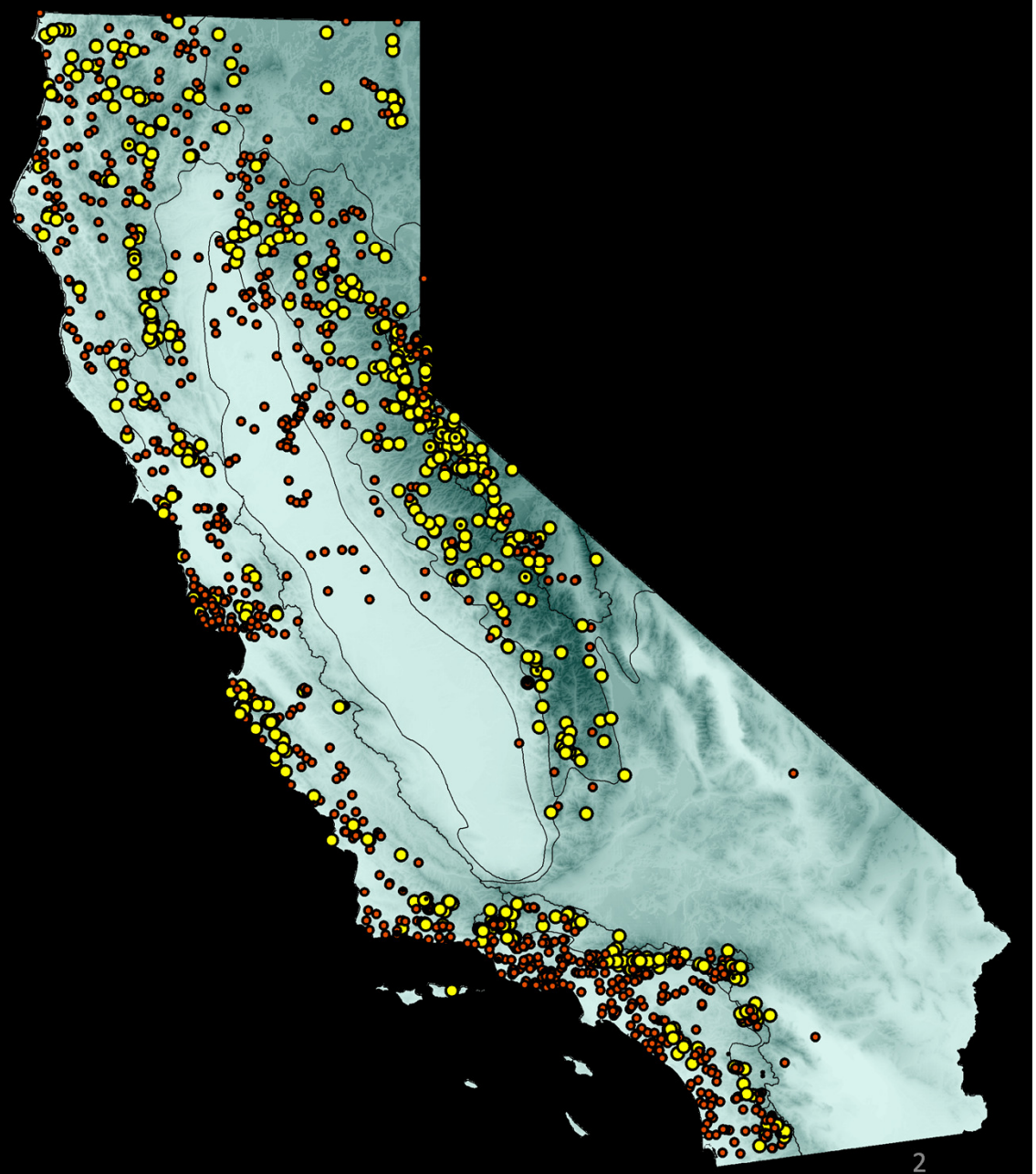
Reference Conditions

Objective:

- Represent all types of perennial streams in California
- Ensure biological integrity at reference sites

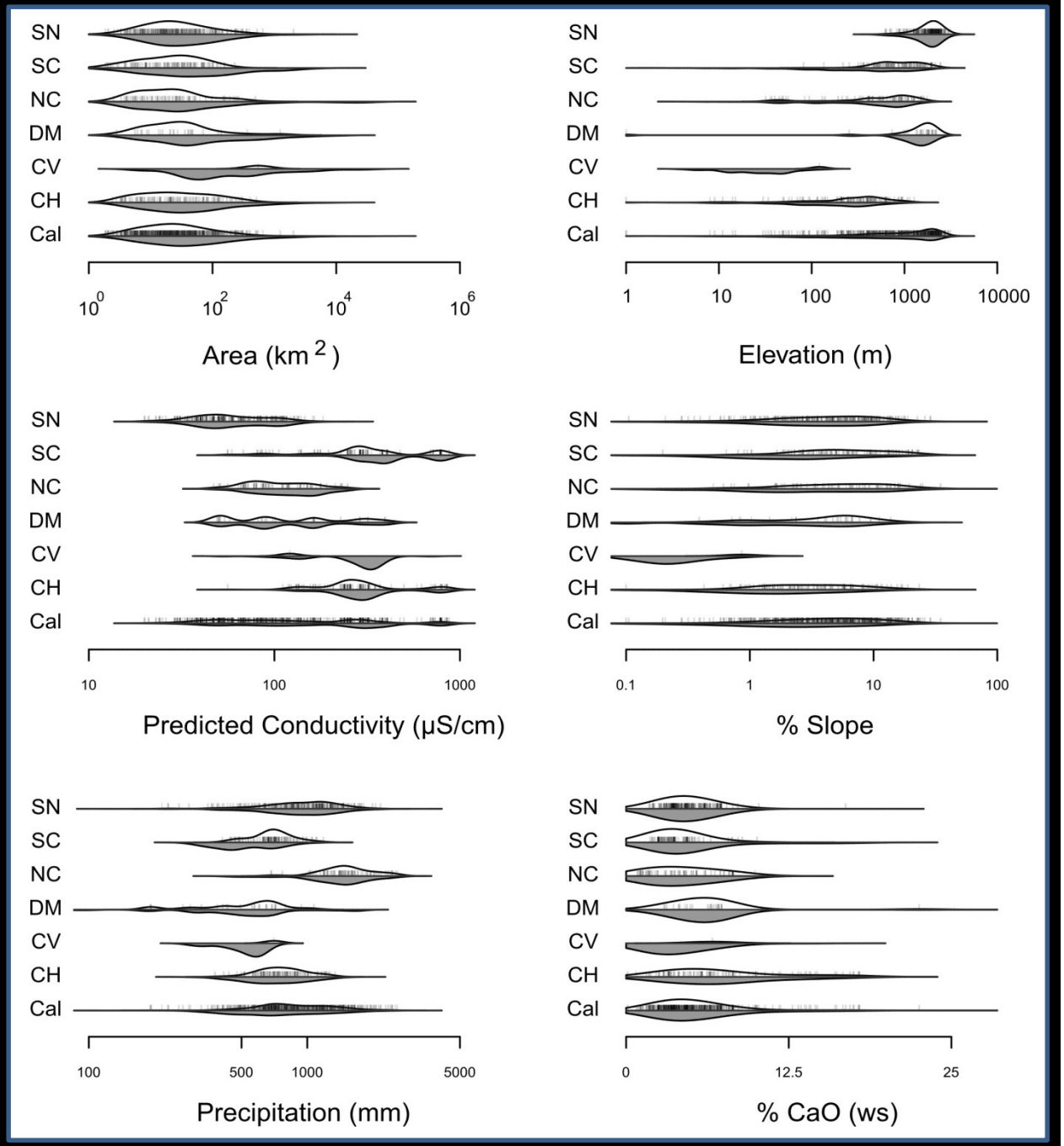
Reference Sites

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**



Gradient Representation

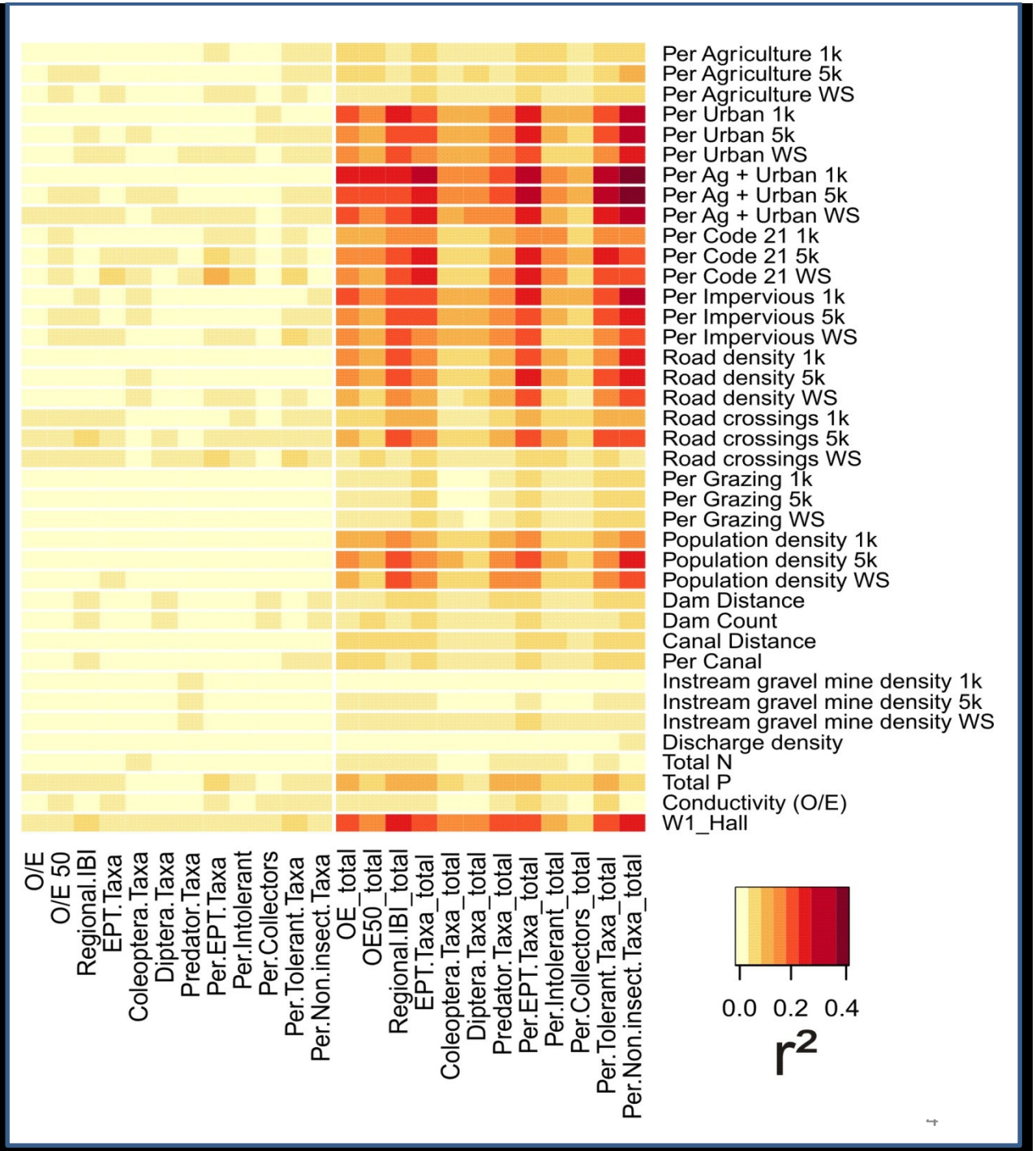
- Overall excellent representation in most regions
- Central Valley and South Coast (xeric only) very under-represented
- Very low gradient , large watershed, low elevation settings slightly under-represented in Chaparral/ S. Coast



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 generally low in the reference pool



Reference Comments

1. Add more technical detail:

"…provide more detail on the process for identifying metrics, thresholds, or kill switches, and the differences among these"

2. Define limits to bio-objective application

"Define how far the traditional approach can be used in reference-poor regions like the Central Valley and South Coast Xeric"

3. Explain how reference data will be used

"It is not clear how reference data will be used in a regulatory context"

Predictive Models:
(Observed/ Expected Models)

Developed in UK (Wright and others 1970s-1980s, RIvPACS), adapted in Australia (AusRivAS) and US (Chuck Hawkins, Utah State… source of most of these slides)

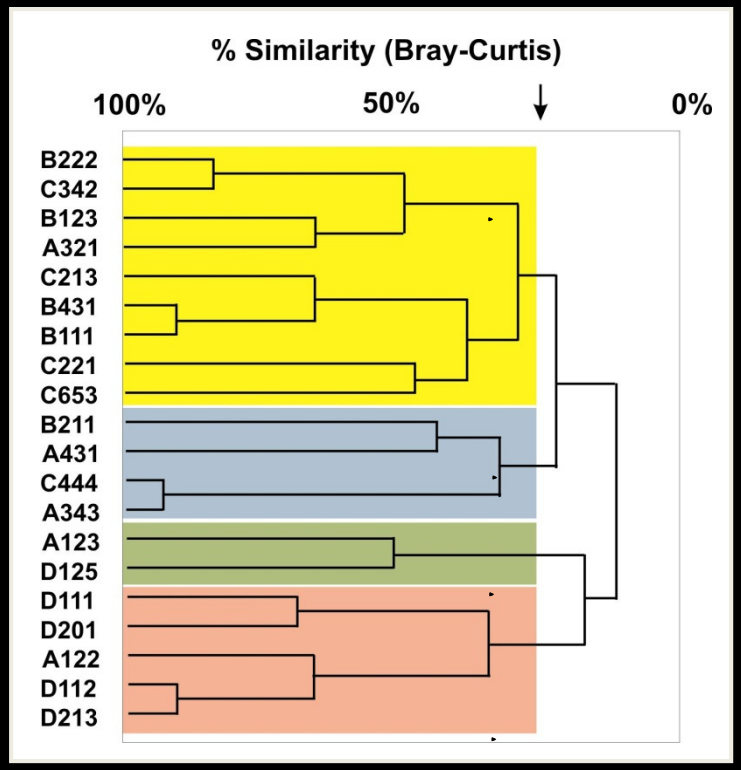
Species-based approach: Compare number of **observed** ("O") taxa to number of **expected** ("E") taxa

"Expected" taxa derived from predictive modeling techniques

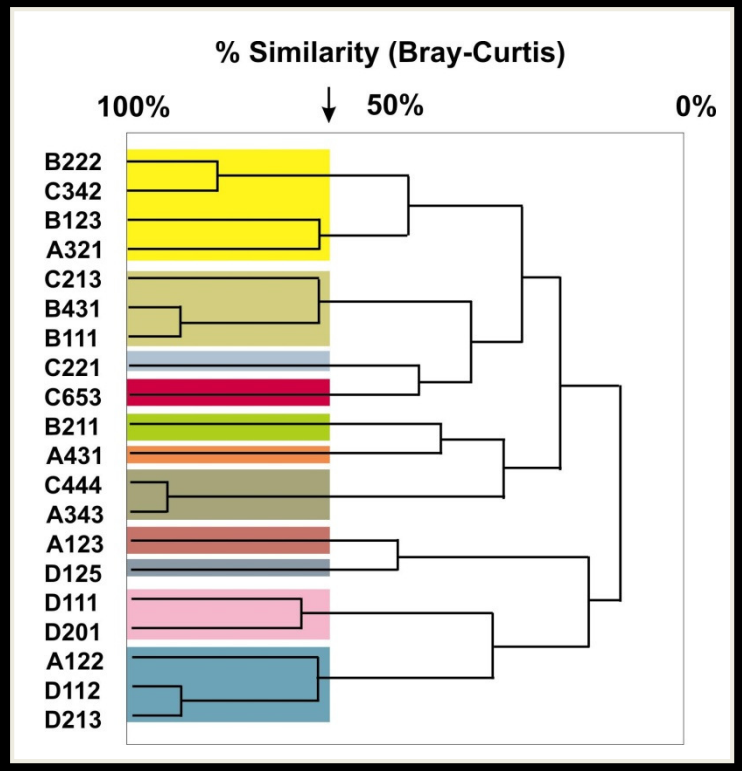
Estimating “E”

Step 1. Classify reference sites based on biological similarity

Clustering techniques used to identify groups of reference sites with similar species composition



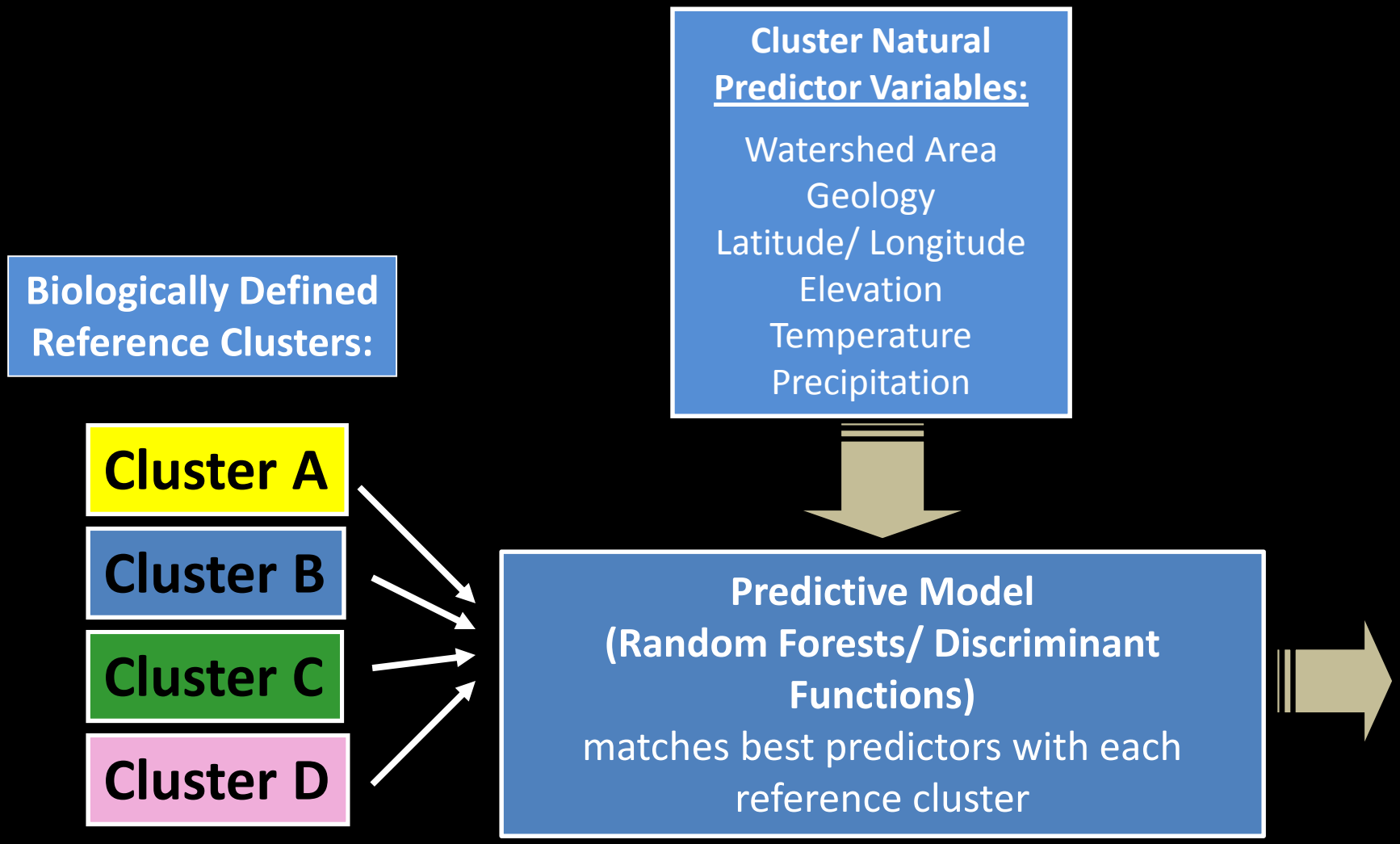
4 classes



11 classes

Estimating "E"

Step 2. Develop model that will predict class membership for new sites



Estimating "E"

Step 3. Estimate capture probabilities

Use discriminant model output + frequencies of occurrence within each class to estimate **probabilities of capture (PC)** for each taxon at a given site

Predictor Variables

Predictive Model
(matches predictors with each reference class)

Cluster	Site's probability of cluster membership	Frequency of species X (*Farula sp.*) in cluster	Expected contribution to PC
A	0.5	0.6	0.30
B	0.4	0.2	0.08
C	0.1	0.0	0.00
D	0.0	0.0	0.00
Probability of *Farula sp.* being in sample if site is in reference condition			**0.38**

Estimating "E"

Step 4. Sum of taxon occurrence probabilities is an estimate of the number of native taxa (E) that should be observed (O)

Taxon	pc	O
Atherix	0.70	*
Baetis	0.92	*
Caenis	0.86	
Drunella	0.63	
Epeorus	0.51	*
Farula	**0.38**	
Gyrinus	0.07	
Hyalella	0.00	*
E	4.07	3

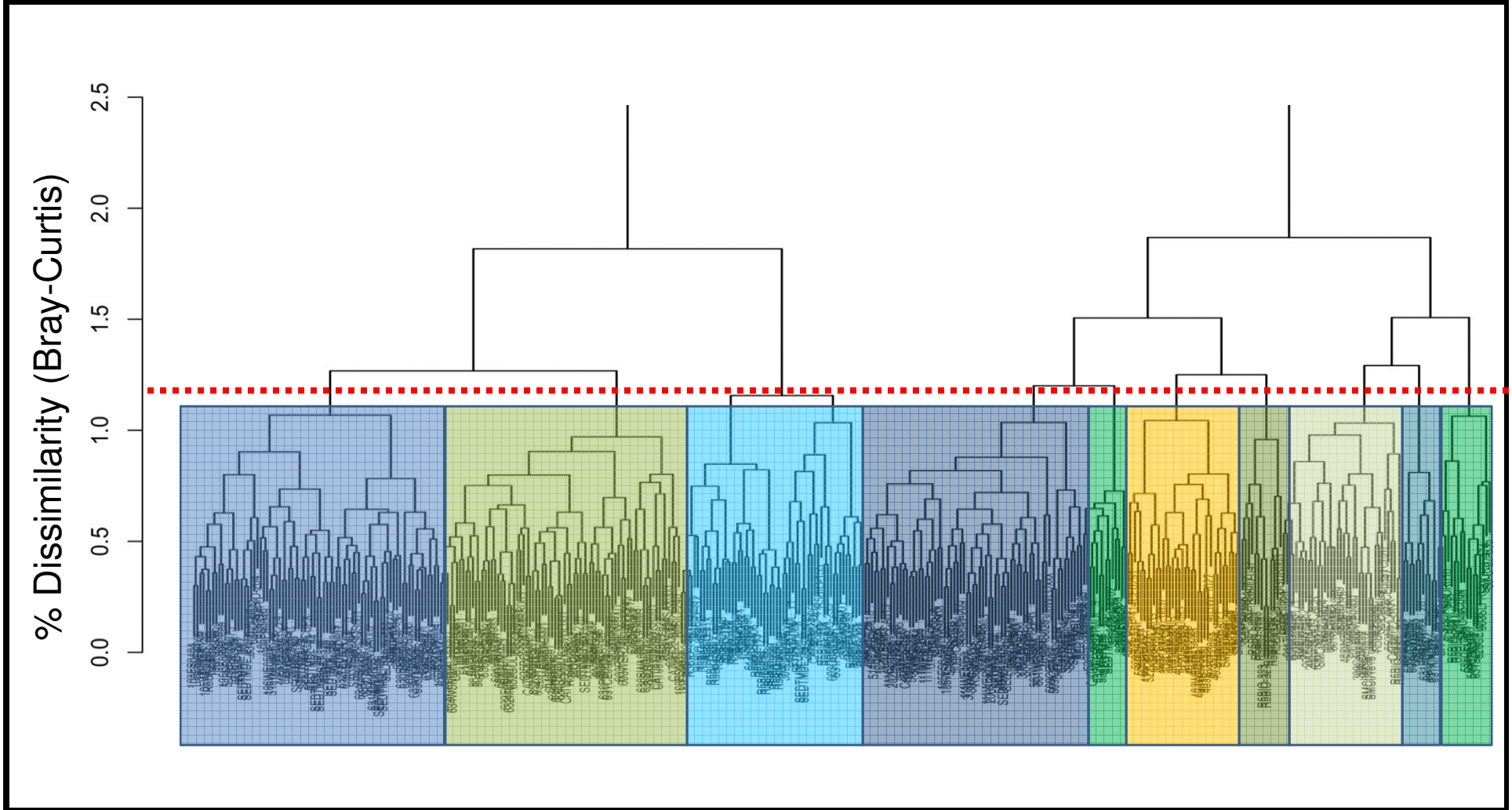
O/E = 3 / 4.07

O/E = 0.74

O/E (scaled 0.0 to 1.0): represents proportion of native assemblage present at test site

Step 2: Cluster biological similarity

(Bray-Curtis dissimilarity, flexible-β = -0.25, rare taxa removed if < 2.5% of sites)



Scoring Tool Performance Measures

1. Precision
2. Accuracy
3. Responsiveness
4. Repeatability
5. Applicability