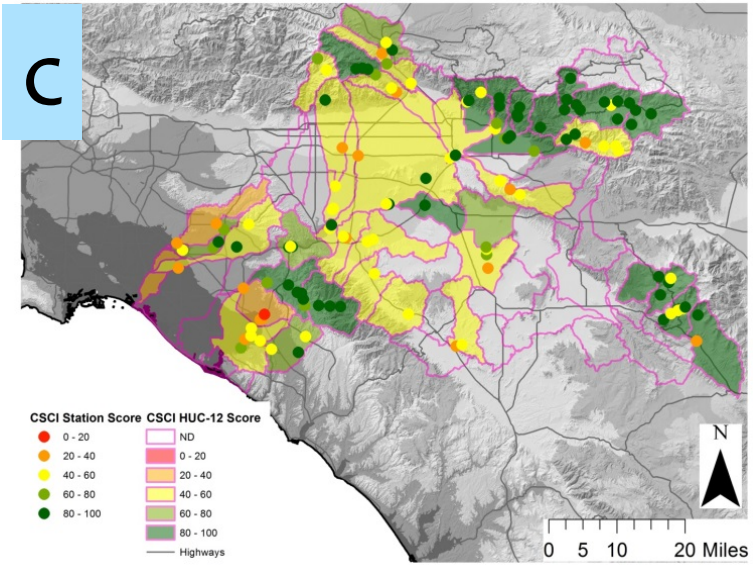


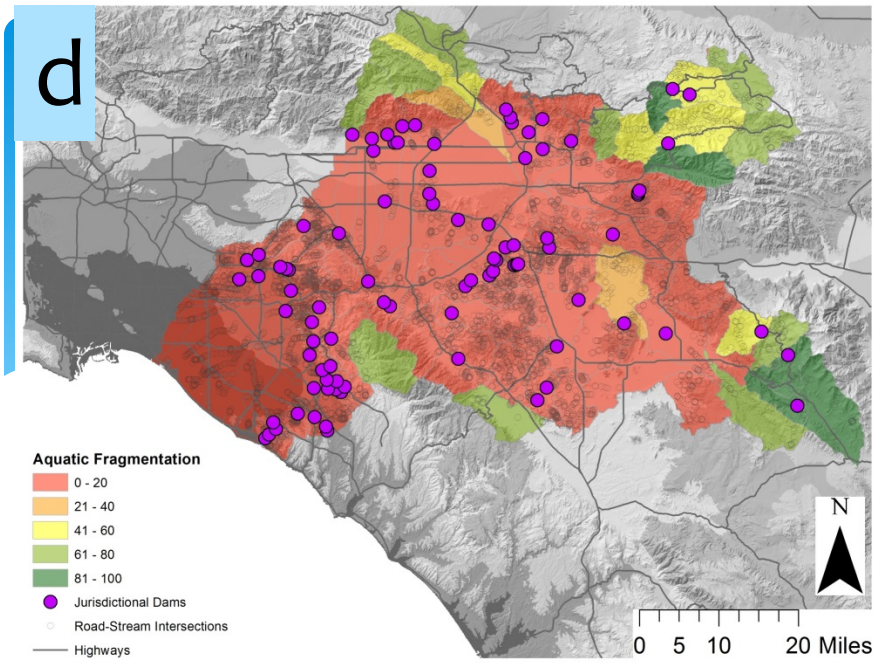
Evaluation of (a) "baseline water stress", (b) geomorphic condition (GC), and (c) California Stream Condition Index indicators at the SAWPA scale.

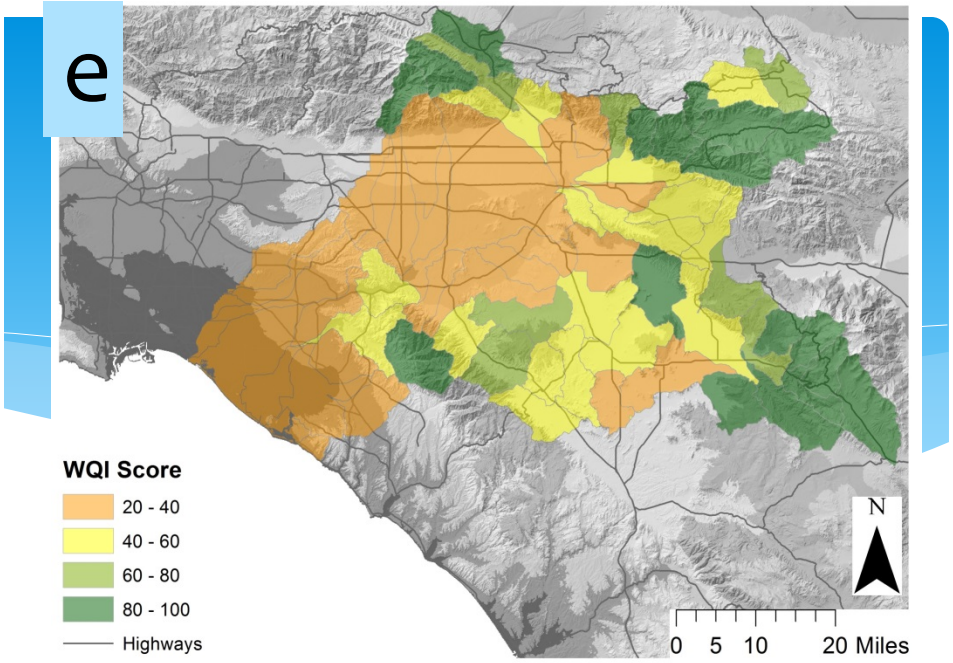
b

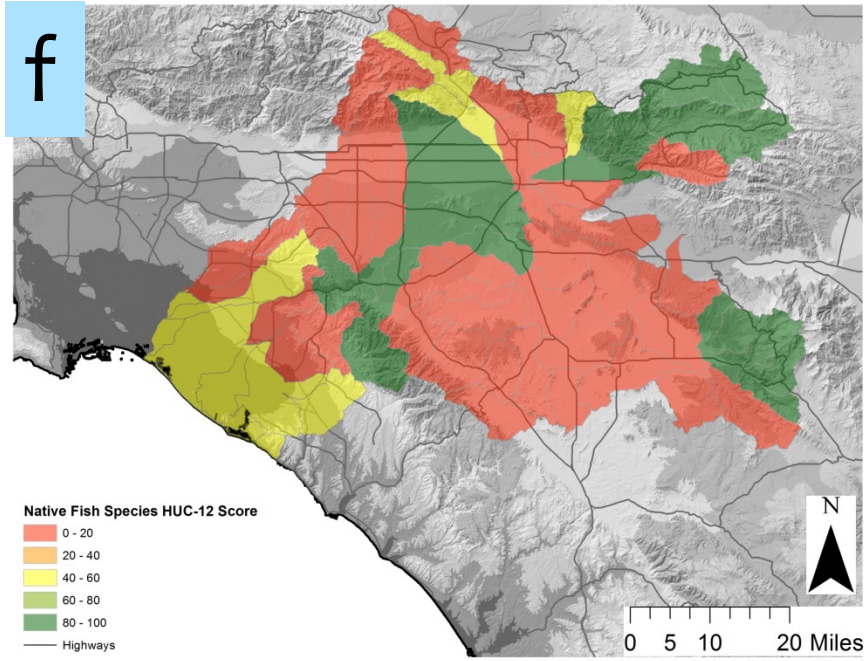


c



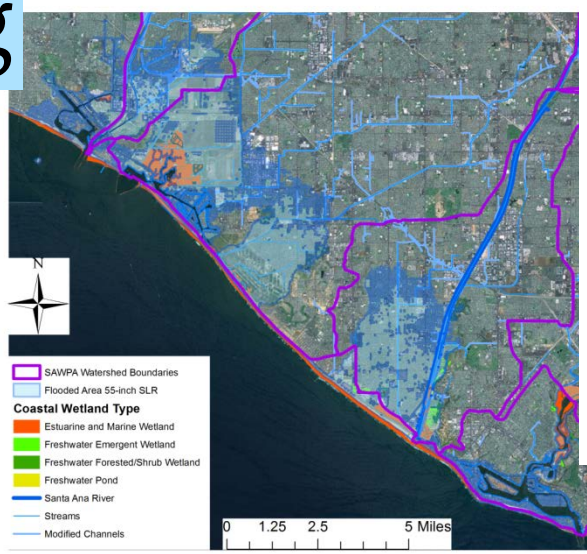


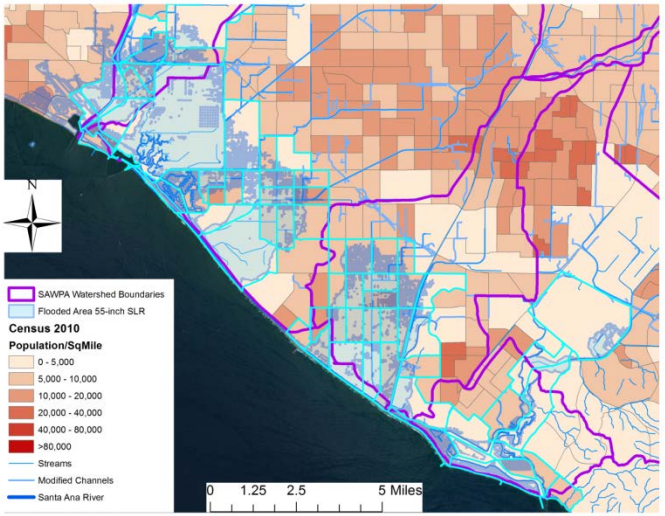




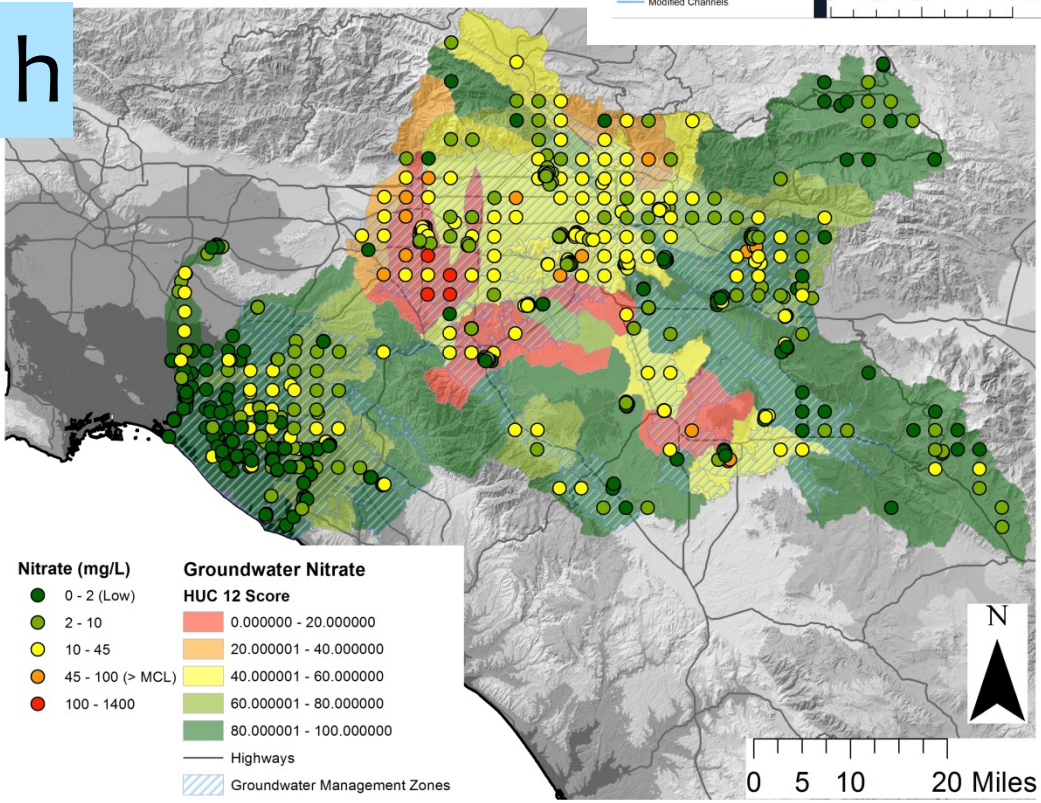
Evaluation of (d) aquatic fragmentation from roads and dams, (e) water quality index, and (f) native fish community indicators at the SAWPA scale.

g





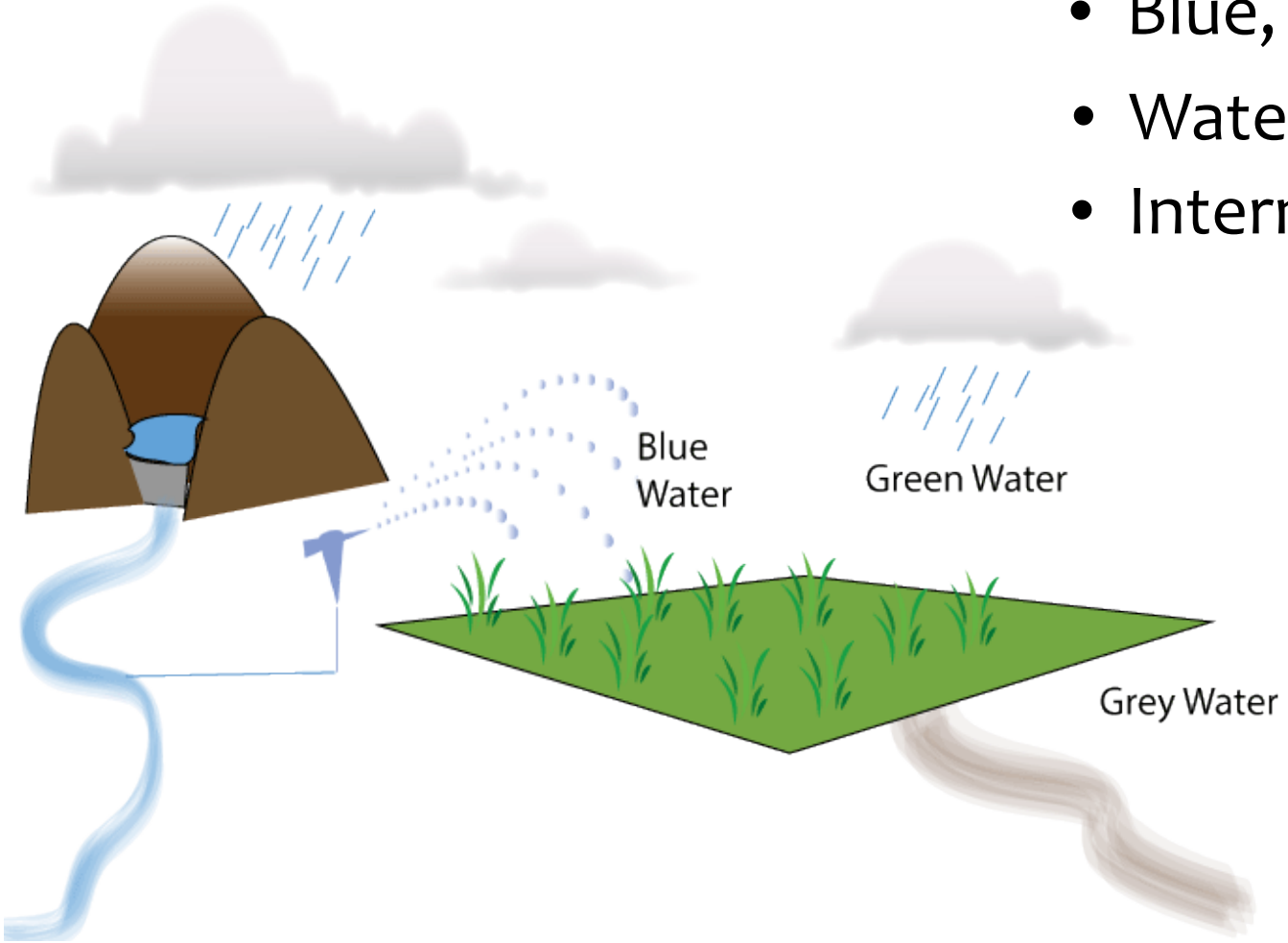
h



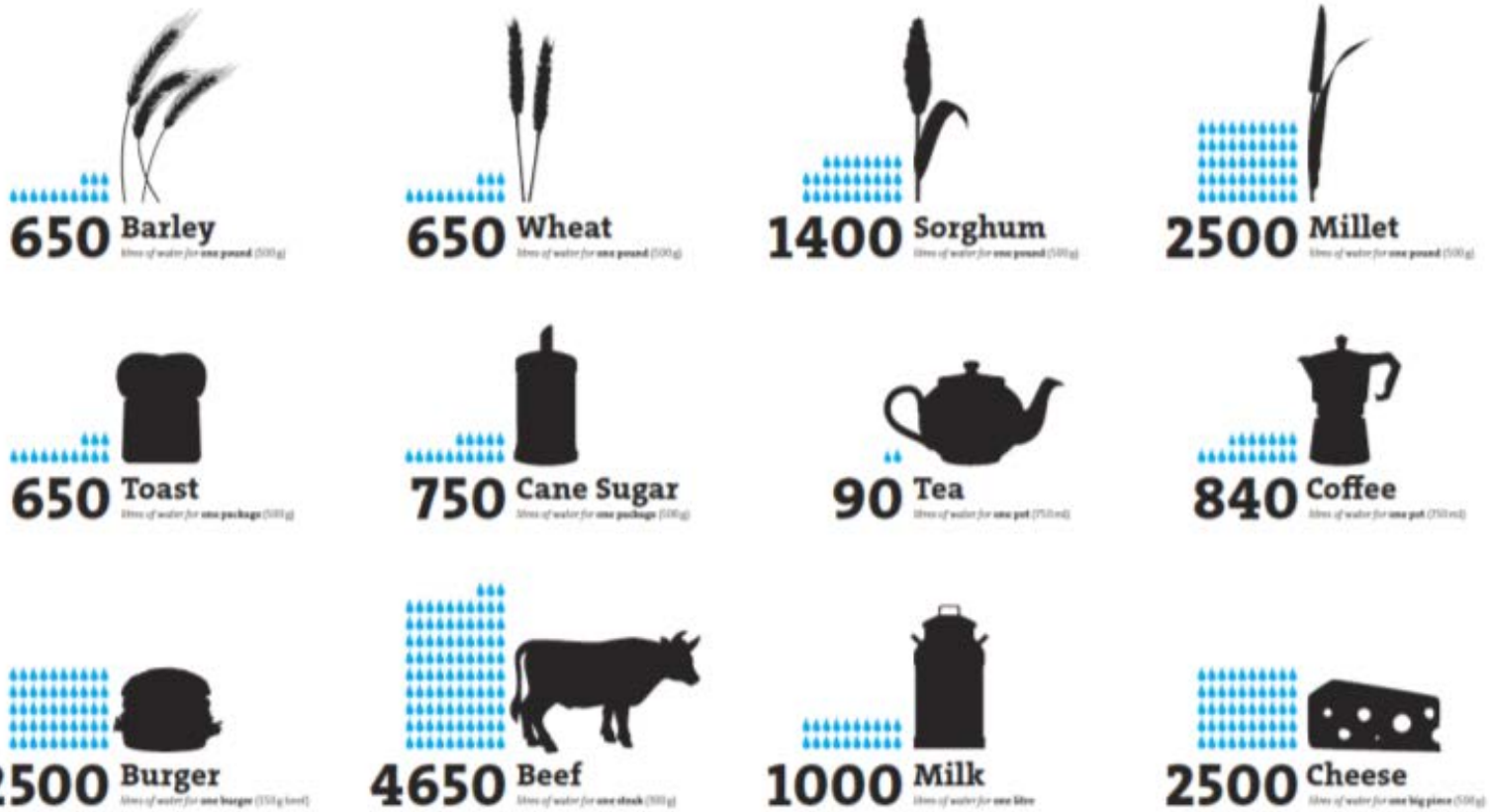
Evaluation of (g) sea level rise threats to infrastructure, wetlands, and population and (h) nitrate in groundwater indicators at the SAWPA scale.

Water Footprint

- Blue, green, and grey
- Water consumption
- Internal and external

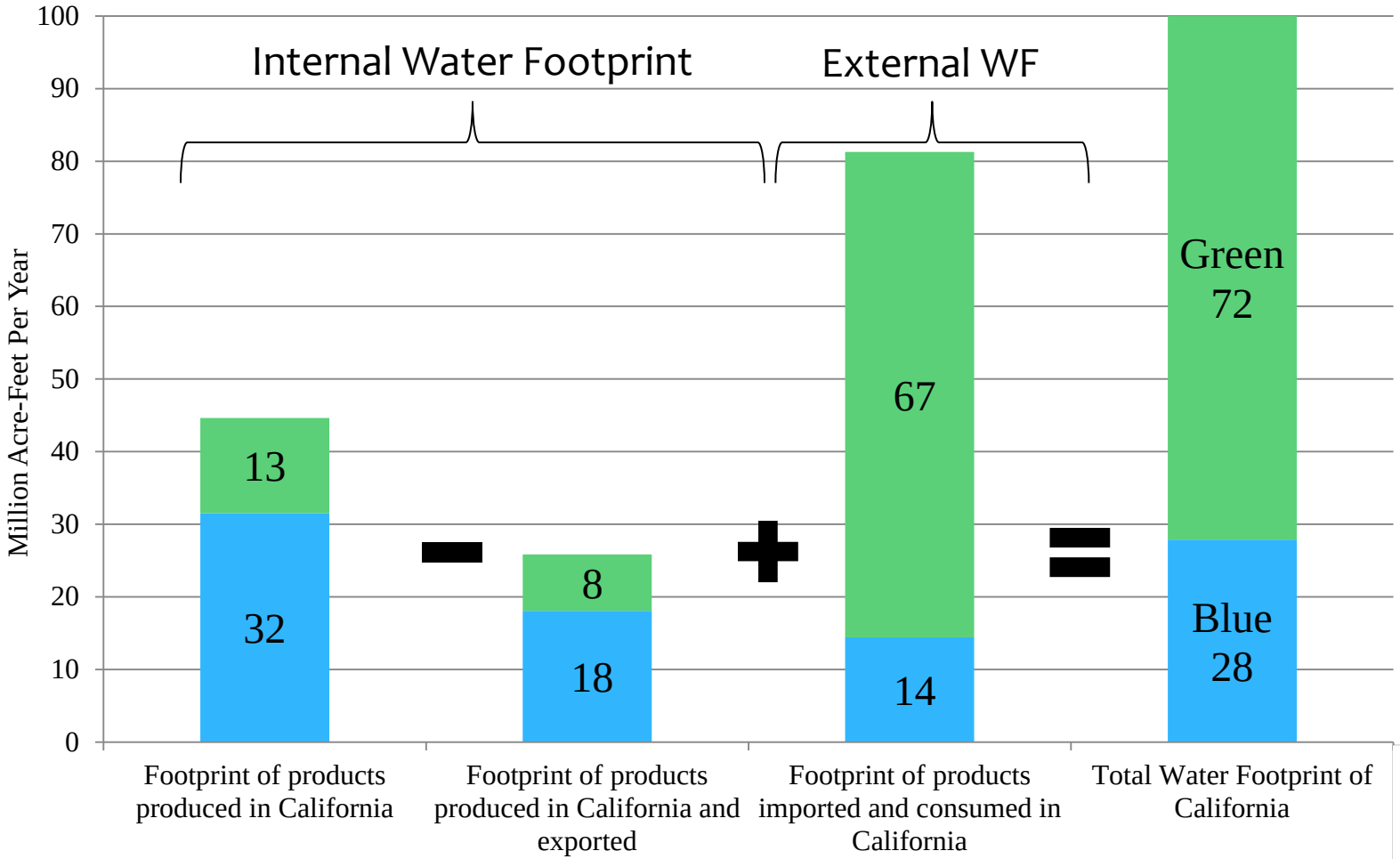


Examples

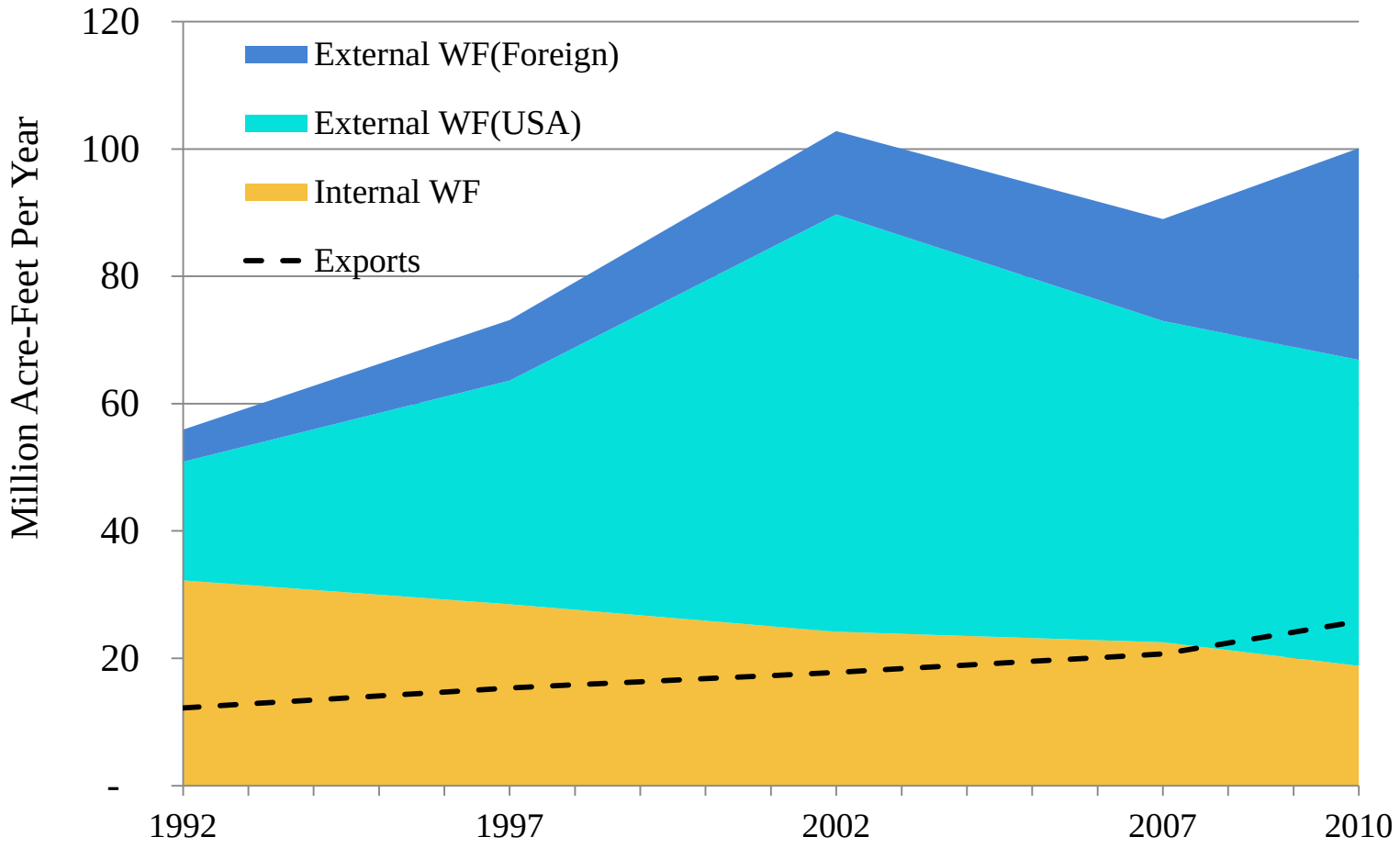


Units = liters/pound/serving
Source: http://virtualwater.eu/

California's Water Footprint in 2010
(*gray water footprint not calculated)



California's Water Footprint, 1992- 2010



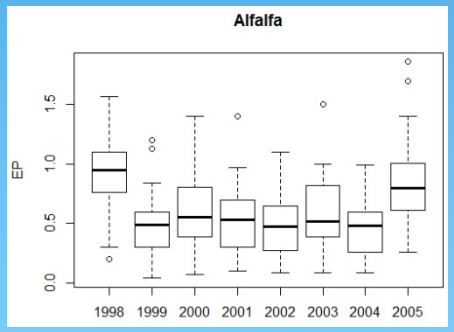
Sources of Variation

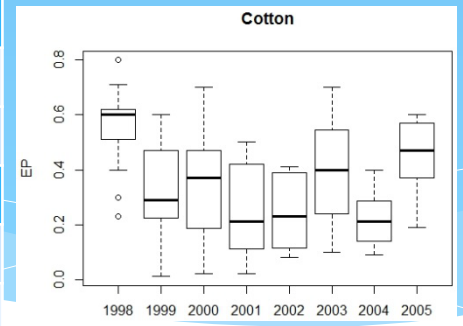
- Like all measurements, the water footprint has several types and sources of variation. An individual's WF can vary with income, diet, and consumption patterns. California's WF for agricultural production varied due to variations in crop-specific irrigation and evapotranspiration rates, which affects the WF.

Table 1. % Change in CA Water Footprint and its components due to variability of water footprints of the nine main crops statewide

	1992	1997	2002	2007
% Change in CA Water Footprint of Agricultural Production				
Lower bound*	-27%	-27%	-27%	-26%
Upper bound*	+33%	+33%	+34%	+33%
% Change in CA Blue Water Footprint				
Lower bound*	-24%	-24%	-20%	-23%
Upper bound*	+29%	+29%	+25%	+29%
% Change in CA Water Footprint				
Lower bound*	-12%	-10%	-7%	-8%
Upper bound*	+14%	+12%	+9%	+10%

Note: * Lower and upper bounds of the 95% confidence interval.



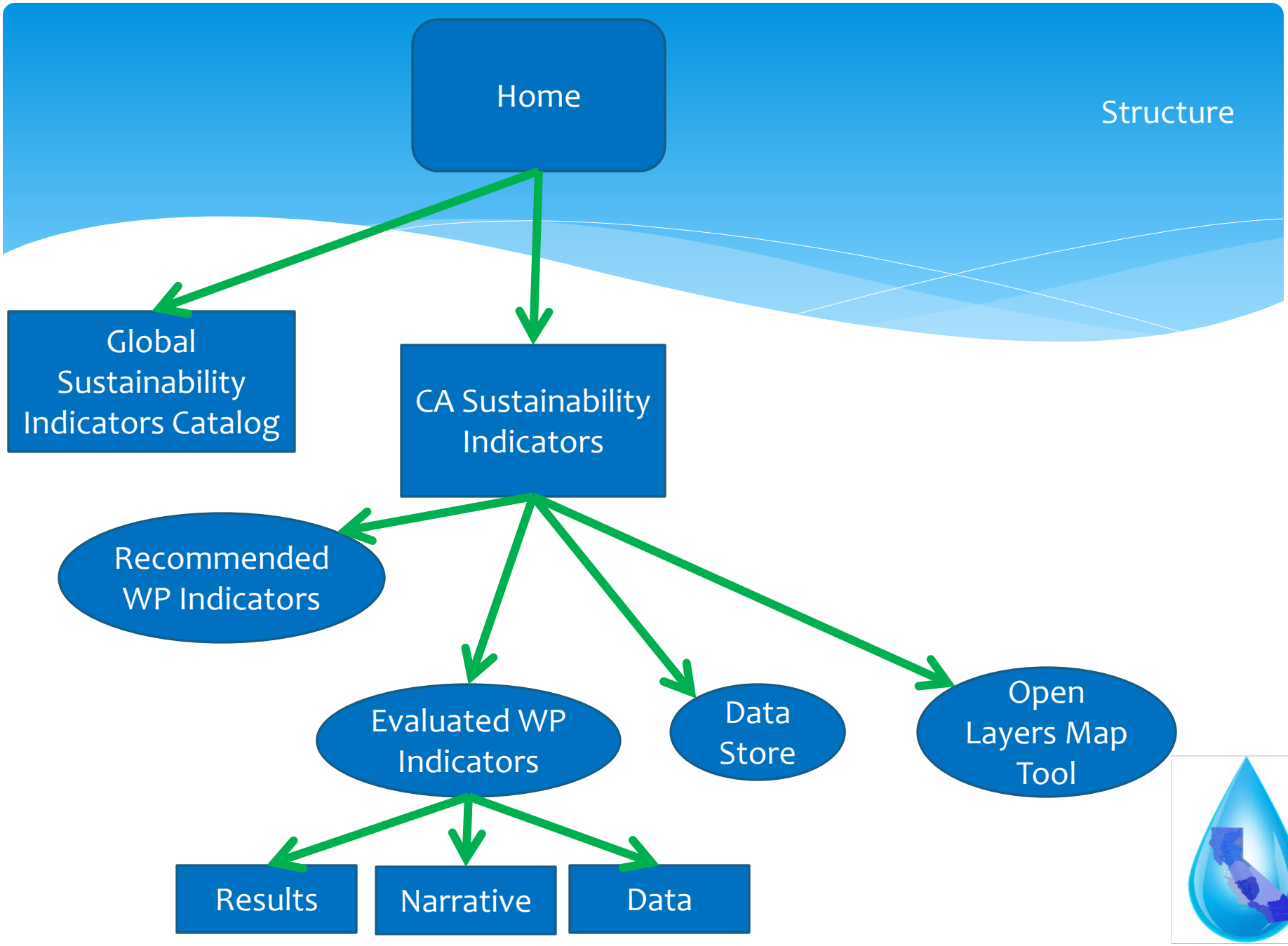


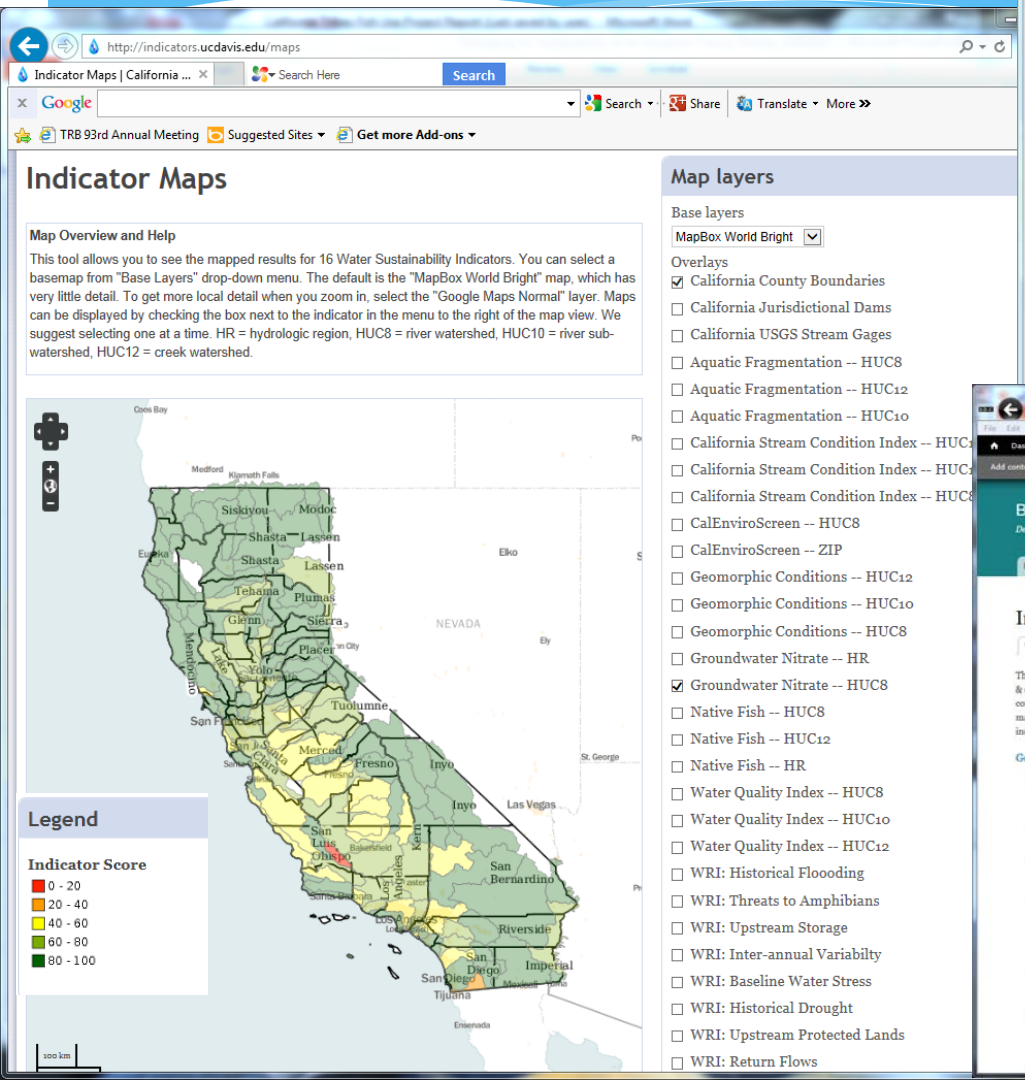
Web-Based Decision Support Tool

* Global indicators catalog
* Water Plan indicators
* Evaluated indicators at state and region scales
* Geo-portal
* What-if scenarios

http://indicators.ucdavis.edu

Structure


Home
Global Sustainability Indicators Catalog
CA Sustainability Indicators
Recommended WP Indicators
Evaluated WP Indicators
Data Store
Open Layers Map Tool
Results
Narrative
Data


http://indicators.ucdavis.edu/maps
Indicator Maps | California ...
Search Here
Search
Google
Search
Share
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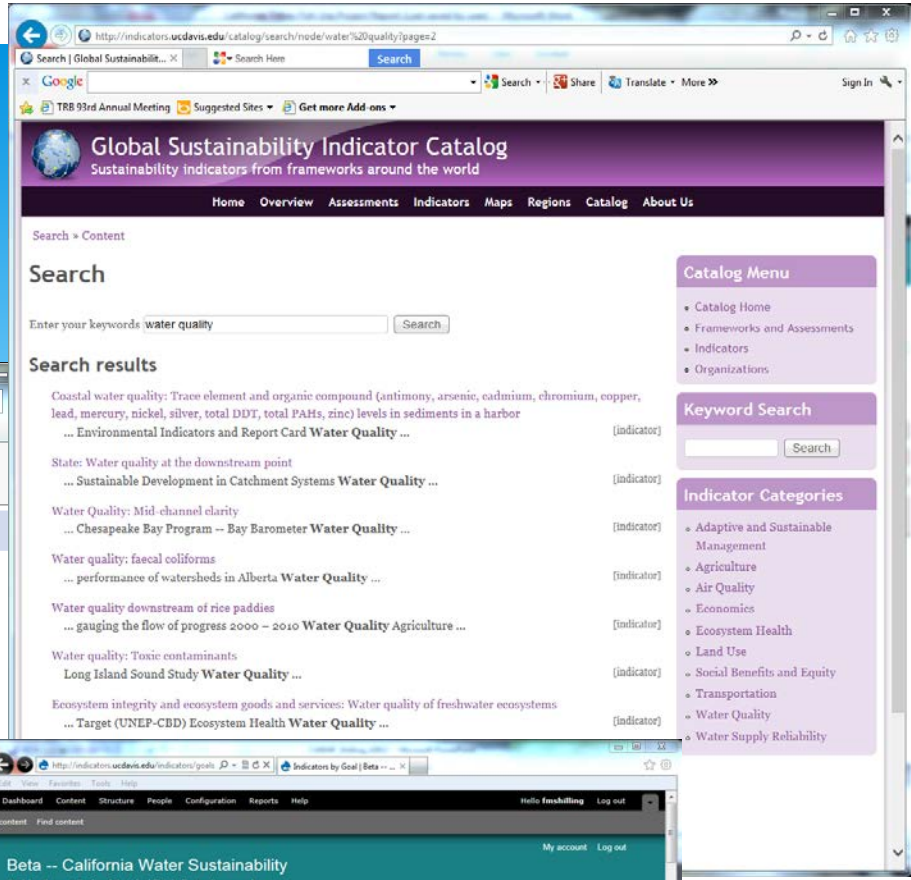
More
TRB 93rd Annual Meeting
Suggested Sites
Get more Add-ons
Indicator Maps
Map Overview and Help
This tool allows you to see the mapped results for 16 Water Sustainability Indicators. You can select a basemap from "Base Layers" drop-down menu. The default is the "MapBox World Bright" map, which has very little detail. To get more local detail when you zoom in, select the "Google Maps Normal" layer. Maps can be displayed by checking the box next to the indicator in the menu to the right of the map view. We suggest selecting one at a time. HR = hydrologic region, HUC8 = river watershed, HUC10 = river sub-watershed, HUC12 = creek watershed.
Map layers
Base layers
MapBox World Bright
Overlays
California County Boundaries
California Jurisdictional Dams
California USGS Stream Gages
Aquatic Fragmentation -- HUC8
Aquatic Fragmentation -- HUC12
Aquatic Fragmentation -- HUC10
California Stream Condition Index -- HUC
California Stream Condition Index -- HUC
California Stream Condition Index -- HUC
CalEnviroScreen -- HUC8
CalEnviroScreen -- ZIP
Geomorphic Conditions -- HUC12
Geomorphic Conditions -- HUC10
Geomorphic Conditions -- HUC8
Groundwater Nitrate -- HR
Groundwater Nitrate -- HUC8
Native Fish -- HUC8
Native Fish -- HUC12
Native Fish -- HR
Water Quality Index -- HUC8
Water Quality Index -- HUC10
Water Quality Index -- HUC12
WRI: Historical Floooding
WRI: Threats to Amphibians
WRI: Upstream Storage
WRI: Inter-annual Variabilty
WRI: Baseline Water Stress
WRI: Historical Drought
WRI: Upstream Protected Lands
WRI: Return Flows
Legend
Indicator Score
0 - 20
20 - 40
40 - 60
60 - 80
80 - 100
Coos Bay
Medford
Klamath Falls
Siskiyou
Modoc
Shasta
Lassen
Eureka
Elko
Tehama
Plumas
Glenn
Sierra
NEVADA
Placer
Yolo
Mendocino
Lake
Tuolumne
San Francisco
Merced
Fresno
Inyo
St. George
Las Vegas
San Luis Obispo
Bakersfield
Kern
San Bernardino
Los Angeles
Riverside
San Diego
Imperial
Tijuana
Mexicali
Ensenada
100 km


http://indicators.ucdavis.edu/catalog/search/node/water%20quality?page=2
Search | Global Sustainabilit...
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Sign In
TRB 93rd Annual Meeting
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Sustainability indicators from frameworks around the world
Home
Overview
Assessments
Indicators
Maps
Regions
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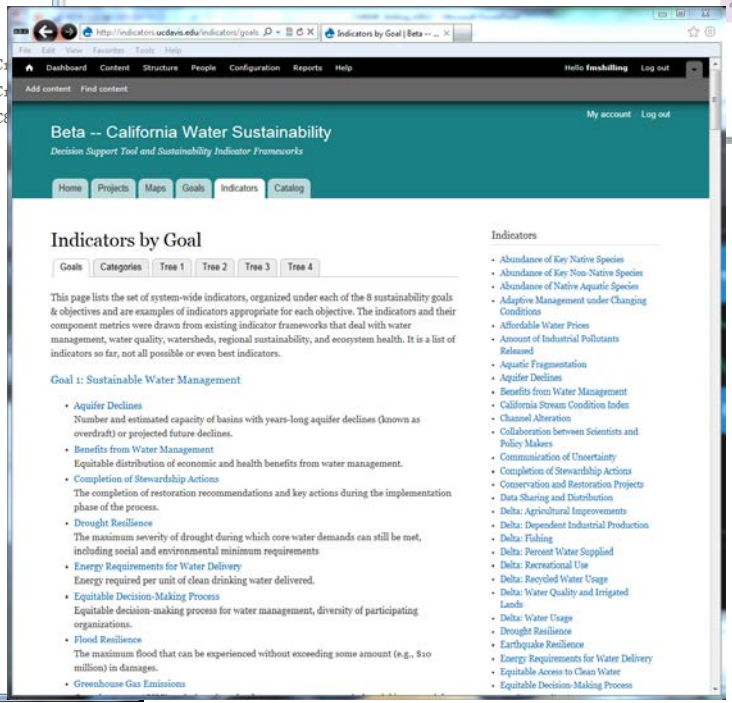
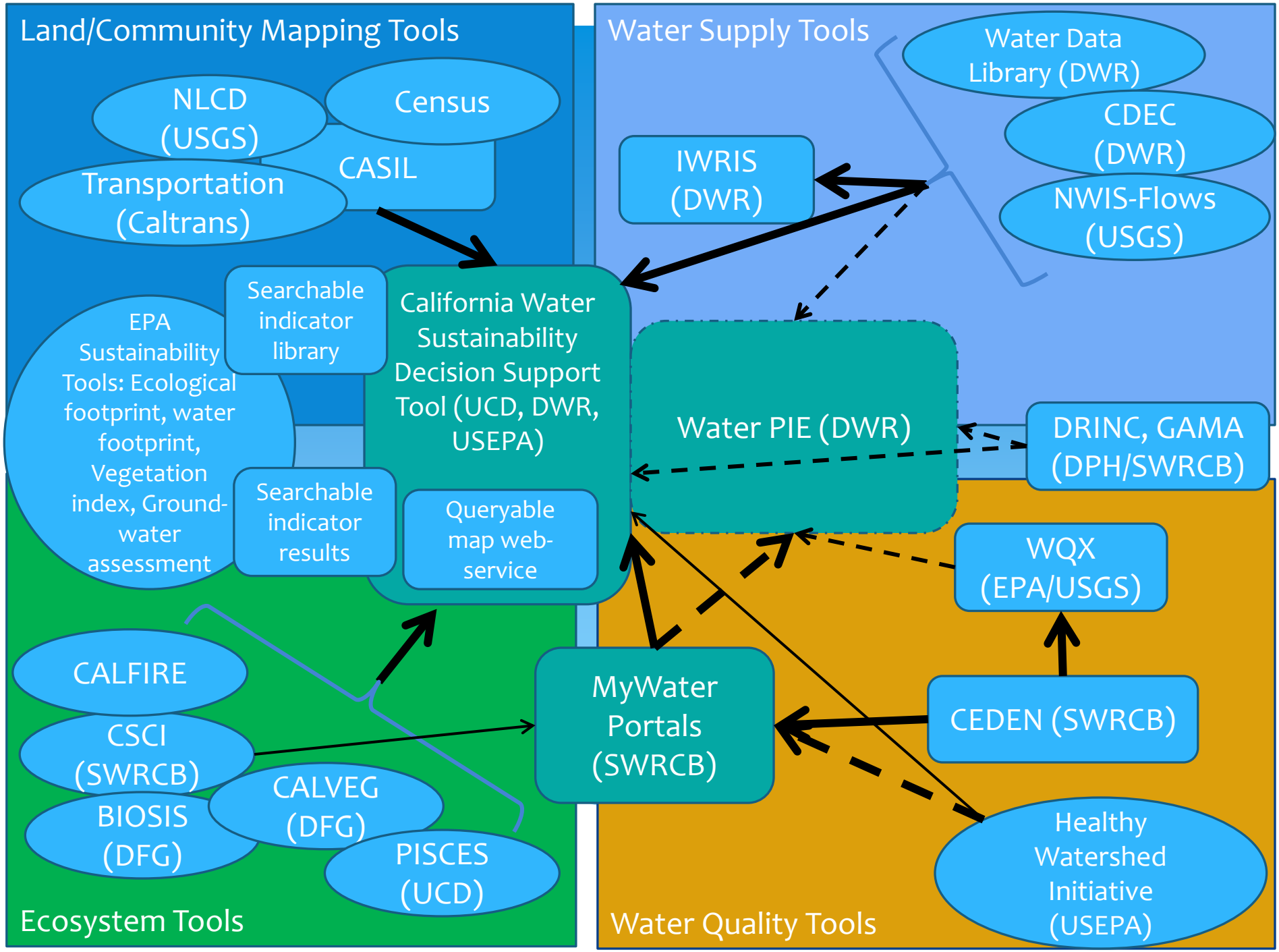
Search » Content
Search
Enter your keywords water quality
Search
Search results
Coastal water quality: Trace element and organic compound (antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, total DDT, total PAHs, zinc) levels in sediments in a harbor
... Environmental Indicators and Report Card Water Quality ... [indicator]
State: Water quality at the downstream point
... Sustainable Development in Catchment Systems Water Quality ... [indicator]
Water Quality: Mid-channel clarity
... Chesapeake Bay Program -- Bay Barometer Water Quality ... [indicator]
Water quality: faecal coliforms
... performance of watersheds in Alberta Water Quality ... [indicator]
Water quality downstream of rice paddies
... gauging the flow of progress 2000 – 2010 Water Quality Agriculture ... [indicator]
Water quality: Toxic contaminants
Long Island Sound Study Water Quality ... [indicator]
Ecosystem integrity and ecosystem goods and services: Water quality of freshwater ecosystems
... Target (UNEP-CBD) Ecosystem Health Water Quality ... [indicator]
Catalog Menu
Catalog Home
Frameworks and Assessments
Indicators
Organizations
Keyword Search
Search
Indicator Categories
Adaptive and Sustainable Management
Agriculture
Air Quality
Economics
Ecosystem Health
Land Use
Social Benefits and Equity
Transportation
Water Quality
Water Supply Reliability


Dashboard
Content
Structure
People
Configuration
Reports
Help
Beta -- California Water Sustainability
Decision Support Tool and Sustainability Indicator Frameworks
Home
Projects
Maps
Goals
Indicators
Catalog
Indicators by Goal
Goals
Categories
Tree 1
Tree 2
Tree 3
Tree 4
This page lists the set of system-wide indicators, organized under each of the 8 sustainability goals & objectives and are examples of indicators appropriate for each objective. The indicators and their component metrics were drawn from existing indicator frameworks that deal with water management, water quality, watersheds, regional sustainability, and ecosystem health. It is a list of indicators so far, not all possible or even best indicators.
Goal 1: Sustainable Water Management
Aquifer Declines
Number and estimated capacity of basins with years-long aquifer declines (known as overdraft) or projected future declines.
Benefits from Water Management
Equitable distribution of economic and health benefits from water management.
Completion of Stewardship Actions
The completion of restoration recommendations and key actions during the implementation phase of the process.
Drought Resilience
The maximum severity of drought during which core water demands can still be met, including social and environmental minimum requirements
Energy Requirements for Water Delivery
Energy required per unit of clean drinking water delivered.
Equitable Decision-Making Process
Equitable decision-making process for water management, diversity of participating organizations.
Flood Resilience
The maximum flood that can be experienced without exceeding some amount (e.g., $10 million) in damages.
Greenhouse Gas Emissions
Indicators
Abundance of Key Native Species
Abundance of Key Non-Native Species
Abundance of Native Aquatic Species
Adaptive Management under Changing Conditions
Affordable Water Prices
Amount of Industrial Pollutants Released
Aquatic Fragmentation
Aquifer Declines
Benefits from Water Management
California Stream Condition Index
Channel Alteration
Collaboration between Scientists and Policy Makers
Communication of Uncertainty
Completion of Stewardship Actions
Conservation and Restoration Projects
Data Sharing and Distribution
Delta: Agricultural Improvements
Delta: Dependent Industrial Production
Delta: Fishing
Delta: Percent Water Supplied
Delta: Recreational Use
Delta: Recycled Water Usage
Delta: Water Quality and Irrigated Lands
Delta: Water Usage
Drought Resilience
Earthquake Resilience
Energy Requirements for Water Delivery
Equitable Access to Clean Water
Equitable Decision-Making Process


Land/Community Mapping Tools
NLCD (USGS)
Census
CASIL
Transportation (Caltrans)
Water Supply Tools
Water Data Library (DWR)
CDEC (DWR)
NWIS-Flows (USGS)
IWRIS (DWR)
Searchable indicator library
EPA Sustainability Tools: Ecological footprint, water footprint, Vegetation index, Ground-water assessment
California Water Sustainability Decision Support Tool (UCD, DWR, USEPA)
Water PIE (DWR)
DRINC, GAMA (DPH/SWRCB)
Searchable indicator results
Queryable map web-service
WQX (EPA/USGS)
CALFIRE
CSCI (SWRCB)
CALVEG (DFG)
BIOSIS (DFG)
PISCES (UCD)
MyWater Portals (SWRCB)
CEDEN (SWRCB)
Healthy Watershed Initiative (USEPA)
Ecosystem Tools
Water Quality Tools

CWQMC Opportunities

* Support integrated, federated water information system for CA (potentially useful in times of drought), for example My Water Quality + Water PIE + DRINC
* Support development of real-time/automated indicators, integrated with information systems (saves $)
* Support annual water sustainability report cards for water flows, supplies, replenishment, quality, biota, cycling, use, etc.
* Support agency/academy collaboration to report on sustainability in general

Contact & More Information

* Indicators.ucdavis.edu
* fmshilling@ucdavis.edu