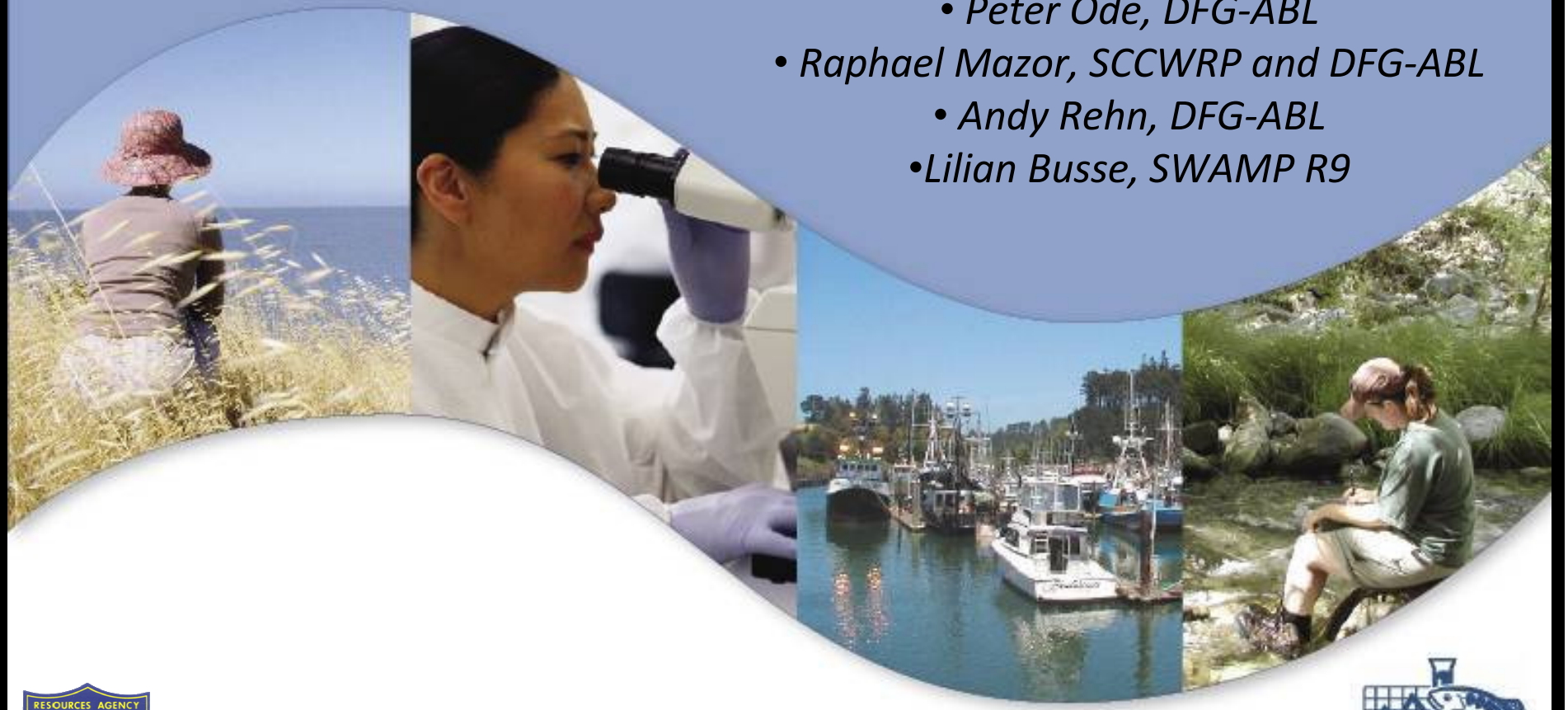
Establishing Reference Conditions for CA's Wadeable Perennial Streams

- *Peter Ode, DFG-ABL*
- *Raphael Mazor, SCCWRP and DFG-ABL*
- *Andy Rehn, DFG-ABL*
- *Lilian Busse, SWAMP R9*



RESOURCES AGENCY CALIFORNIA DEPARTMENT FISH&GAME

Aquatic Bioassessment Laboratory

Water Boards

SWAMP Surface Water Ambient Monitoring Program

Establishing Reference Conditions for CA's Wadeable Perennial Streams

- Background
- RCMP Development
- RCMP Implementation Part I: The Standard Model
  - Develop screening dataset
  - Working with metrics: data reduction and pattern analysis
  - Setting screening thresholds and standardizing statewide
- RCMP Implementation Part II: Alternative Models

the central challenge

Objective definition of biological expectations in different environmental settings is fundamental to defensible regulation based on biological endpoints

Expectations must be **flexible** enough to accommodate CA's diverse ecological and landuse settings, but have **consistent** meaning throughout the state

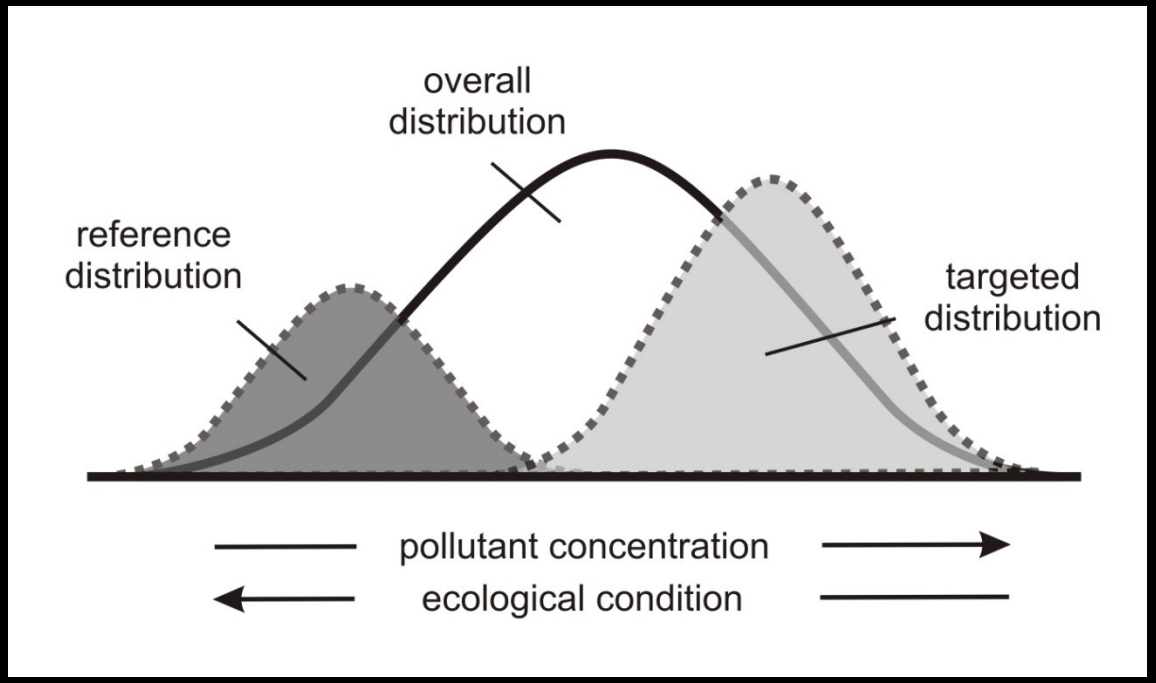
Many Uses of Reference Data in Bio-objectives Process

Tiering Objectives

- Defines biological expectation in least disturbed state (= y-axis: overall and within each tier)
- Anchors waterbody classification gradient (= x-axis for "tiering")

- Establishes upper limits for stressor modeling
- Defines the zoogeographic clustering dataset
- Essential for scoring tool development: (MMIs and O/Es)

Reference program gives waterboards much more than just better bioassessment



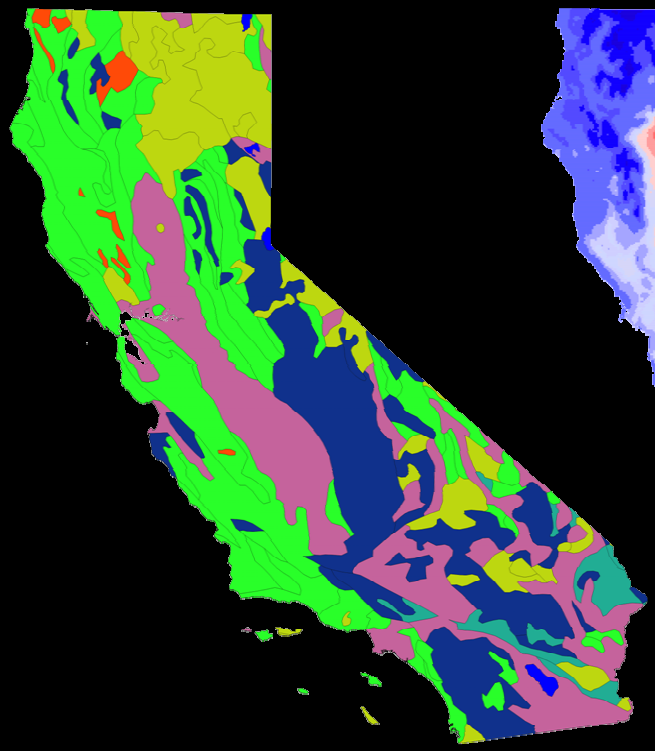
- Most state monitoring is focused on problem areas… few resources are put toward identification and protection of our best resources

- Reference approach can help develop objective thresholds for pollutants (e.g., nutrients, fine sediments) with non-zero natural values

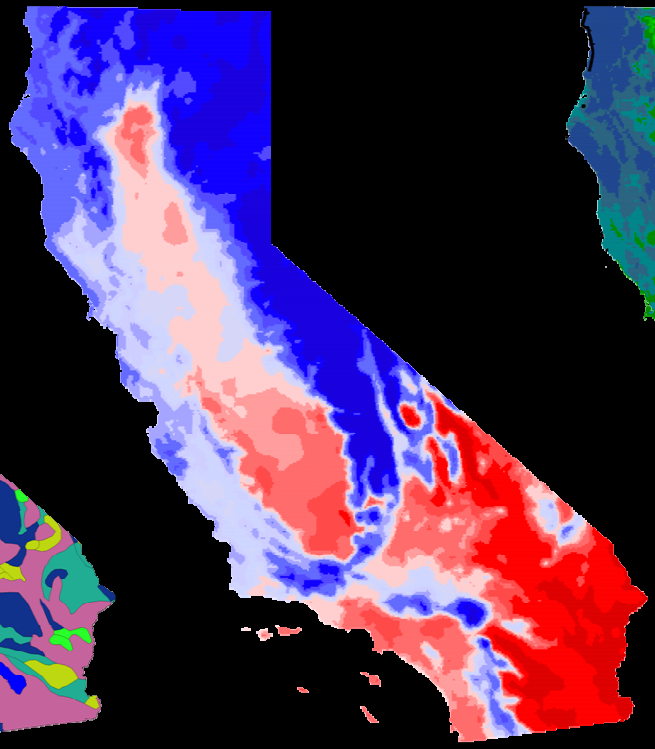
Technical Challenges: California is not Kansas

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

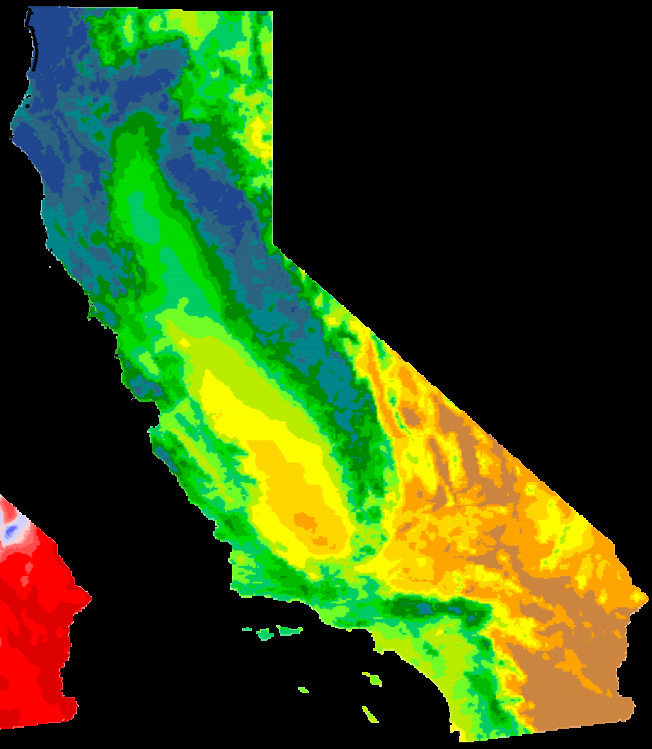
Geology



Temperature



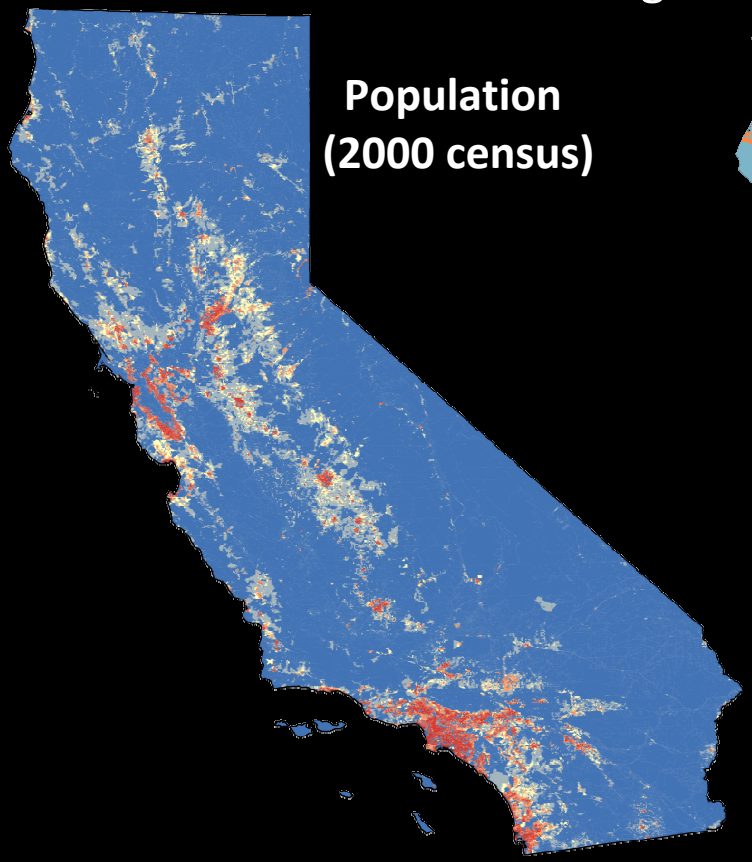
Precipitation

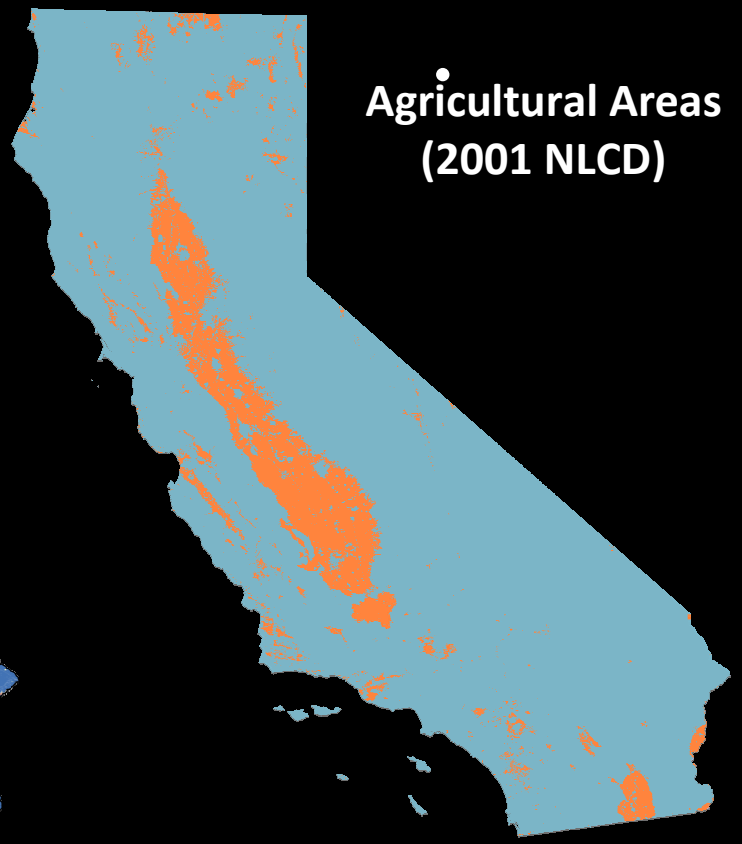


Management of biological variability requires good representation of biology at reference sites **across major gradients = need 100s of sites**

Technical Challenges: California IS Kansas

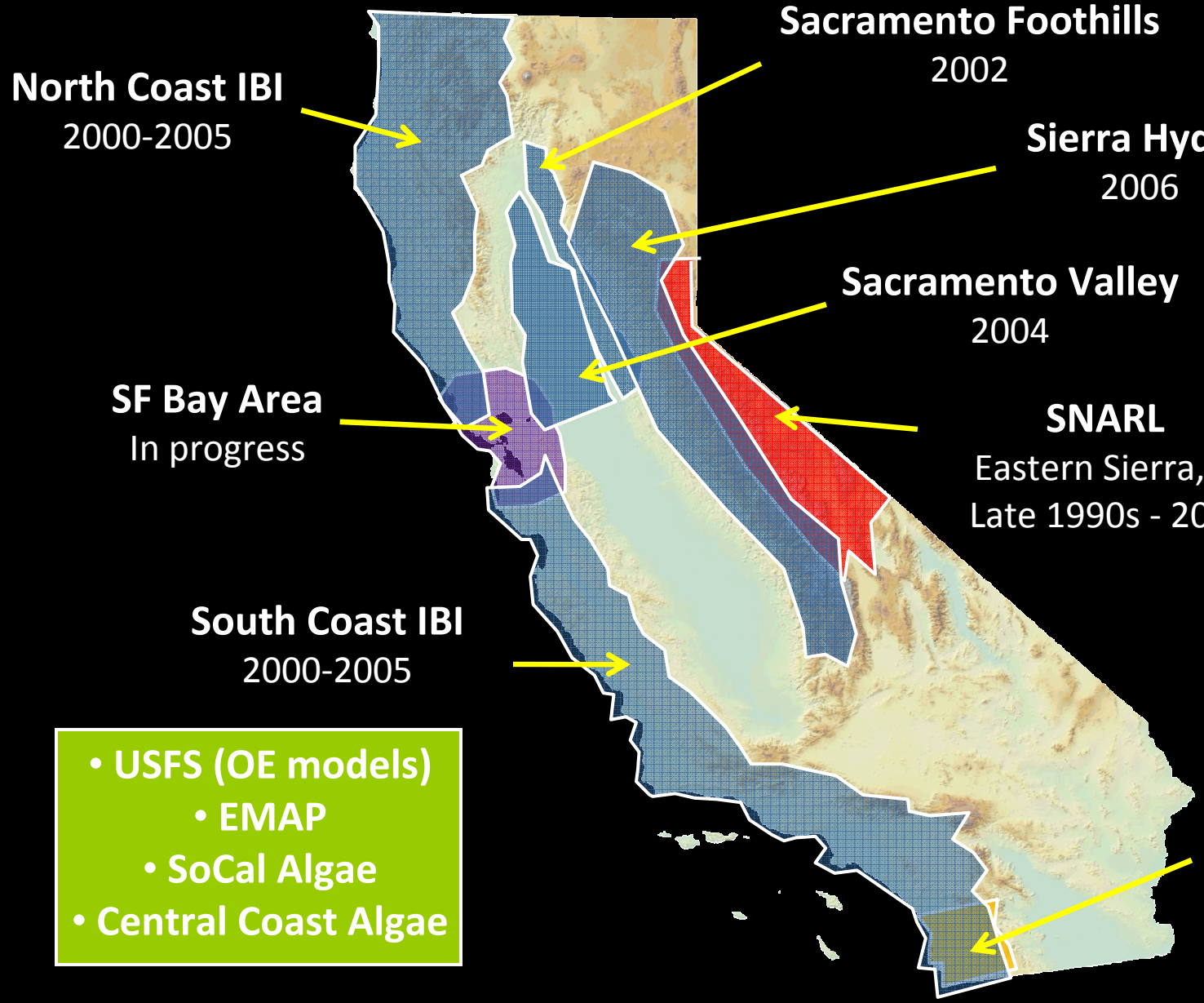
High degree of anthropogenic modification (e.g., impervious surface and intensive agriculture) in some regions





- Extensive human modification complicates the reference selection process because it introduces gaps in representation of natural gradients
- Intense development pressures make some regions unsuited for standard reference approaches

Significant CA Reference Projects (1997 – 2010)



North Coast IBI
2000-2005

Sacramento Foothills
2002

Sierra Hydro
2006

Sacramento Valley
2004

SF Bay Area
In progress

SNARL
Eastern Sierra, some Sierra
Late 1990s - 2008

South Coast IBI
2000-2005

San Diego IBI
2001

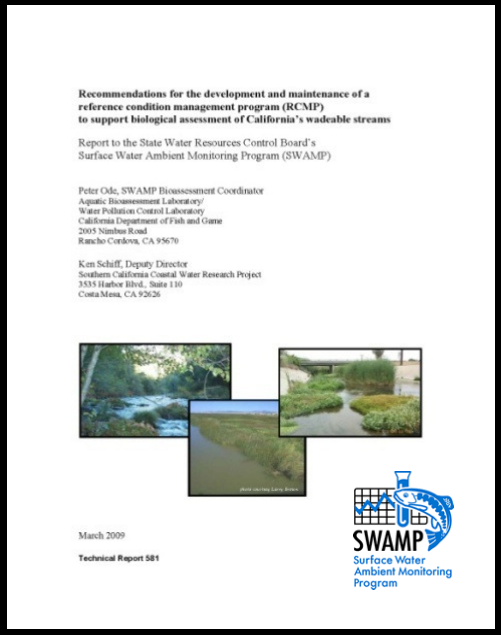
- **USFS (OE models)**
- **EMAP**
- **SoCal Algae**
- **Central Coast Algae**

RCMP Development
(funded in 2006, developed in 2007)

A solid reference program was the SWAMP bioassessment program's highest priority

One of the first tasks was to assemble a panel to outline the plan

RCMP Development Panel *(met October 2007)*



Recommendations for the development and maintenance of a reference condition management program (RCMP) to support biological assessment of California's wadeable streams

Report to the State Water Resources Control Board's
Surface Water Ambient Monitoring Program (SWAMP)

Peter Ode, SWAMP Bioassessment Coordinator
Aquatic Bioassessment Laboratory/
Water Pollution Control Laboratory
California Department of Fish and Game
2005 Nimbus Road
Rancho Cordova, CA 95670

Ken Schiff, Deputy Director
Southern California Coastal Water Research Project
3535 Harbor Blvd., Suite 110
Costa Mesa, CA 92626

March 2009

Technical Report 581

SWAMP
Surface Water Ambient Monitoring Program

- David Herbst, *UC Santa Barbara-SNARL*
- Peter Ode, *ABL*
- Raphael Mazor, *SCCWRP/ABL*
- Phil Larsen, *EPA-ORD*
- Andy Rehn, *ABL*
- Lenwood Hall, *U. Maryland*
- Terry Fleming, *EPA Region 9*
- Chuck Hawkins, *Utah State*
- Alan Herlihy, *Oregon State*
- Ken Schiff, *SCCWRP*

GUIDING PHILOSOPHIES

- **Use natural condition as the desired state whenever possible** - However, highly developed regions still require tools for setting expectations
- **Balancing statewide consistency with regional flexibility**

  Strategy should balance a set of desirable, but sometimes conflicting traits: *objectivity, consistency and flexibility*
- **Reference site management is an iterative process**

  The strategy should build in continuing analysis of data to tailor reference pool to the way the data are used
- **The RCMP should be transparent**

  Transparency and comprehension of the RCMP process will improve stakeholder confidence and provide structure for discussions about setting objective and fair standards.

We are following the RCMP framework

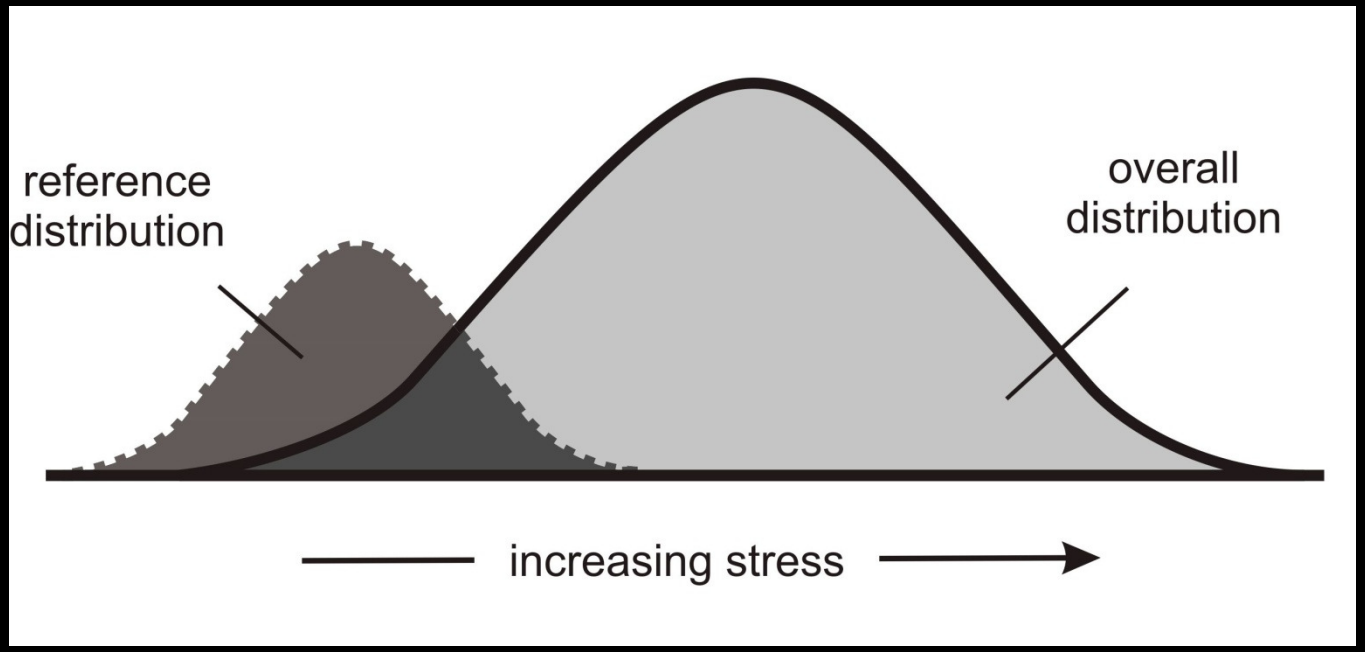
- RCMP Implementation Part I: The Standard Model
  - Step 1 – **Assemble candidate data** (targeted and probability)
  - Step 2 – **Calculate a large suite of metrics** (natural gradients, local chem/ habitat data and GIS stressor metrics)…. *data ready for stressor modeling*
  - Step 3 – Data Reduction → **Develop Initial Screening Criteria**
  - Step 4 – Evaluate representation of gradients … where do we have gaps?

    …. target new collection efforts in data gaps
  - Step 5 – Cluster Reference Biology --- > revise sub-regions as necessary and revise screening criteria (Steps 3-5 may need multiple iterations)
  - Step 6 – Align threshold setting process among regions … *data ready for MMIs/OEs*

- RCMP Implementation Part II: The Alternative Models
  - Overview of approaches we're considering, this will be developed for review at next science panel meeting

Step 1: Assemble candidate data

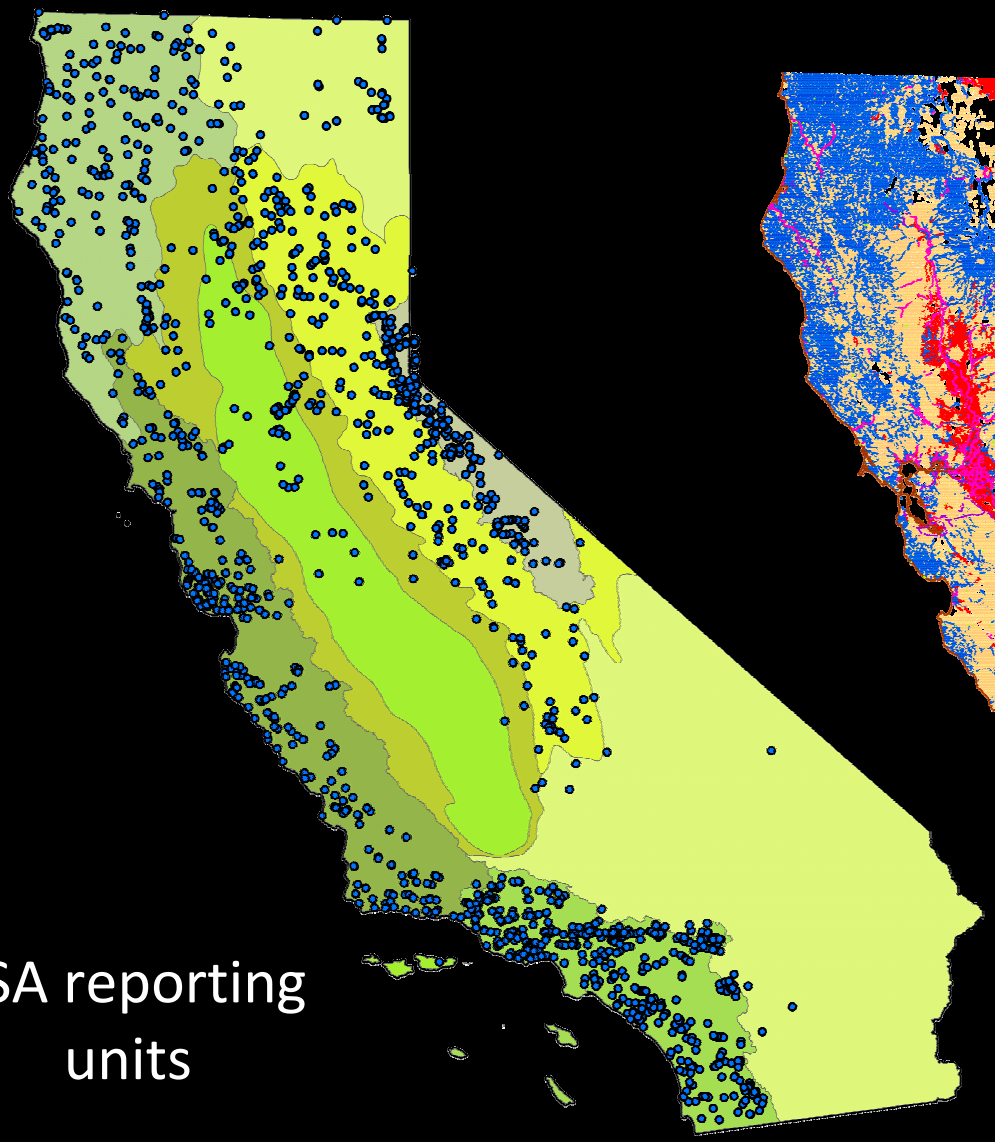
reference candidates + probability



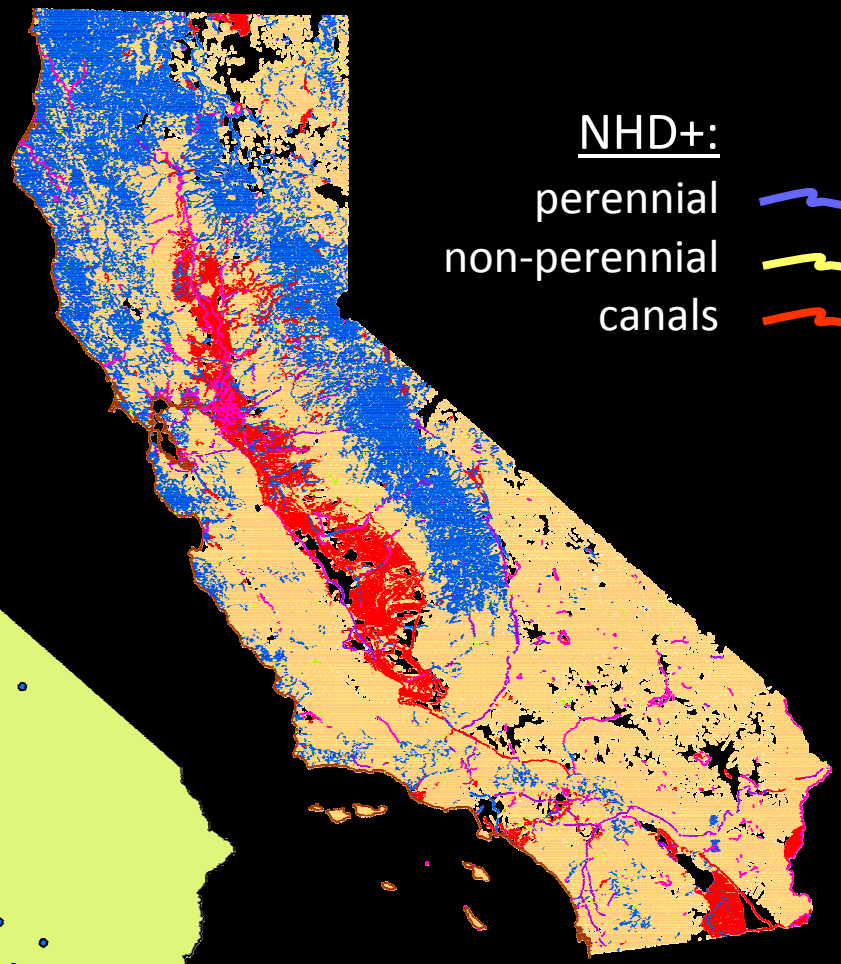
Probability Datasets (EMAP/CMAP/PSA, SMC, USFS, TRPA, others) will be used to generate the distribution curves needed for setting regional thresholds and to evaluate gradient representation

> 1700 sites

(½ probability/ ½ reference candidates)



PSA reporting units



NHD+:

perennial

non-perennial

canals

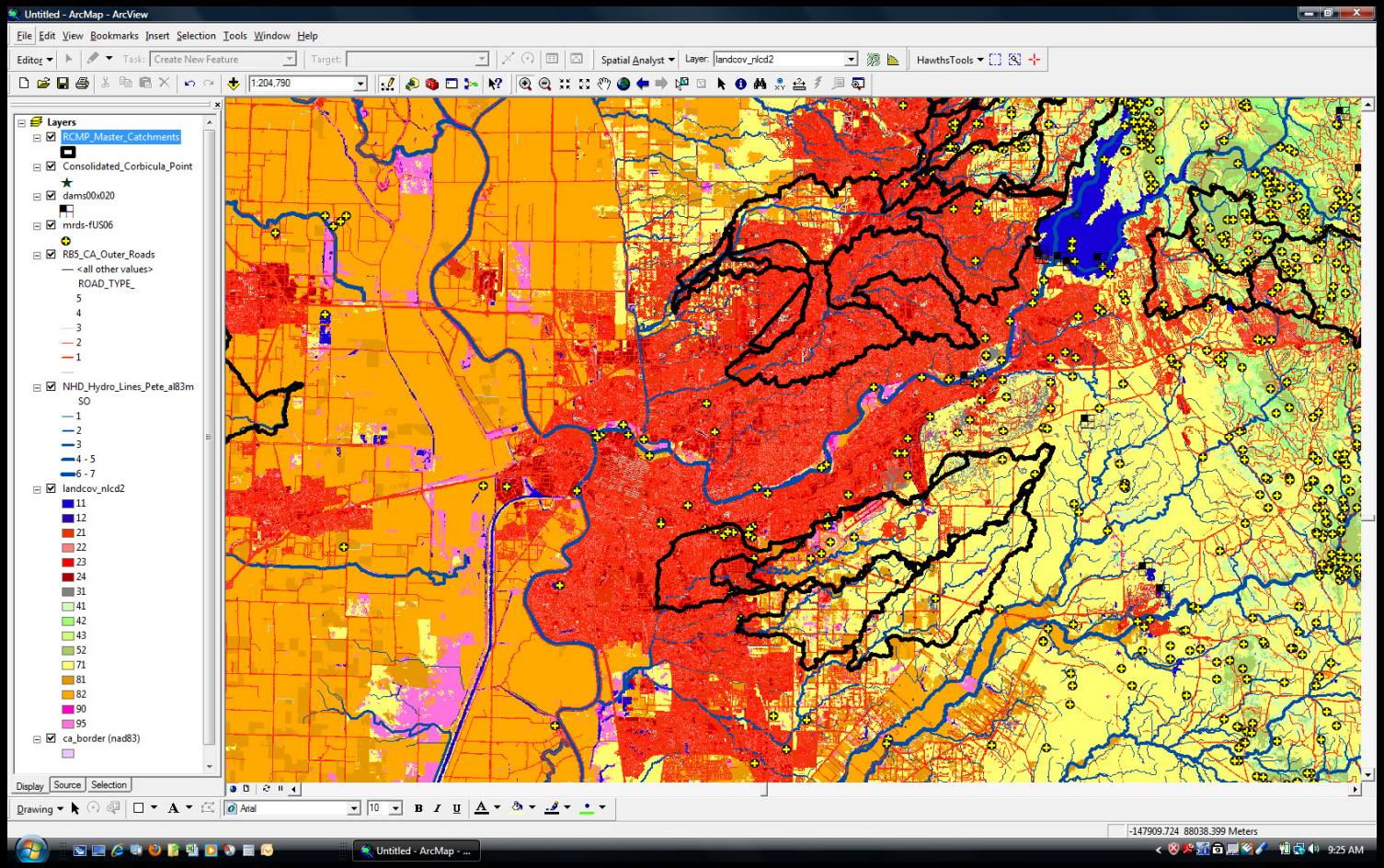
Step 2: Calculate metrics

Lots of GIS data

- Natural gradients
- Stressor gradients

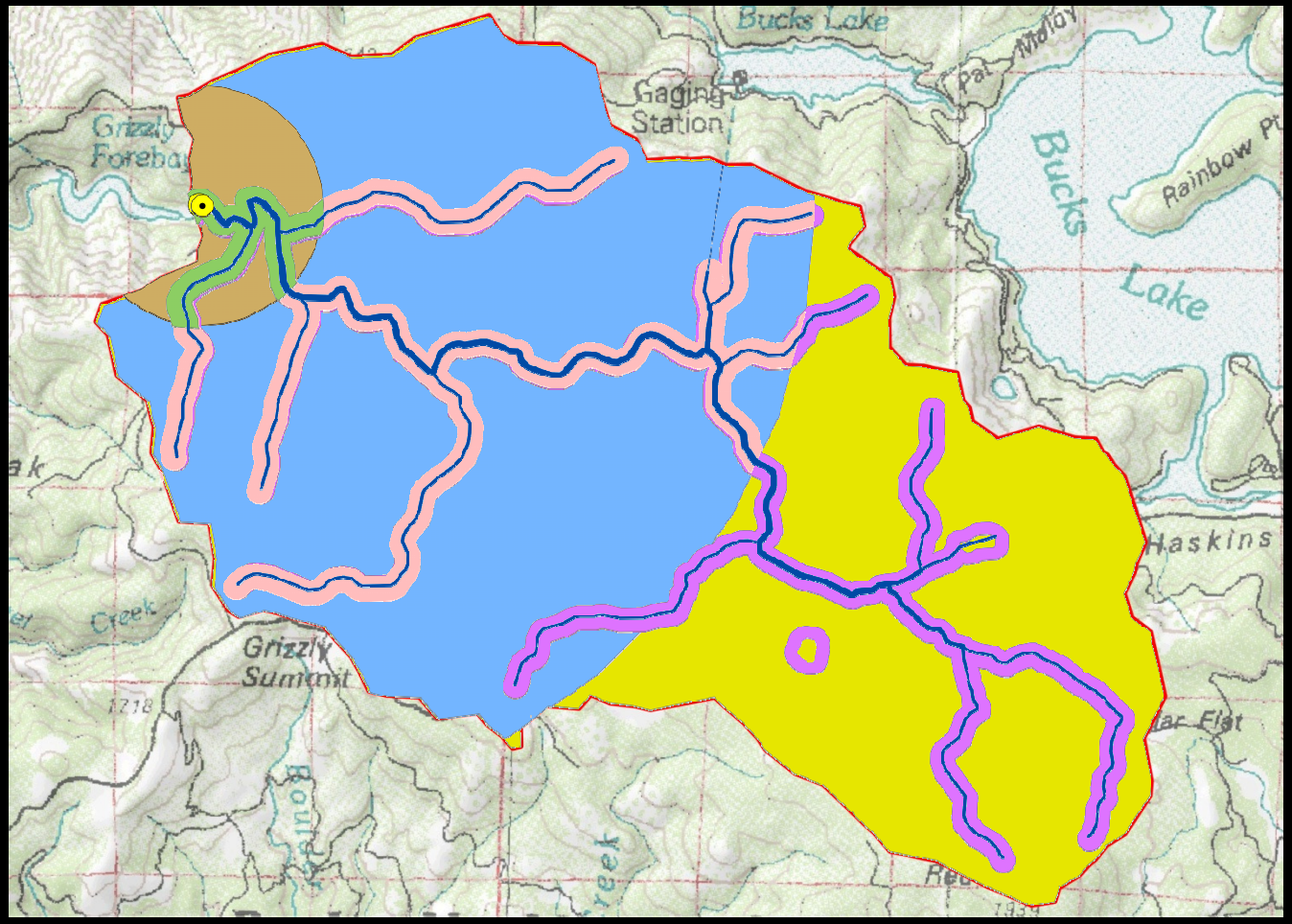
Local condition data

- Chemistry (nutrients, cond, pH, etc.)
- Physical habitat (instream and riparian condition)



Standardized Spatial Analysis

Position of stressors in watershed influences their impact



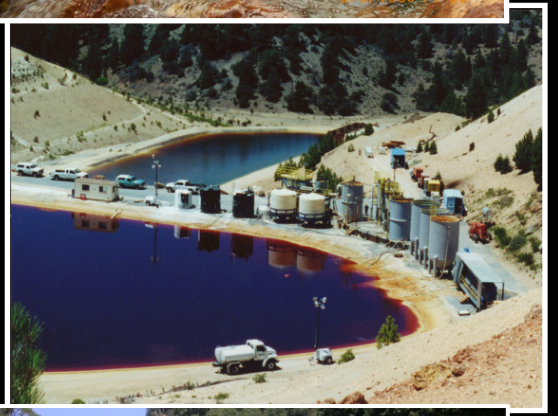
Metric Overview:
station data + natural gradients

- **Station Data**
  - Regional board, PSA region, county, HUC, stream ID, ownership information
- **Natural Gradients**
  - **POINT DATA:** Coordinates, elevation, climate (PPT/T), ecoregion, stream order, stream volume, stream gradient
  - **BASIN DATA:** area, stream length, basin geology, mineral content

Metric Overview: **stressors**

(> 150 metrics)

- **Infrastructure**: roads, railroads
- **Population**
- **Hydromodification**
  - manmade channels, canals, pipelines
- **Landuse**
  - NLCD metrics, NLCD change (1992-2001), NLCD % Impervious
  - Timber Harvest, Grazing
- Fire history, dams, mines
- 303d list, NPDES/CWIQS discharges
- Invasive invertebrates, plants



Metric Overview: local condition

- **Chemistry:** nutrients, conductance, pH, Cl^-, turbidity

- **Habitat** (SWAMP metrics at many sites … similar to EMAP):
  - Riparian condition, canopy
  - Instream condition, fines
  - Human disturbance

Lots of metrics + Lots of QC

- 1700 sites x 180 metrics x 1-6 spatial scales = a gazillion records
- Automated data generation requires careful review
- Nearly done with this phase

Steps 3-6: Working with Metrics

(overview only … details at next science panel meeting)

Step 3 – Data Reduction and **Developing Initial Screening Criteria**

Step 4 – Evaluate representation of gradients in each region … where do we have gaps?

…. target new collection efforts in data gaps

Step 5 – Cluster Reference Biology --- > revise sub-regions as necessary and **revise screening criteria**

(Steps 3-6 may need multiple iterations)

Step 6 – Align threshold setting process among regions …… *data ready for MMIs/OEs*

Data reduction

- Minimize redundancy:
  - Spatial correlation
  - Stressor correlation
- Balance redundancy reduction with loss of unique information at different scales
  - Any given variable may occur at one scale but not another

Metric Evaluation:
Different Approaches for Different Metrics

Quantitative:

- Filter approach (each metric applied independently)
- Multi-metric approach
- Kill switch: high threshold values of certain metrics invalidate an otherwise acceptable site

Qualitative:

- Visual screening (e.g., aerial photos)
- Local history information

RCMP Panel recommended starting with a hybrid approach: multi-metric approach + kill switches

Setting thresholds

Identify appropriate thresholds for different regions

- statistical thresholds (e.g., 10th percentile of overall dist.)
- natural breaks (e.g., Jenks)
- published thresholds

Zero tolerance: some factors act as kill switches

- 303d listed streams
- nearby mines, other significant discharge sources
- very high values of certain metrics

Combining stressors: issues to explore

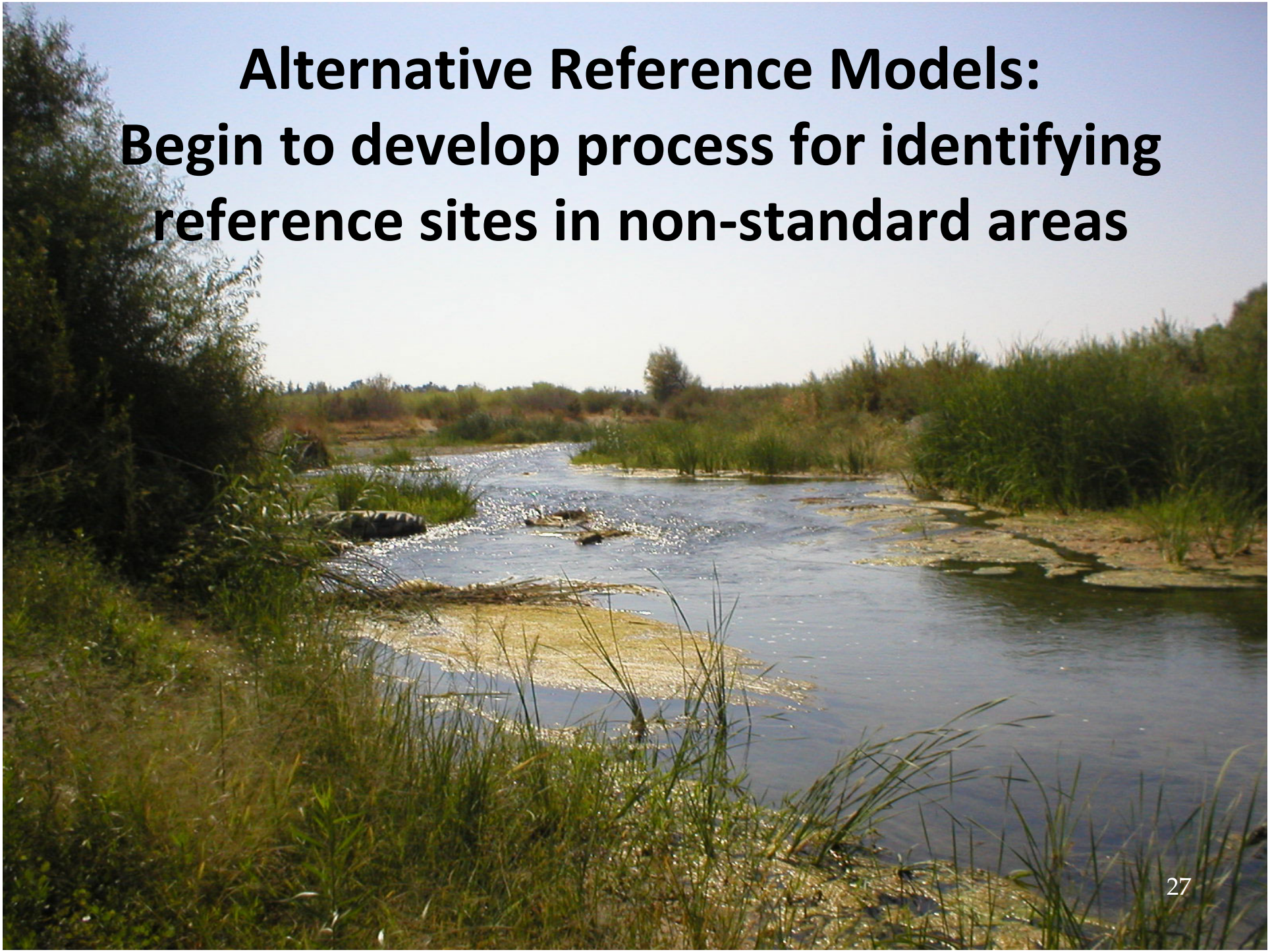
1. How to build a multi-metric index?
2. How to integrate local and remote sensing data?
3. Weighting of factors? All metrics are not equal.
4. What are appropriate kill-switches?
5. Any other ideas?

PHASE II of Standard Model:
Adding new sites to the pool

1. Apply new regional screening criteria
2. Desktop review of candidate watersheds

   … select target stream sites
3. Field reconnaissance of candidate sites
   i. Local condition screens
      a. Missed point sources
      b. Recent fires, grazing, etc.
      c. Erosion, bank stability problems
      d. Hydromodification
   ii. Access- short term, long term

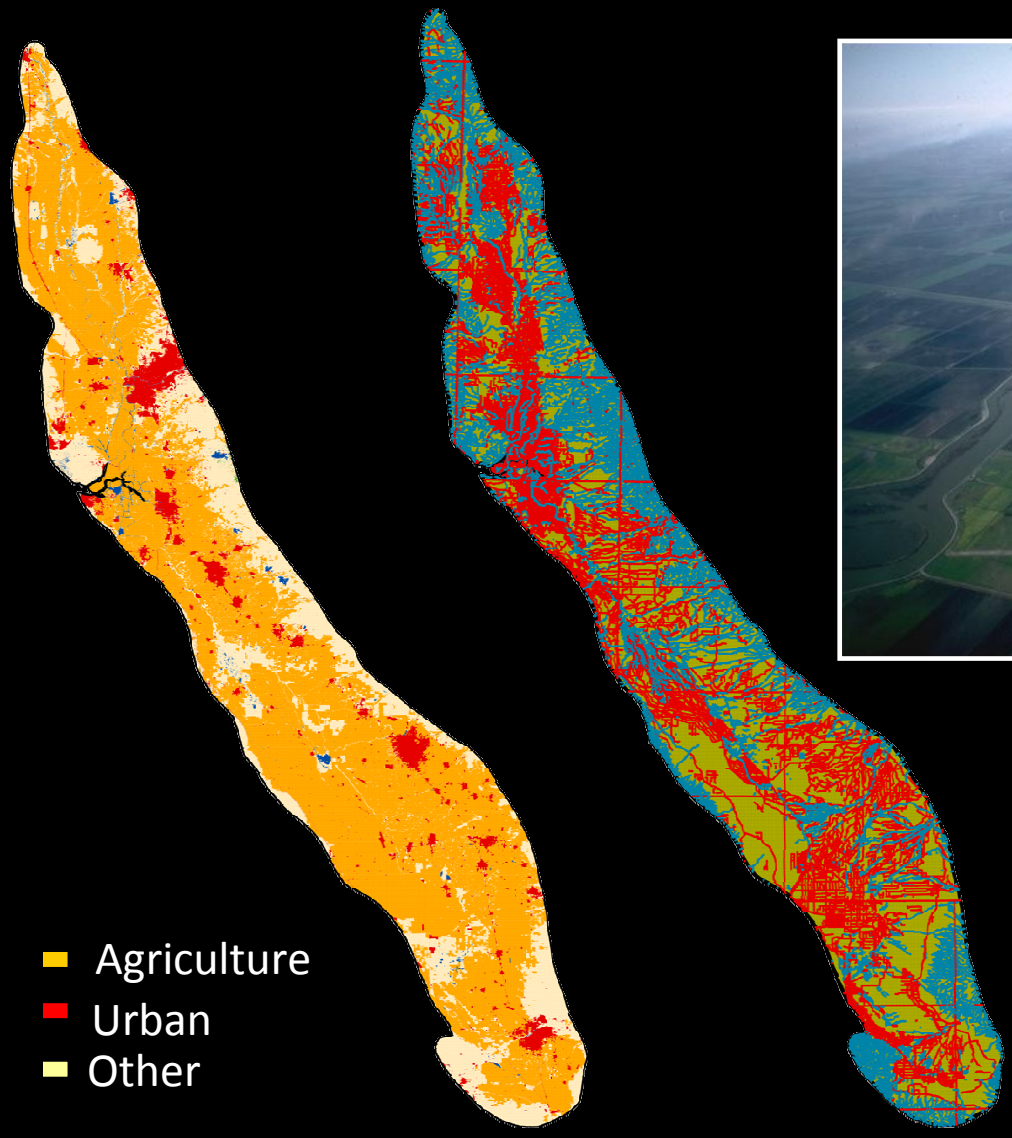
Alternative Reference Models: Begin to develop process for identifying reference sites in non-standard areas

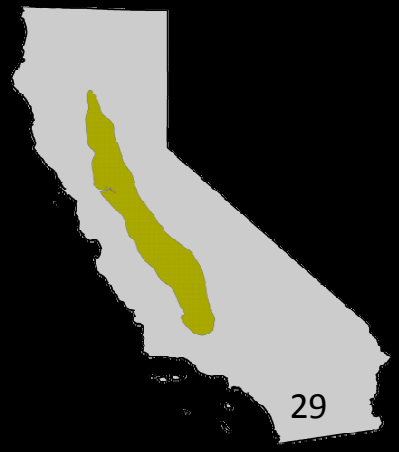


How to set standards for biotic condition where reference streams are hard to find?

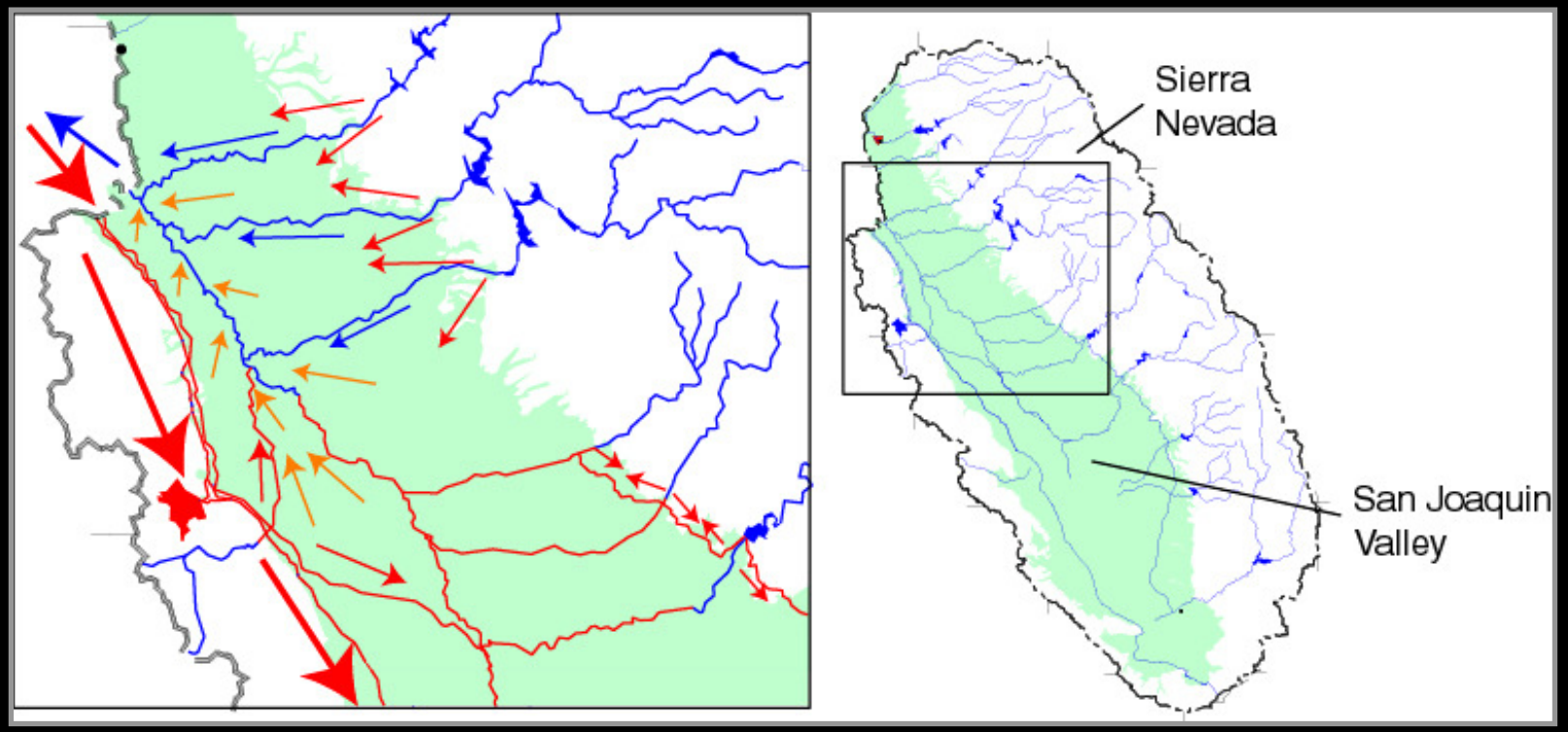
Ode, P., D. Pickard, J.Slusark and A. Rehn. 2005. Adaptation of a bioassessment reference site selection methodology to creeks and sloughs of California's Sacramento Valley and alternative strategies for applying bioassessment in the valley. Report to Central Valley Regional Water Quality Control Board.

Valley floor almost completely converted to agricultural/ urban land uses and extensively “plumbed”





Altered flows in the southern Central Valley



- Instream flows (natural flow routes)
- Diversions, canals, and dry streambeds
- Agricultural and other return flows

Can't use standard watershed flow model to quantify upstream stressor sources if there is no "upstream"

slide courtesy Larry Brown, USGS

Alternate Models for Setting Biological Expectations

1. Use a modified version of the standard approach (e.g., use less stringent thresholds, emphasize local condition measures, emphasize other data sources -- pesticide records, historic data?)

2. Alternate approaches (see RCMP document)

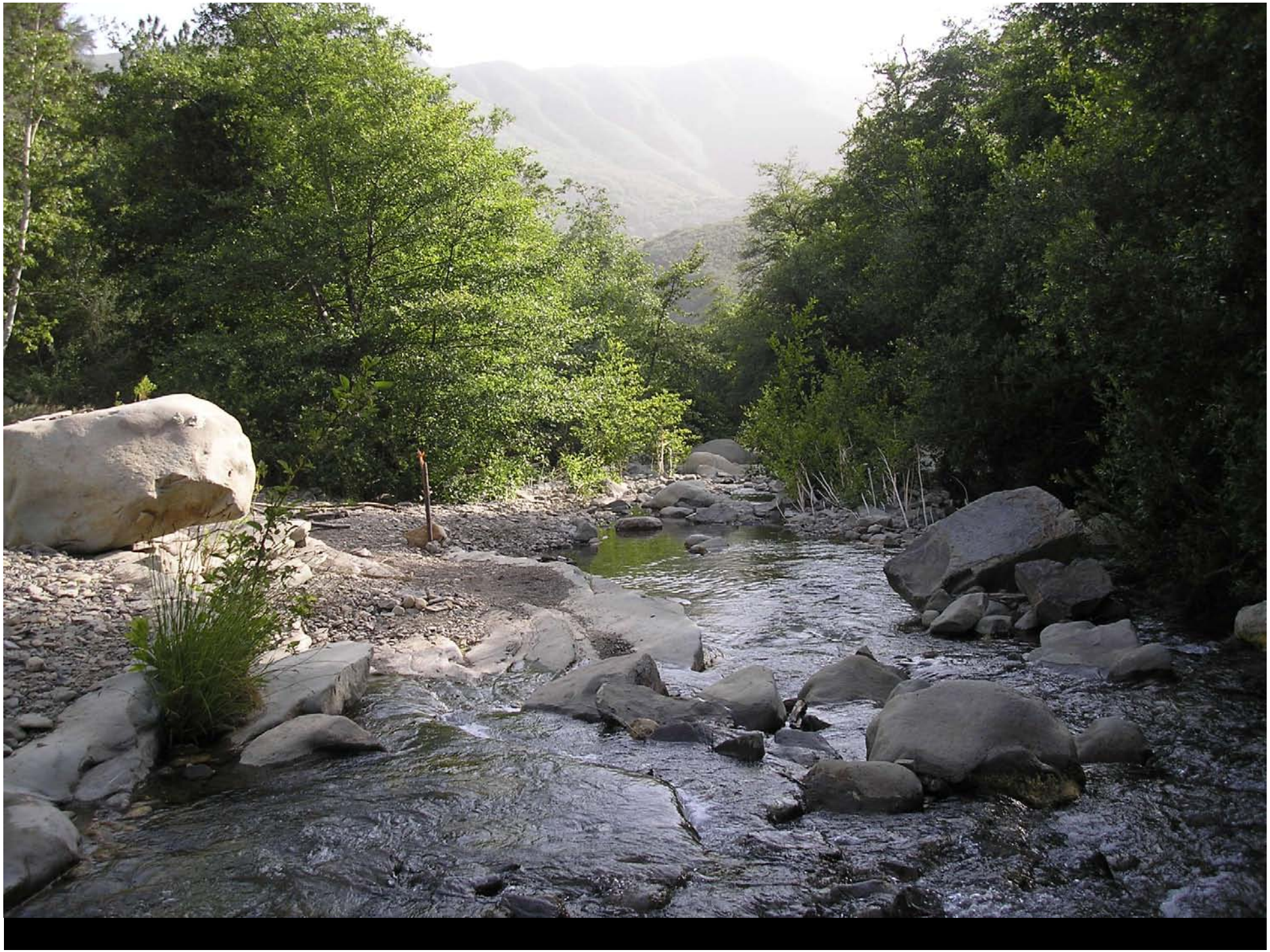
- Use existing scoring tools (e.g., IBIs, O/Es) to screen sites, pick
- Species pool approach
- Factor-ceiling approach (Carter and Fend)
- Model taxon preferences for key environmental gradients and use to predict expected assemblage

- *We will talk about this topic a lot more next time, but interested in any ideas*

Initial Steps in Alternate Process (useful for most alternates strategies)

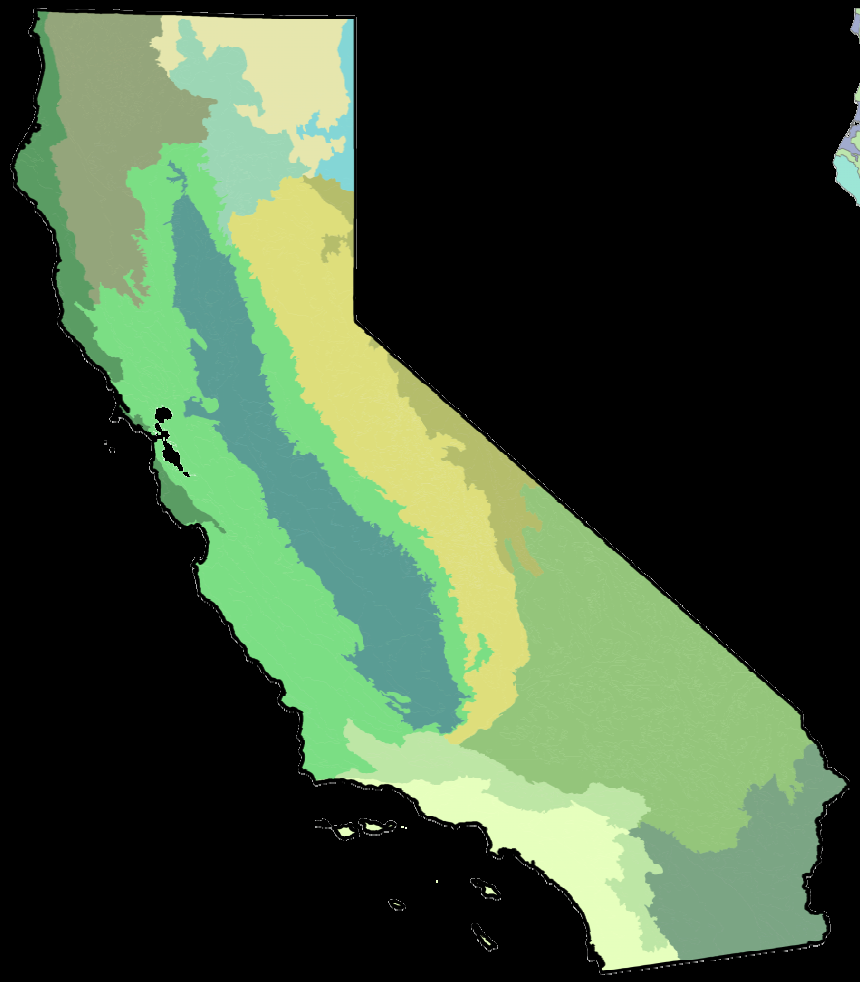
1. Relax restriction against using biology – identify sites with high quality biology in region of interest
2. Use environmental data from these sites to identify key physical, chemical and landscape characteristics that are associated with best sites
3. Identify new sites with these characteristics

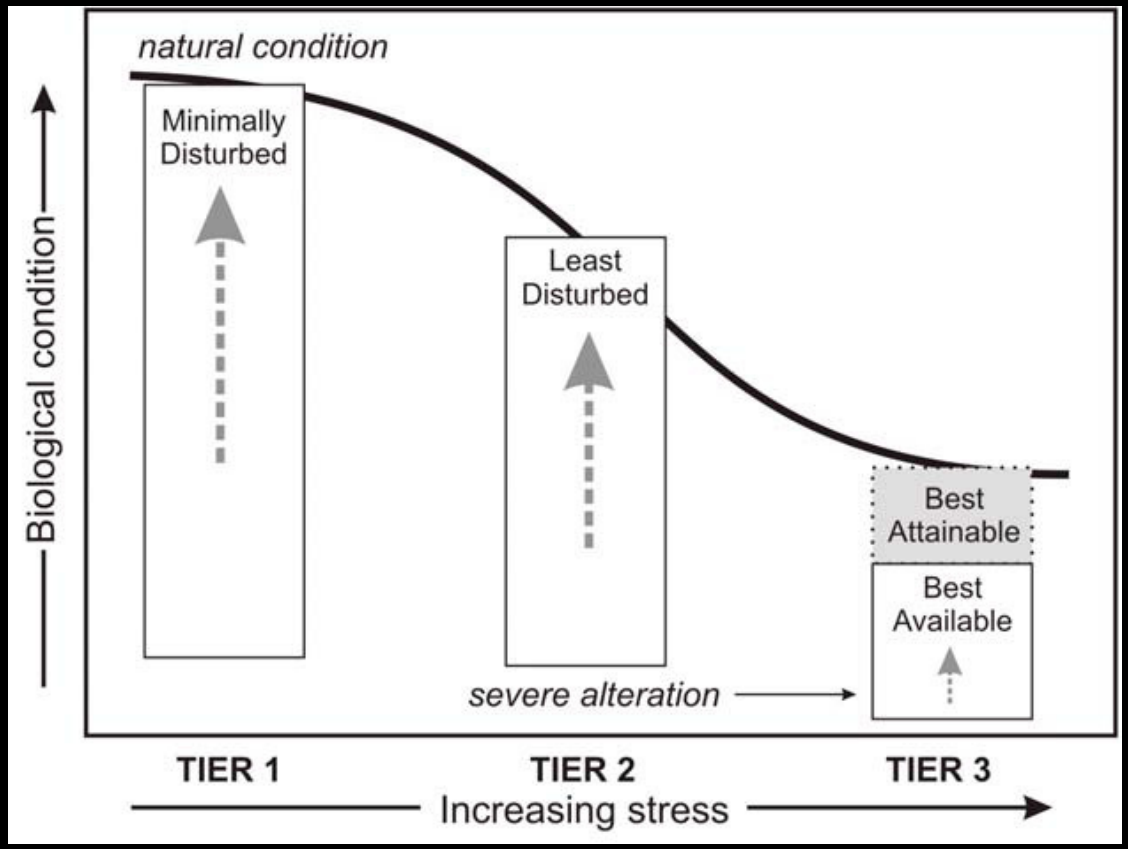
2011 sampling effort will include lower elevation SMC and Central Valley sites



Omernik Ecoregions (Draft II, April 2010)

Level III – 13 Level IV - 189




natural condition
Minimally Disturbed
Least Disturbed
Best Attainable
Best Available
severe alteration
Biological condition
TIER 1
TIER 2
TIER 3
Increasing stress

the 800 lb Gorilla:

How to "balance consistency with regional flexibility"?

WHY?

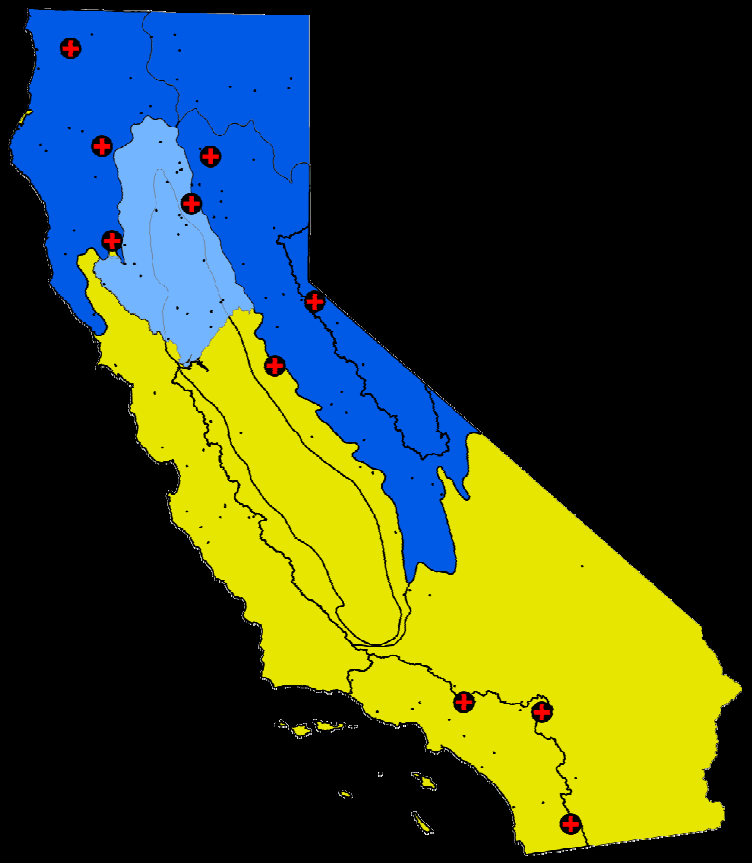
1. Flexibility is essential for accommodating regional differences in major metrics and their thresholds
2. Transparency/Simplicity essential for feasibility and repeatability and end user confidence
3. Consistency essential for statewide assessments and inter-regional comparisons

HOW? *draw on science panel here*

- Standardize the process, not the metrics or the thresholds
- We will constantly re-assess this
- Some issues we'll be pursuing follow…..

Index Period Documentation/ Validation

Index Period: Standardized sampling period used to restrict biological sampling to minimize effects of seasonal variation in biological communities … will be needed for biocriteria implementation (see stormwater permit)



Region	Early	CORE Index Period	Late
Northern Mountains	May	June - September	October
Northern Valley and Chaparral	May	June – August	September
Southern and Central Xeric	April	May – July	August

Index Period Study Objective:
document temporal variability of biology in different regions of the state