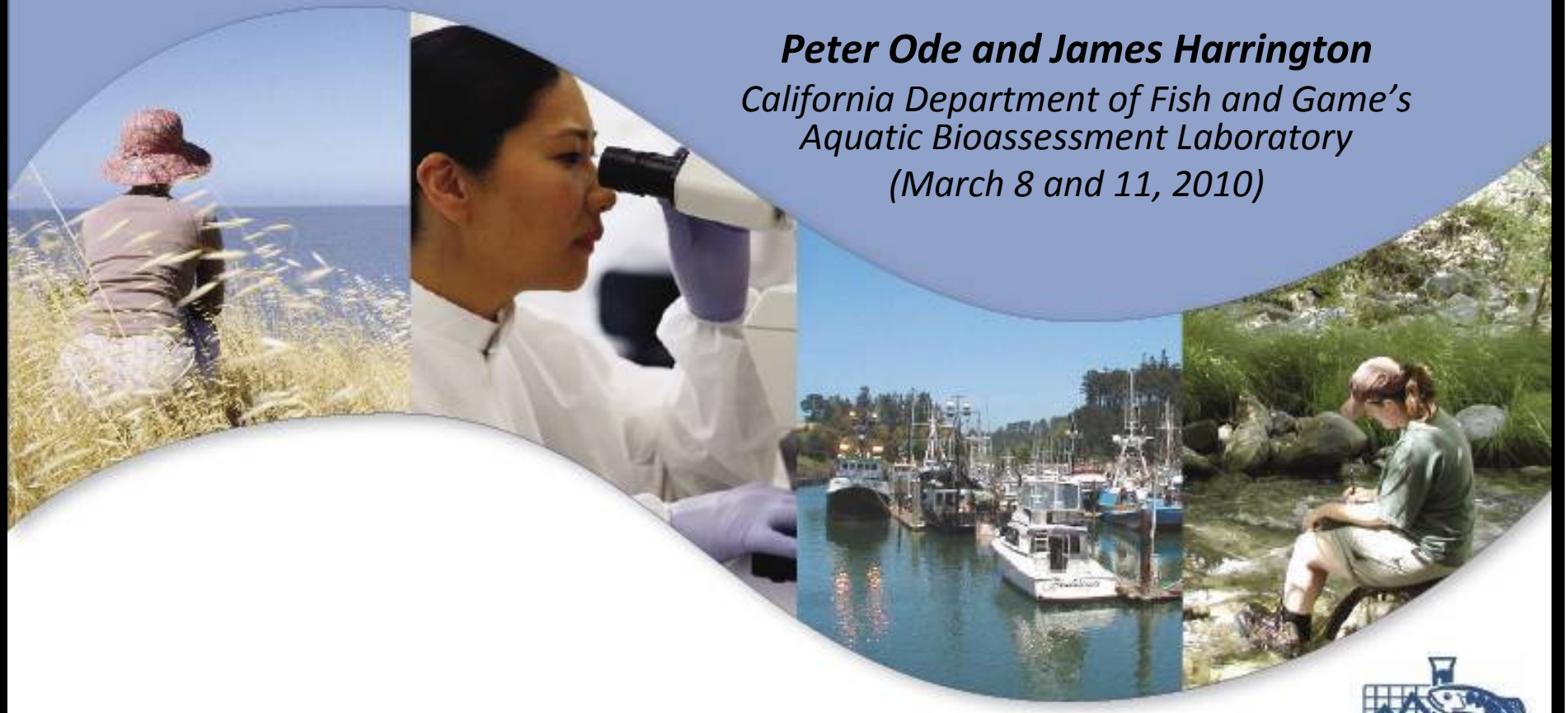
Biological Objectives
Introduction to Bioassessment



Peter Ode and James Harrington
California Department of Fish and Game's
Aquatic Bioassessment Laboratory
(March 8 and 11, 2010)

Aquatic Bioassessment Laboratory

Water Boards

SWAMP
Surface Water Ambient Monitoring Program

What is bioassessment?

Why use bioassessment?

How does bioassessment work?

- scoring biology
- reference conditions

SWAMP

Many Types of Biological Data Used in WQ Monitoring

Biological Monitoring Tools used by SWAMP

- tissue chemistry
- egg shell chemistry
- pathogen monitoring
- indicator species monitoring
- invasive species monitoring
- sediment toxicity
- water column toxicity (including Toxicity Identification Evaluations)
- fish habitat indices (e.g., condition of spawning gravels, numbers of spawning fish, etc.)
- ***bioassessment*** = direct measurement of waterbody health from the organisms that live in those waterbodies

Bioassessment is the subject of biological objectives

What is bioassessment?

- Science of interpreting the ecological condition of a resource (e.g., streams/rivers) from its **resident** biota (fish, insects, algae, plants, etc.)

- Study of associations between ecological condition and both natural and anthropogenic sources of variation

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SWAMP

CORE PRINCIPLE

Most waterbodies contain diverse groups of organisms that have predictable responses to multiple stressors.

Since they live in waterbodies for long periods of time, resident organisms provide a record of stream conditions over time.

Monitoring biology provides a window into stream health.

Advantages to Monitoring Resident Biology

- Provides **direct evidence** of aquatic life condition
- Incorporates measures of non-chemical stresses (e.g., fine sediments, hydromodification, invasive species)
- Ecological indicators provide helpful context for interpreting other WQ measures (e.g., chemistry)

Why monitor biology: POLICY

"The objective of this Act is to restore and maintain the chemical, physical, and **biological integrity** of the nation's waters" -- Clean Water Act section 101(a)

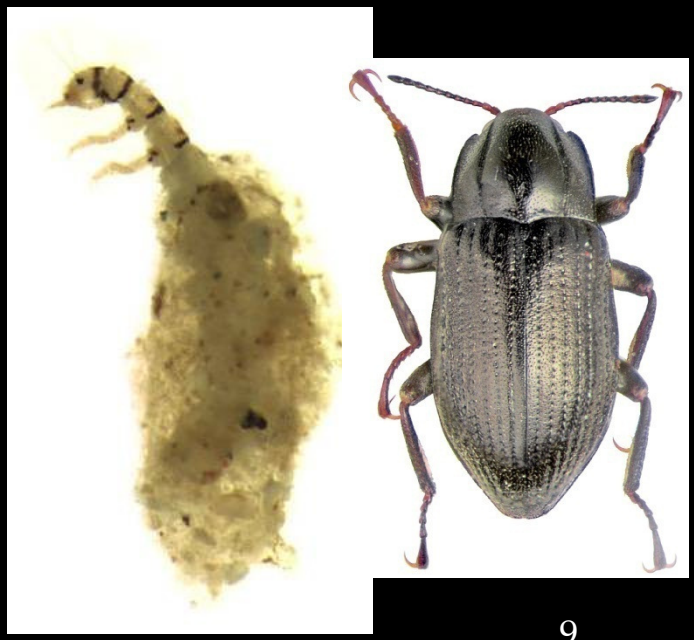
Bioassessment gives State and Regional Boards tools for meeting the CWA biological integrity objective

Benthic Macroinvertebrates (BMIs)

Bottom-dwelling invertebrates, not microscopic

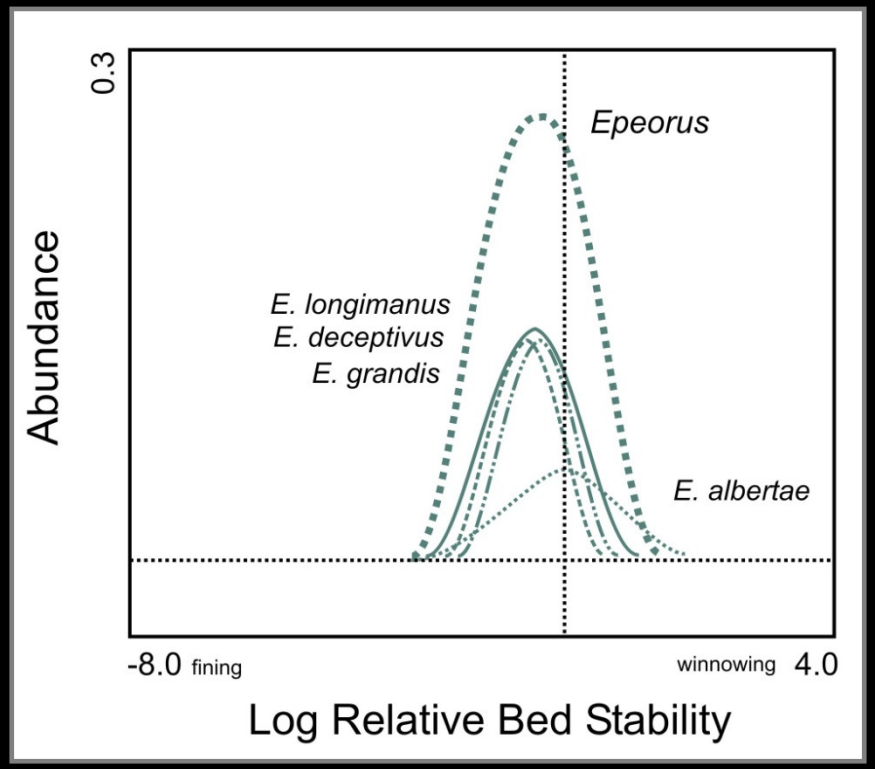
DIVERSE and ABUNDANT: Dozens to > 100 BMI species present at a site, thousands of individuals/m^2

Unique preferences for different micro-habitats, physical settings, but also different sensitivities to stresses (pollutants, sediments, flow conditions, etc.)

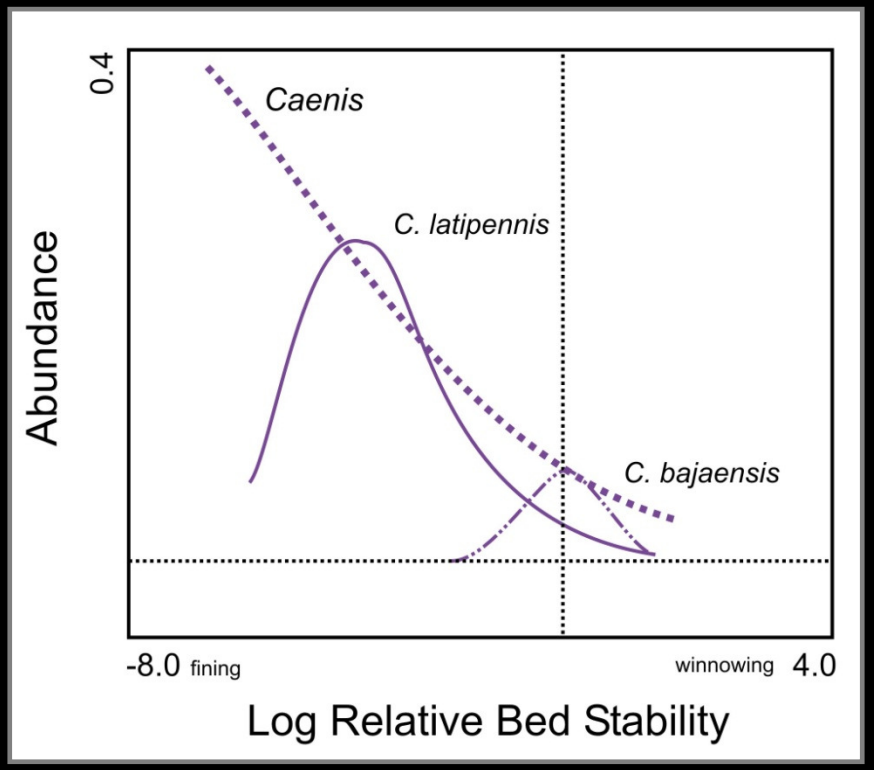


Sediment intolerant vs. sediment tolerant

Epeorus



Caenis



Multiple Indicators

SWAMP's current focus is on BMIs, but long term strategy will include multiple assemblages. Ongoing efforts to develop algal indicators for streams.

algae photos courtesy Robert Sheath

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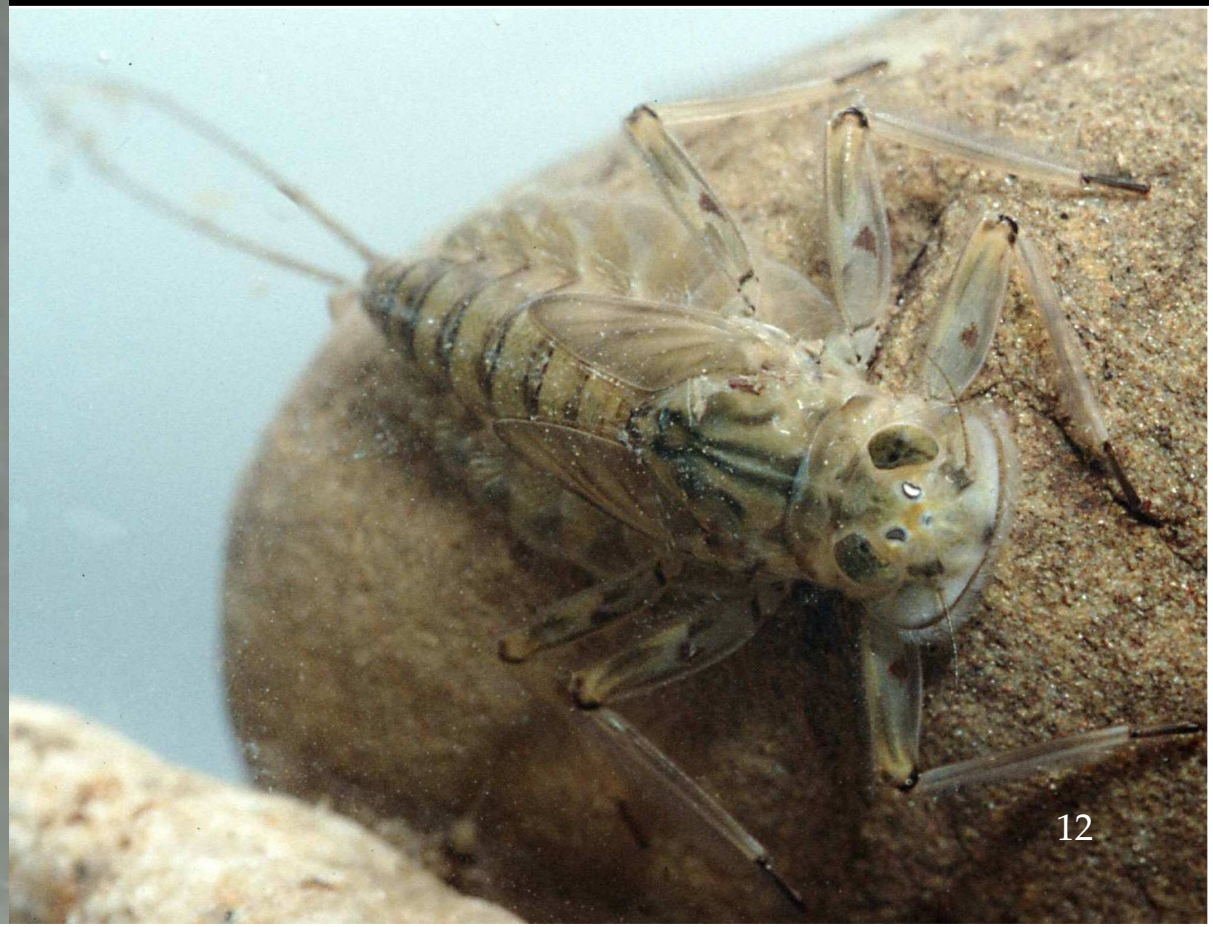
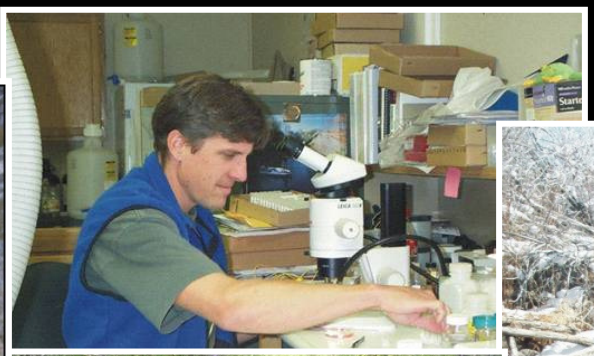
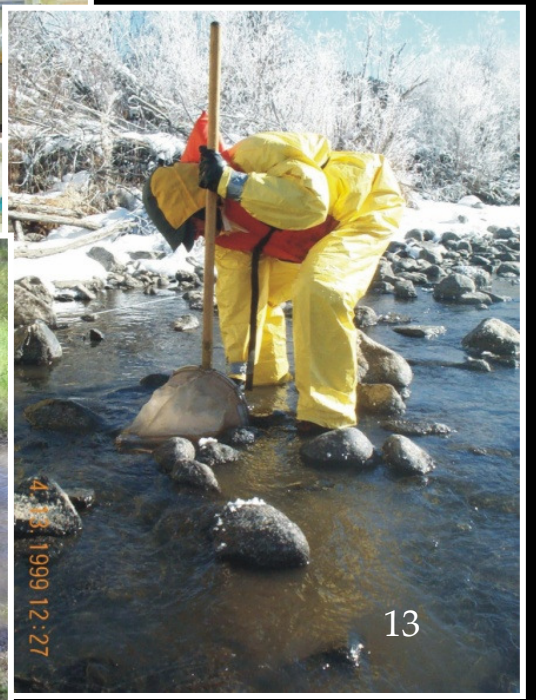


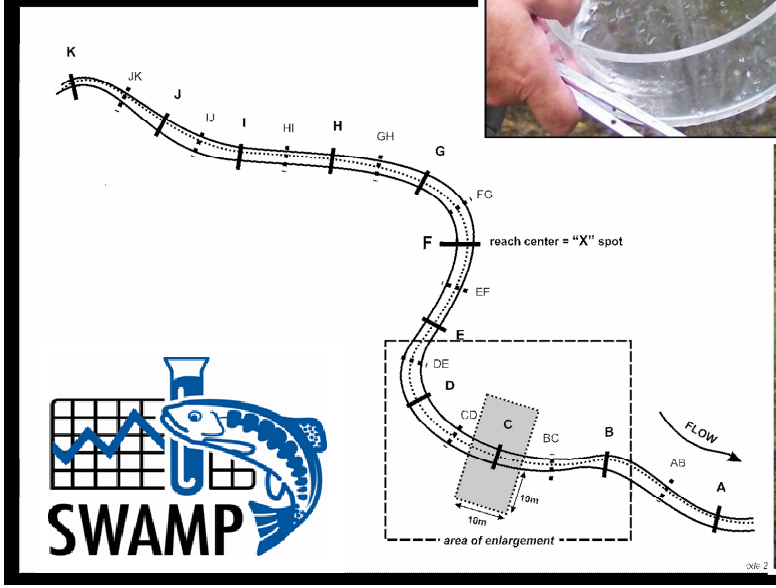
SWAMP

Data Collection and Processing

- SWAMP has established standard methods for collecting BMIs, algae and habitat data
- Standardized Reporting of Taxonomic Data (SWAMP-SAFIT)
- Standardized Data Management (SWAMP-CEDEN)







Tools for Scoring Biological Condition from the List of Organisms at a Test Site

- **Multimetric indices** (e.g., Index of Biotic Integrity or IBIs)
- **Predictive models** (e.g., O/E or RIVPACS)

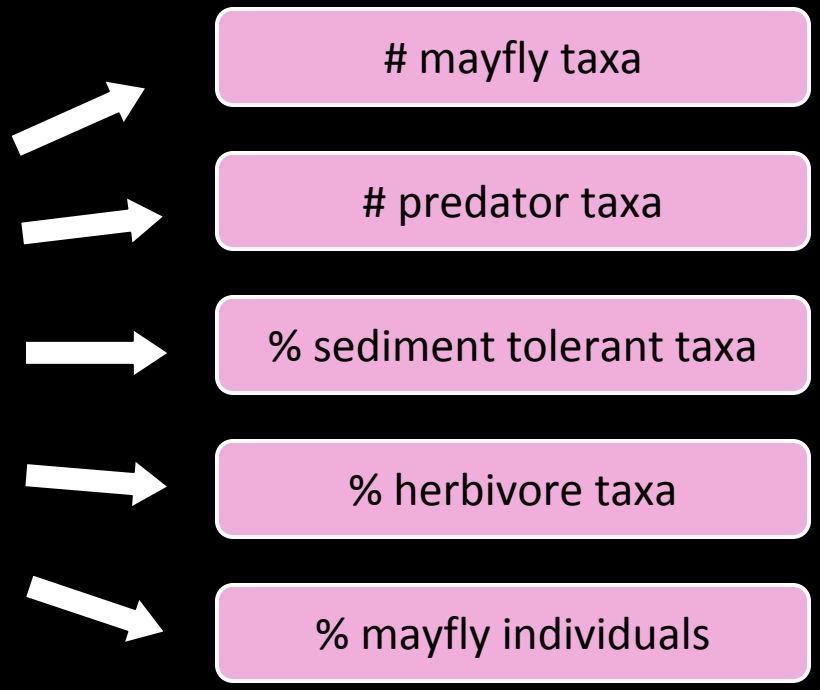
  ➢ Compare organisms observed at test sites to those expected to occur in least disturbed "**reference**" sites

  ➢ Produce easily interpreted scores with quantifiable precision

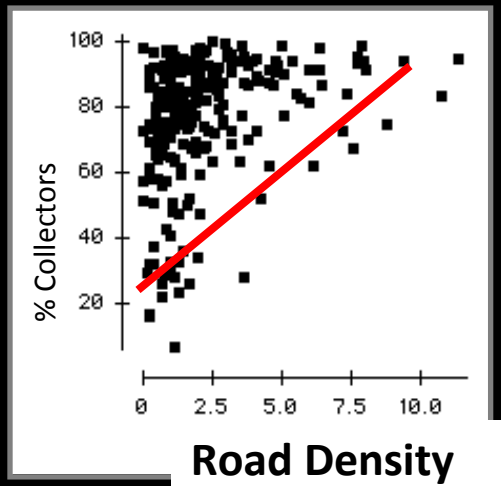
Multimetric Indices (MMIs)
(e.g., Index of Biotic Integrity, IBI)

Step 1. Organism list is converted into metrics representing diversity, ecosystem function, and sensitivity to disturbance

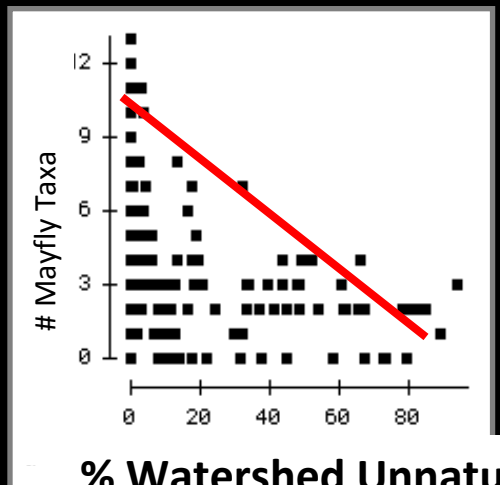
Taxon	Count
Mayfly species 1	43
Mayfly species 2	12
Mayfly species 3	2
Beetle species 1	1
Beetle species 2	1
Midge genus 1	65
Midge species 1	3
Midge species 2	10
Midge genus 2	3
Dragonfly species 1	2
Stonefly species 1	1
Stonefly species 2	14
Worm species 1	9
Worm species 2	2



Step 2. Metrics are evaluated for responsiveness to key stressor gradients and other performance criteria

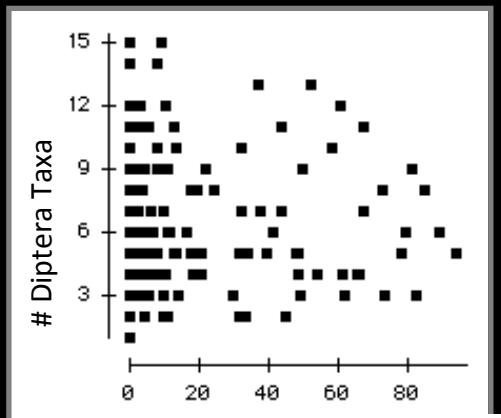


Road Density

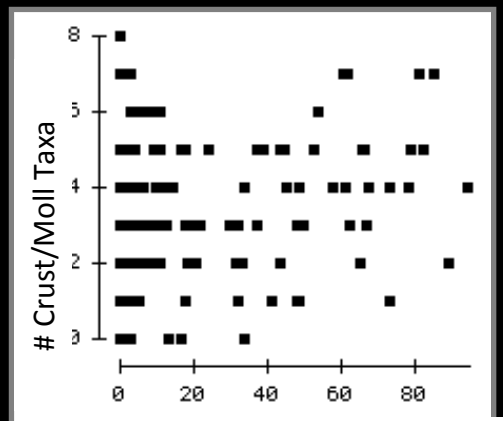


% Watershed Unnatural

Responsive Metrics



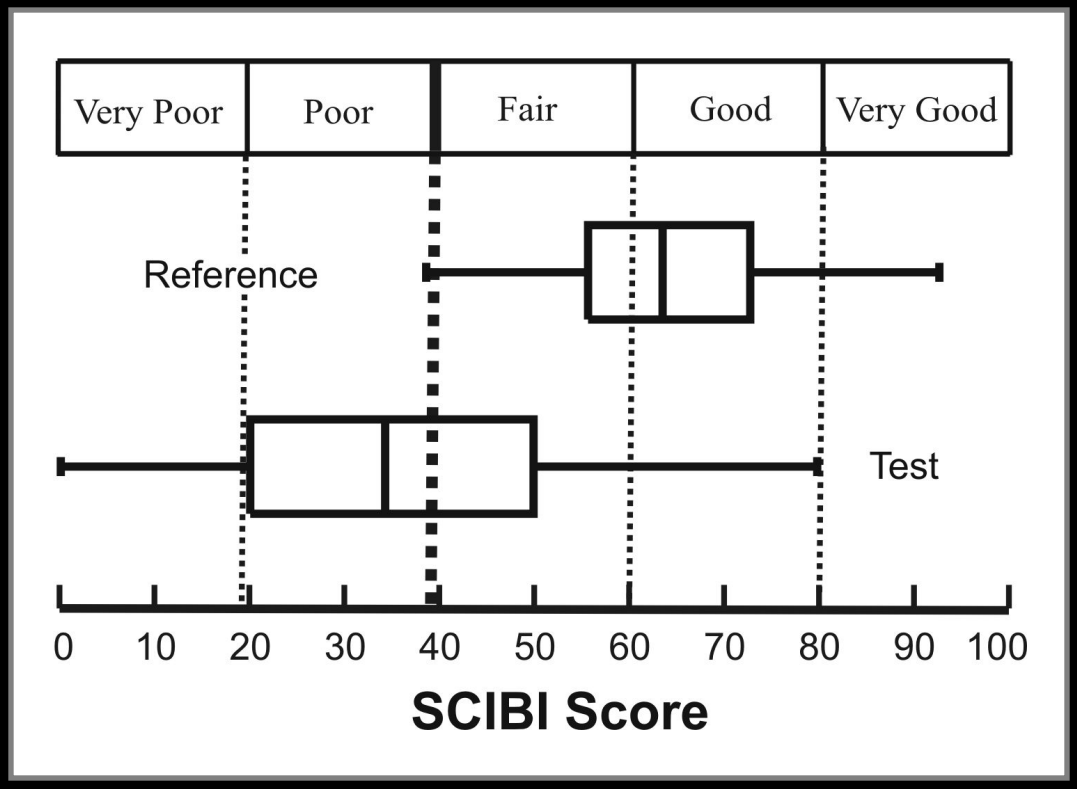
% Watershed Unnatural



% Watershed Unnatural

Not-so-responsive Metrics

Step 3. Best metrics are scored, then assembled into an index



IBI Score (1-100) is a measure of how similar/dissimilar a test site is to metrics at high quality **reference sites**

Predictive Models

- Based on “raw” species data … species list **not** converted to metrics
- Compare number of **observed** (“O”) species to number of **expected** (“E”) species
- “Expected” species list derived from predictive modeling techniques using data from **reference sites**
- O/E score (scaled 0.0 to 1.0): represents the proportion of **native** species present at test site

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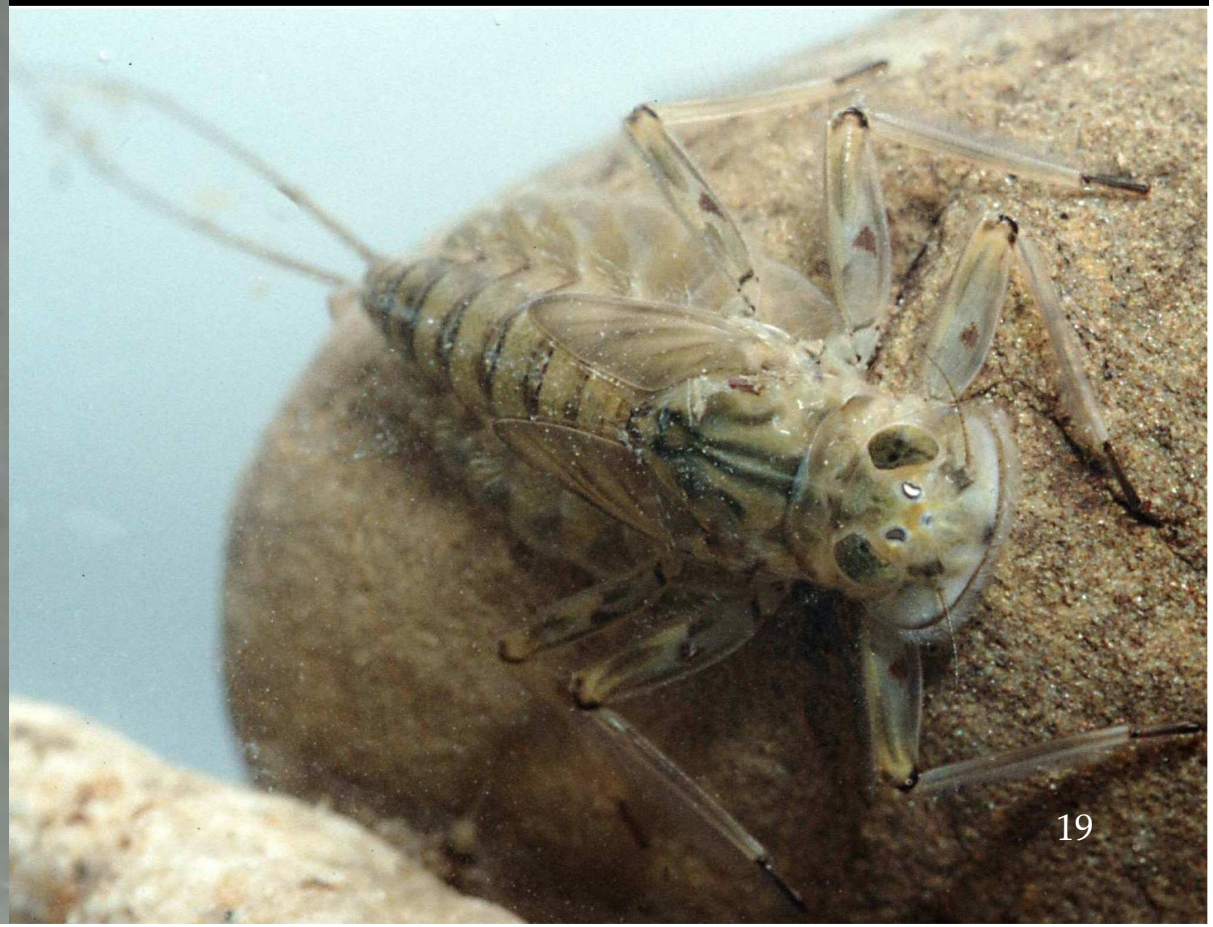
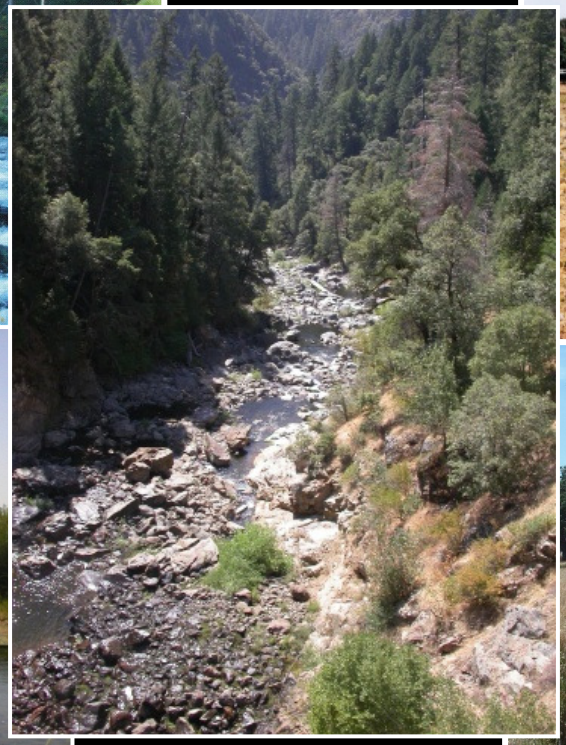


SWAMP

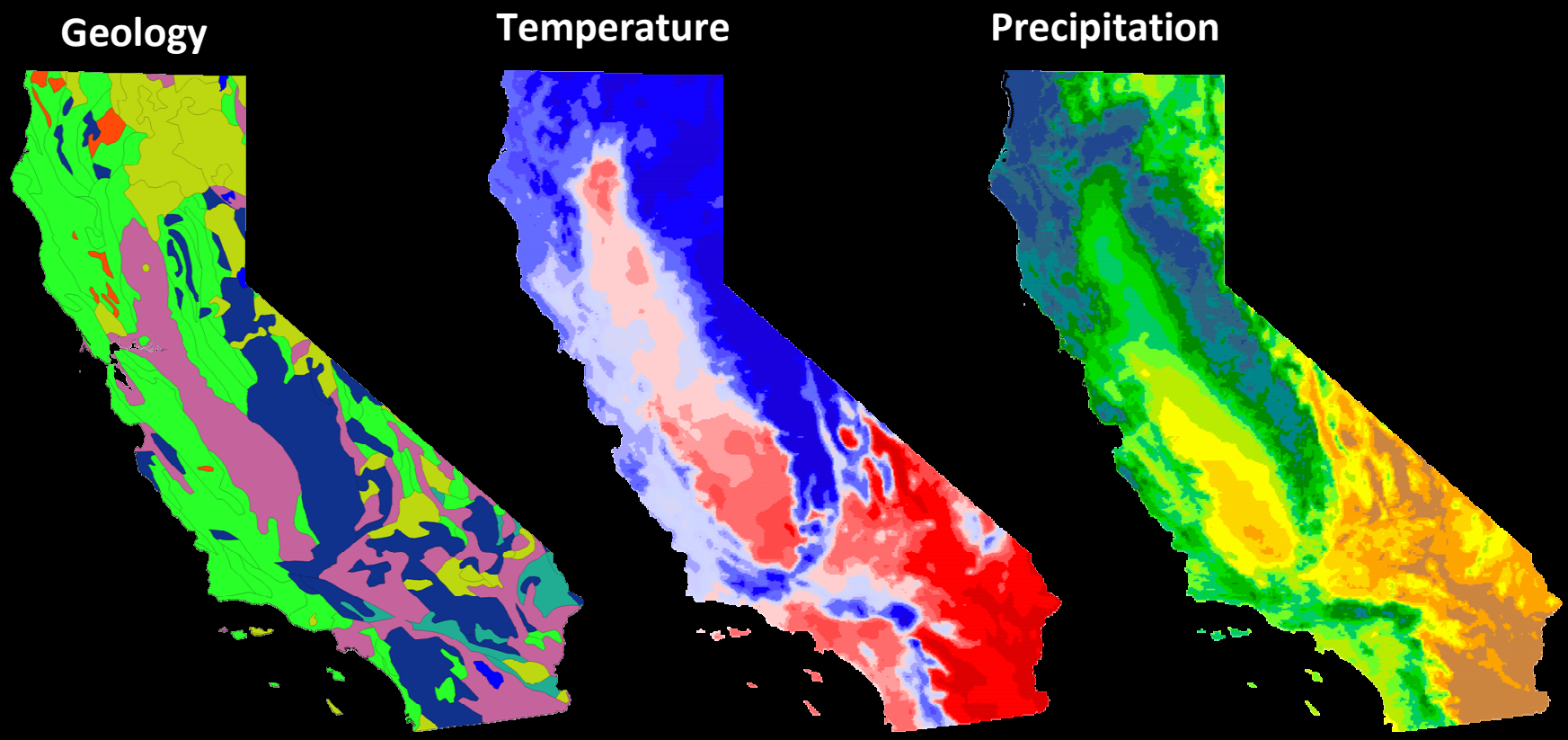
Bioassessment Tools Depend on Reference Sites

(sites with low levels of disturbance)

"What should the biology look like at a test site?"



Strong natural gradients result in a large degree of **natural variation** in biological expectations



Accurate predictions of expected biota require reference data from the full range of natural environmental settings

Reference Condition Management Plan

(adopted March 2009)

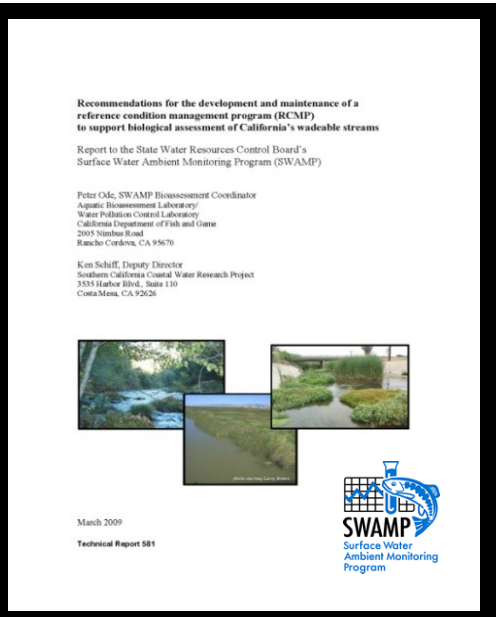
- RCMP is SWAMP's standardized process for identifying & sampling "reference sites" throughout CA

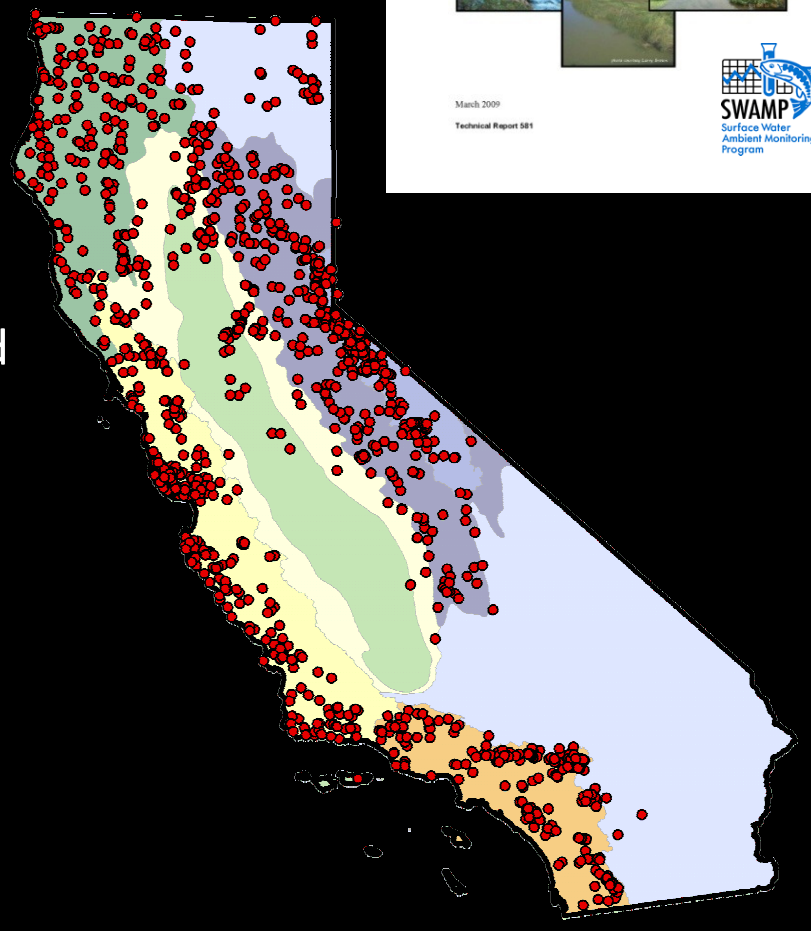
- Now in implementation phase:

  ✓ Screen existing sites (~1500) with GIS and local data

  ✓ Identify data gaps and collect bio/chem/hab data where missing

  ✓ Monitor temporal variability (both inter-annual & intra-annual)





Bio-Objectives: Regulatory Application

defining fair and objective expectations across CA

Reference program can define reasonable expectation here:

What about here?

- Biological potential differs from stream to stream due to both natural and anthropogenic causes
- Biological objectives must balance statewide consistency with sensitivity to local conditions