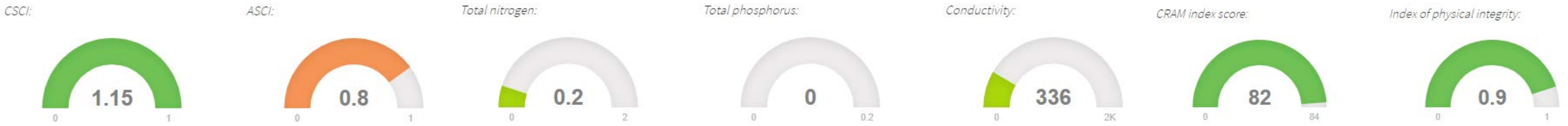
SMC's Stream Quality Index: An integrated tool for stream assessment

Cal WQMC meeting June 6th, 2019



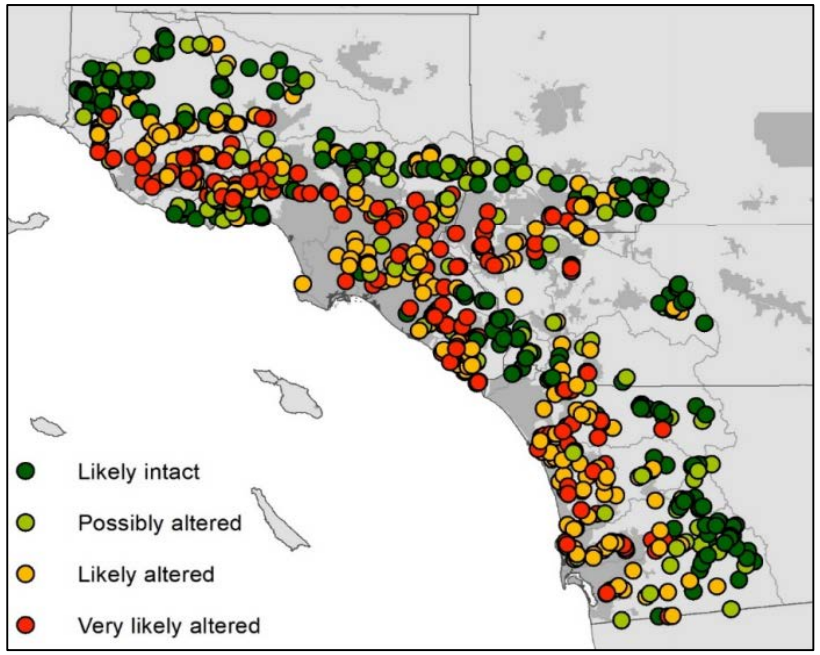
Stormwater Monitoring Coalition (SMC)

- 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***?

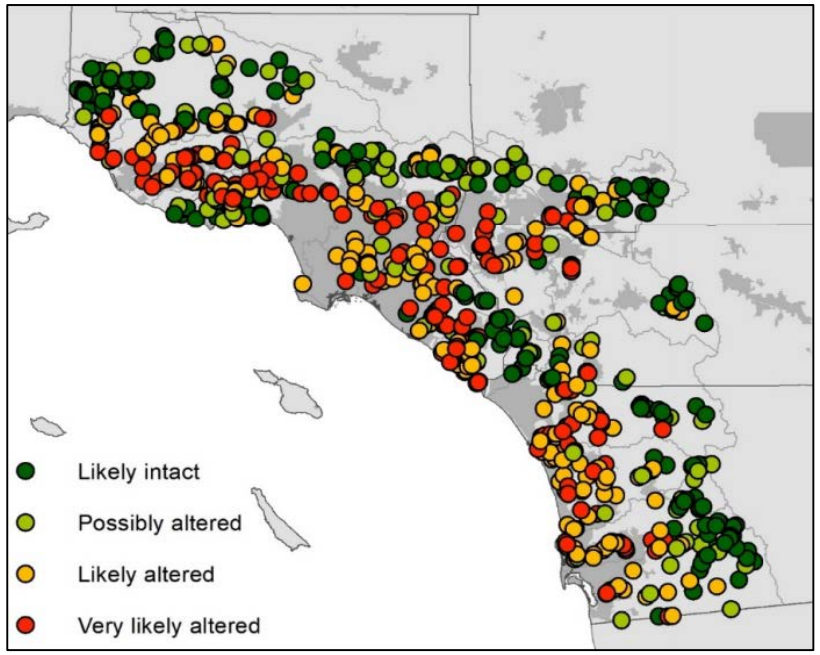
- Most comprehensive source of stream data in SoCal



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

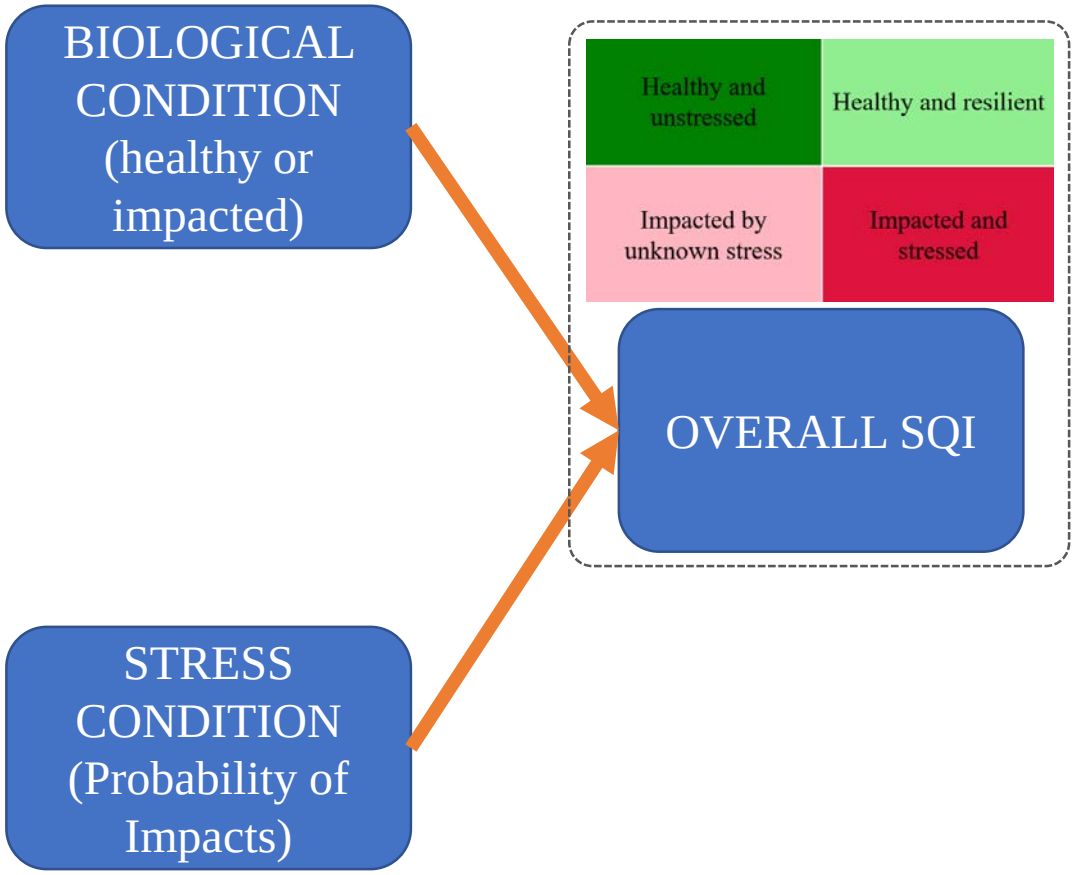
	Chemistry stress low	Chemistry stress high
Habitat stress low	Low stress	Stressed by chemistry degradation
Habitat stress high	Stressed by habitat degradation	Stressed by chemistry and habitat degradation

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



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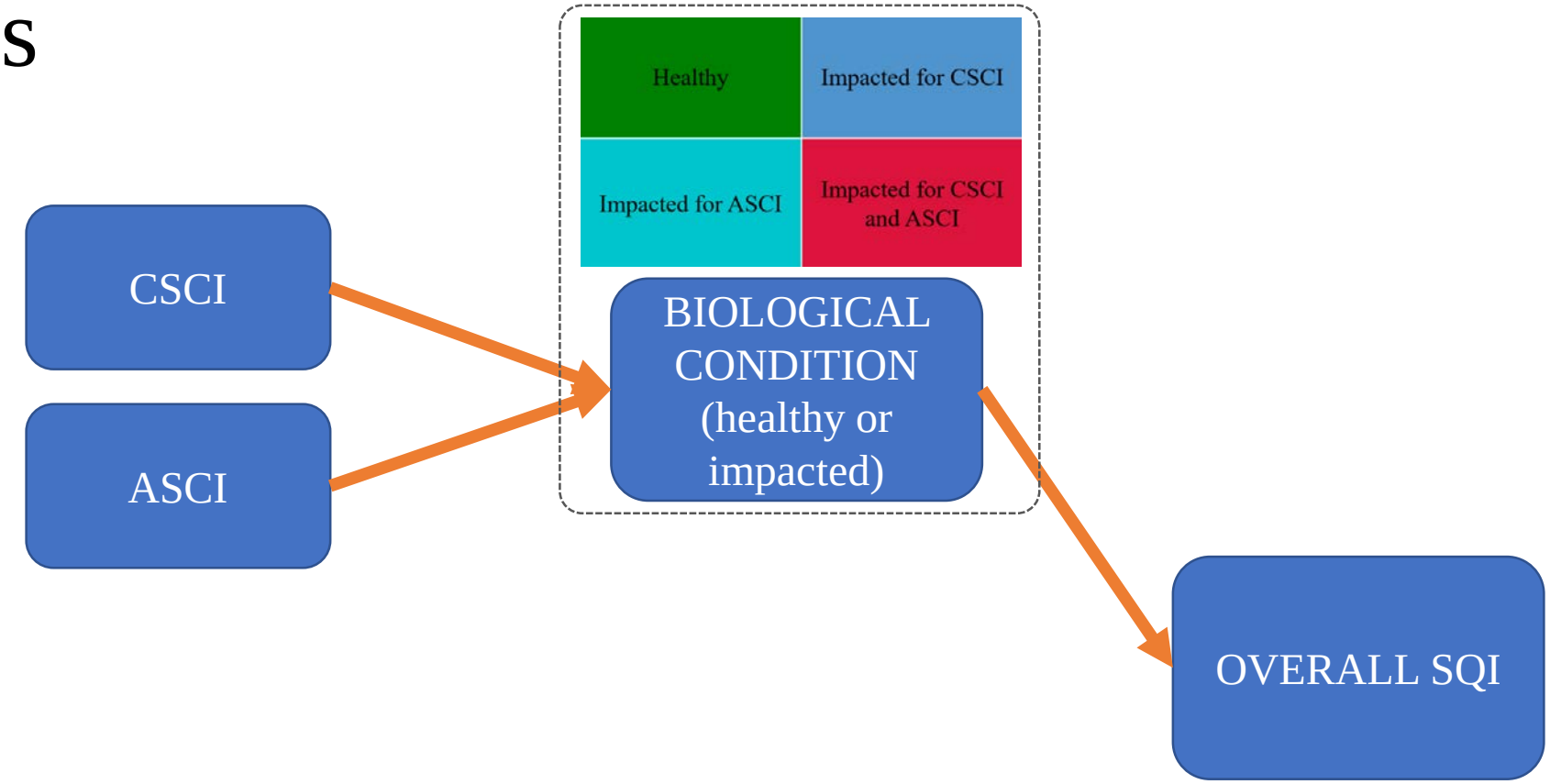

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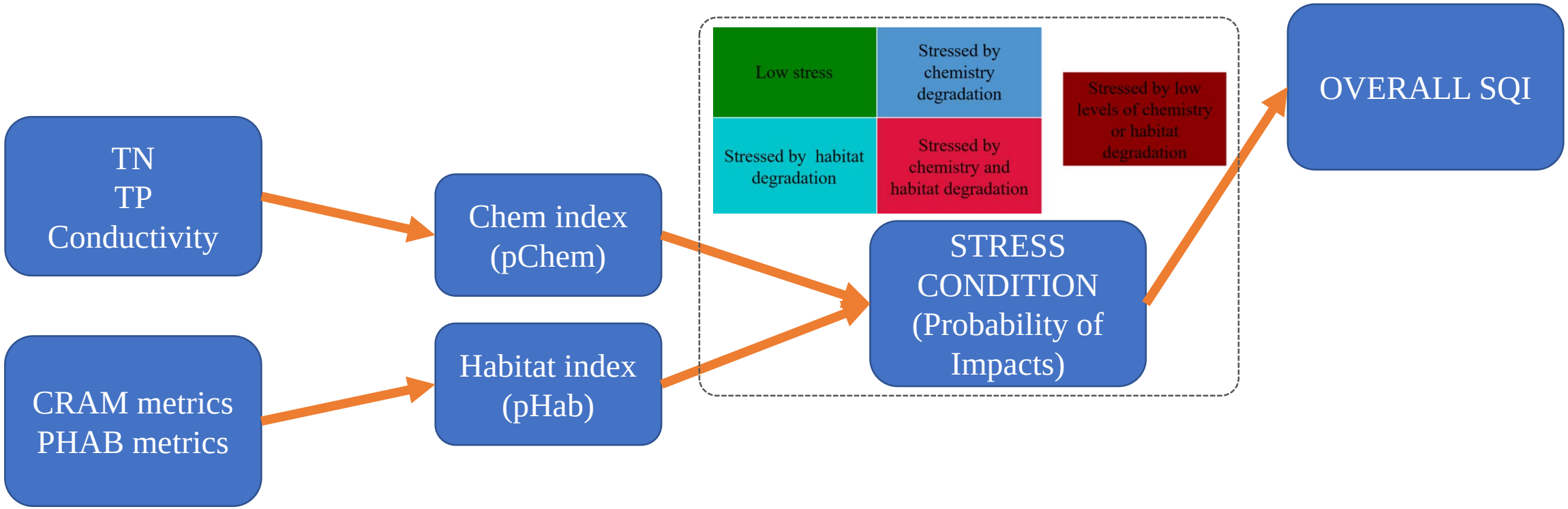

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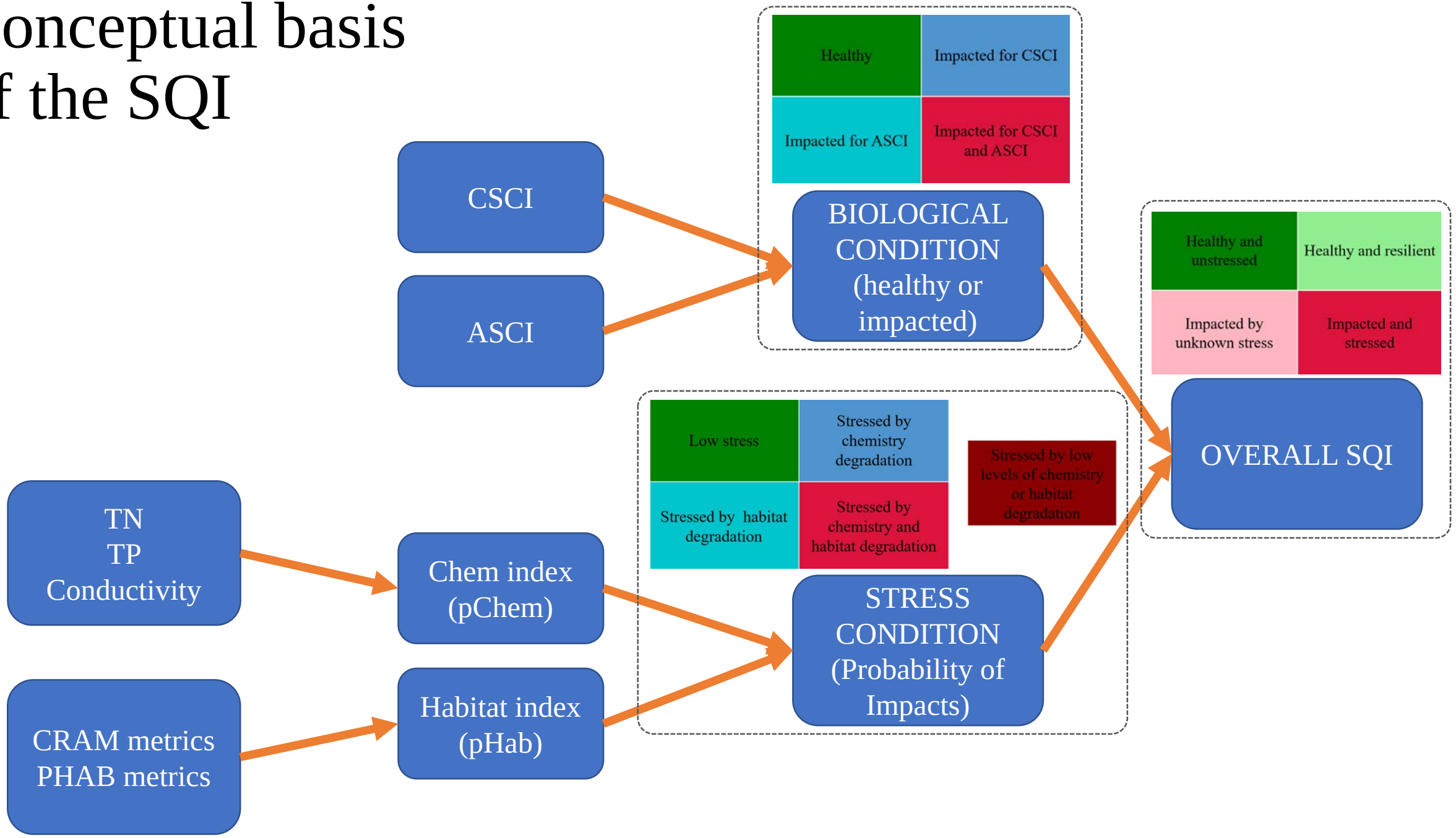


Quantitative approach

- 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***

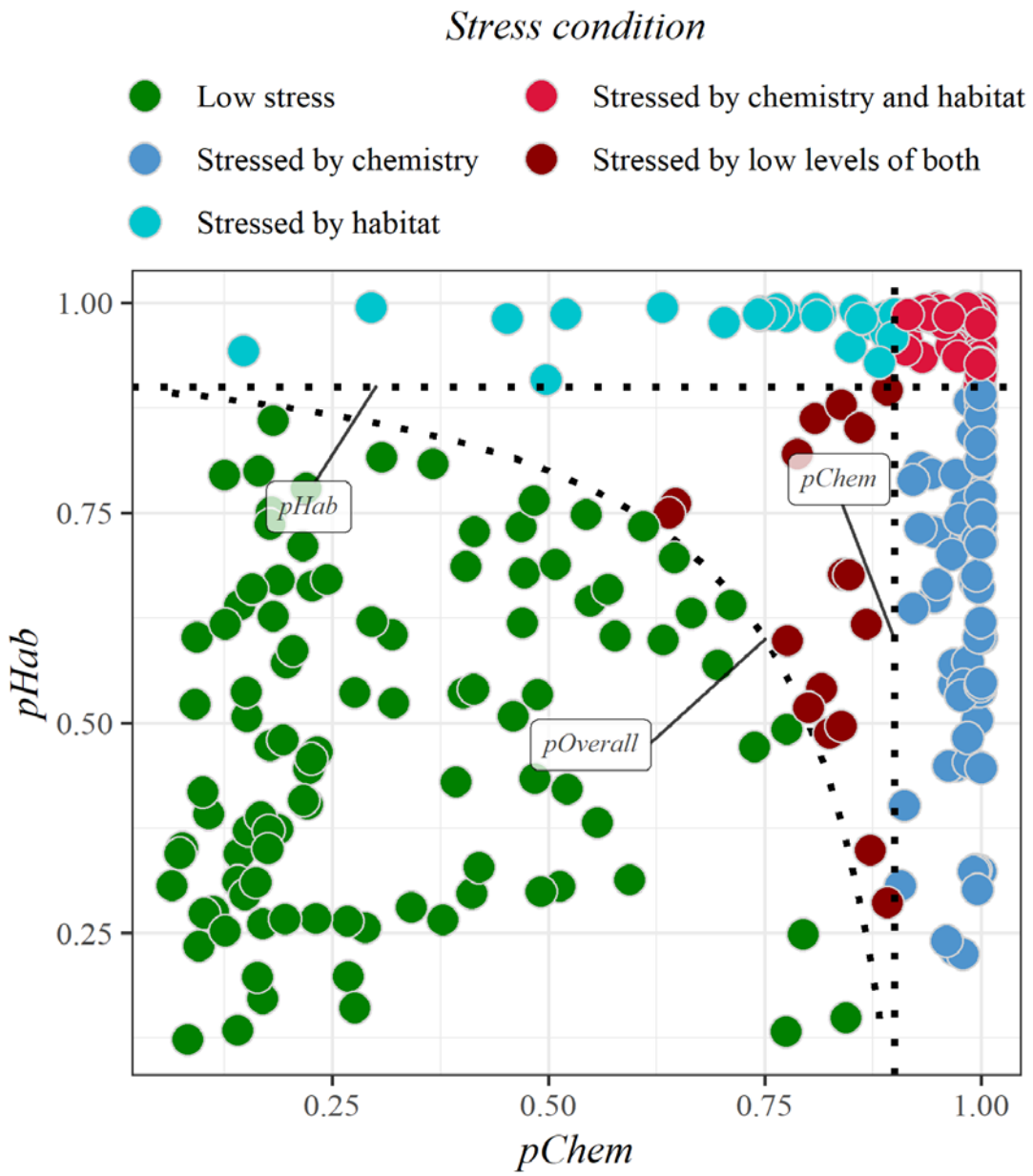
$$pChem: p(bio) \sim TN + TP + cond$$

- 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

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ASCI high	Healthy	Impacted for CSCI
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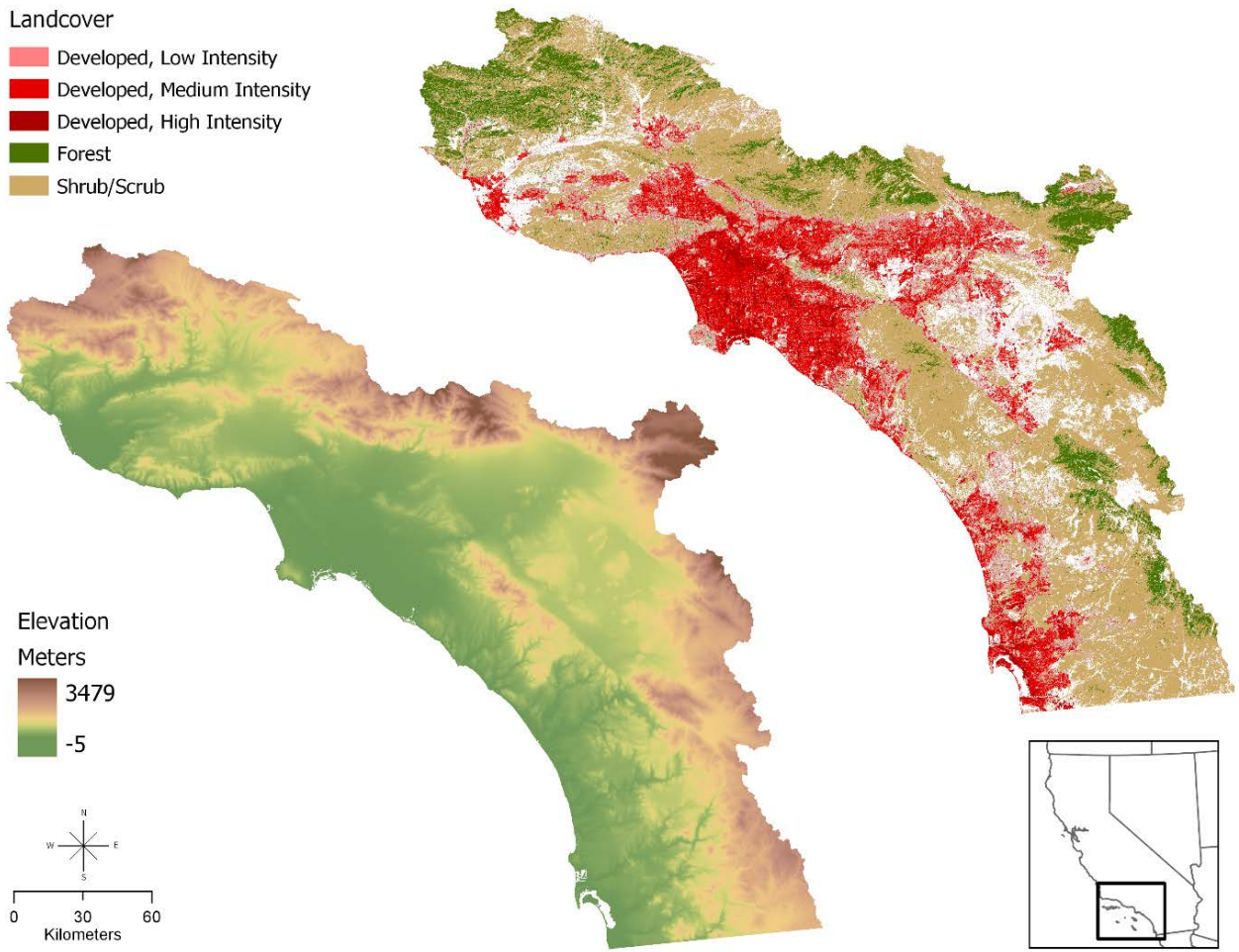
Habitat stress high	Stressed by habitat degradation	Stressed by chemistry and habitat degradation

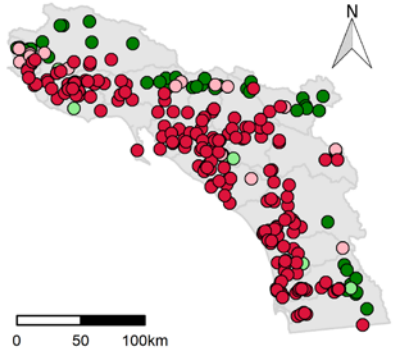
Stressed by low levels of chemistry or habitat degradation

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



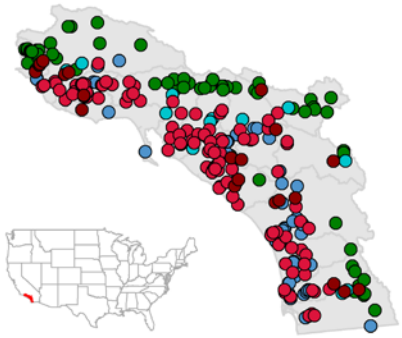


Healthy and unstressed
Healthy and resilient
Impacted by unknown stress
Impacted and stressed

Biological condition

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

Stress condition



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 %

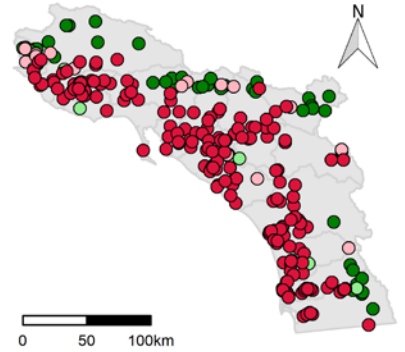
Stress condition

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

8 %

Overall SQI

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

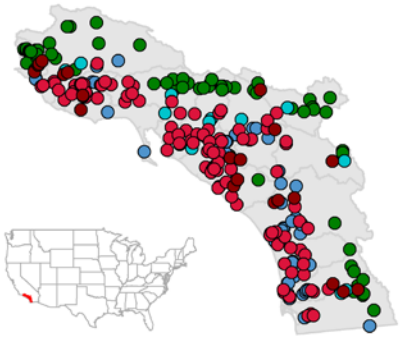


- Healthy and unstressed
- Healthy and resilient
- Impacted by unknown stress
- Impacted and stressed

Biological condition

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

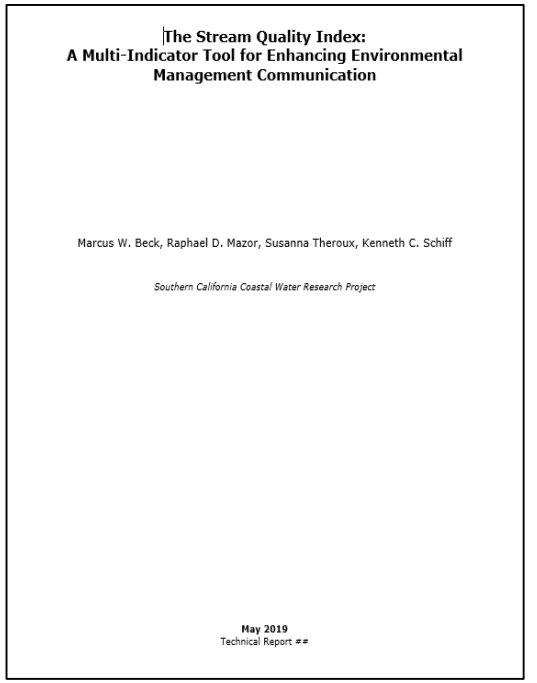
Stress condition



- 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

SQI products

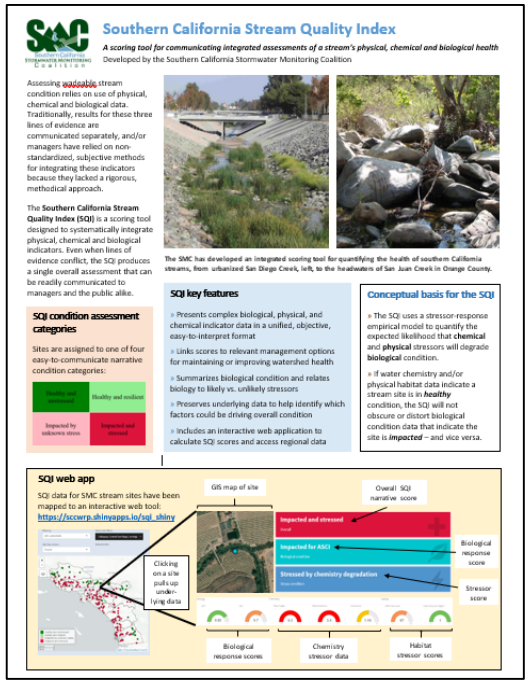
1. ***Tech report*** (and manuscript forthcoming)
   - Rationale and conceptual framework
   - Case studies
2. ***Fact Sheet***
   - Communication tool
   - High-level
3. ***Web application***
   - Interactive
   - Access to SMC data

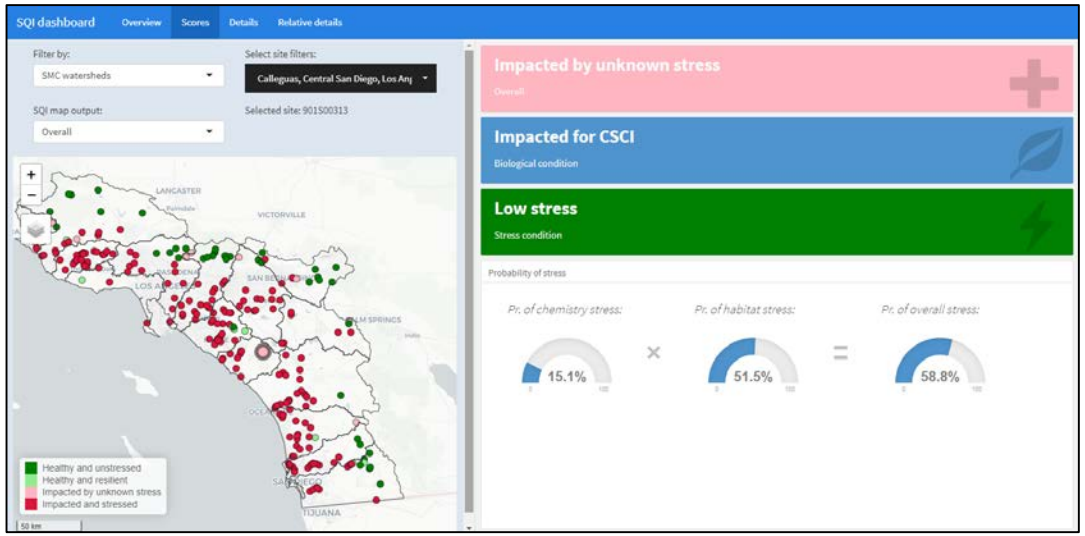

The Stream Quality Index:
A Multi-Indicator Tool for Enhancing Environmental Management Communication

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

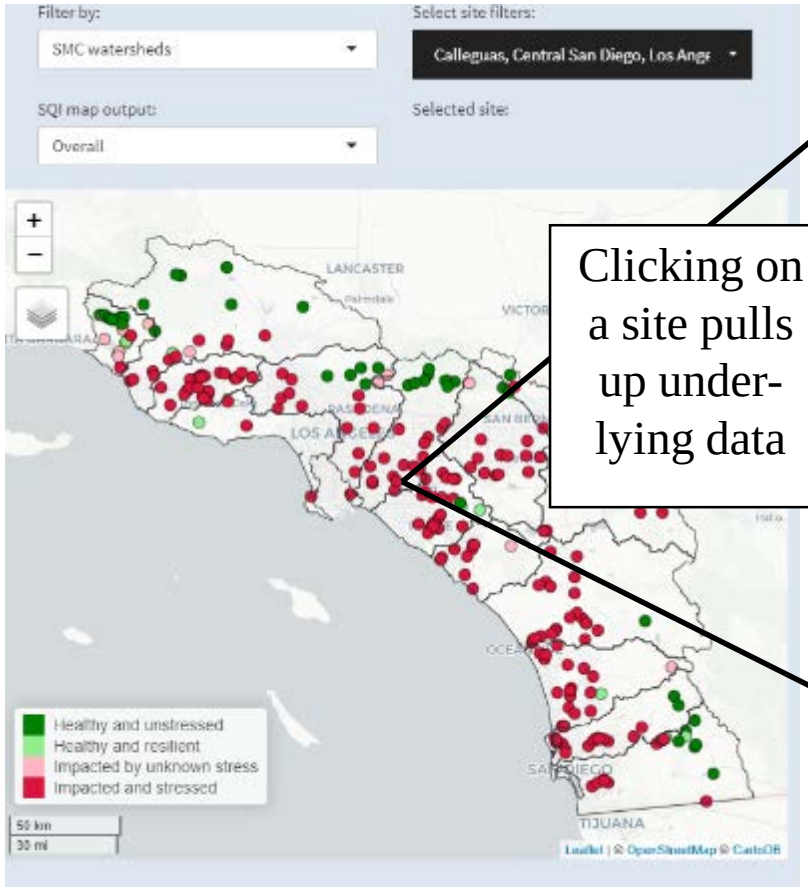
Southern California Coastal Water Research Project

May 2019
Technical Report ##



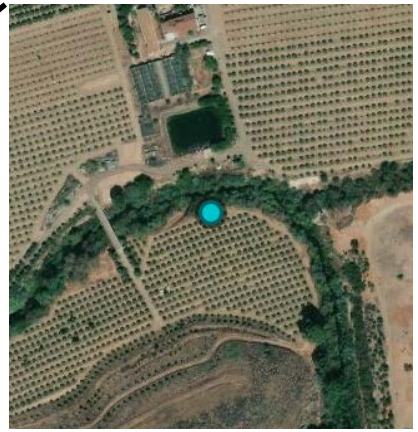


SQI web application:
https://sccwrp.shinyapps.io/sqi_shiny

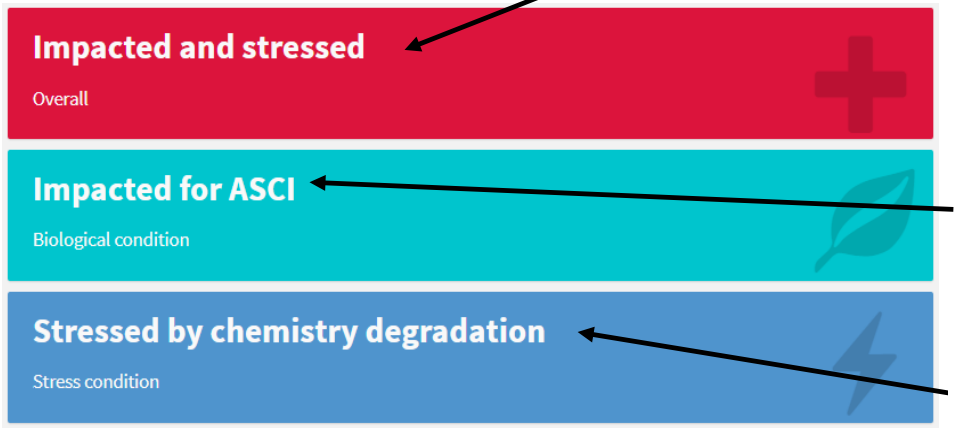


Clicking on a site pulls up under-lying data

GIS map of site

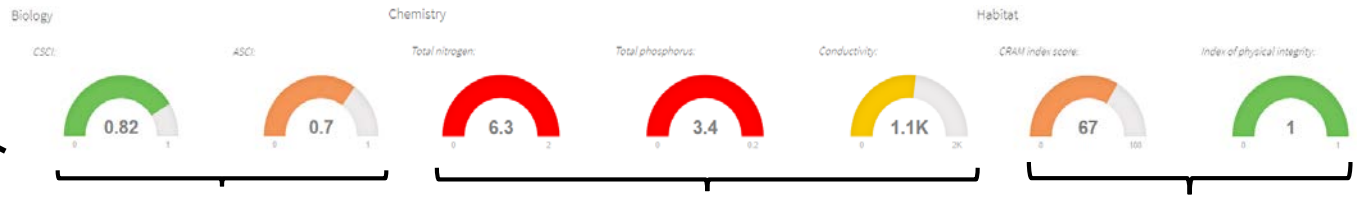


Overall SQI narrative category



Biological response category

Stressor category



Biological response scores

Chemistry stressor data

Habitat stressor scores

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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

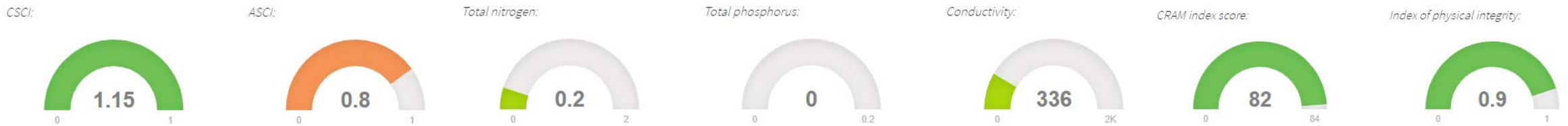
Using the SQI

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?



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

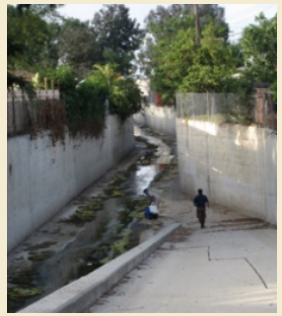
Nutrients

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



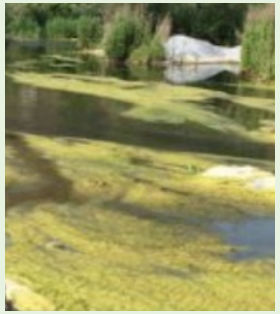
California Rapid Assessment Method (CRAM)

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)

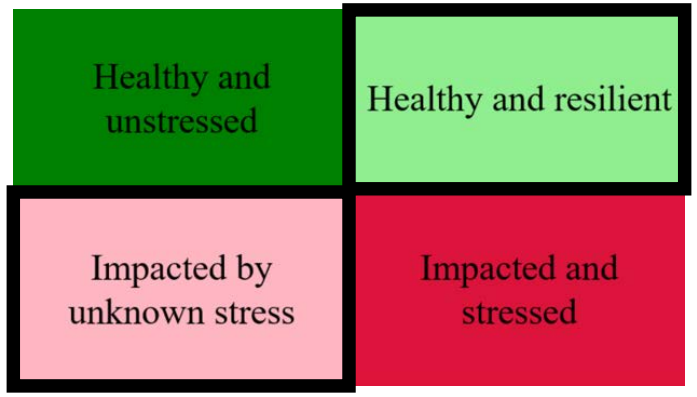
Quantifies biological condition based on plants such as diatoms and soft-bodied algae

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



- Underlying data are ***always accessible***