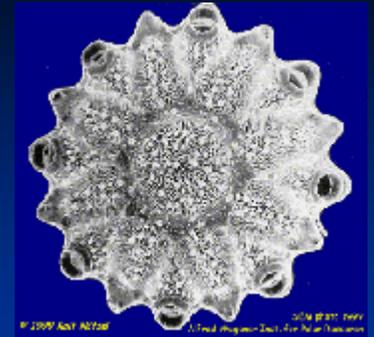
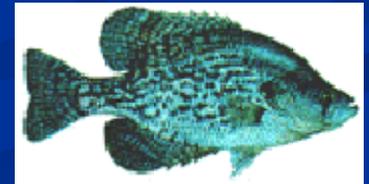




# Module 11



# Biological Criteria



# Theme

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“The true health of our aquatic environments is reflected by the biological communities that reside within them”

Prof. J. Karr  
University of Washington

# Aquatic Life Use Support in California

- Warm Freshwater Habitat
- Cold Freshwater Habitat
- Fish Spawning
- Fish Migration
- Wildlife Habitat
- Preservation of Biological Habitats of Special Significance
- Rare and Endangered Species
  
- Aquaculture
- Freshwater Replacement
  
- Saline Water Habitat
- Estuarine Habitat
- Marine Habitat

ALUS Designations applied broadly to waterbody types

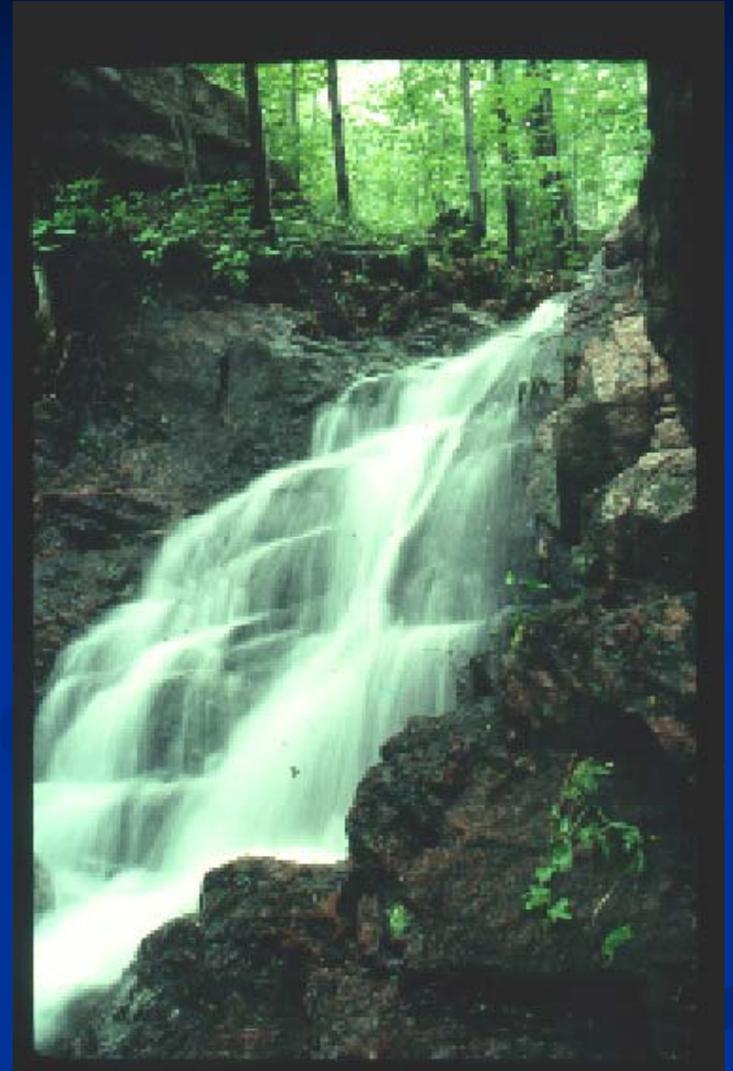
Objectives largely expressed as a narrative

Biocriteria would provide quantitative tools for ALUS protection

# CWA Section 101 Objective

To Restore & Maintain  
the Chemical, Physical,  
& Biological Integrity  
of the Nation's  
Waters

Sec 303(c) WQS that  
serve the purposes of the Act



# Biological Integrity

## QUANTITATIVE MEASURES

The ability of an aquatic ecosystem to support and maintain a balanced adaptive community of organisms having a **species composition, diversity, and functional organization** comparable to that of **natural** habitats within a region

REFERENCE

CLASSIFICATION

# Classification and Reference

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## *Concept of the Ecoregion:*

- ✓ Identifies regions of ecological similarity from which to select reference sites.
- ✓ Biological conditions expected to be the same.

# SWAMP Statewide Stream Survey

100 Samples per year

5 Ecoregions

4 Landuse categories

Agriculture

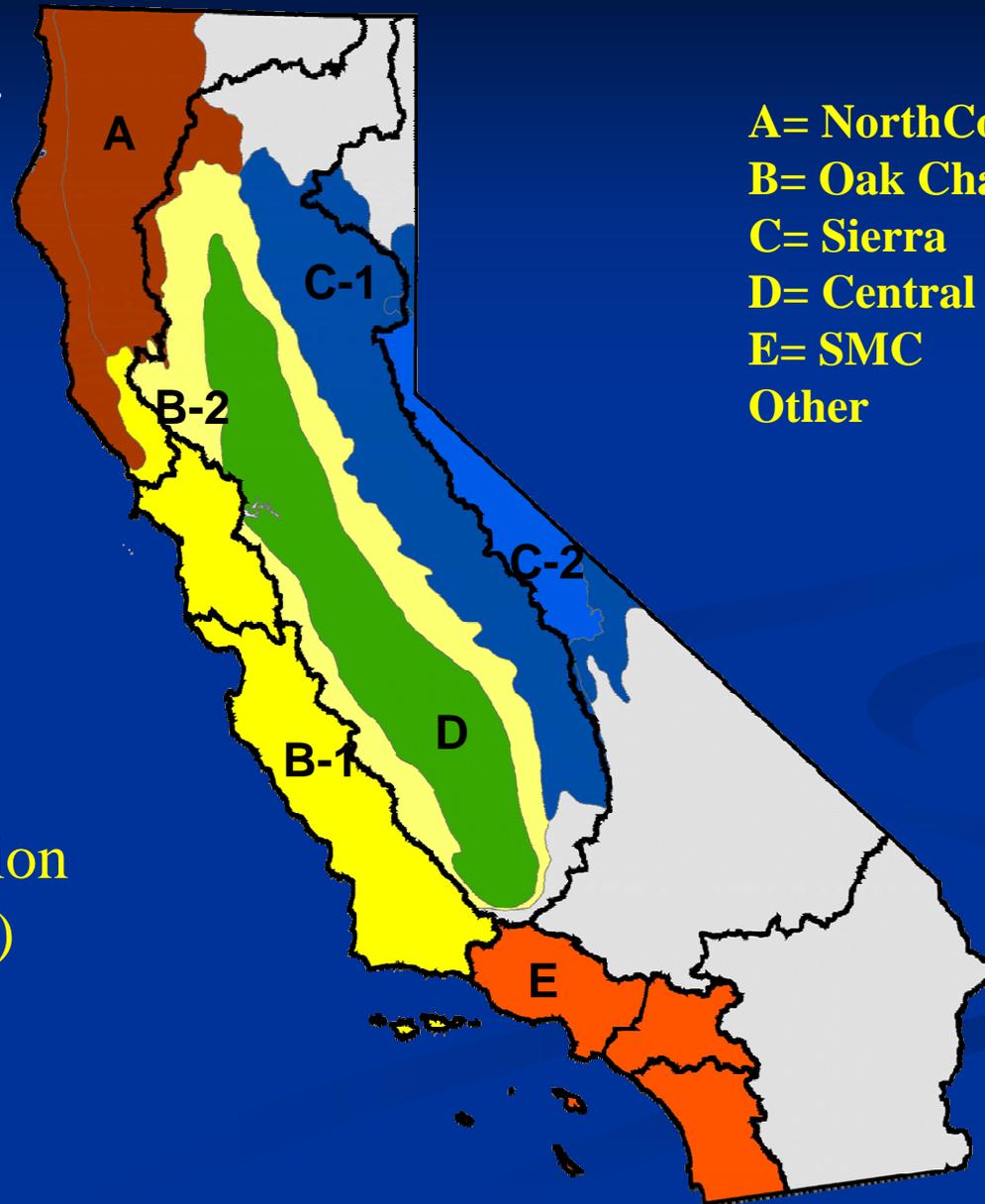
Urban

Forested

Other

Plus reference condition

Program (75 per year)



A= NorthCoast

B= Oak Chaparral

C= Sierra

D= Central Valley

E= SMC

Other

# Direct Quantitative Measures of Community Structure and Function

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- ✓ Number of individuals
- ✓ Relative abundance
- ✓ Species composition
- ✓ Diversity
- ✓ Distribution of functional groups
- ✓ Tolerant/Intolerant Species
- ✓ Diseases and Anomalies
- ✓ Native/Non-native Species

# Definitions

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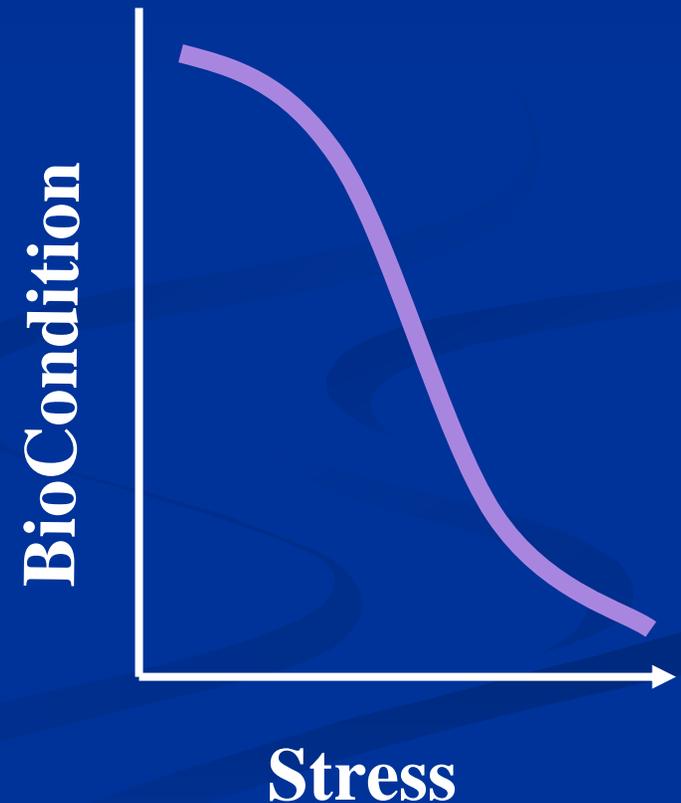
- ✓ **Attribute.** Any measurable component of a biological system.
- ✓ **Metric.** Attribute that shows a quantitative change in value along a gradient of human influence.
- ✓ **Multimetric Index.** Integrates several biological metrics to express a site's condition or health.

# Theory behind bioassessments

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Biological communities respond to anthropogenic stress.

The response is measurable and predictable



# BIOASSESSMENTS





## Fish community bioassessment



Invertebrate community  
bioassessment using a kicknet

# Algae



chlorophyll a



taxonomic  
id's



ash-free  
dry mass



**Mayfly**



**Slimy Sculpin**



**Stonefly**

**Minimally disturbed, forested watershed in Maine**



**Midges**



**Snails**



**Leeches**

**Stream draining a shopping mall in Maine**

# Undisturbed/Minimally Disturbed Stream



Stoneflies

Dragonflies,  
Damselflies

Mayflies

Beetles

Midges

Caddisflies

1 inch

Courtesy of Susan Davies, ME DEP

# Nutrient Enriched Stream



Crane flies

Caddisflies

Non-insects

Beetles

Midges

Stoneflies

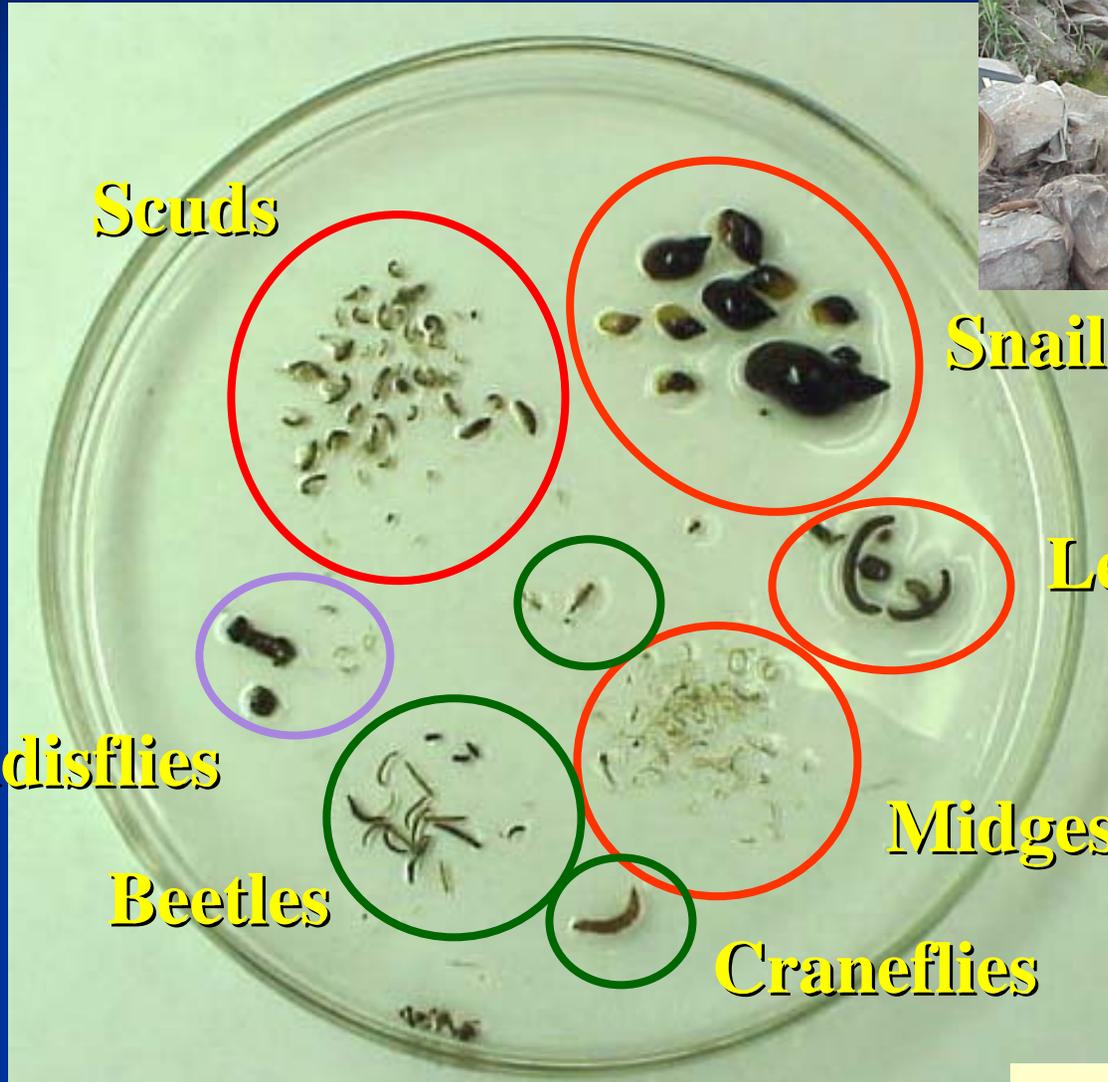
Blackflies

Mayflies

1 inch

Courtesy of Susan Davies, ME DEP

# Drainage from a Shopping Mall Parking Lot



Scuds

Snails

Leeches

Caddisflies

Midges

Beetles

Craneflies

1 inch

# Value Of Biological Information: Ohio Comparison Of Biosurvey With Chemical Evaluation

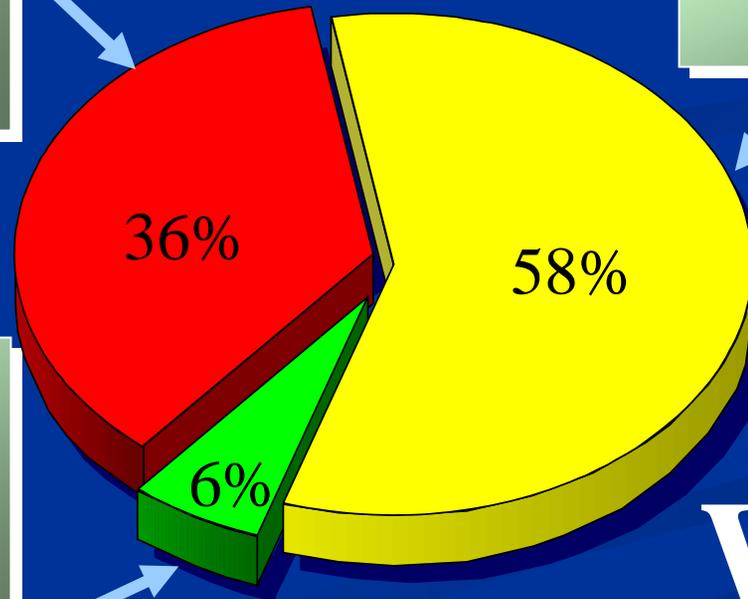
**Chemical Evaluation  
Indicates No Impairment**

**Biosurvey Shows  
Impairment**

**Chemical Prediction &  
Biosurvey Agree**

**Biosurvey Shows  
No Impairment**

**Chemical Evaluation  
Indicates Impairment**



# WHY?

# Aquatic Life Use in California

(incorporating biology in water quality standards)

## Bioassessment

pHab

Bugs

IBI O/E

Fish?

Algae

CRAM

## Nutrient Criteria

Numeric Nutrient  
Endpoints

Algae

## Wetland Policy

CRAM

## Sediment Quality Objectives

Benthic Response Indices

# Development of Bioassessment Tools in California

	Habitat	Algae	Invertebrates	Fish
Ephemeral	y			
Intermittent	y	?	?	?
Perennial	pHab CRAM	% cover Biomass Algal IBI	IBI or O/E	?
Rivers	pHab CRAM	y	y	y
Lakes/Reservoirs	pHab CRAM	y	y	y
Bay/Estuaries	CRAM	y	BRI,	y
Coast/Ocean		y	So Cal BRI	So Cal Fish Index <sub>22</sub>

# Developing Biocriteria in CA

## SWAMP

**Standardized biological protocols**



**Classify water bodies into similar groups or classes**



**Identify reference sites in each class**



**Conduct bioassessments at reference sites in each class**



**Develop Assessment Tool**

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## STANDARDS



**Develop Biocriteria for each Aquatic Life Use**



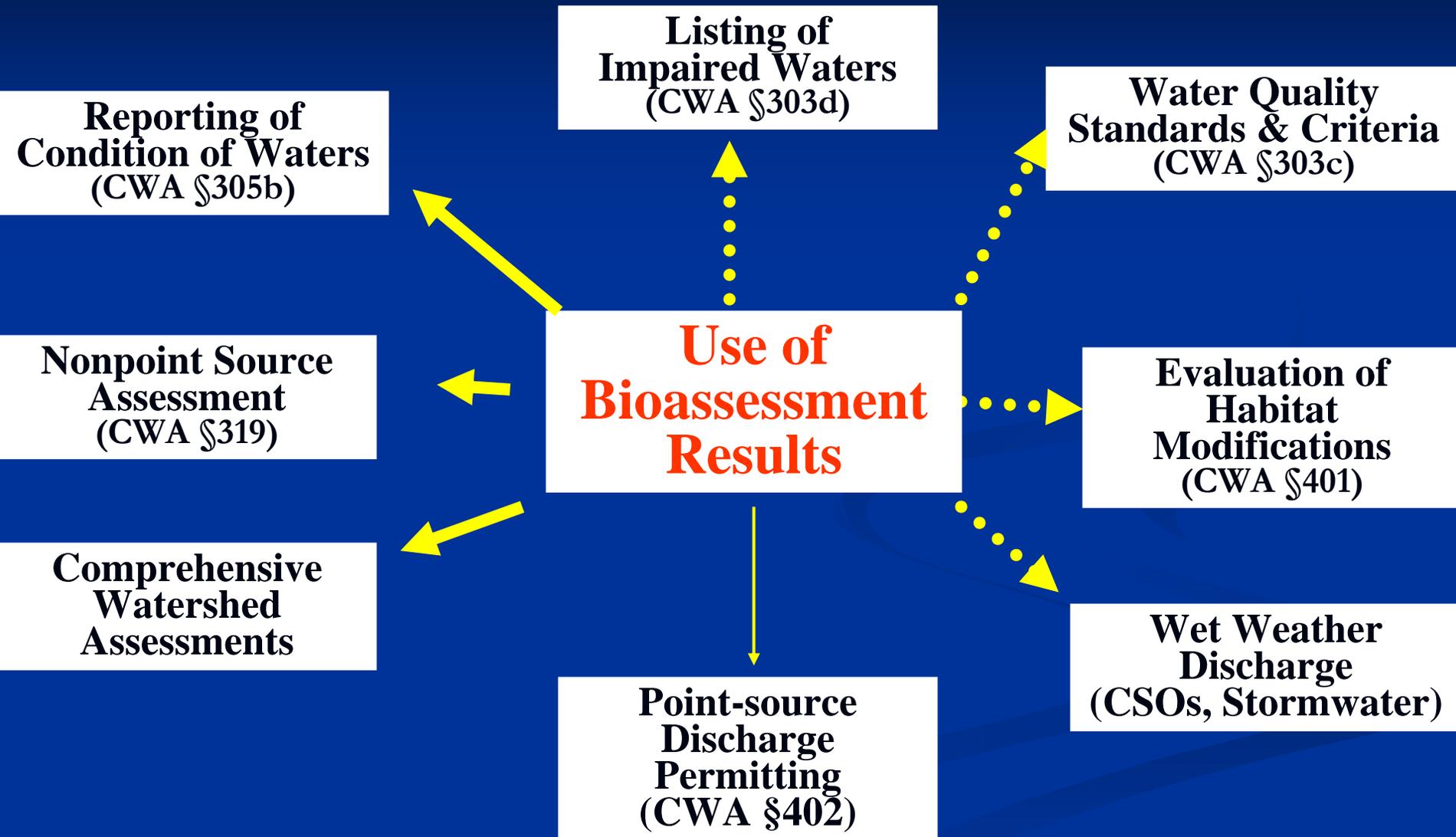
**Apply Biocriteria to all Water Bodies**

# Narrative and Numeric Biocriteria

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- ✓ Narrative Biocriteria- General Statements of Desired Level of Biological Condition for a Given Use Designation.
- ✓ Numeric Biocriteria- Specific Quantitative Measures (e.g., Metrics) of Desired Level of Biological Condition for a Given Use Designation.

# Use of Biological Information



# Tiered Aquatic Life Use (TALU)

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- States and Tribes can (and have) used biological Information to refine (or "tier") aquatic life uses
  - Help determine "highest attainable" use(s)
  - Develop criteria to protect them
  - Develop goals for incremental progress
  - Clearer communication to the public

# The Biological Condition Gradient - Levels

Biological Condition

*Natural structure & function of biotic community maintained*

1

*Minimal changes in structure & function*

2

*Evident changes in structure and minimal changes in function*

3

*Moderate changes in structure & minimal changes in function*

4

*Major changes in structure & moderate changes in function*

5

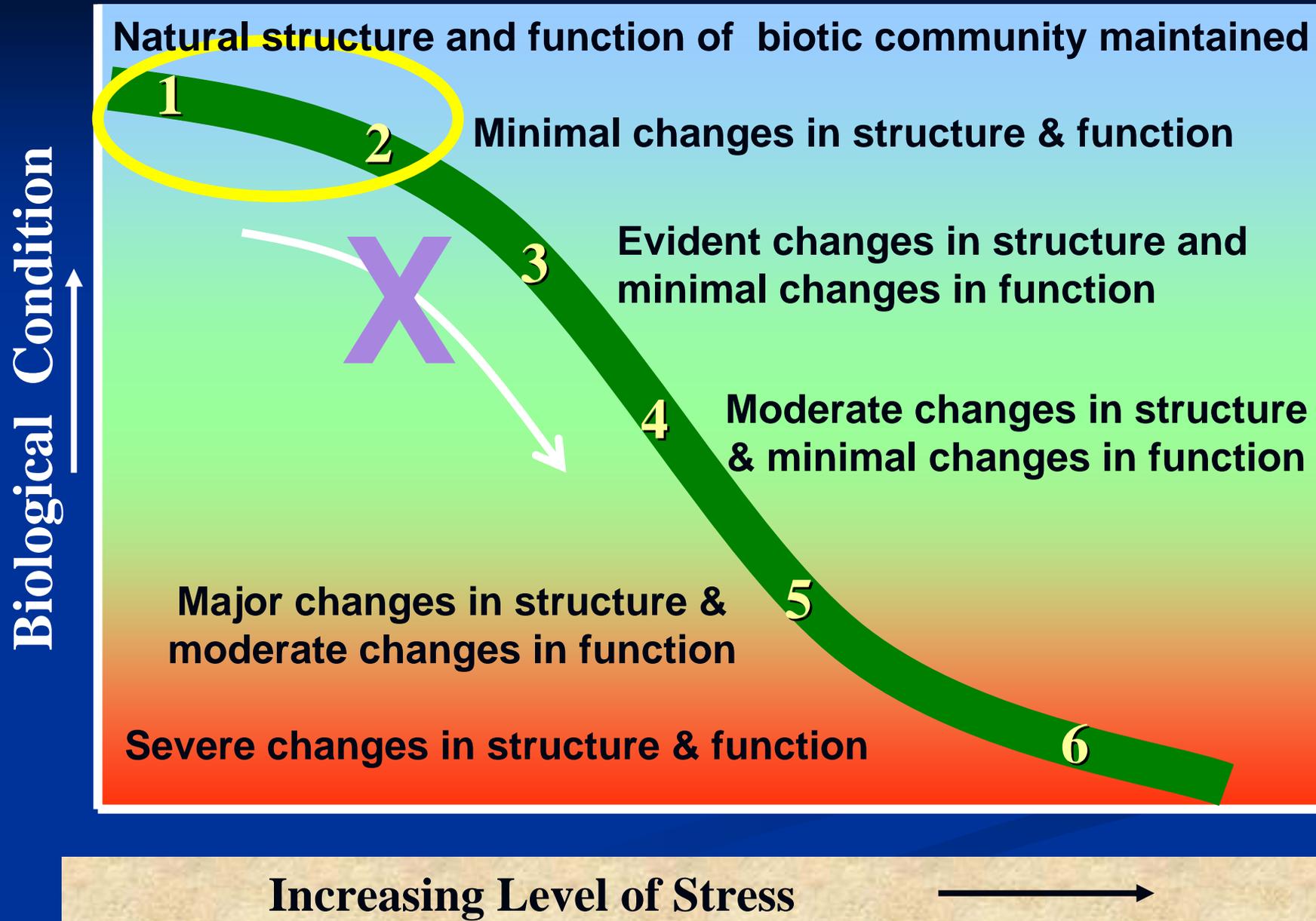
*Severe changes in structure & function*

6

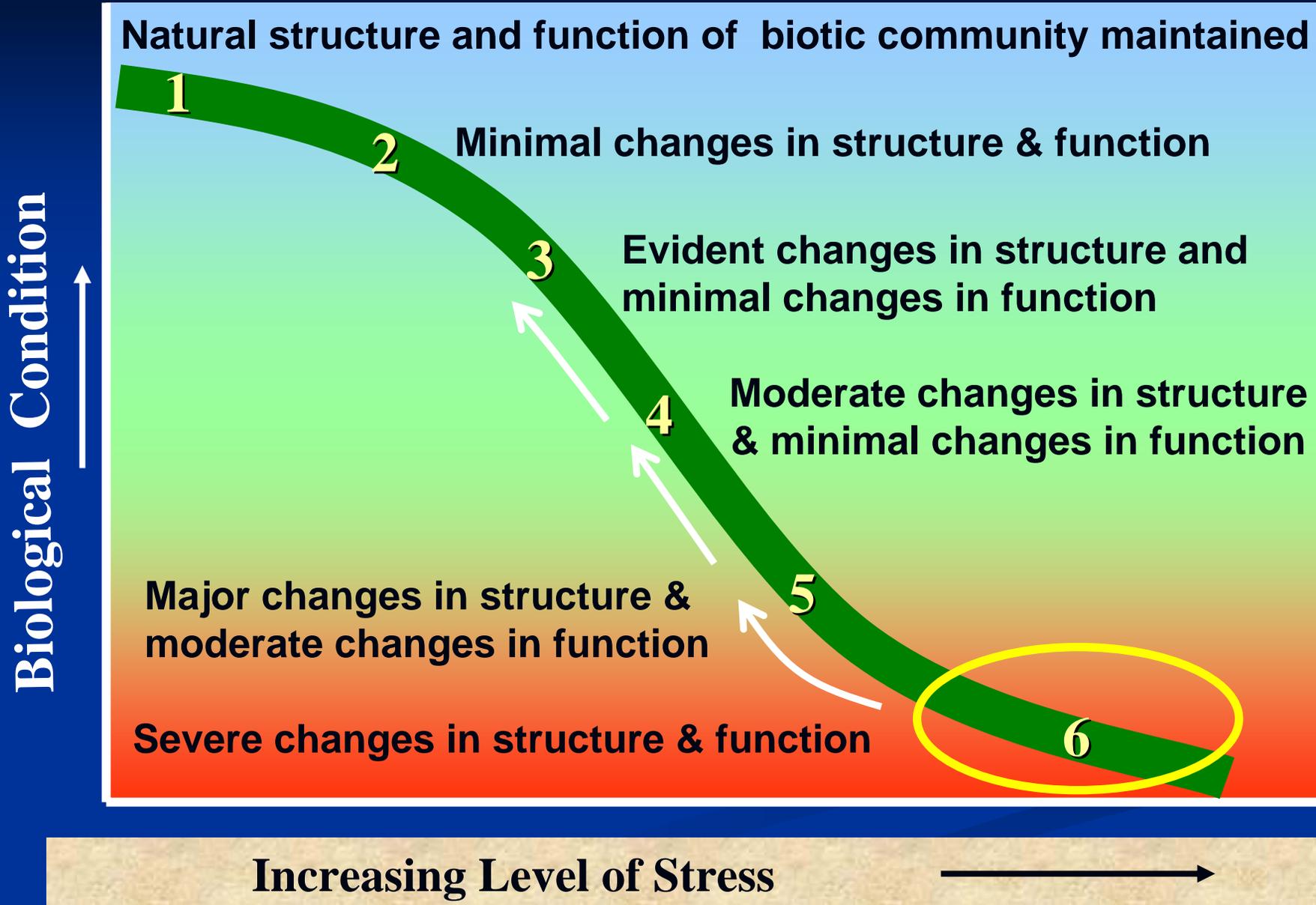
Increasing Levels of Stressors



# Biological Condition Gradient-Protect HQ Waters

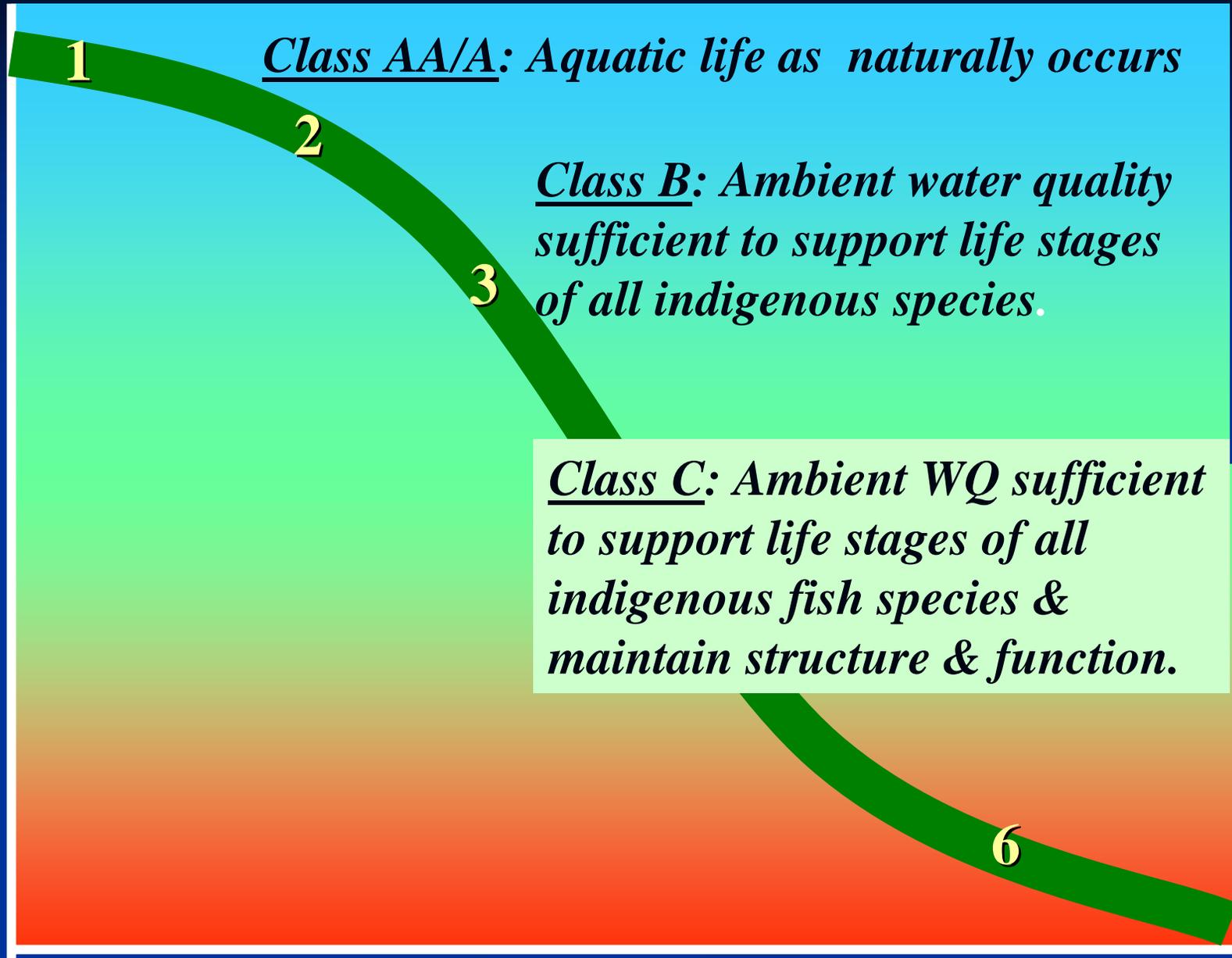


# Biological Condition Gradient - Incremental Goals



# Designated Aquatic Life Uses: Maine Example

Biological Condition



Increasing Level of Stressors



# Maine Tiered Uses Based on Measurable Ecological Values

## Narrative Standard

## Ecological Value

## Quantifiable Measures

**CLASS A**  
*natural*



Taxonomic and Numeric Equality ; Presence of Indicator Taxa



Similarity, Richness, Abundance, Diversity; EPT, Indicator Taxa, Biotic Index

**CLASS B**  
*unimpaired, maintain indigenous taxa*



Retention of taxa and numbers; Absence of hyperdominance; Presence of sensitive taxa



Community loss; Richness; Abundance; diversity; equitability; evenness; EPT; Indicator Taxa, Biotic Index

**CLASS C**  
*maintain structure*



Resistance, Redundancy; Resilience; Balanced Distribution



Richness; Diversity; Equitability; Evenness

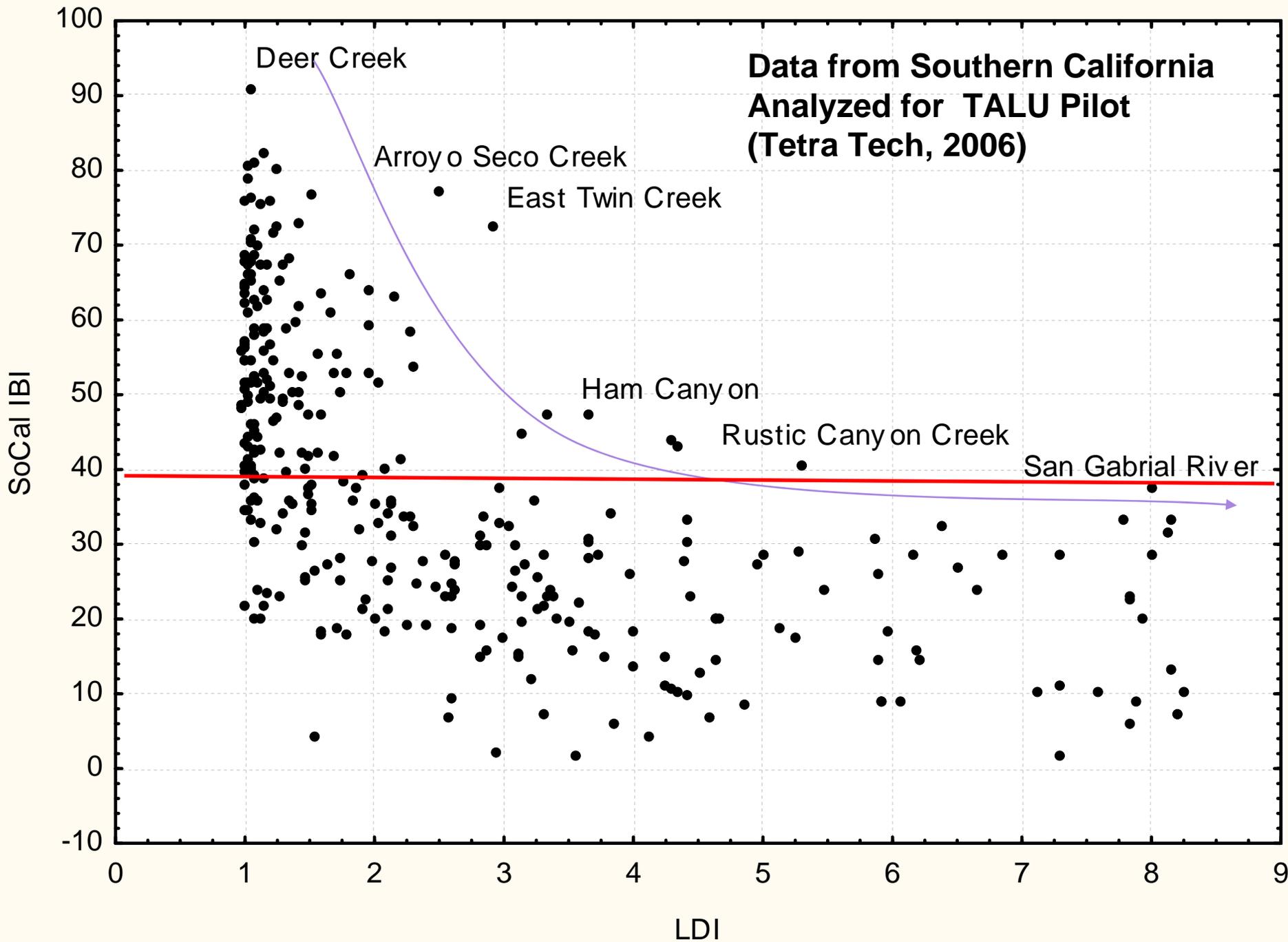
*and function*



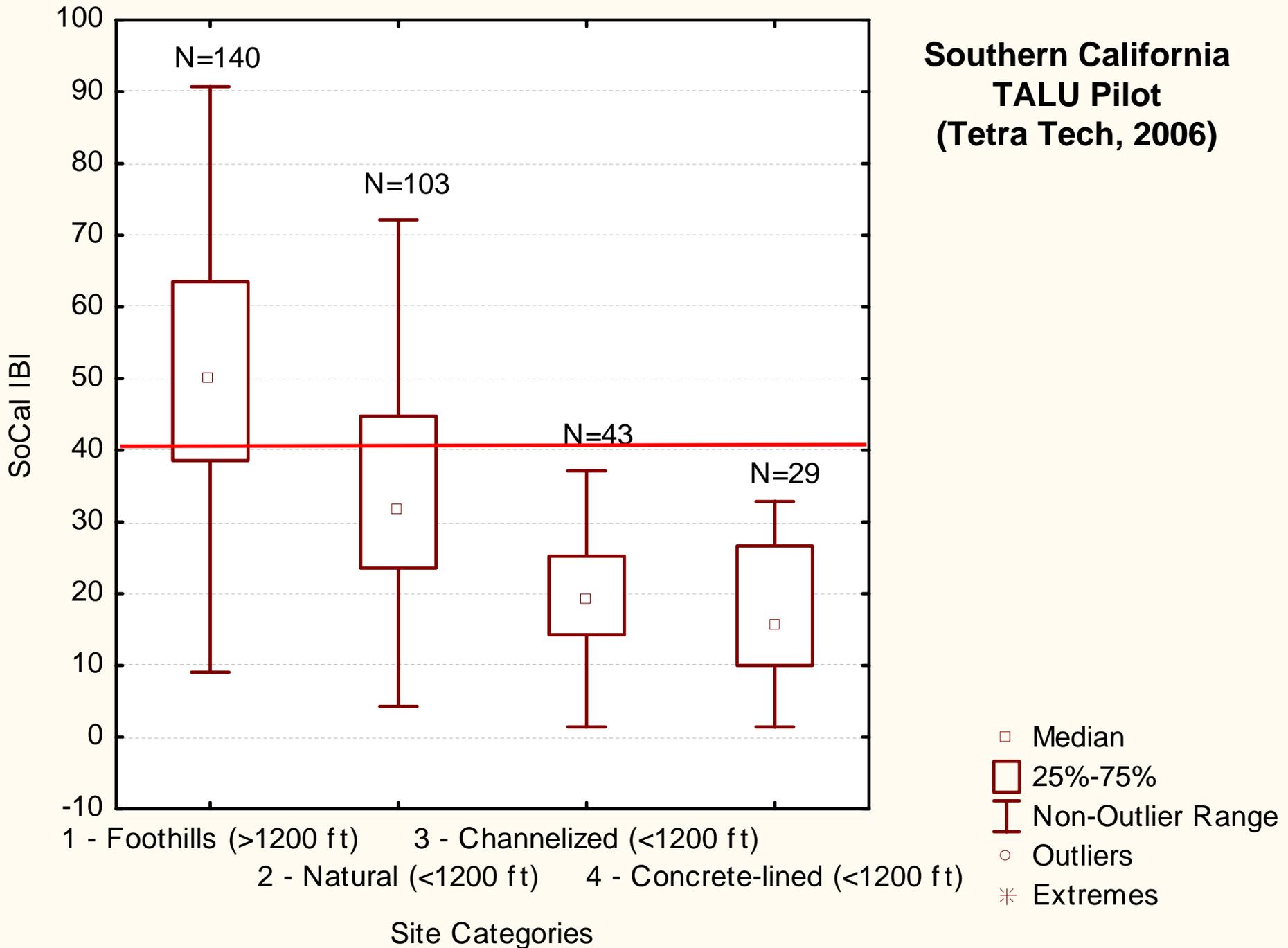
Energy Transfer; Resource assimilation; Reproduction



Trophic groups; Richness; abundance; community loss; fecundity; colonization rate



# Southern California TALU Pilot (Tetra Tech, 2006)



# Regulatory Issues: TALU

- Tiered Uses
  - How to define tiered uses?
  - How to set expectations for each tiered use?
  - Statewide Plan vs. Basin Plans?
- Tiered Objectives
  - Narrative objectives with interpretive tools? or
  - Numeric biological objectives?
- Guidance
  - Use in 305(b) or 303(d) assessments?
  - Use in permits for compliance/enforcement?

# Biological Criteria

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- Biological Information can be used to develop more appropriate aquatic life uses and the criteria to protect them.
- Biological criteria have attributes that chemical criteria do not:
  - Direct measure of resource we are trying to protect
  - Cumulative impacts of all stressors
- Biological Information and criteria play a role in all facets of water quality management

# TALU Benefits

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## Strengthens Water Management Programs:

- More precisely define and measure aquatic life goals
- Better assess current and potential conditions
- Quantify progress towards meeting aquatic life goal
- Demonstrate environmental outcomes
- More effectively communicate the health of the waters to the public