

# SMC's Stream Quality Index: An integrated tool for stream assessment

Cal WQMC meeting June 6<sup>th</sup>, 2019

CSCI:



ASCI:



Total nitrogen:



Total phosphorus:



Conductivity:



CRAM index score:



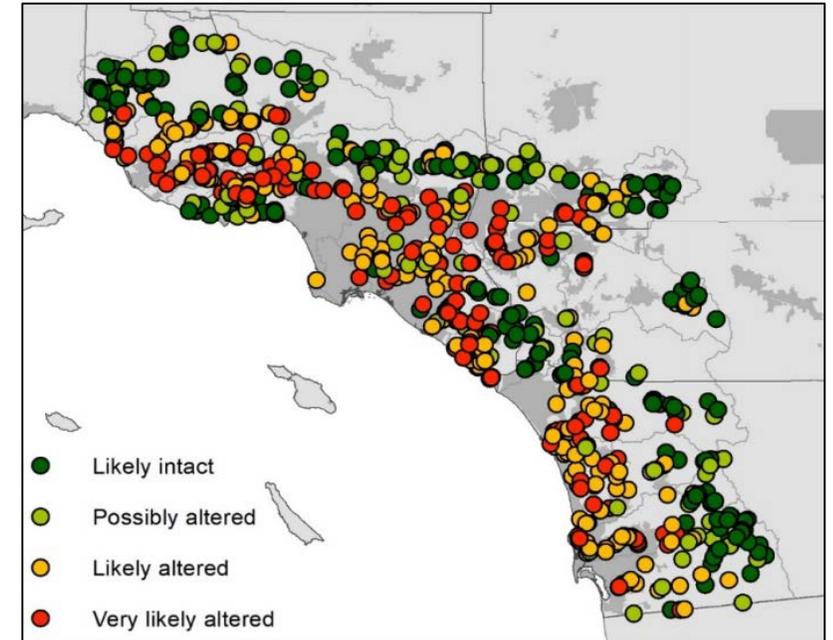
Index of physical integrity:



# Stormwater Monitoring Coalition (SMC)



- Formed in 2001 by cooperative agreement between NPDES permittees and regulatory agencies in SoCal
- RMP initiated in 2009 for wadeable streams:
  1. What is the *biological condition*?
  2. What *stressors* are associated with poor condition?
  3. Are conditions *changing over time*?
- Most comprehensive source of stream data in SoCal

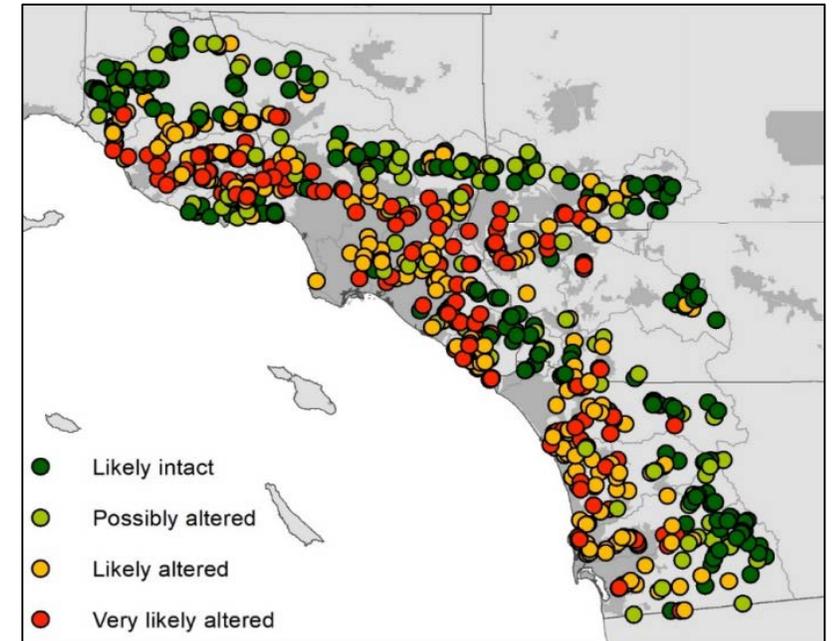


# Stormwater Monitoring Coalition (SMC)



## Challenges:

- The SMC needs to *evaluate* and *communicate* different response indicators
- Indicators are typically evaluated *one at a time* and often present *conflicting information*
- *Subjective, irreproducible, or inadequate* methods are common, such as averaging or binning indicators with different purposes



# Goals of the Stream Quality Index (SQI)

A *communication tool* to leverage multiple indicators:

- Links *quantitative scores* to relevant *management options*
- Summarizes *biological condition* and relates to *likely vs unlikely stressors*
- Preserves *underlying data* to identify which factors are *driving condition*

# Conceptual basis of the SQI

## Biological condition

	CSCI high	CSCI low
ASCI high	Healthy	Impacted for CSCI
ASCI low	Impacted for ASCI	Impacted for CSCI and ASCI

## Stress condition

	Chemistry stress low	Chemistry stress high
Habitat stress low	Low stress	Stressed by chemistry degradation
Habitat stress high	Stressed by habitat degradation	Stressed by chemistry and habitat degradation

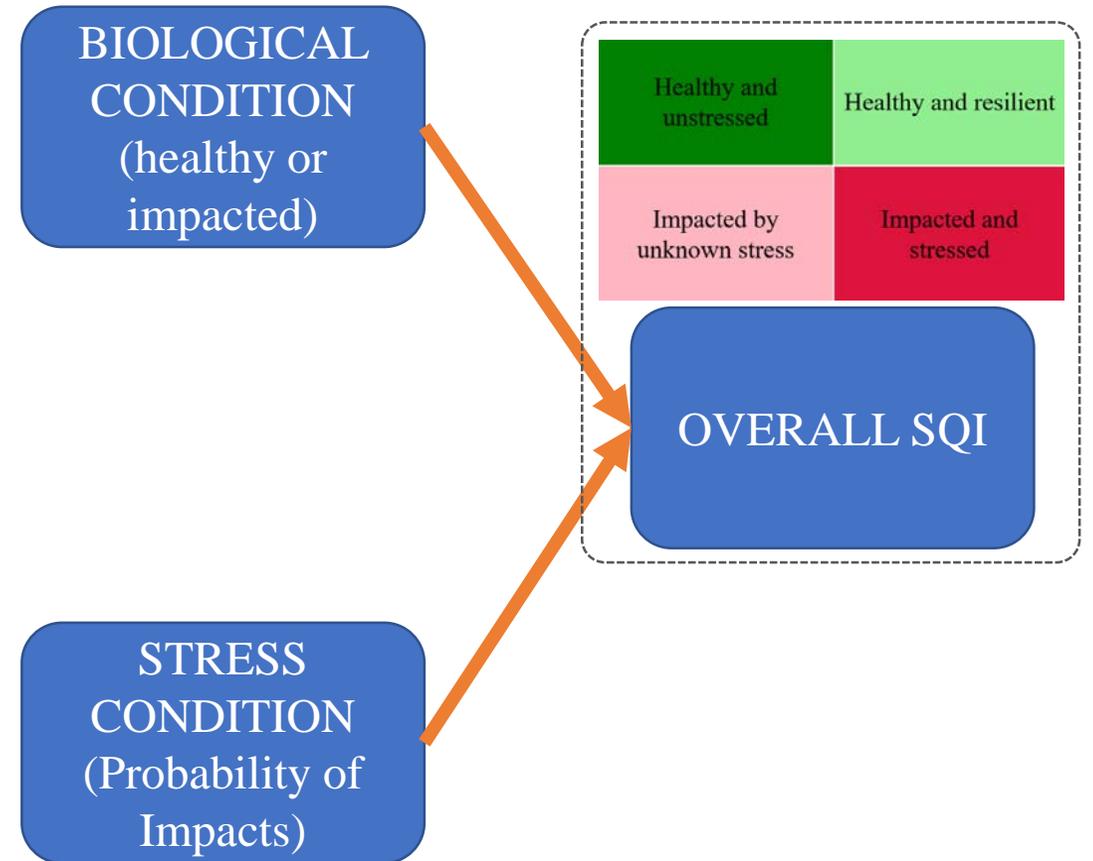
Stressed by low levels of chemistry or habitat degradation

## Overall SQI

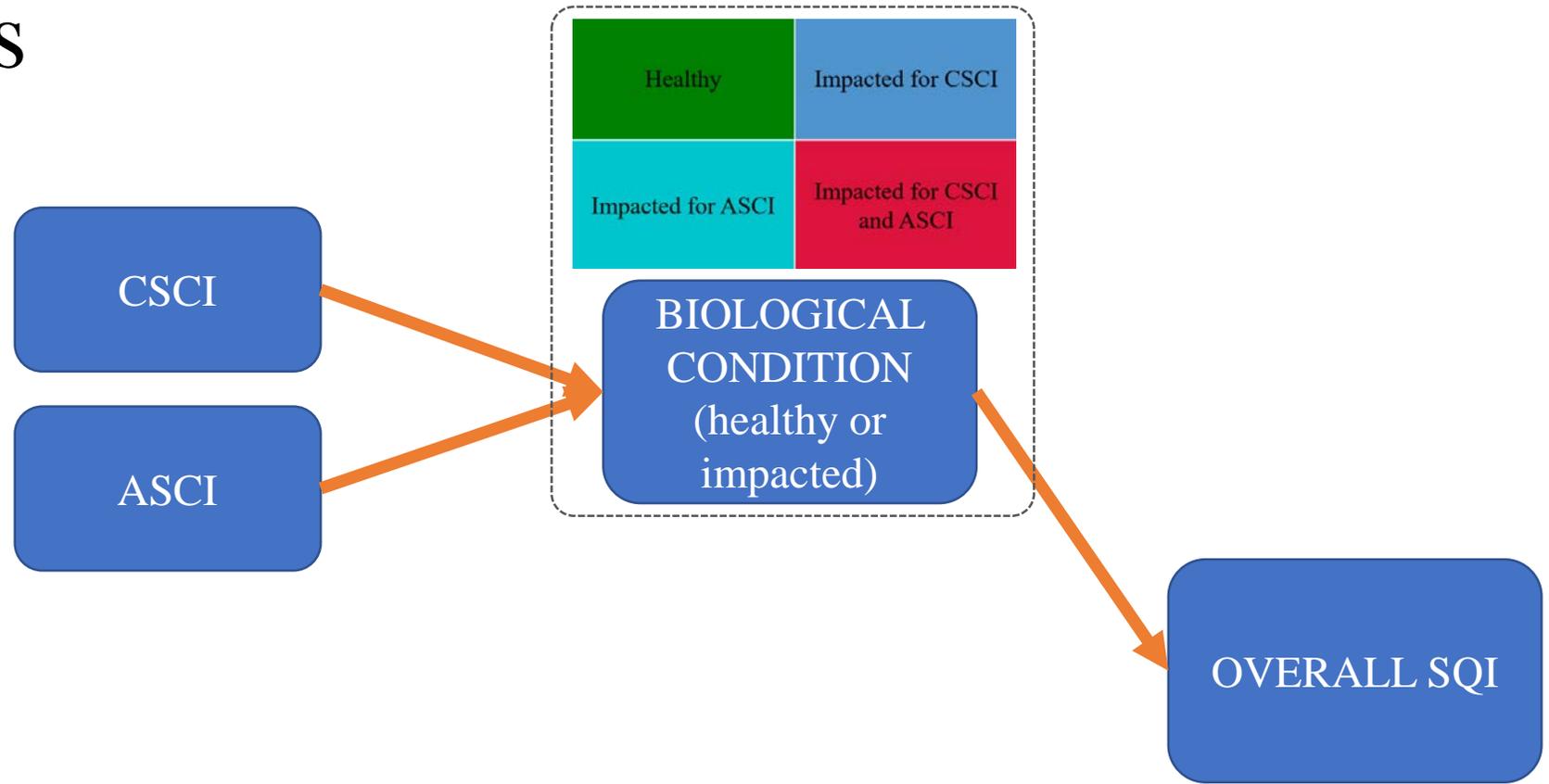
	Unstressed	Stressed
Biology Healthy	Healthy and unstressed	Healthy and resilient
Biology Impacted	Impacted by unknown stress	Impacted and stressed



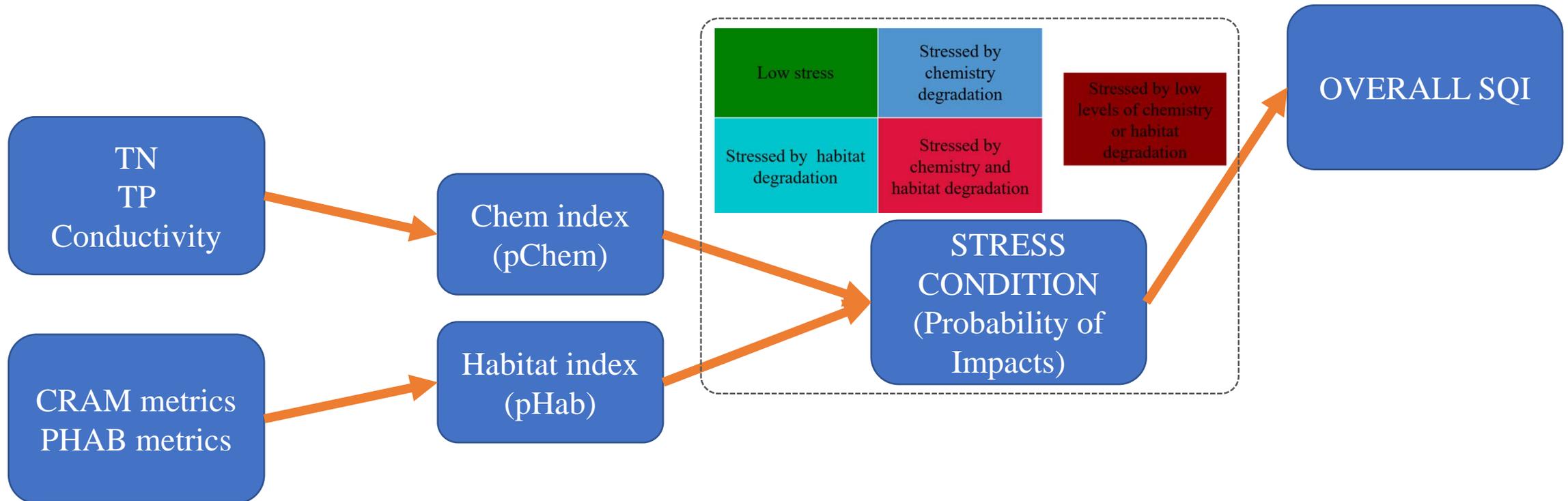
# Conceptual basis of the SQI



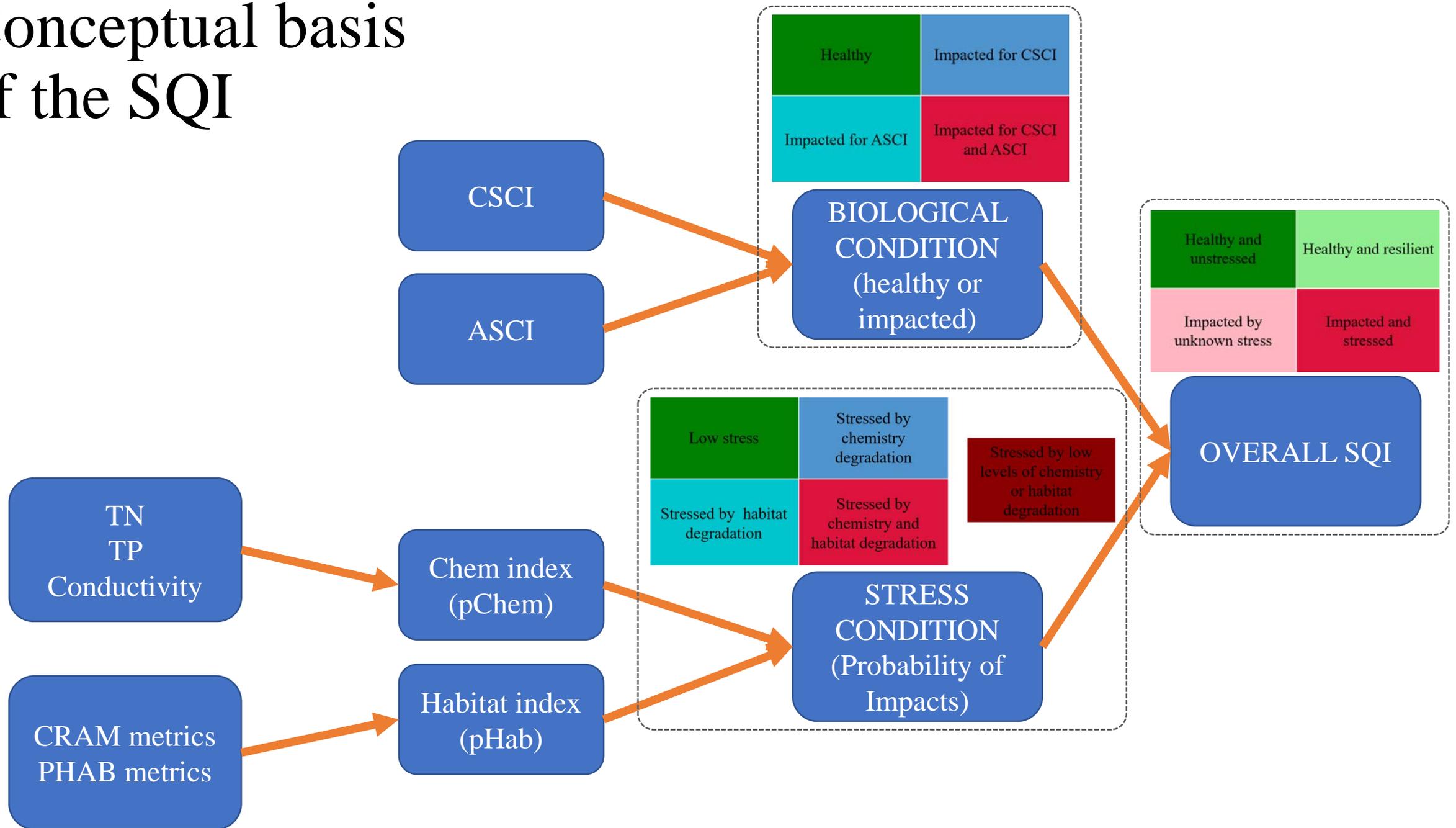
# Conceptual basis of the SQI



# Conceptual basis of the SQI



# Conceptual basis of the SQI



# Quantitative approach

- SQI categories are based on *likelihood* of observing *altered biology* for *observed stressors* at a site
- Biology was converted from *scores* to altered/unaltered *categories*

	BMI likely intact: (CSCI > 0.92)	BMI possibly altered: (CSCI 0.79 - 0.92)	BMI likely altered: (CSCI 0.63 - 0.79)	BMI very likely altered: (CSCI < 0.63)
Algae likely intact: (ASCI > 0.93)	5	3	-1	-2
Algae possibly altered: (ASCI 0.83 - 0.93)	3	2	-2	-4
Algae likely altered: (ASCI 0.70 - 0.83)	-1	-2	-3	-5
Algae very likely altered: (ASCI < 0.70)	-2	-4	-5	-6

# Quantitative approach

We modelled the *likelihood* (probability) of *altered biology* as a function of *observed stressors*

- Likelihood of altered bio from *Chemistry*

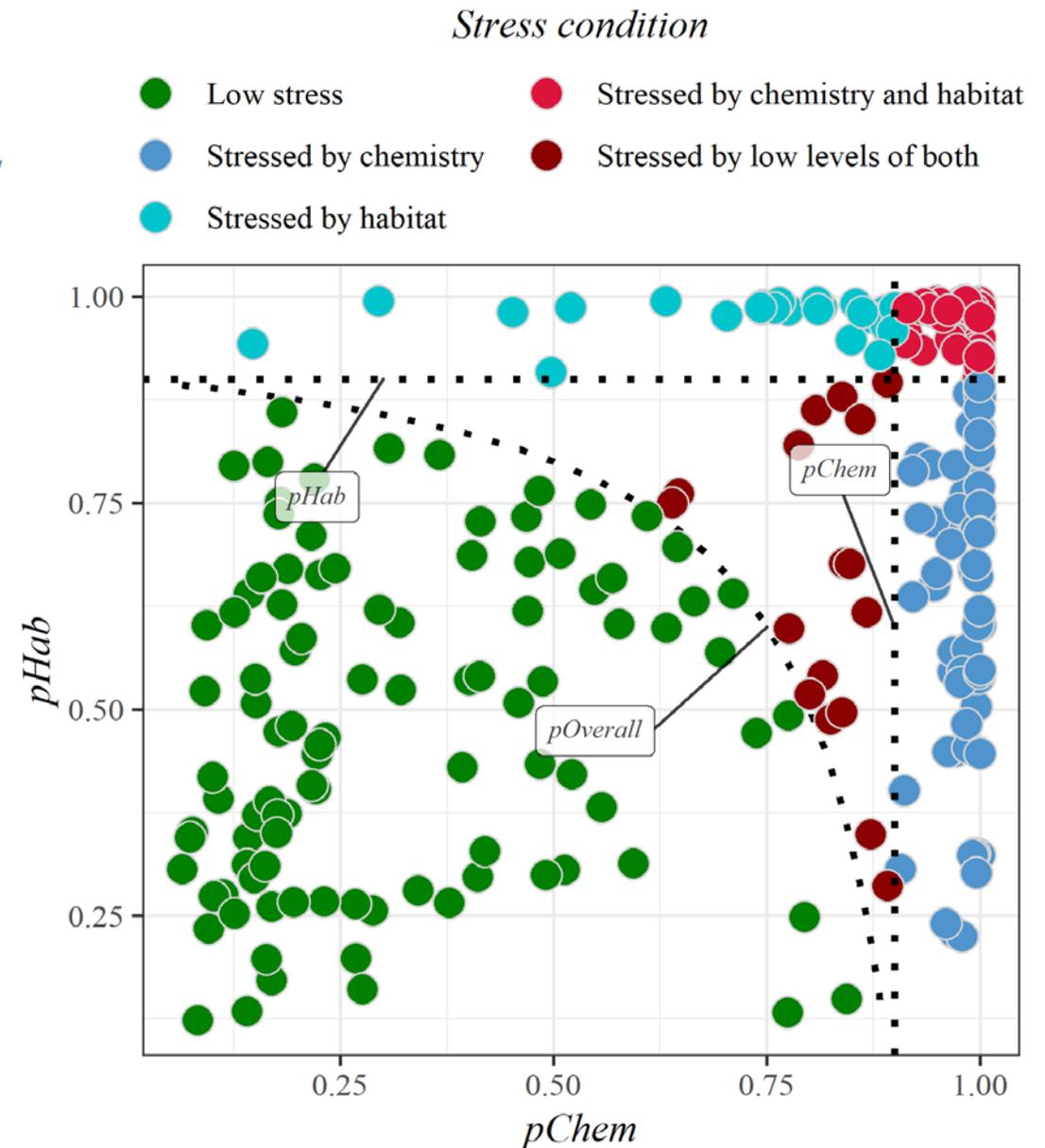
$$pChem: p(bio) \sim TN + TP + cond$$

- Likelihood of altered bio from *Habitat*

$$pHab: p(bio) \sim CRAM + IPI$$

- *Overall* likelihood of altered bio from both

$$pOverall: p(bio) \sim pChem \times pHab$$



# Conceptual basis of the SQI

## Biological condition

	CSCI high	CSCI low
ASCI high	Healthy	Impacted for CSCI
ASCI low	Impacted for ASCI	Impacted for CSCI and ASCI

## Stress condition

	Chemistry stress low	Chemistry stress high
Habitat stress low	Low stress	Stressed by chemistry degradation
Habitat stress high	Stressed by habitat degradation	Stressed by chemistry and habitat degradation

Stressed by low levels of chemistry or habitat degradation

## Overall SQI

	Unstressed	Stressed
Biology Healthy	Healthy and unstressed	Healthy and resilient
Biology Impacted	Impacted by unknown stress	Impacted and stressed



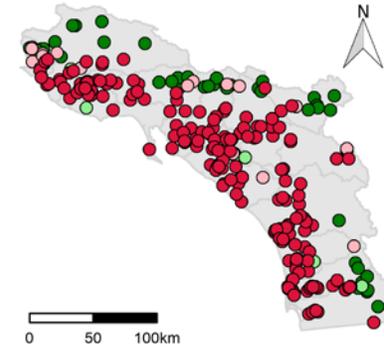
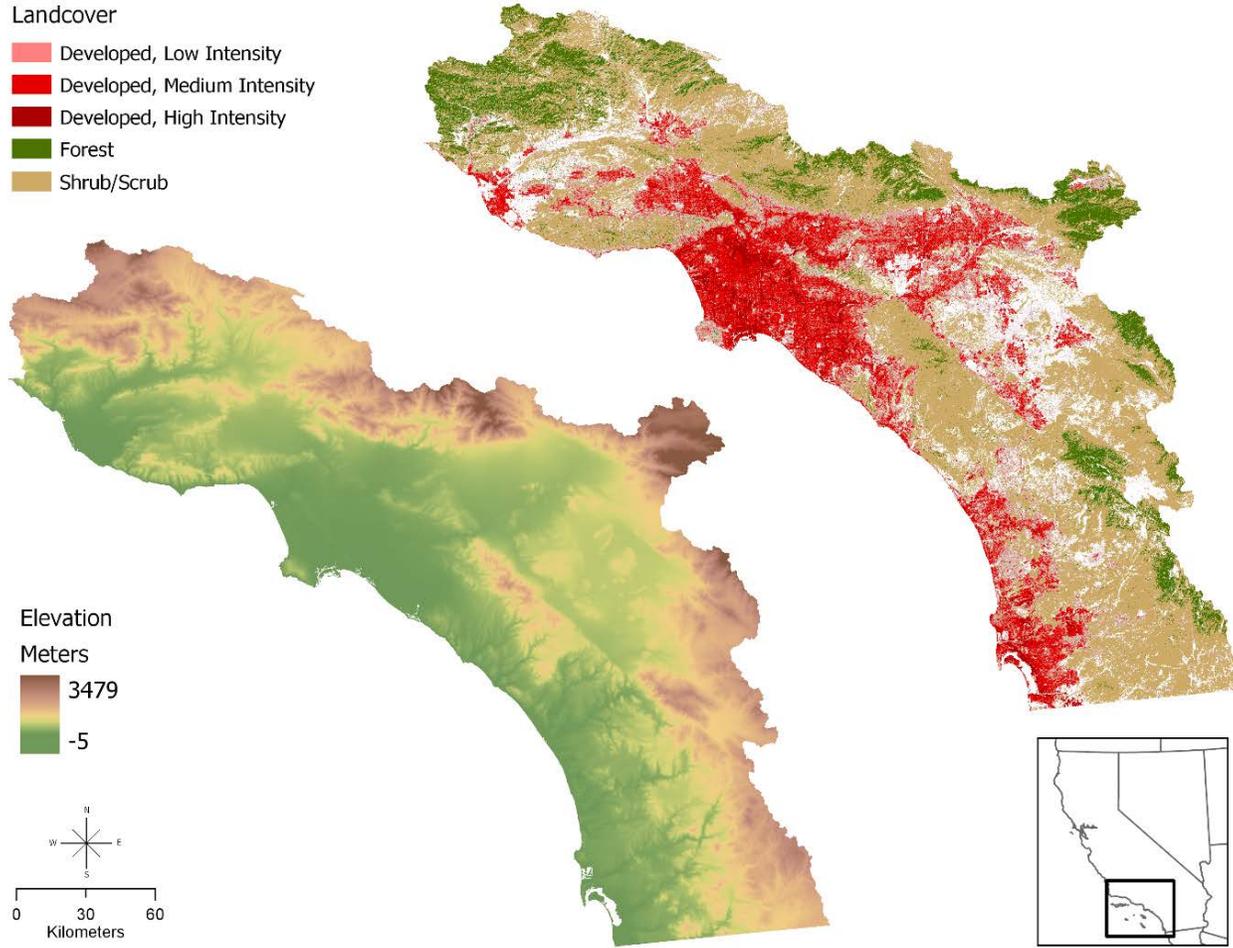
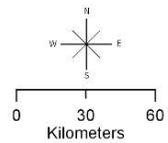
# Application of the SQI: SMC data

## Landcover

- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Forest
- Shrub/Scrub

## Elevation

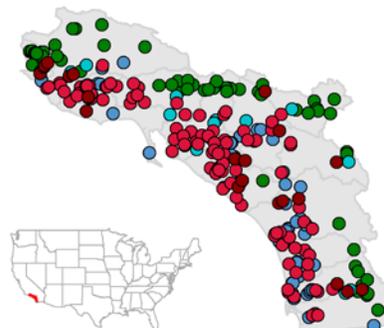
- Meters
- 3479
  - 5



Biological condition



Stress condition



- Healthy and unstressed
- Healthy and resilient
- Impacted by unknown stress
- Impacted and stressed

- Healthy
- Impacted for CSCI
- Impacted for ASCI
- Impacted for CSCI and ASCI

- Low stress
- Stressed by chemistry degradation
- Stressed by habitat degradation
- Stressed by chemistry and habitat degradation
- Stressed by low levels of chemistry or habitat degradation

# Application of the SQI: SMC data

## Biological condition

	CSCI high	CSCI low
ASCI high	23 %	11 %
ASCI low	16 %	50 %

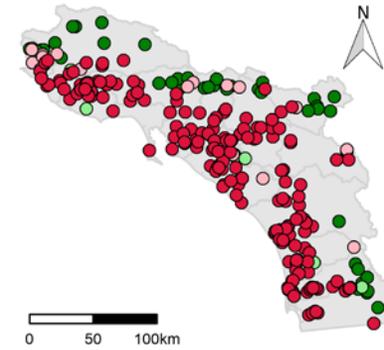
## Stress condition

	Chemistry stress low	Chemistry stress high
Habitat stress low	26 %	21 %
Habitat stress high	5 %	40 %

8 %
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## Overall SQI

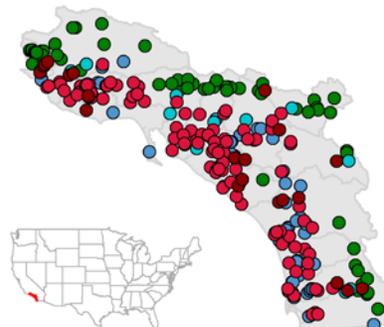
	Unstressed	Stressed
Biology Healthy	19 %	3 %
Biology Impacted	7 %	71 %



Biological condition



Stress condition



- Healthy and unstressed
- Healthy and resilient
- Impacted by unknown stress
- Impacted and stressed

- Healthy
- Impacted for CSCI
- Impacted for ASCI
- Impacted for CSCI and ASCI

- Low stress
- Stressed by chemistry degradation
- Stressed by habitat degradation
- Stressed by chemistry and habitat degradation
- Stressed by low levels of chemistry or habitat degradation

# SQL products

## 1. *Tech report* (and manuscript forthcoming)

- Rationale and conceptual framework
- Case studies

## 2. *Fact Sheet*

- Communication tool
- High-level

## 3. *Web application*

- Interactive
- Access to SMC data

**The Stream Quality Index:  
A Multi-Indicator Tool for Enhancing Environmental  
Management Communication**

Marcus W. Beck, Raphael D. Mazor, Susanna Theroux, Kenneth C. Schiff

Southern California Coastal Water Research Project

May 2019  
Technical Report #8

**SCM Southern California Stream Quality Index**  
A scoring tool for communicating integrated assessments of a stream's physical, chemical and biological health  
Developed by the Southern California Stormwater Monitoring Coalition

Assessing **stream** condition relies on use of physical, chemical and biological data. Traditionally, results for these three lines of evidence are communicated separately, and/or managers have relied on non-standardized, subjective methods for integrating these indicators because they lacked a rigorous, methodical approach.

The Southern California Stream Quality Index (SQI) is a scoring tool designed to systematically integrate physical, chemical and biological indicators. Even when lines of evidence conflict, the SQI produces a single overall assessment that can be readily communicated to managers and the public alike.

**SQI key features**

- Presents complex biological, physical, and chemical indicator data in a unified, objective, easy-to-interpret format
- Links scores to relevant management options for maintaining or improving watershed health
- Summarizes biological conditions and relates biology to likely vs. unlikely stressors
- Preserves underlying data to help identify which factors could be driving overall condition
- Includes an interactive web application to calculate SQI scores and access regional data

**Conceptual basis for the SQI**

- The SQI uses a stressor-response empirical model to quantify the expected likelihood that chemical and physical stressors will degrade biological condition.
- If water chemistry and/or physical habitat data indicate a stream site is in healthy condition, the SQI will not obscure or distort biological condition data that indicate the site is impacted – and vice versa.

**SQI condition assessment categories**

Sites are assigned to one of four easy-to-communicate narrative condition categories:

- Healthy and unstressed
- Impacted by unknown stress
- Impacted for CSCI
- Impacted and stressed

**SQI web app**

SQI data for SMC stream sites have been mapped to an interactive web tool [https://ccwrp.shinyapps.io/sql\\_shiny](https://ccwrp.shinyapps.io/sql_shiny)

Clicking on a site provides underlying data

Overall SQI narrative score

Impacted and stressed

Impacted for CSCI

Stressed by chemistry degradation

Biological response score

Stressor score

Biological response scores

Chemistry stressor data

Habitat stressor scores

**SQL dashboard** Overview Scores Details Relative details

Filter by: SMC watersheds Select site filters: Calleguas, Central San Diego, Los Arroyos

SQI map output: Overall Selected site: 901500313

Healthy and unstressed  
Healthy and resilient  
Impacted by unknown stress  
Impacted and stressed

**Impacted by unknown stress**

Overall

**Impacted for CSCI**

Biological condition

**Low stress**

Stress condition

Probability of stress

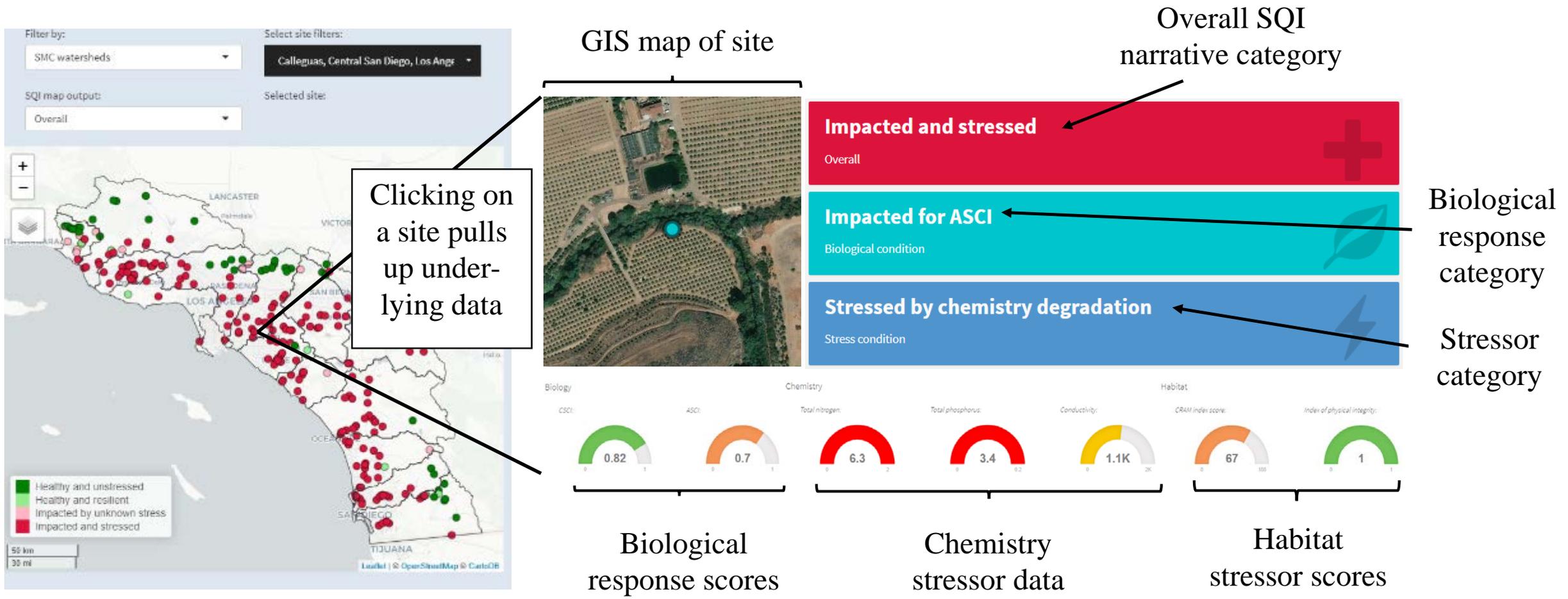
Pi. of chemistry stress: 15.1%

Pi. of habitat stress: 51.5%

Pi. of overall stress: 58.8%

# SQI web application:

[https://sccwrp.shinyapps.io/sqi\\_shiny](https://sccwrp.shinyapps.io/sqi_shiny)



# Goals of the Stream Quality Index (SQI)

A *communication tool* to leverage multiple indicators:

- Links *quantitative scores* to relevant *management options*
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- Preserves *underlying data* to identify which factors are *driving condition*

# Using the SQI

- Is *best used for screening*; major decisions may require more information
- Requires *physical*, *chemical*, and *biological* data to calculate overall condition score; data gaps limit usefulness
- Was calibrated for use in *southern California* – but could be applied to other regions

# Using the SQI

The SQI can serve as a key *communication tool* for:

- Generating *watershed report cards* for the general public
- *Enhancing dialogue* among stakeholders
- Establishing and/or evaluating *regional priorities* for restoration or protection

*How would this group use the SQI??*

# Questions?

CSCI:



ASCI:



Total nitrogen:



Total phosphorus:



Conductivity:



CRAM index score:



Index of physical integrity:



[https://sccwrp.shinyapps.io/sqi\\_shiny](https://sccwrp.shinyapps.io/sqi_shiny)



# Do we really need another index?

CA has a robust suite of *chemical*, *physical*, and *biological* indicators

## Chemical stressor indicators



### Nutrients

Nutrients such as nitrogen and phosphorous can lead to excessive algae and toxin-producing cyanobacteria

### Specific conductivity

Excess salts are a useful surrogate for other human-related contaminants such as toxic pesticides and trace metals

## Physical stressor indicators



### California Rapid Assessment Method (CRAM)

Evaluates stress within riparian zone, adjacent floodplain and other stream corridors

### Index of Physical Integrity (IPI)

Evaluates stress from within stream itself, such as streambed substrate and diversity of micro-habitats

## Biological response indicators



### California Stream Condition Index (CSCI)

Quantifies biological condition based on aquatic insects and other invertebrates

### Algal Stream Condition Index (ASCI)

Quantifies biological condition based on plants such as diatoms and soft-bodied algae

# Benefits of the SQI

- A *stressor-response framework*, biology (ALU) as primary endpoint
- A quantitative approach to scoring, but output is described categorically: *interpretable results*
- *Does not obscure* results: if stressors indicate a site is impacted, but biology indicates a site is healthy (and vice versa), the SQI retains this information

Healthy and unstressed	Healthy and resilient
Impacted by unknown stress	Impacted and stressed

- Underlying data are *always accessible*