

Science Supporting Biointegrity- Biostimulatory Policies for California Wadeable Streams

Presentation to SCCWRP Commission

June 1, 2018

Biological Assessment—Rather Than Chemistry-- is the Best Way to Assess Aquatic Life Uses

- Reflect disturbance from all stressors on a waterbody
- Integrate impacts over time and throughout a watershed
- Direct measure of aquatic life use

Two Part Talk

- **Bio**integrity science- Mazor
- **Bio**stimulatory science- Sutula

Biointegrity Science: Goals for today

- Review state of biointegrity science in California
- Review state of science-informed policy decisions
- Review decisions made in biointegrity programs in other states

Take-home messages

- Fundamental science is largely complete
- Implementation in policy has already started, but decisions are still being made
- California is largely in line with other states (with a few differences)

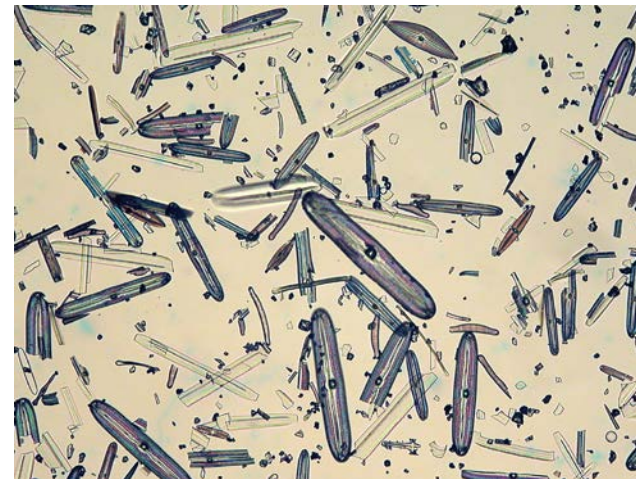
Technical Needs to Use Bioassessment

- Need a way to measure biological integrity
- Need thresholds to assess biological integrity
- Need to relate biological integrity to manageable causal factors

Biological data is complex

Need indices to turn bioassessment data in biointegrity information

Sample Date	Collection Method	Code	Life Stage	Distinct Code	Count
6/17/2015	BMI_RWB_MCM	1Apedilum	L	1	1
6/17/2015	BMI_RWB_MCM	1Bezzia/ Palpomyia	L	1	3
		Caloparyphus/			
6/17/2015	BMI_RWB_MCM	1Euparyphus	L	0	7
6/17/2015	BMI_RWB_MCM	1Coenagrionidae	L	1	1
6/17/2015	BMI_RWB_MCM	1Cricotopus	L	0	3
		Cricotopus			
6/17/2015	BMI_RWB_MCM	1bicinctus group	L	1	4
6/17/2015	BMI_RWB_MCM	1Dicotendipes	L	1	1
6/17/2015	BMI_RWB_MCM	1Ephydriidae	L	1	1
6/17/2015	BMI_RWB_MCM	1Euparyphus	L	1	10
6/17/2015	BMI_RWB_MCM	1Fallceon	L	1	2
6/17/2015	BMI_RWB_MCM	1Gammarus	X	1	6
6/17/2015	BMI_RWB_MCM	1Hemerodromia	L	1	2
6/17/2015	BMI_RWB_MCM	1Hydropsyche	L	1	1
6/17/2015	BMI_RWB_MCM	1Hydroptila	L	1	4
6/17/2015	BMI_RWB_MCM	1Labrundinia	L	1	1
6/17/2015	BMI_RWB_MCM	1Lymnaea	X	1	105
6/17/2015	BMI_RWB_MCM	1Oligochaeta	X	1	2
		Orthocladius			
6/17/2015	BMI_RWB_MCM	1complex	L	1	8
6/17/2015	BMI_RWB_MCM	1Ostracoda	X	1	95
6/17/2015	BMI_RWB_MCM	1Oxyethira	L	1	4
6/17/2015	BMI_RWB_MCM	1Pentaneura	L	1	4
6/17/2015	BMI_RWB_MCM	1Physa	X	1	278
6/17/2015	BMI_RWB_MCM	1Polypedilum	L	1	2
6/17/2015	BMI_RWB_MCM	1Prostoma	X	1	1
		Pseudochironomu			
6/17/2015	BMI_RWB_MCM	1s	L	1	2
6/17/2015	BMI_RWB_MCM	1Rheotanytarsus	L	1	6
6/17/2015	BMI_RWB_MCM	1Simulium vittatum	L	1	3



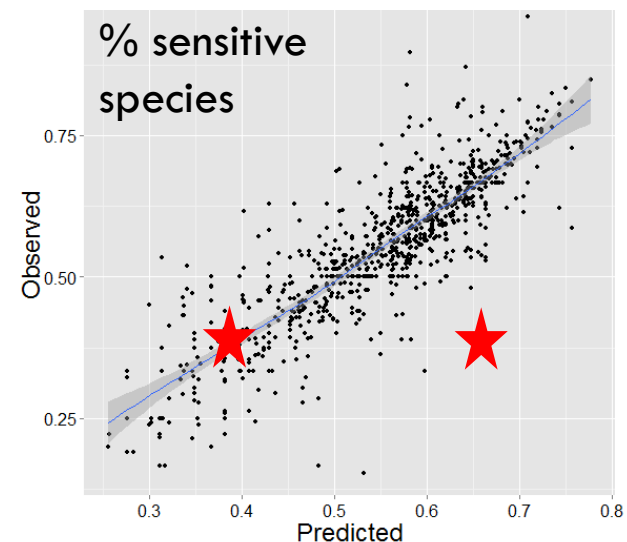
We have a “world class” index—and we’re completing another.

Benthic macroinvertebrates

- California Stream Condition Index (CSCI) finalized in 2016
- A *predictive approach* corrects for natural factors that may distort traditional indices
- Based on large reference data set

Benthic algae

- Algae Stream Condition Indices (ASCIs)
- Will be finalized this June
- Options for diatoms, soft-bodied algae
- Same predictive approach as CSCI



Technical Needs to Use Bioassessment

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- Need to relate biological integrity to manageable causal factors

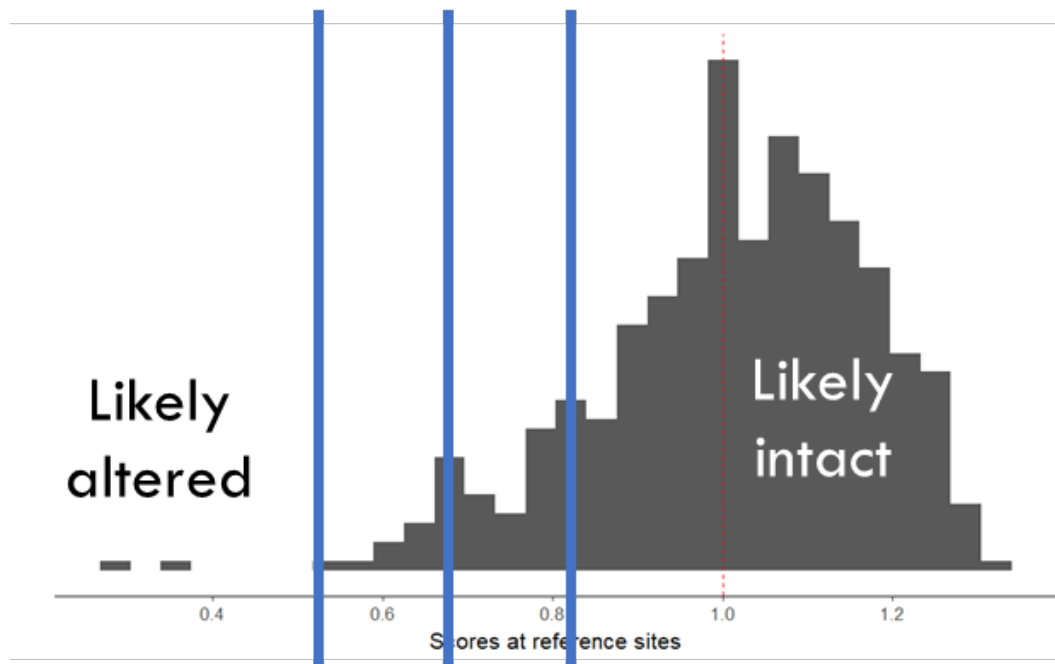
There are two common options for setting thresholds

1. Based on natural (reference) variability
2. Based on expert opinion (biological condition gradient; BCG)

We have explored both, so managers can use either (or a combination)

Reference approach is the standard

- Long history of usage, proven defensibility.
- But perception of arbitrariness (choosing a percentile)



CA has used 1st, 10th, and 30th percentiles in various programs already

Biological Condition Gradient Models (BCG) can connect numeric targets to policy goals

BCG approach:

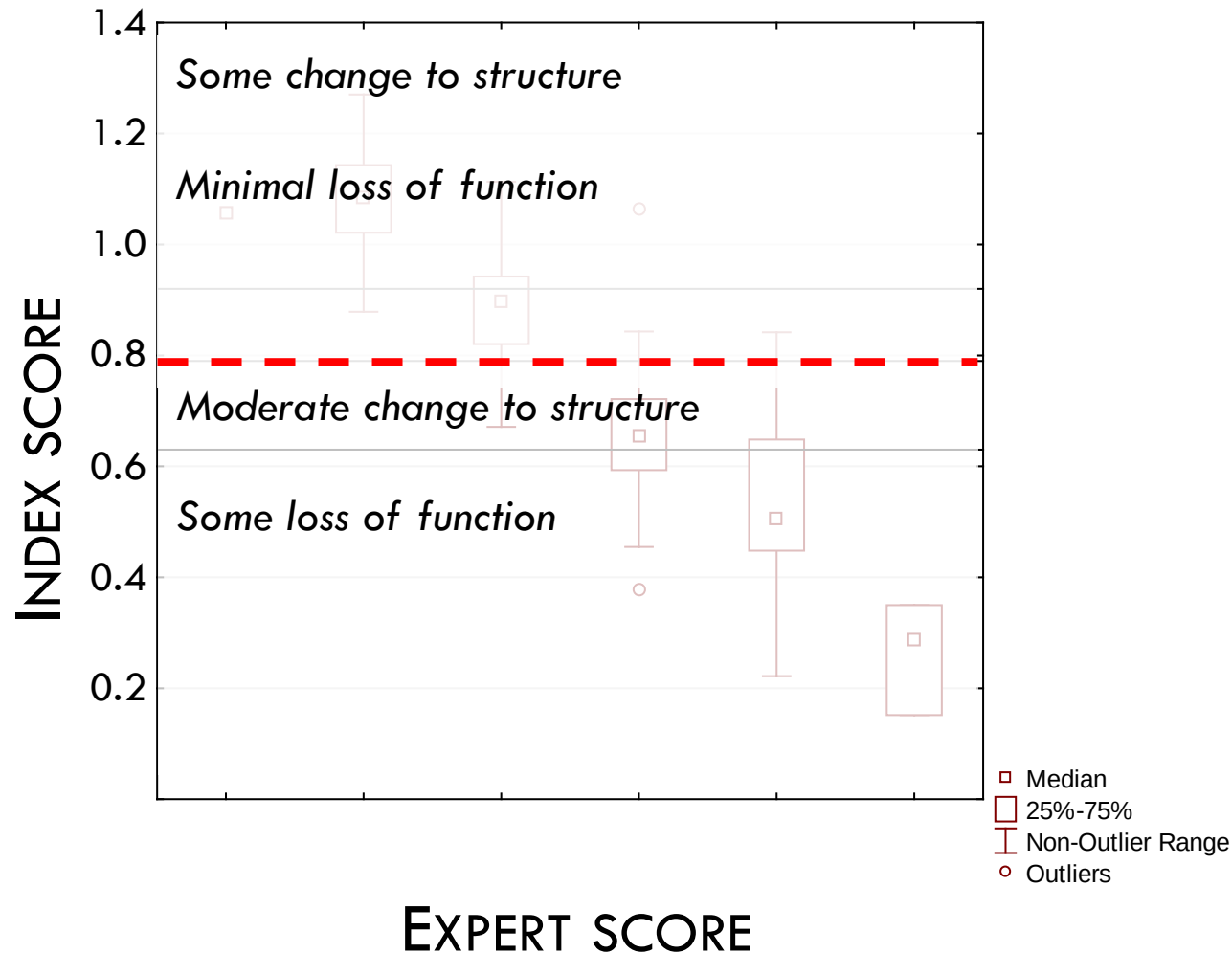
Experts assign sites to standard (national) classes of condition

Used taxonomy data for bugs and algae

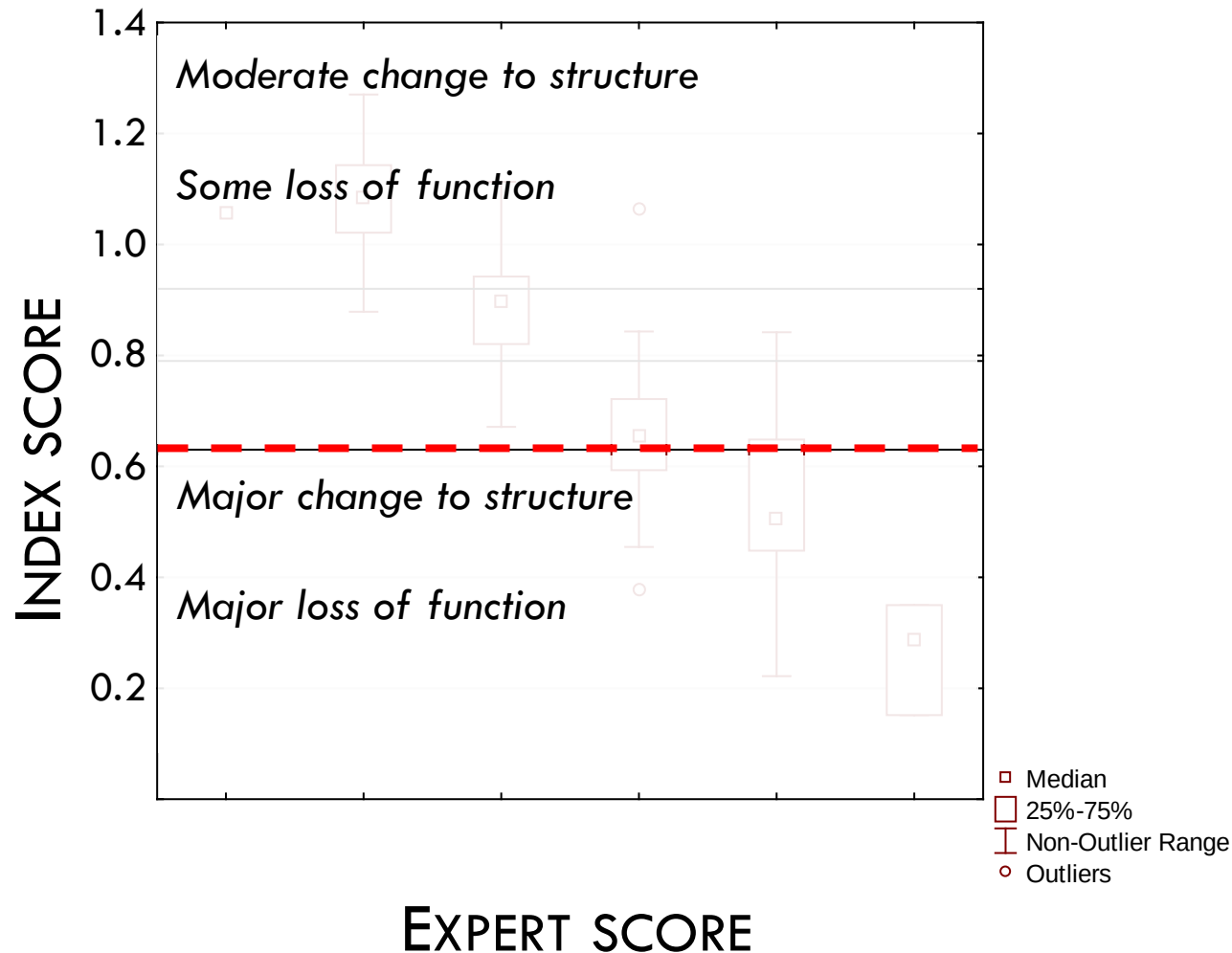
The classes may be linked to index scores

Bin	Description
1	Natural or native condition
2	Minimal alteration in structure or function
3	Evident changes in structure, minimal loss of function
4	Moderate changes in structure, some loss of function
5	Moderate changes in structure and function
6	Severe changes in structure and major loss of function

BCG CONNECTS INDEX SCORE TO NARRATIVE DESCRIPTION, POLICY GOALS



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Technical Needs to Use Bioassessment

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Relating biointegrity to manageable factors

Technical elements required:

- Conceptual model to link stressors to aquatic life
- Response models to help set protective stressor thresholds
- Causal assessment framework for guiding site-specific actions
- Evaluation of management options and technology

Causal assessment tools are available, need streamlining

CADDIS: EPA's Causal Assessment/Diagnosis Decision Information System

Complete and evaluated for California

- A structured evaluation of multiple lines of evidence associating stressors with observed degradation
- Time- and data-intensive

Rapid Causal Assessment

In development

- Streamlines elements of CADDIS for screening of stressors
- Nearly simultaneous with condition assessment
- Supports more intensive analyses, where appropriate

Bio-integrity use in policy is already happening/in the works

Three examples illustrate key decisions needed/made:

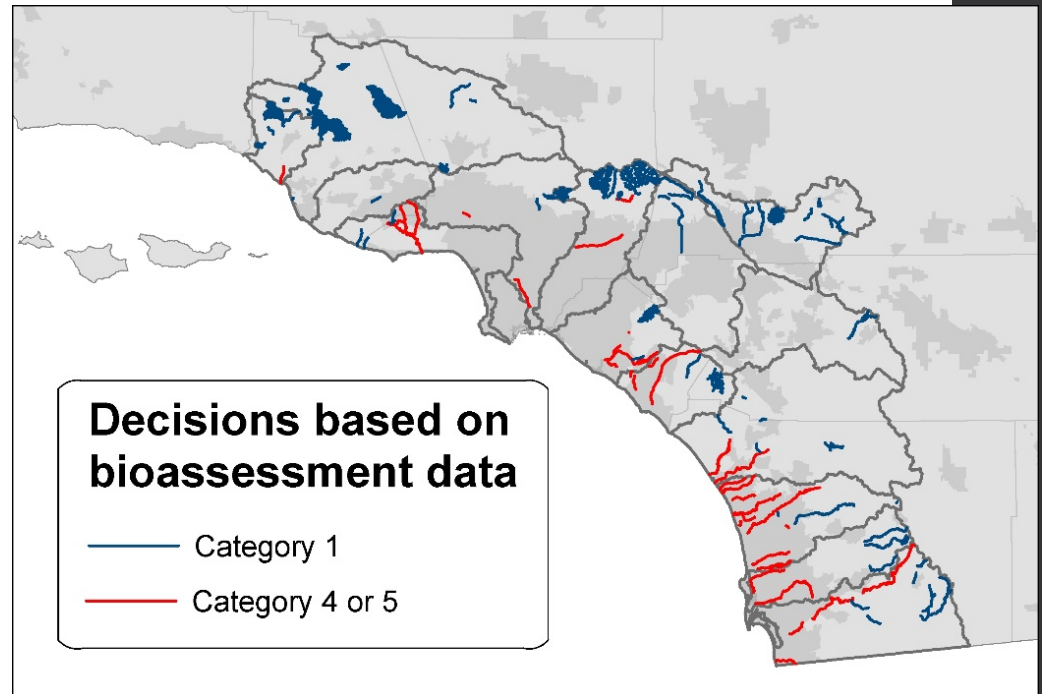
- Integrated report
- San Diego's proposed biological objectives
- Statewide biointegrity-biostimulatory policy

INTEGRATED REPORT

First systematic application of biointegrity data to make listing decisions

Impaired streams (requiring TMDLs) identified

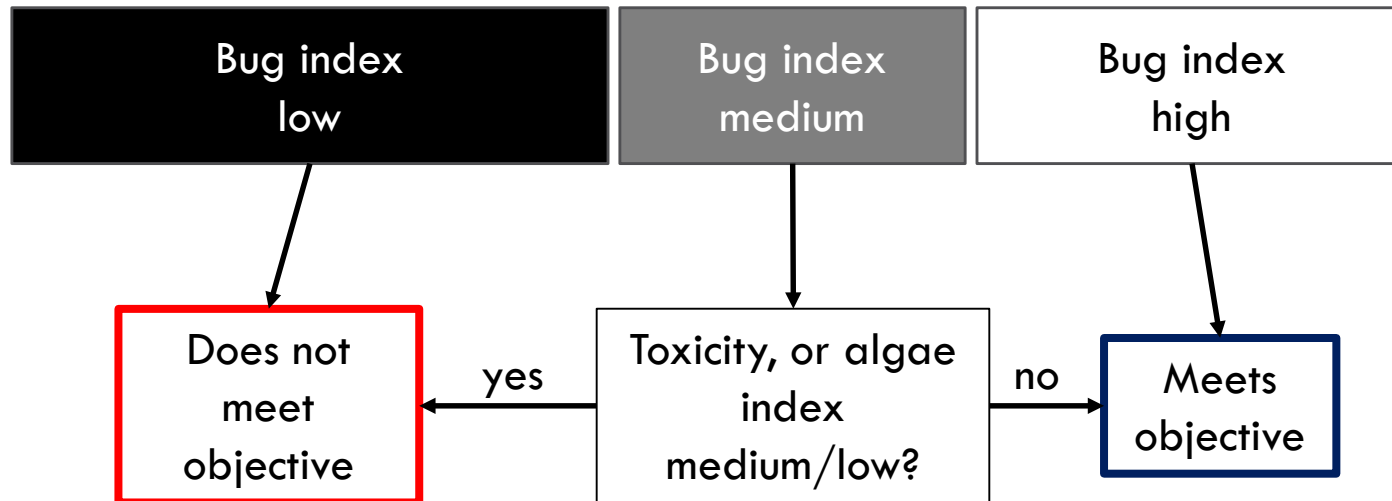
High-quality streams listed for first time



Key decisions—Made

- Two thresholds (10th and 30th percentiles of reference)
- Two lines of evidence (bugs and WQ standard exceedances)

RB9's proposed bio-objectives



Key decisions—Proposed

- Two thresholds (1st and 10th percentiles of reference)
- Two lines of evidence (bugs and algae)
- Modified channels & other constraints addressed through implementation, *not* tiered uses/objectives

Statewide biointegrity-biostimulatory policy goals

To use biointegrity (BI) tools and concepts to develop policies that protect aquatic life.

Establish a statewide narrative water quality objective for biostimulatory substances, with numeric guidance

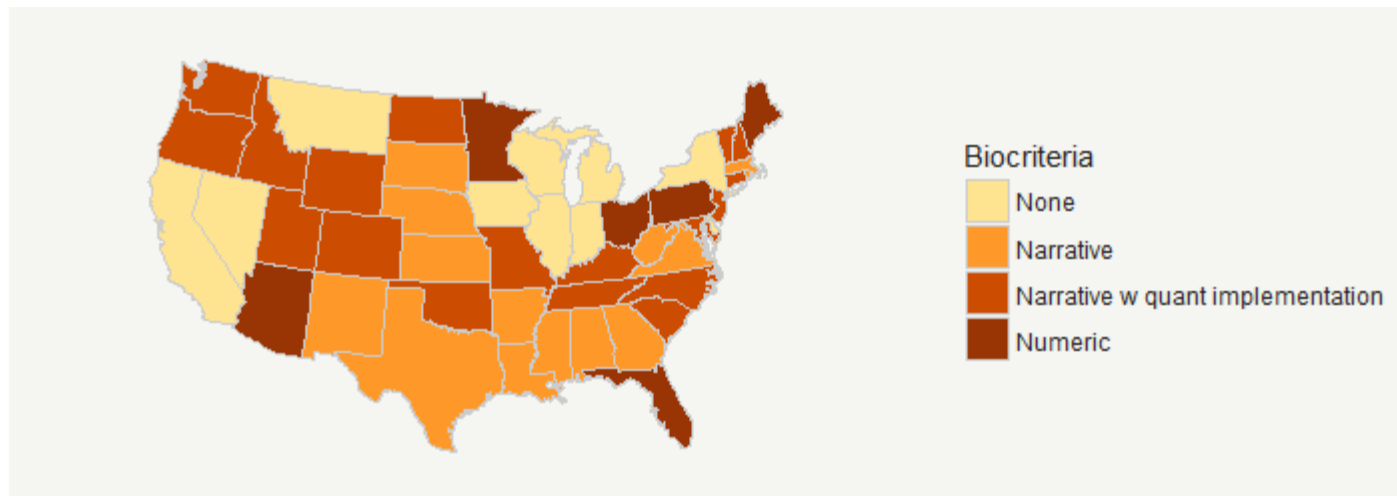
Develop an implementation program for joint policy

Challenging decisions for using biointegrity in policy:

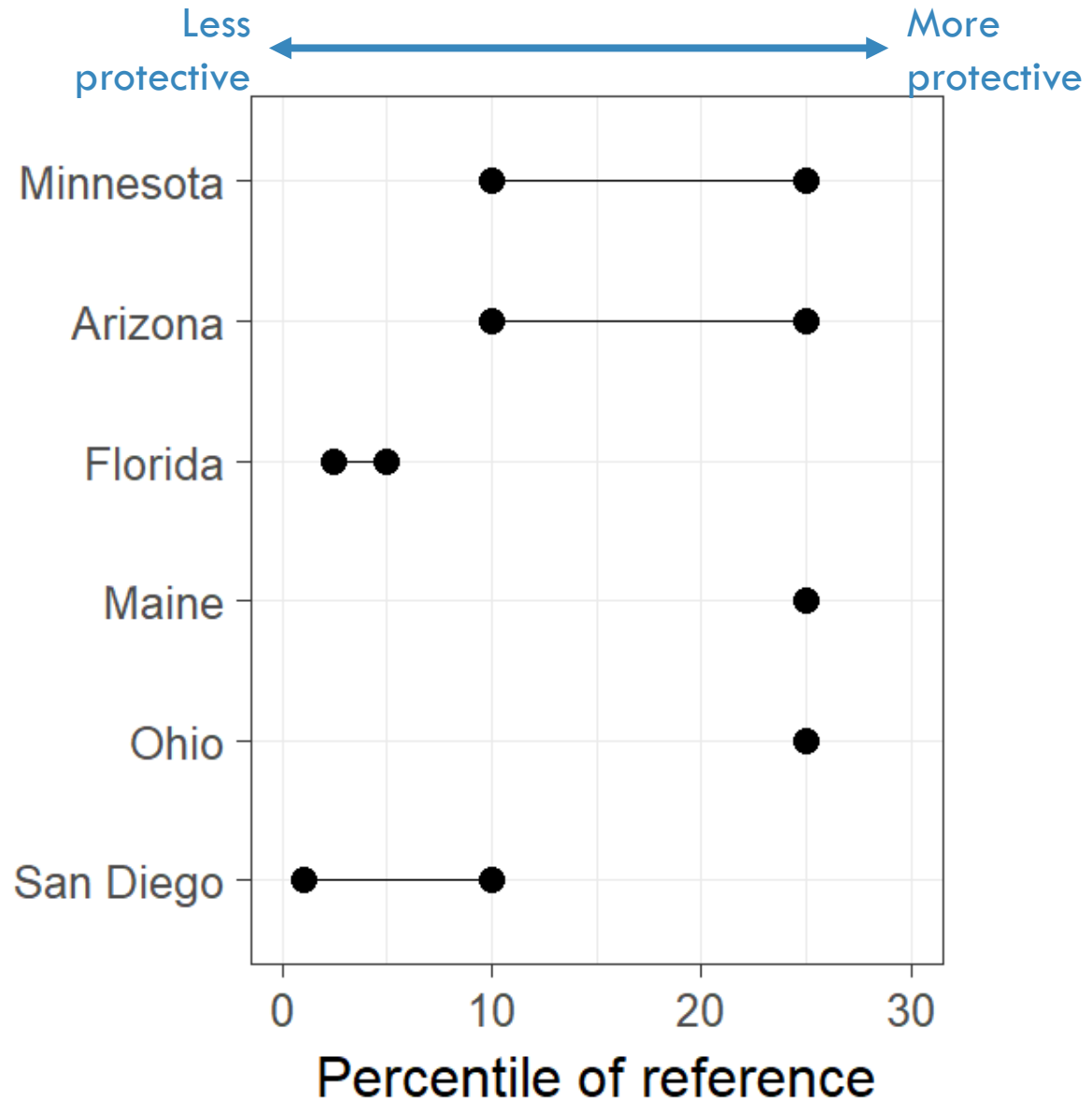
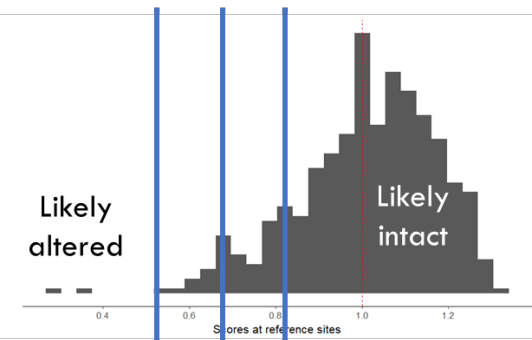
- Selecting biointegrity endpoints
 - E.g., 10th percentile? 20th?
- Using multiple lines of evidence
 - Multiple biological indicators (e.g., bugs + algae)
 - Independent applicability (e.g., bio vs chem)
- Considerations for constrained streams (e.g., modified channels, urban watersheds)
 - In statewide policy? In watershed implementation?

...but might differ in others

- Proposed thresholds could be less protective
- Other states with numeric criteria also have tiered (often modified) uses



Proposed targets may be less protective than most other states



Most states with numeric criteria have tiered/modified uses

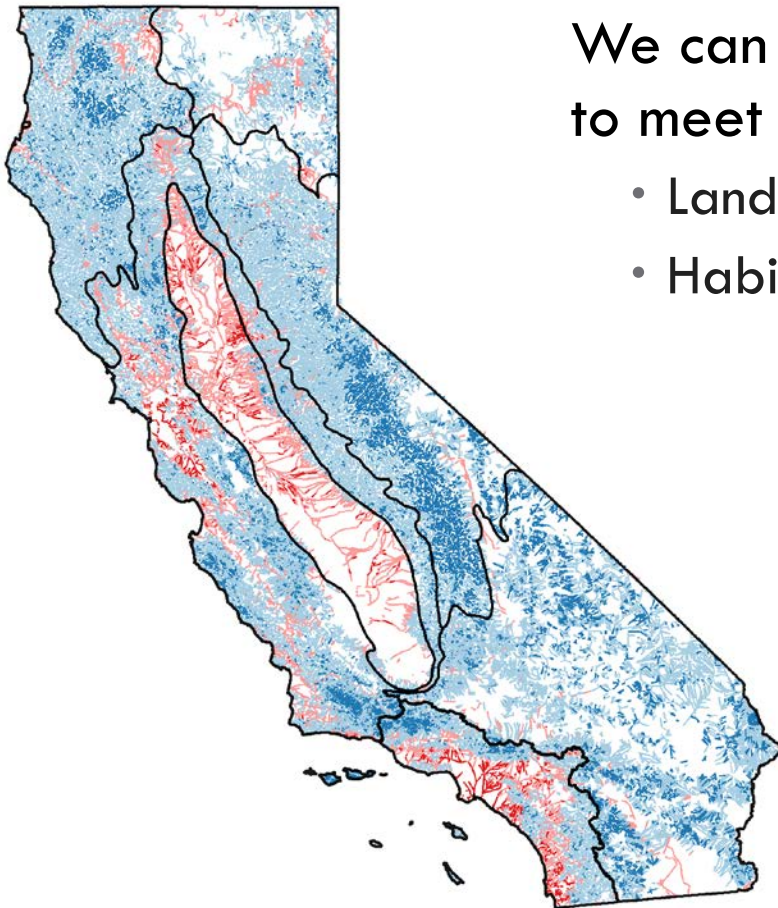
What type of evidence supports modified use designation?

- OH, ME: Presence of dams, mine drainage
- MN, FL: Habitat index score, channel structure
- AZ: Effluent-dependence.

In all cases, attained use (i.e., high bio scores) *precludes* modified designation

Science for “tiered uses”?

Tools are available, if needed.



We can identify streams that are unlikely to meet objectives

- Landscape models
- Habitat quality index

The tools let us estimate:

- How many streams are constrained?
- Where are they?
- What might they achieve?

Bio-integrity is ready for incorporation into policy and management

- Fundamental science is largely complete
 - We can measure biointegrity and set thresholds (tiered, if desired)
 - We can link to stressors
- Some key policy decisions still being made
 - Selecting targets
 - Independent applicability, multiple indicators
 - Implementation in constrained channels
- California is largely in line with other states (with a few differences)

Two Part Talk

- Biointegrity science

- Biostimulatory science

“Biological Assessment—Rather Than Chemistry-- is the Best Way to Assess Aquatic Life Uses”

Also True for Nutrient Pollution Impacts

- Nutrients can cause eutrophication = excessive accumulation of organic matter
- Focus on alone nutrients can be misleading!
- Biological measures better assessment of beneficial use impacts

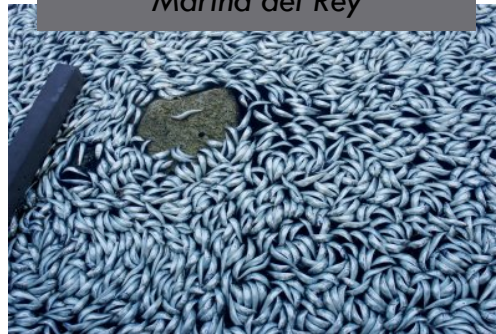
Water Board has An Existing Policy to Address Eutrophication: Narrative Biostimulatory Objective

Applicable Across All Waterbody Types



Toxic cyanobacterial bloom in Clear Lake

Hypoxia-induced fish kill in Marina del Rey



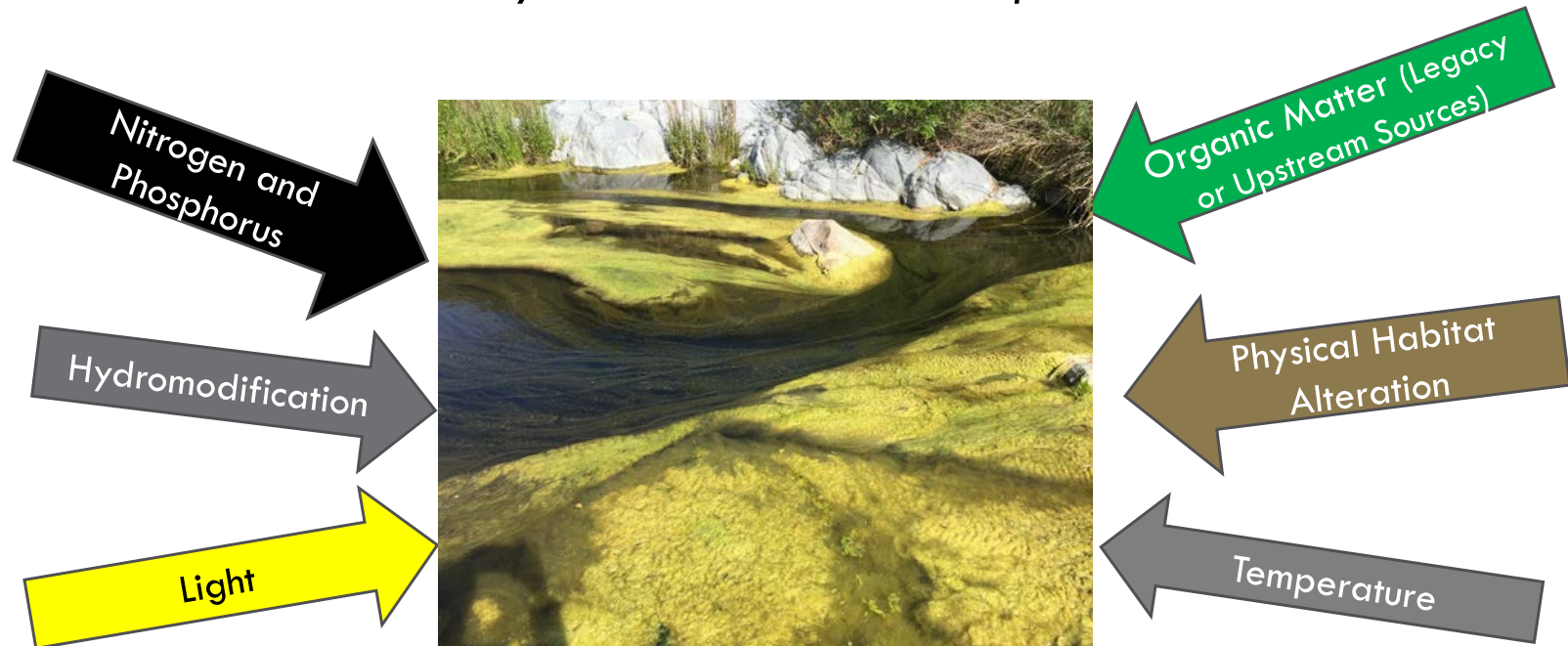
Impact to fish habitat and aesthetics of trout stream in Sta. Margarita R.



We lack consensus on biological assessment indicators
We lack consensus on thresholds that support beneficial uses
Need science to support implementation program

What Are Biostimulatory Substances/Conditions?

Biostimulatory Conditions Cause Eutrophication



Water Board staff want to set statewide NUTRIENT numeric targets, but provide policy vehicles to manage other factors at watershed scale

Biostimulatory Science for Wadeable Streams— Take Home

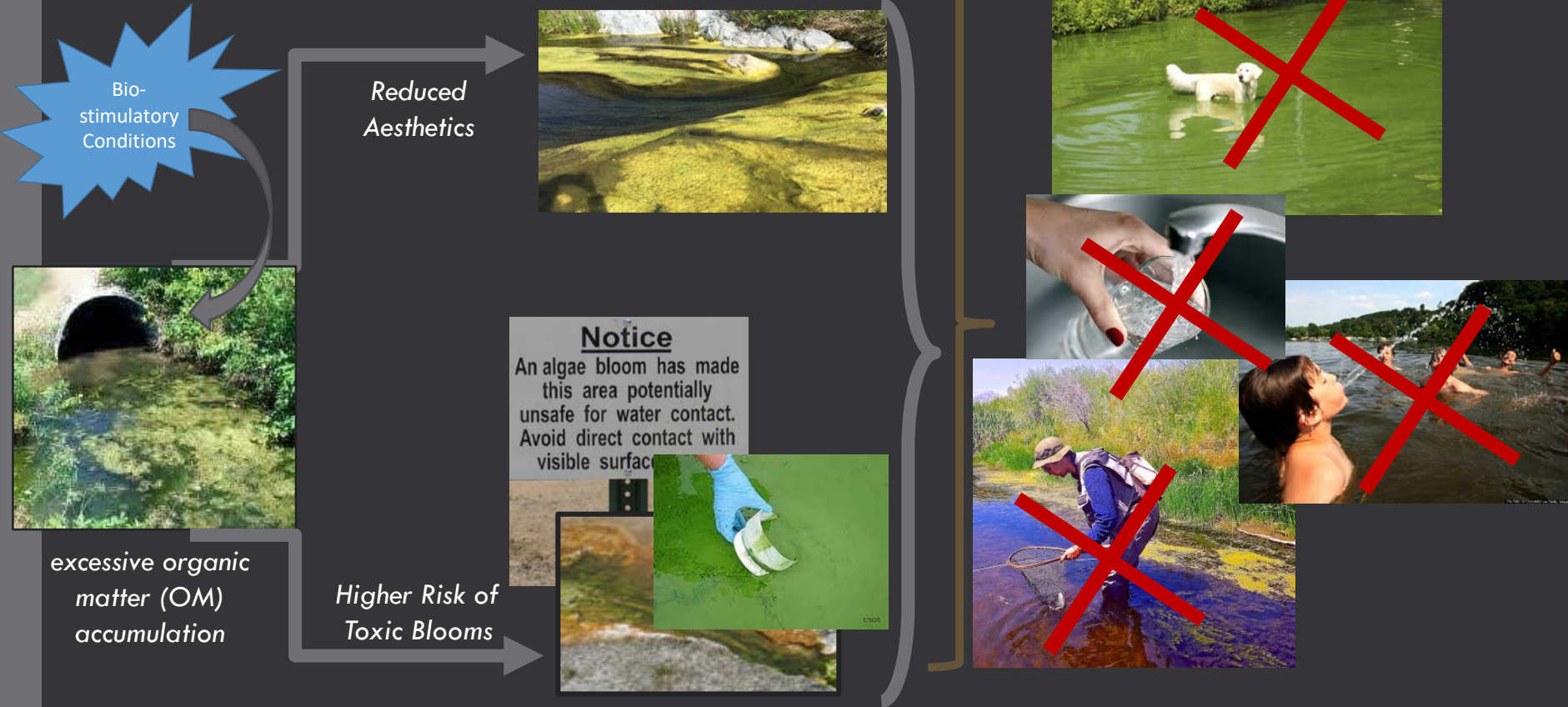
Biostimulatory science has greatly benefited from integration with biointegrity

- We have consensus on conceptual models and indicators
 - A subset of key indicators are already integrated into bioassessment protocol
- Synthesis of science supporting decisions on statewide biostimulatory targets is nearly complete
- We continue to work on watershed demonstration studies
 - Focus on use of science to support implementation

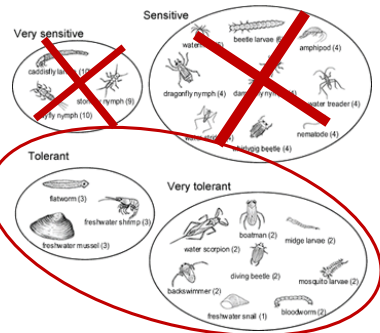
Conceptual Model Identifies Key Indicators of Impact on Aquatic Life....



Same Pathways Impact Human Uses....



California's Approach: Biostimulatory Objectives



IMPAIRMENT PATHWAYS

RESPONSE INDICATORS

BIOSTIMULATORY NUMERIC TARGETS

ALU- Altered Structure

CSCI

ASCI

ALU- OM Enrichment

REC2-Reduced Aesthetics:

Benthic Chl-a; AFDM

Percent Cover

ALU- Toxins

MUN and REC1-Toxins

Cyanotoxins

ALU- Altered DO and pH

DO, pH

Establish Endpoints
Diagnostic of
Eutrophication
Response

Set Targets for
*Biostimulatory
Substances:*
Total Nitrogen and
Total Phosphorus

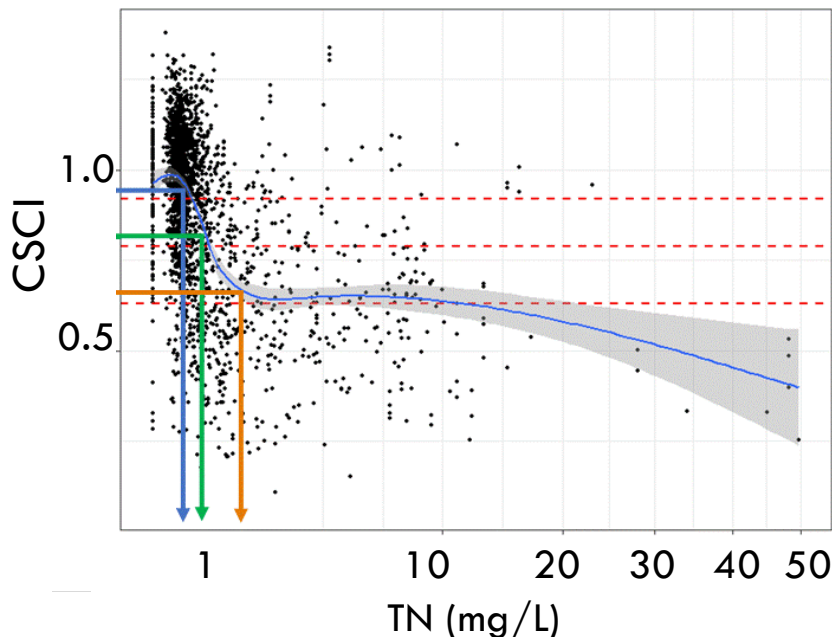
Manage other
conditions at watershed
scale



Scientific Basis for Biostimulatory Thresholds Relies on Both Original Analyses and Existing Science

BIOINTEGRITY STRESS-RESPONSE MODELING (CALIFORNIA DATA)

ALU Targets for Benthic Chl-*a*, AFDM, Macroalgae % Cover, TN and TP



EXISTING LITERATURE OR GUIDANCE—GLOBAL

MACROALGAL % COVER (HUMAN USE)

- Published literature on recreational user surveys (REC2)

CYANOTOXINS (HUMAN HEALTH):

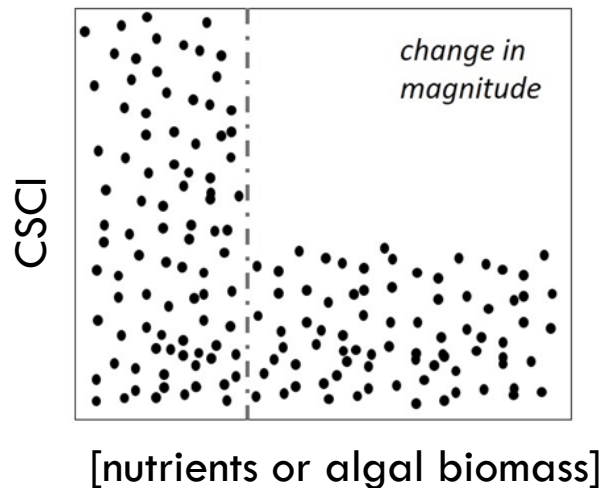
- CCHAB guidance for REC1 advisories
- Pending EPA cyanotoxin criteria to protect human health

DO AND PH (AQUATIC LIFE)

- Existing basin plan objectives
- Literature on effects of diel swings on aquatic life

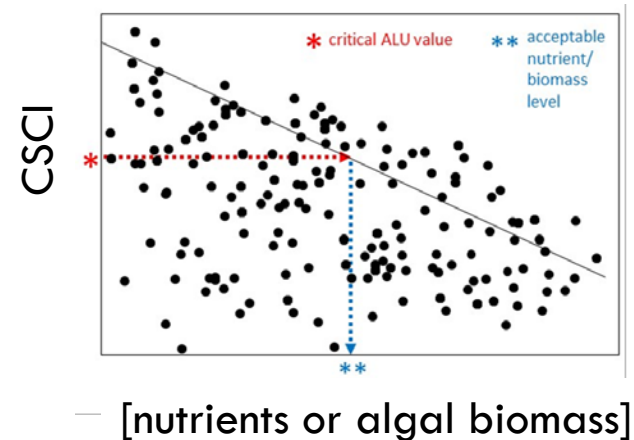
Biointegrity Stress-Response Models: Two approaches to Thresholds

Change Point Analysis



We've completed change point analyses based on CSCI and So Cal Algal IBIs

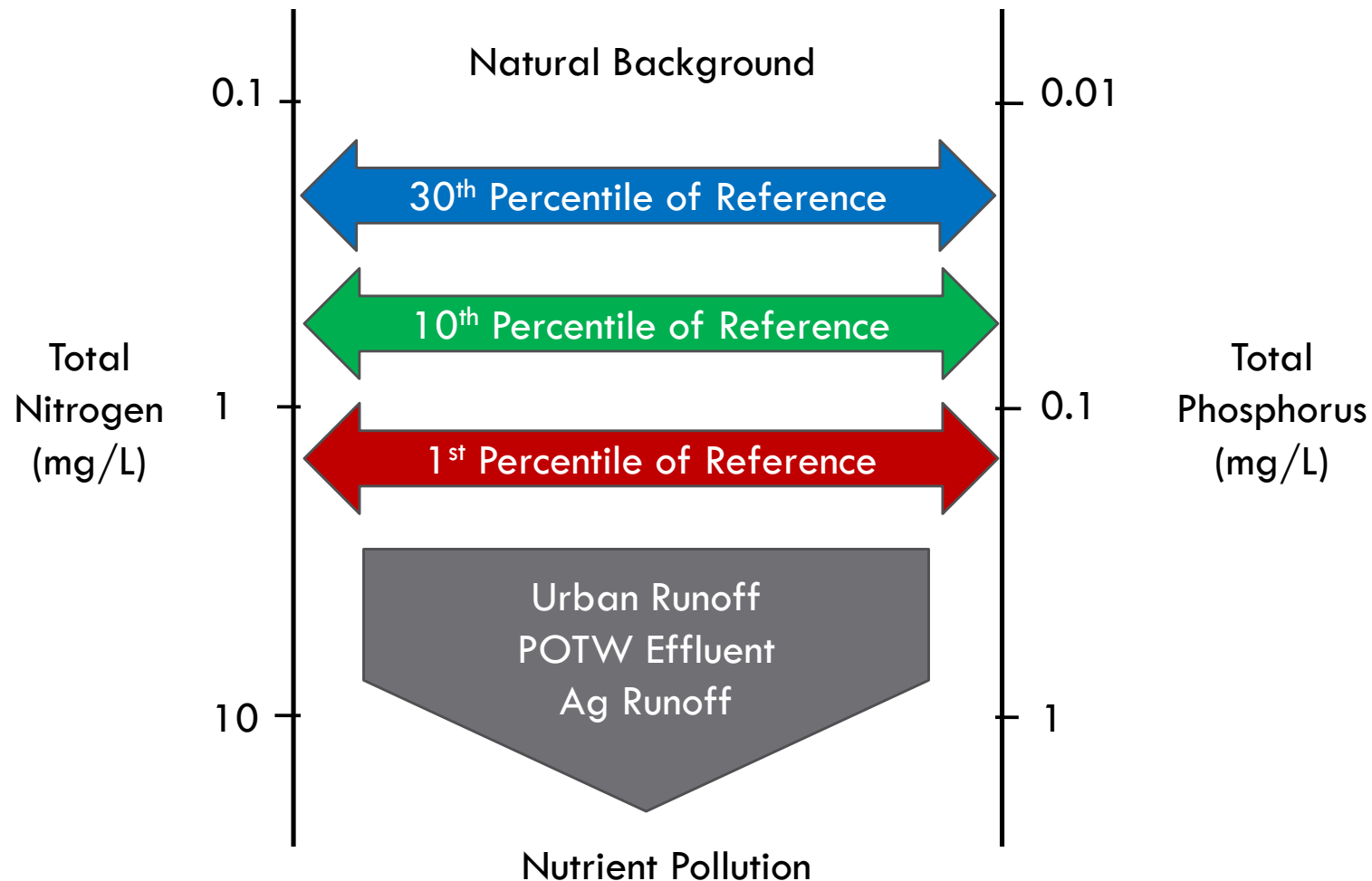
Aquatic Life Endpoint:
BCG or Reference-Based



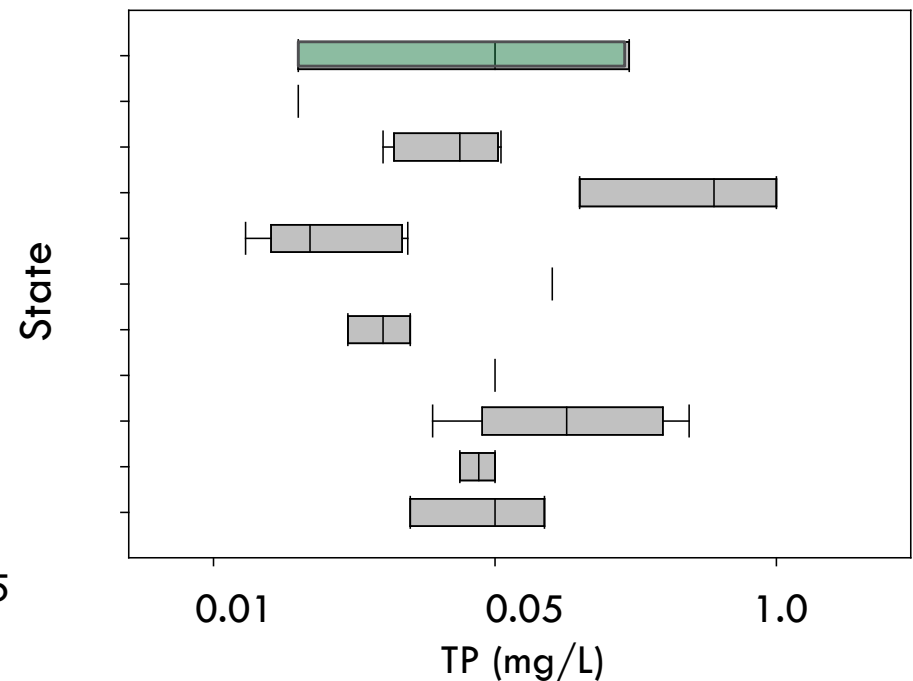
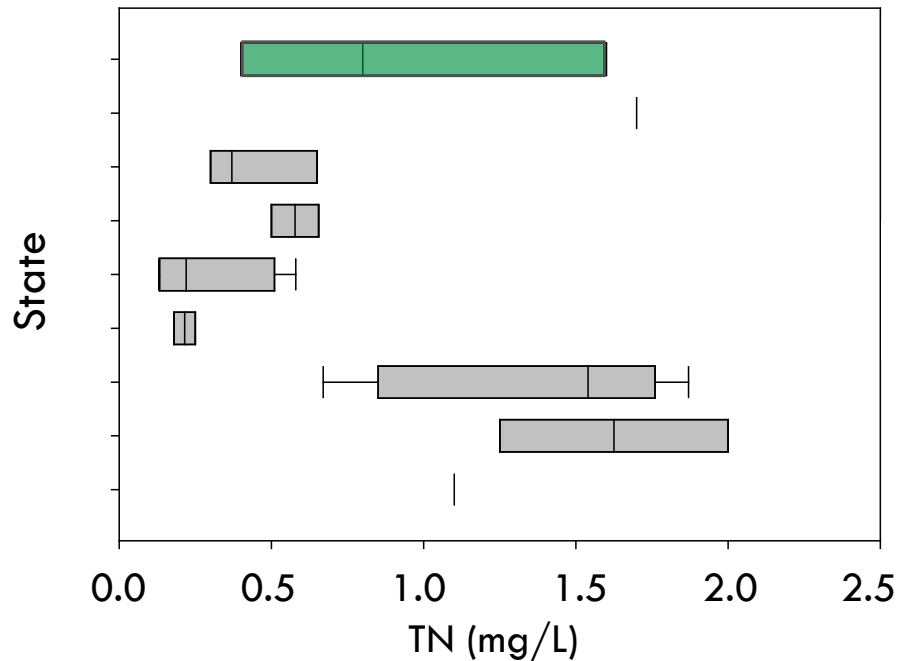
We've completed models using CSCI endpoints

- Thresholds for BCG vs reference
- ASCI results are still pending

Thresholds that Impact Aquatic Life Are Extremely Low Relative to Urban/Ag Runoff and POTW Wastewater



CALIFORNIA'S RANGE OF TN AND TP THRESHOLDS IS COMPARABLE TO OTHER STATES' NUTRIENT CRITERIA

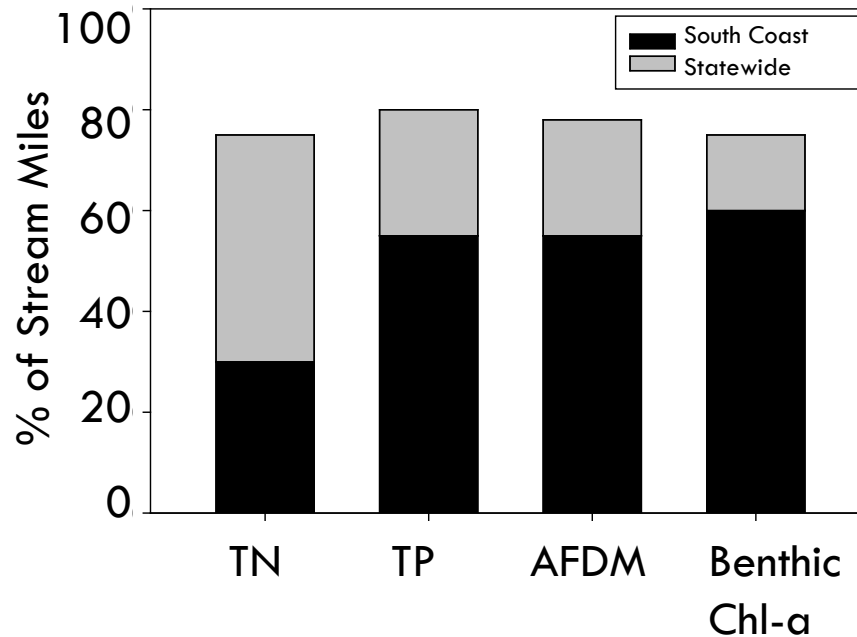


Range of CA Nutrient Thresholds at or Below Available Waste Water Treatment Technology

Parameter	Total Phosphorus (mg L ⁻¹)	Total Nitrogen (mg L ⁻¹)
Secondary Effluent (no nutrient removal)	4-6	20-30
Typical Biological Nutrient Removal	1	10
Limits of Conventional Treatment Technology	0.05-0.07	3 – 4
Reverse Osmosis	<0.01	1
Range of Thresholds Protective of 30 th to 1 st percentile of CSCI	0.020 – 0.25	0.18 – 1.7

Good News: Statewide, 80% of Stream Miles < Thresholds for 10th percentile of CSCI Reference

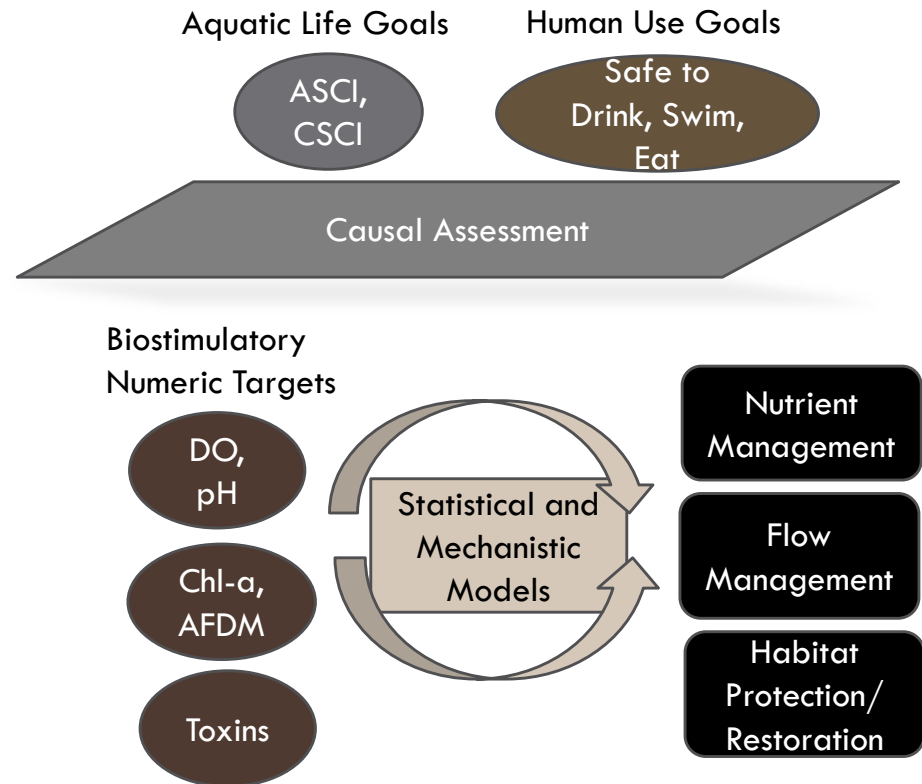
Bad News: Within South Coast, Only 30 -55% Meet those thresholds



Watershed Approach Allows Thorough Exploration of Uses, Indicators, and Causal Factors

Case Study: Santa Margarita River Watershed

- Investigate causal mechanisms
- Manage other biostimulatory factors?
- Site specific nutrient targets via multiple lines of evidence through mechanistic models
 - Dissolved oxygen and human uses protected?
- Seasonal targets?



Next Steps

- Wrap up manuscripts supporting statewide guidance
 - Algal Stream Condition Index
 - Biological condition gradient
 - Landscape models of constraints on biointegrity in developed landscapes
 - Biostimulatory indicator and threshold science
- Vet products with Science Panel fall 2018
- Continue to work on watershed demonstration projects



On to Policy Development?

Water Board staff will have revised timeline for amendments in fall 2018

Comments? Questions?