

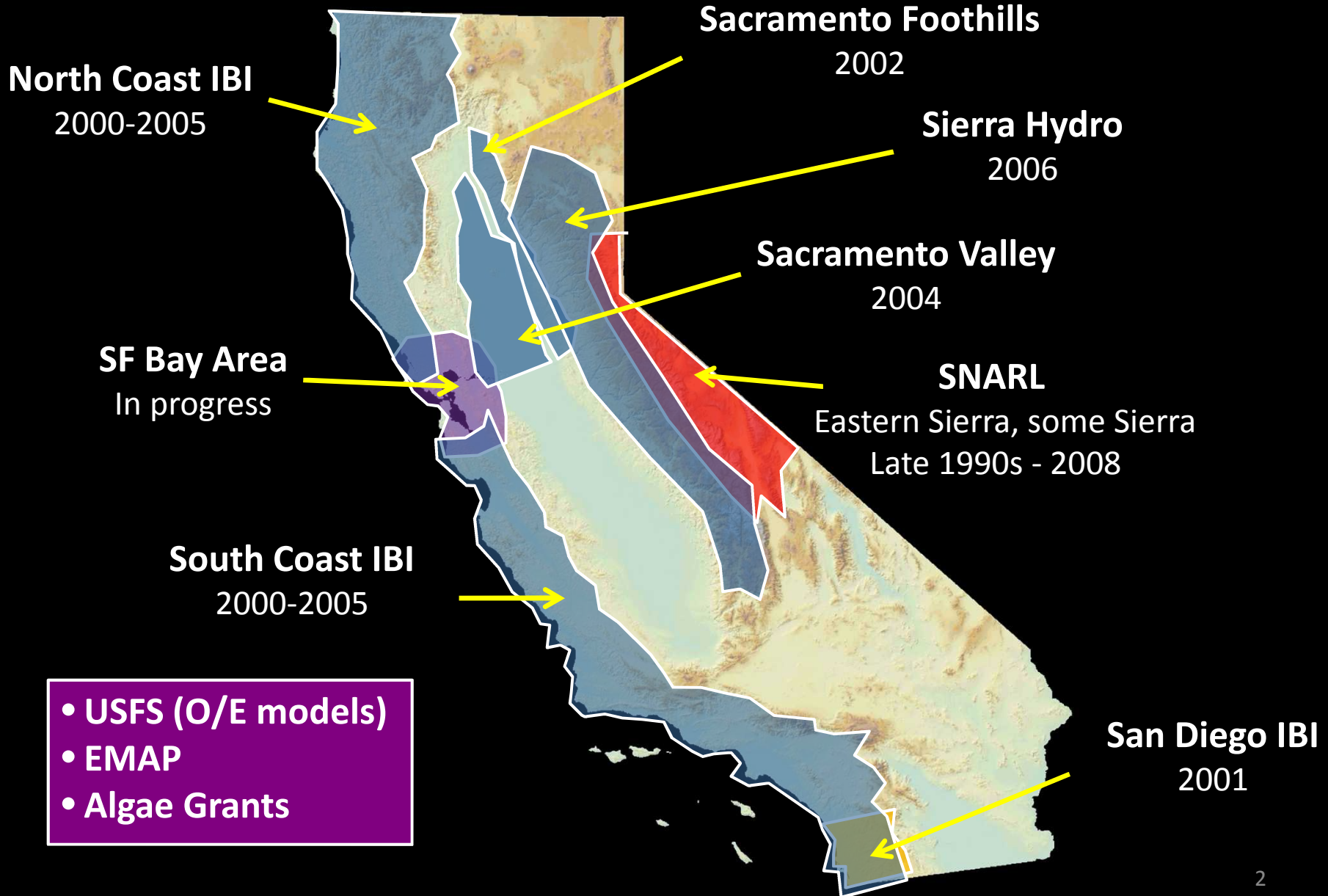
Development and Evaluation of Reference Criteria for California's Perennial Streams

Peter Ode

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CA Department of Fish and Game*

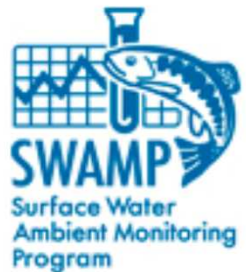


Significant CA Reference Projects (1997 – 2010)



Why a New Reference Effort ?

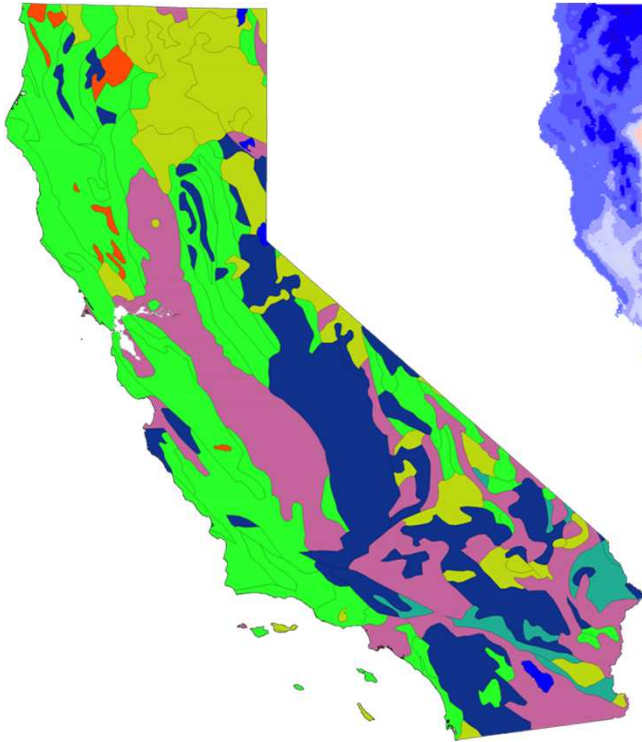
- **Biocriteria are coming!**
 - California is preparing to promulgate a narrative standard with numeric implementation targets for BMIs in wadeable perennial streams (~2014)
- **Reference sites have limitations** for statewide application
 - Spatial coverage is limited
 - Reference site definitions not consistent
 - Reference distributions not fully representative



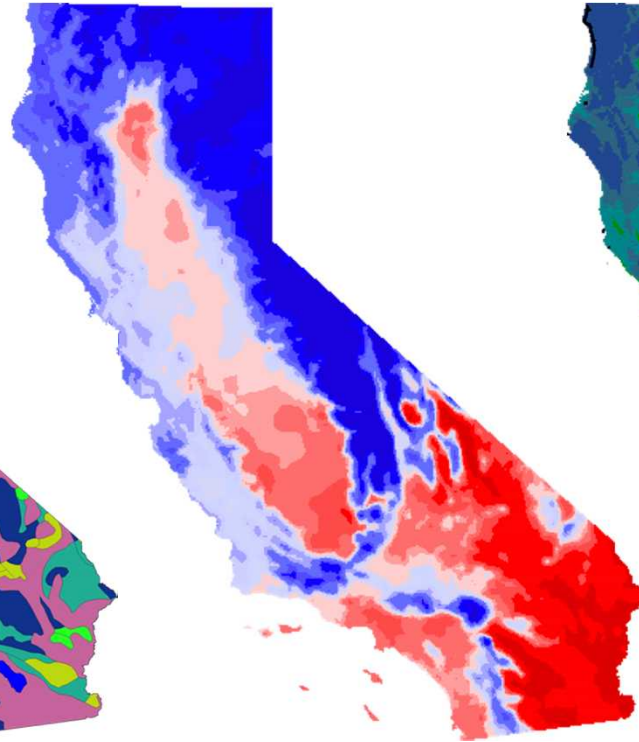
Technical Challenges:

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

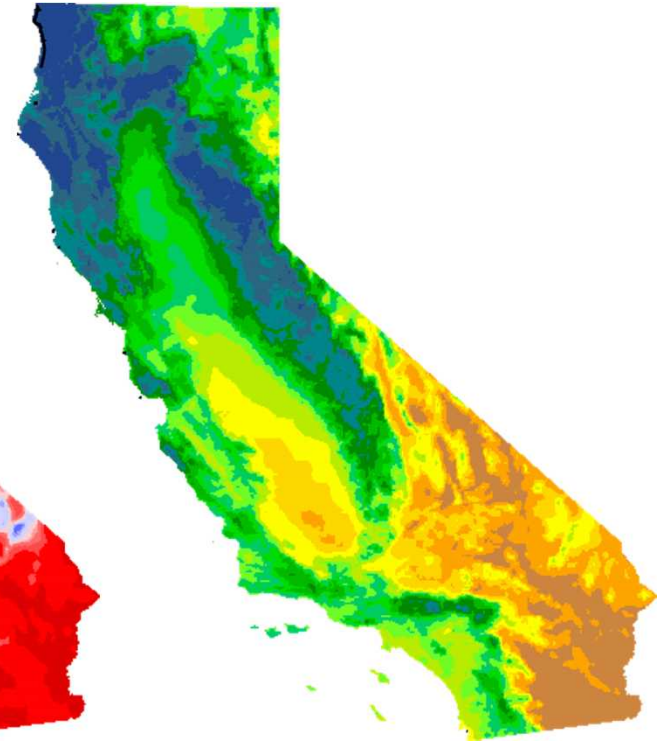
Geology



Temperature



Precipitation



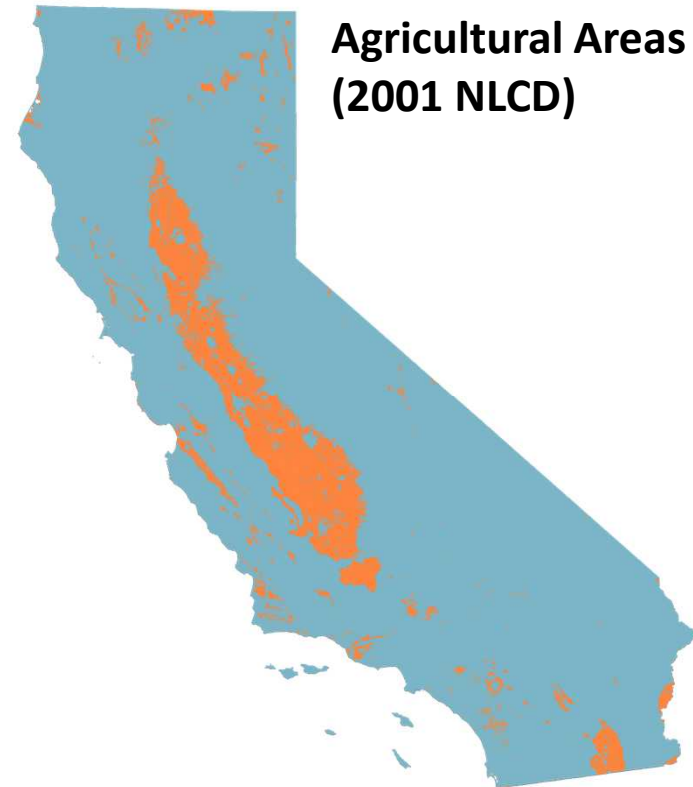
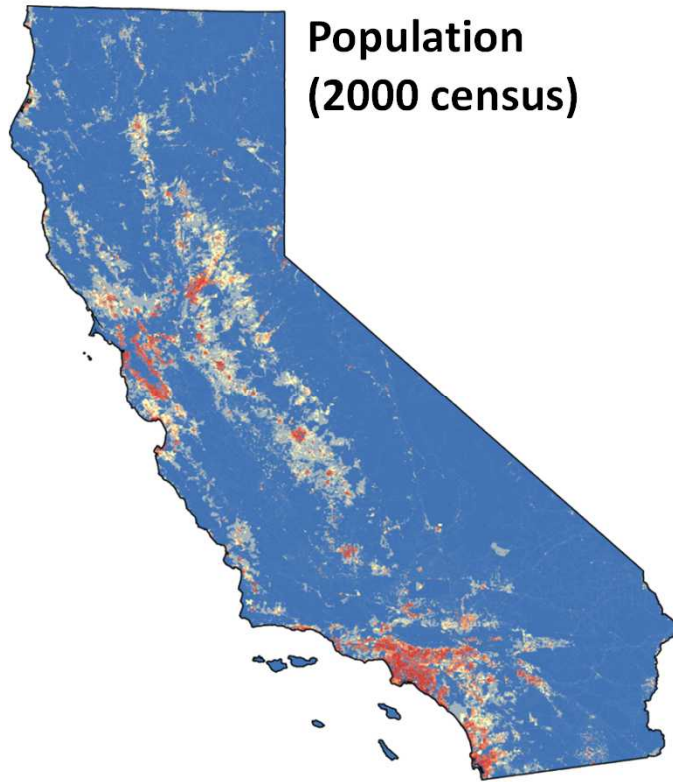
Griffith/Omernik 2010

13 Level III Ecoregions

180 Level IV Ecoregions

Technical Challenges:

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



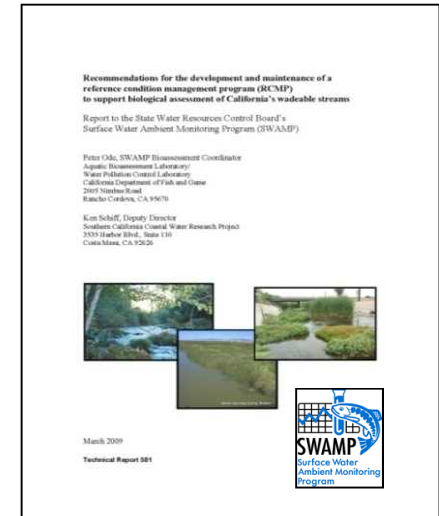
- Extensive modification introduces **gaps in representation** of natural gradients
- Widespread development can make some regions unsuited for standard reference approaches

CA's Reference Condition Management Plan

(Ode and Schiff, adopted March 2009)

RCMP Philosophy and Objectives

- Use natural condition (or something close to it) as the desired state whenever possible
- Reference sites must represent CA's environmental diversity

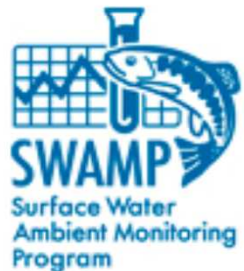


Balancing site purity and representativeness

Trade-off: Need to allow limited sources of anthropogenic stress in order to get good representation of all stream types, but not so much that we sacrifice biological integrity

Performance Objectives:

1. Reference pool represents the majority of CA streams
2. Biological “quality” is maintained at reference sites

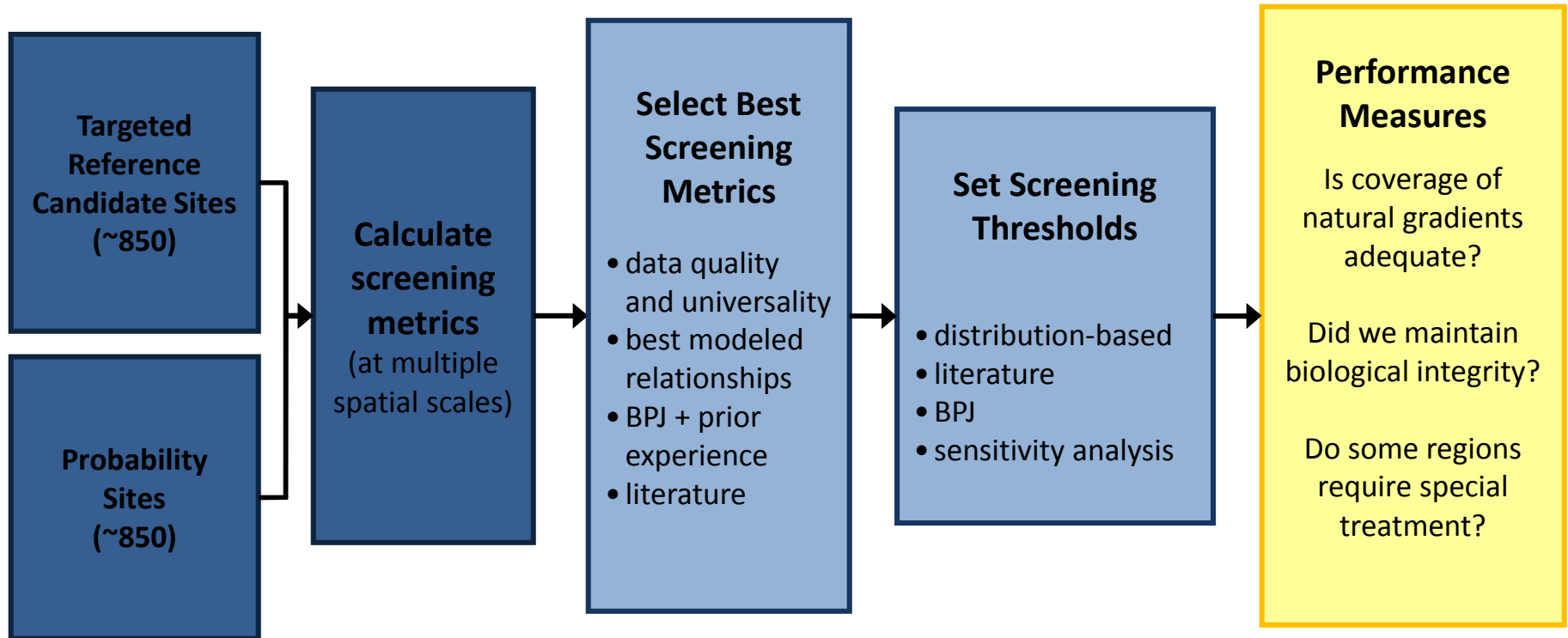


Reference Condition Process

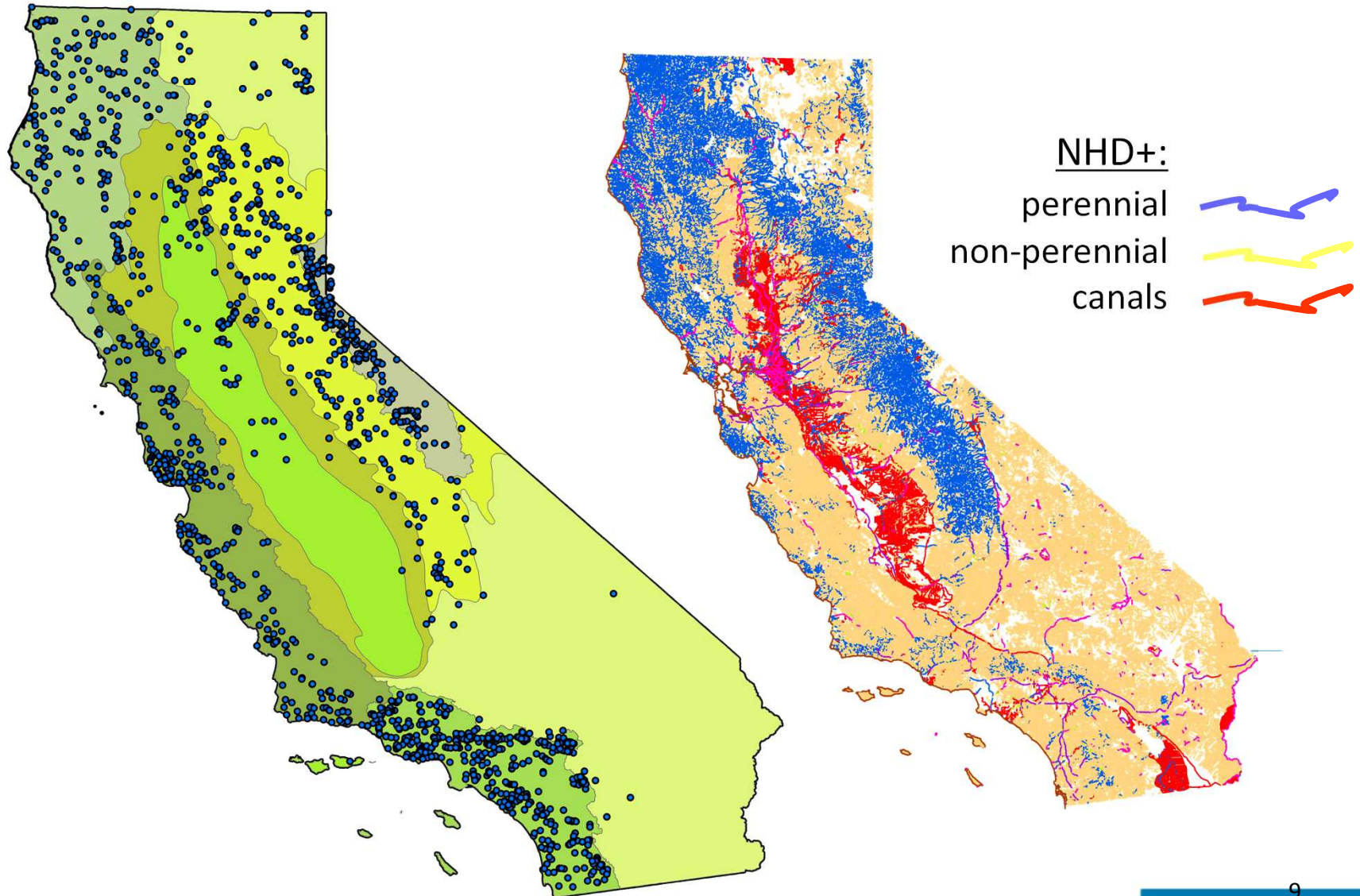
Establish Pool of Candidate Sites

Select Sites

Measure Performance



Assemble Data from > 1700 sites



Metric Overview:

station data + natural gradients

- **Station Data**

- Regional board, PSA region, county, HUC, stream ID, ownership information

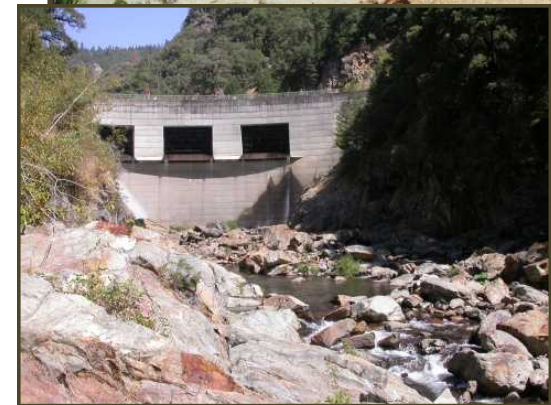
- **Natural Gradients**

- **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

(> 170 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/CWIIQS 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



Thresholds are comparable or stricter than other CA indices and include many more criteria

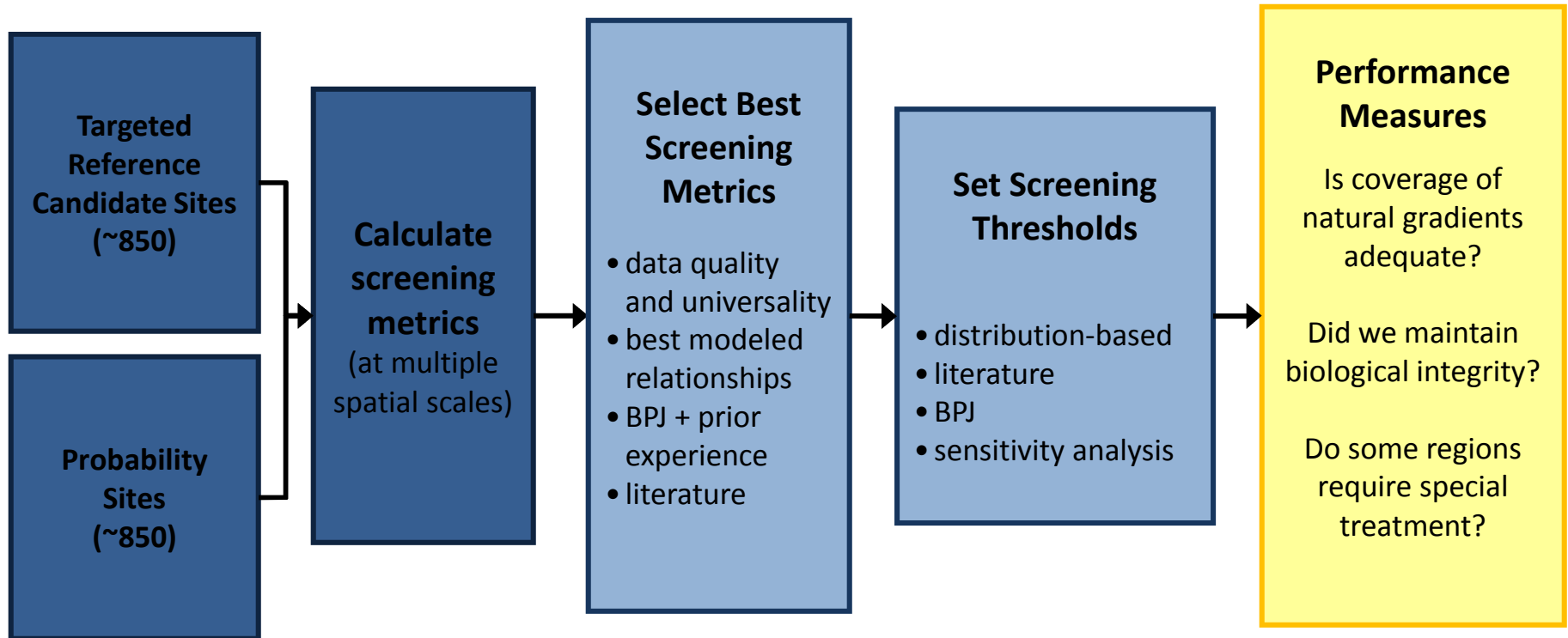
Metric	2011 Bio-objectives	South Coast IBI (5k,ws)	North Coast IBI (1k, ws)	Current O/Es (Hawkins 2005)
Local Disturbance (W1_Hall)	1.5	-	-	riparian vegetation, erosion, grazing, etc.
% Agricultural	3,3,10	5	5	
% Urban	3,3,10	3	3	
% Ag + Urban	5,5,10			
% Code 21	7,7,10	in urban	in urban	
Road Dens (km/km ²)	1.5	2.0	1.5/ 2.0	
Paved road x-ings (#/ws)	5/10/50			
TN, TP (mg/L)	3.0/ 0.5	-	-	
Nearest Dams	>10 km	-	-	
Active Producing Mines	0 (5k)	-	-	
% Canals & Pipelines	10	-	-	
Gravel Mine Density	0.1 (r5k)			
Conductivity	<2000 uS, + <99%, >1%			
BPJ Screen	X	X	X	X

Reference Condition Process

Establish Pool of Candidate Sites

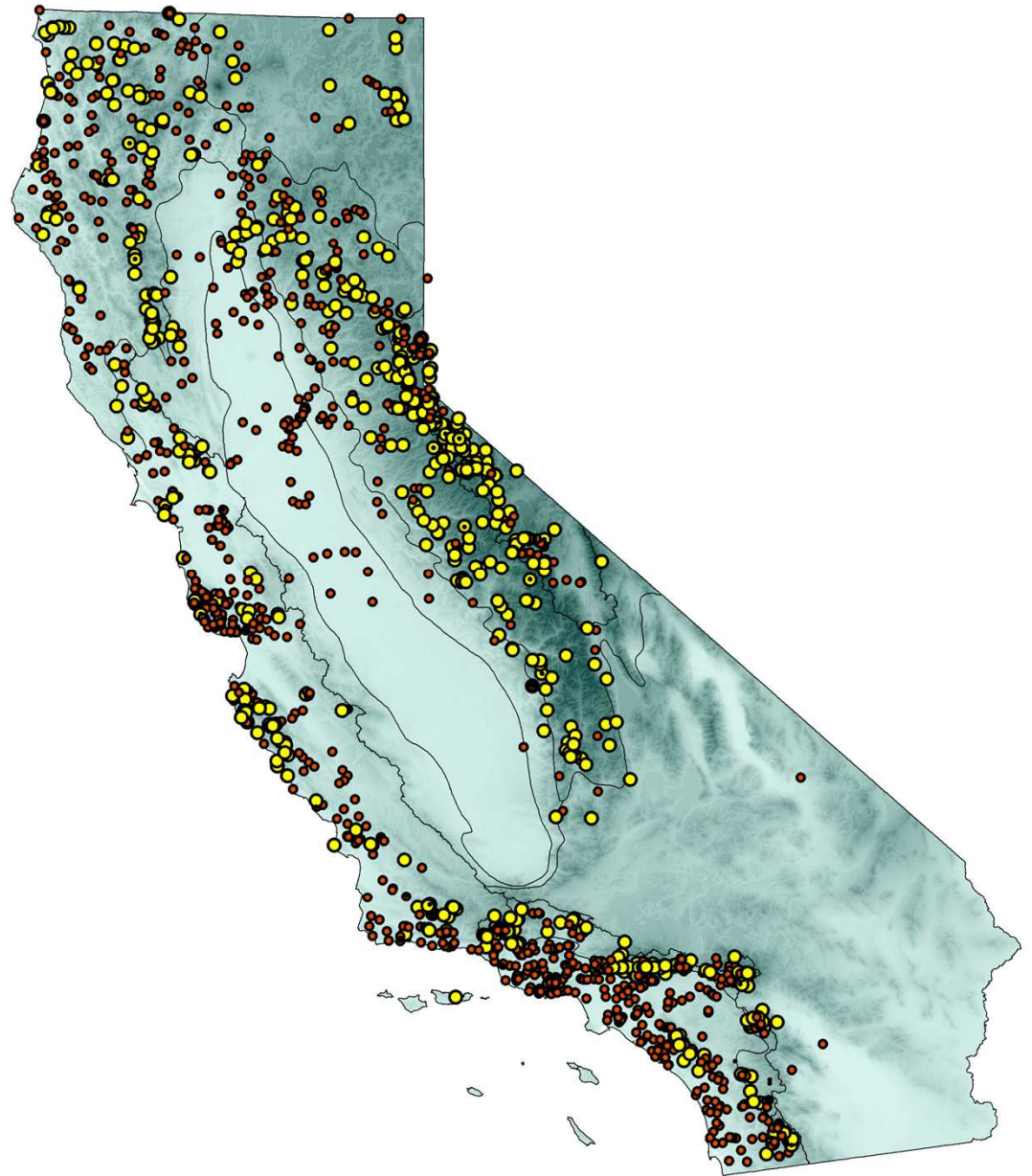
Select Sites

Measure Performance

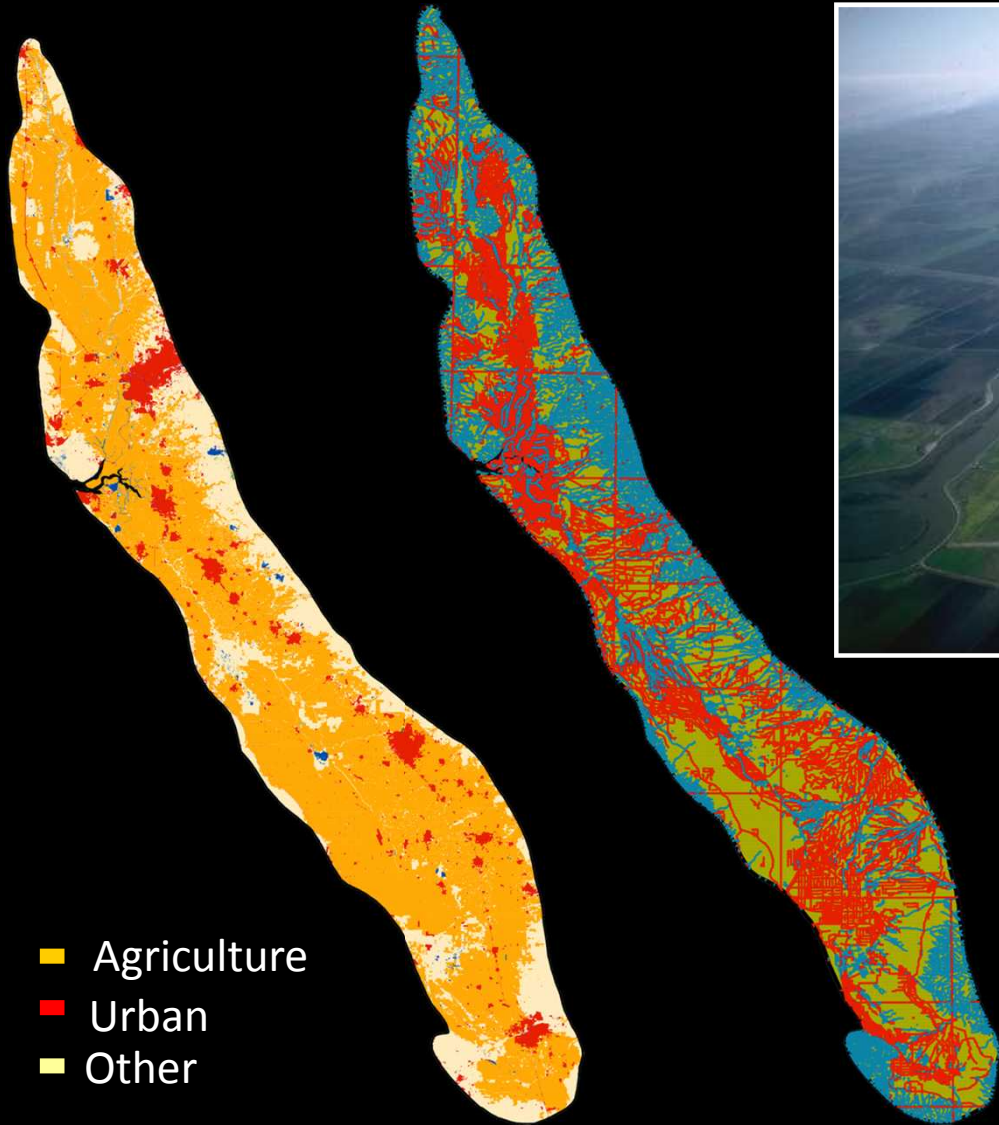


Reference Sites

REGION	n
North Coast	79
Central Valley	1
Coastal Chaparral	87
Interior Chaparral	30
South Coast Mountains	96
South Coast Xeric	22
Western Sierra	131
Central Lahontan	142
Deserts + Modoc	27
TOTAL	615



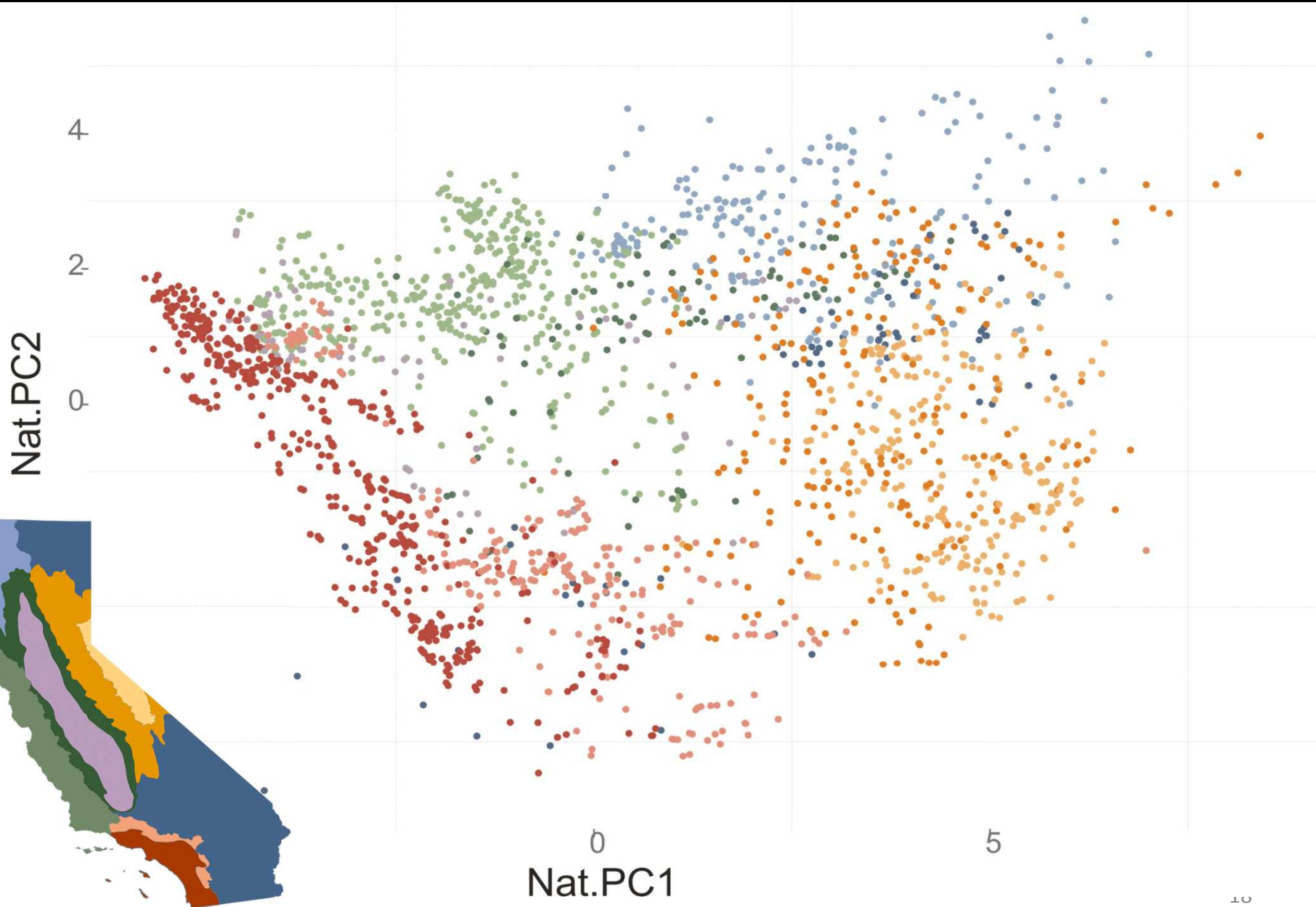
Valley floor almost completely converted to agricultural + urban land uses and extensively “plumbed”



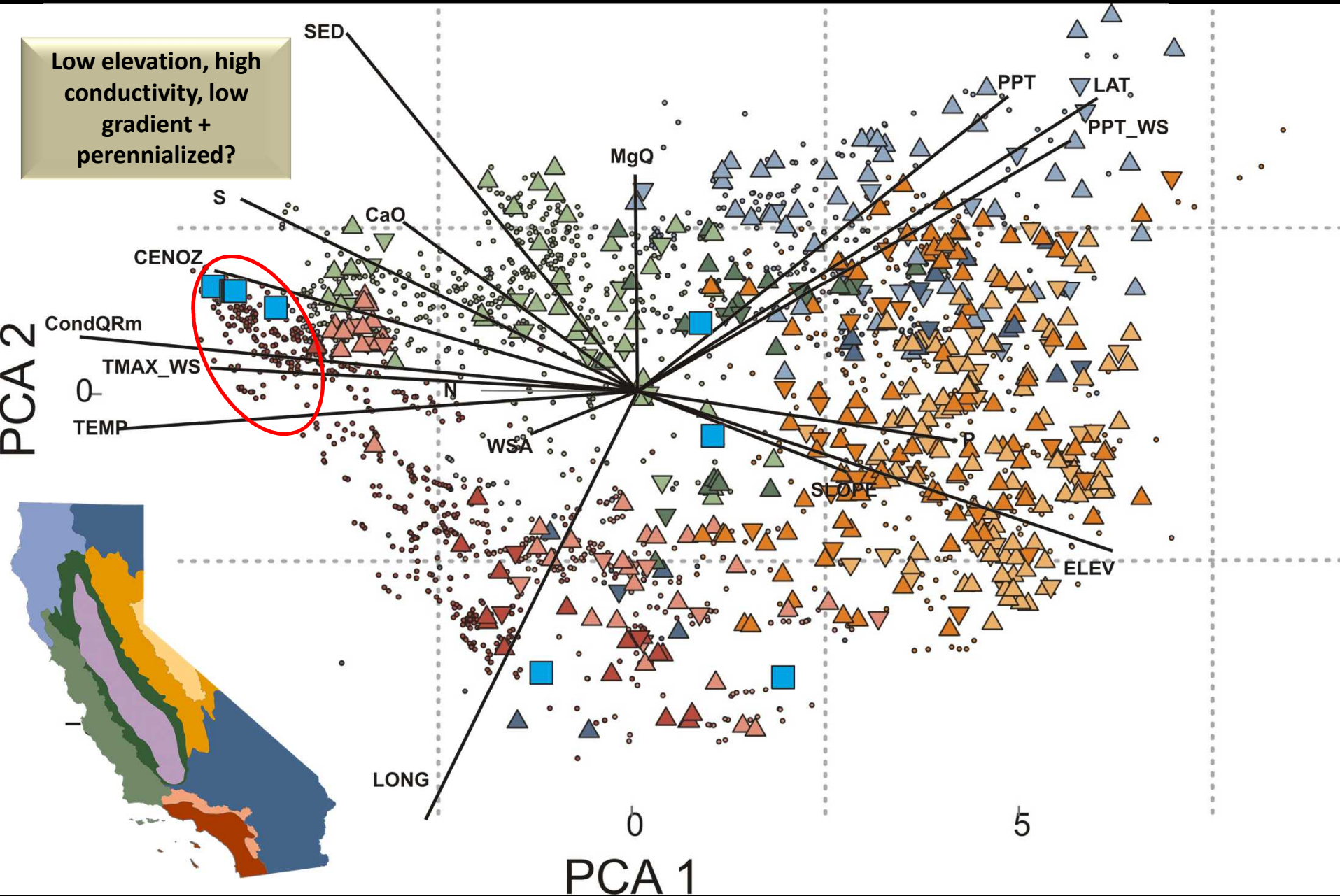


Southern Coast has similar issues with urbanization

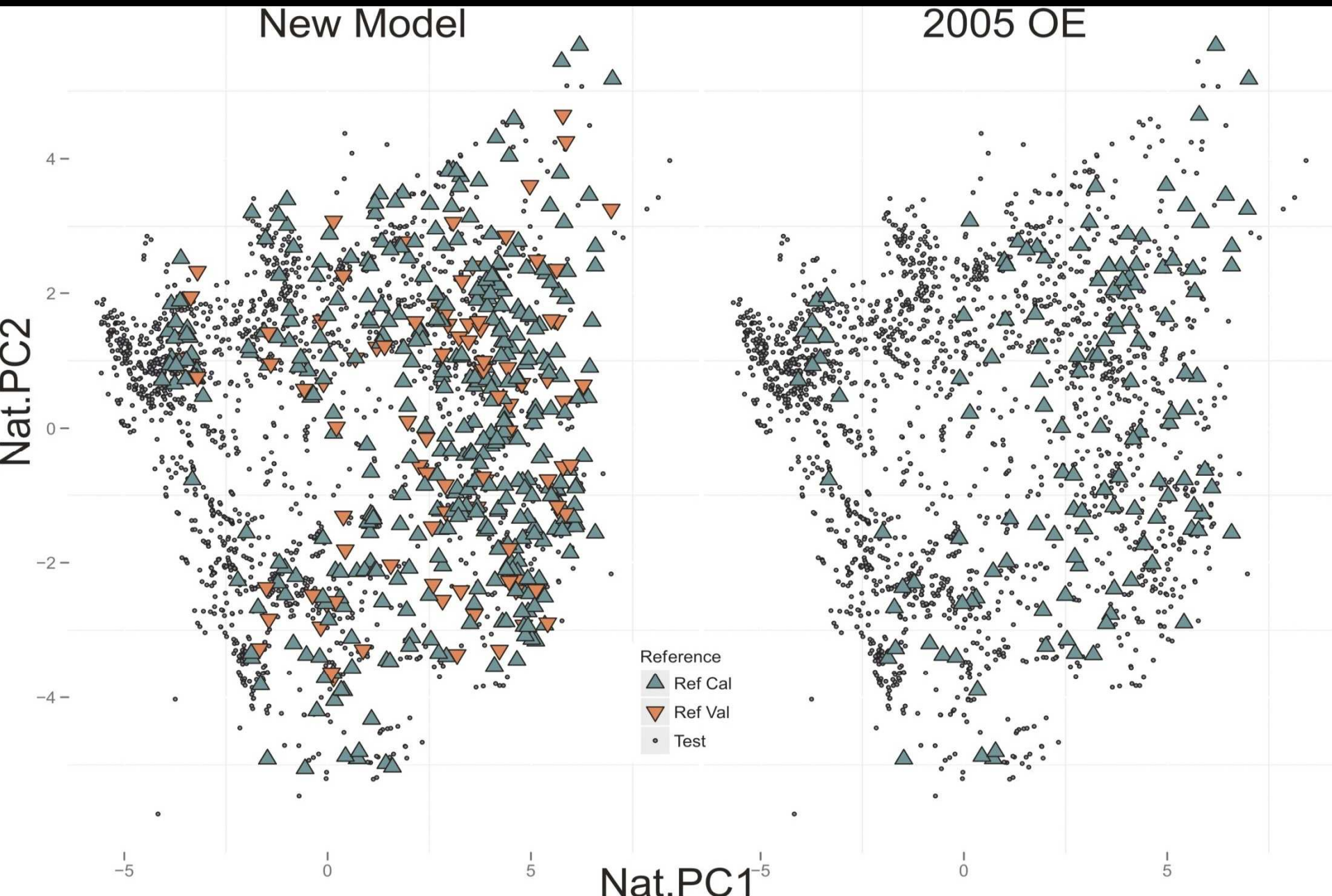
Multivariate view of natural diversity



Multivariate evaluation of representativeness

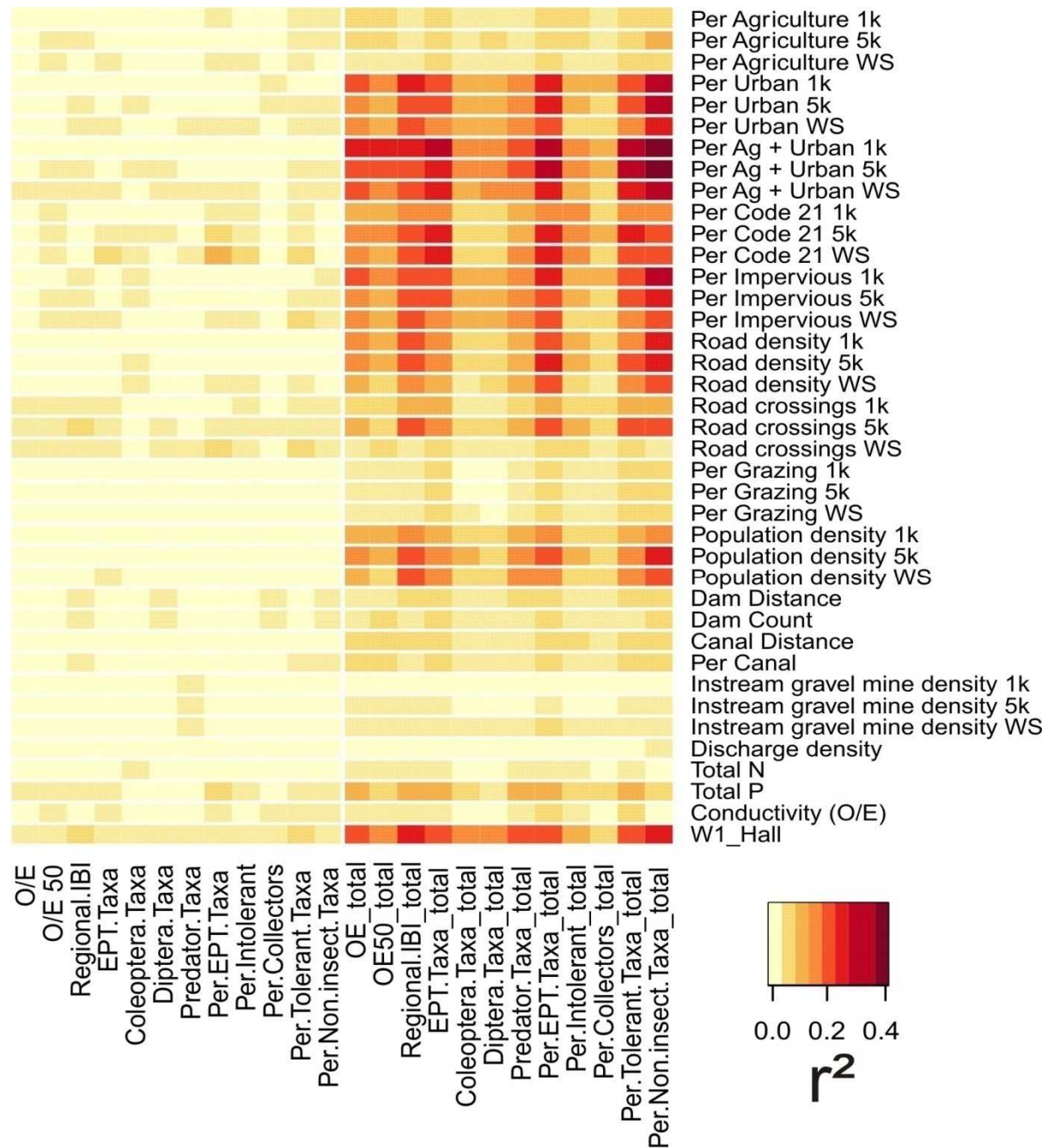


New reference pool fills in many gaps



Biological Integrity

- “Heatmap” of biological variation related to various stressors in both the reference population (left) and across all sites (right)
- Anthropogenic sources of variation were very low in the reference pool



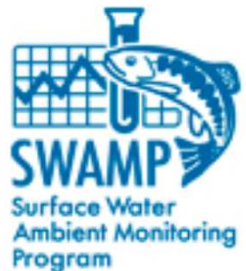
Reference Conditions: Performance Summary

Stream Type Representation

- Overall excellent representation in most regions (absent in Central Valley, fewer in SoCal xeric region)
- Some under-representation of very low gradient, high conductivity, low elevation settings in Chaparral and South Coast

Biological Integrity

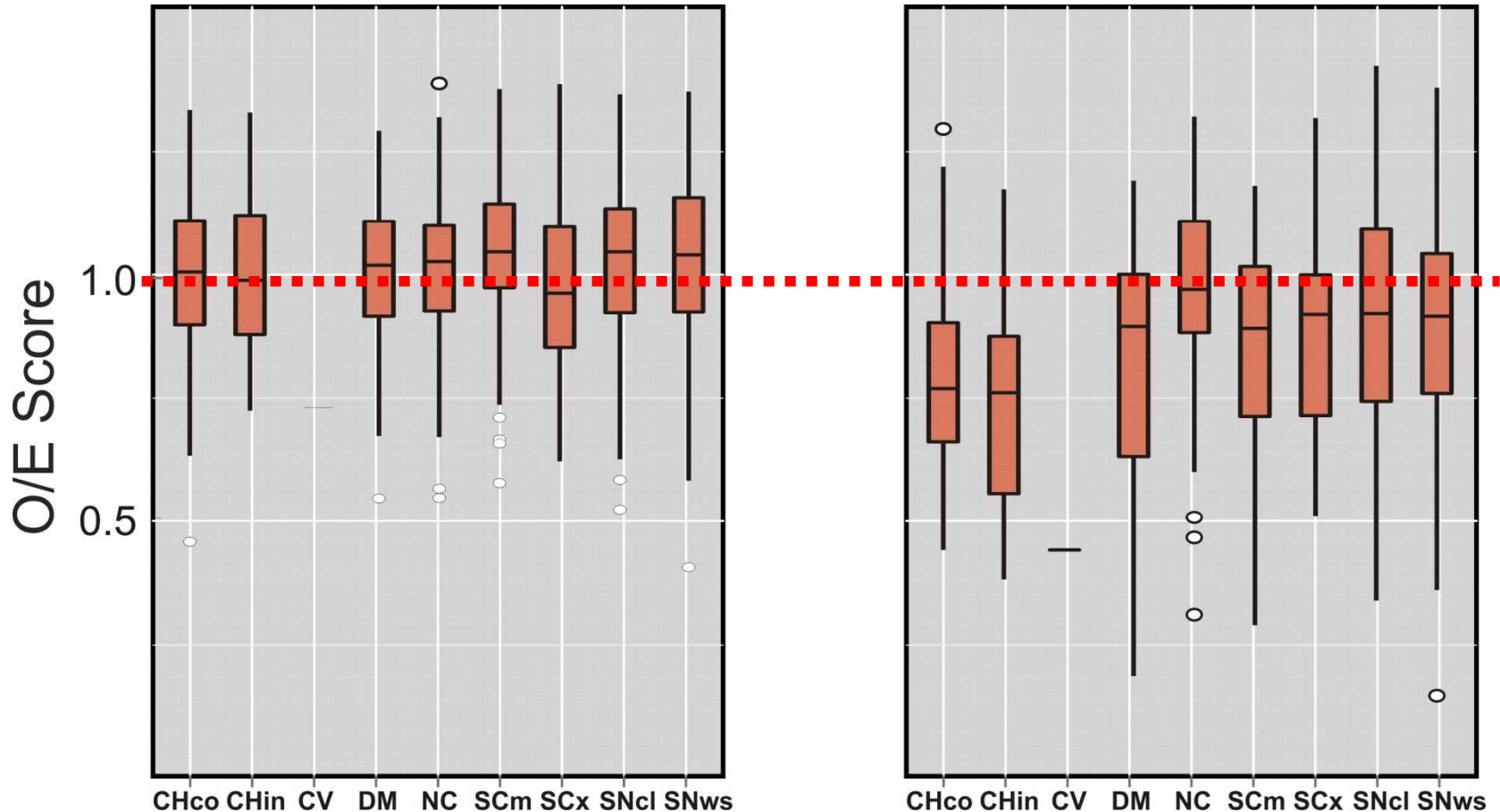
- Greatly reduced anthropogenic sources of variation in biological assemblages in reference pool
- Random Forests model of anthropogenic stressors at reference sites explained none of the variation in O/E scores



Representativeness Improves Regional Consistency in Scoring Tools

New Model

O/E 2005



- New indices have little regional bias and are more precise

Technical Team



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Jason May, *USGS*

David Herbst, *SNARL*

Peter Ode, *DFG-WPCL/ABL*

Ken Schiff, *SCCWRP*

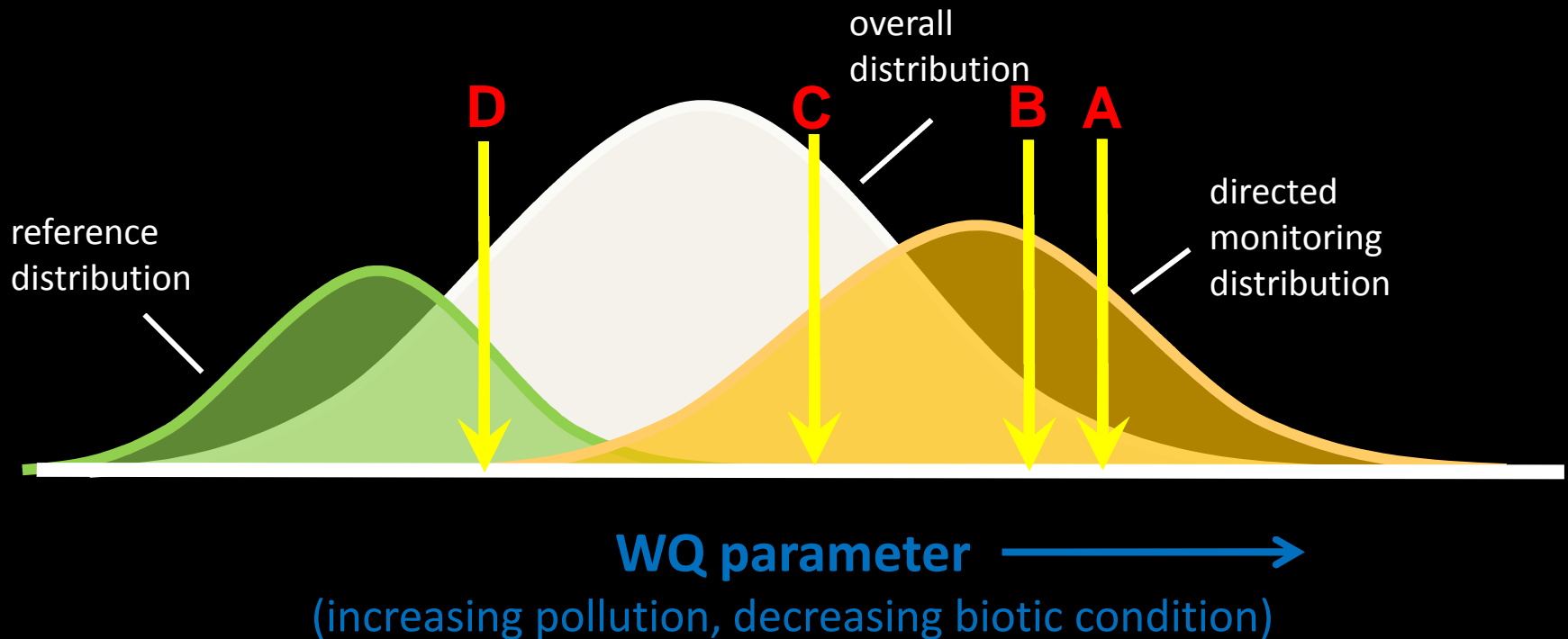
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Betty Fetscher, *SCCWRP*

Kevin Lunde, *SF Water Board*

Reference program provides perspective for many WQ parameters



- Knowledge of the reference distribution can provide objective benchmarks for a wide range of parameters with non-zero natural values (i.e., not just for biology anymore)