Rapid Causal Assessment Screening Tool

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Goals

- **Develop a user-friendly tool to screen sites for likely causes of biological impairment**

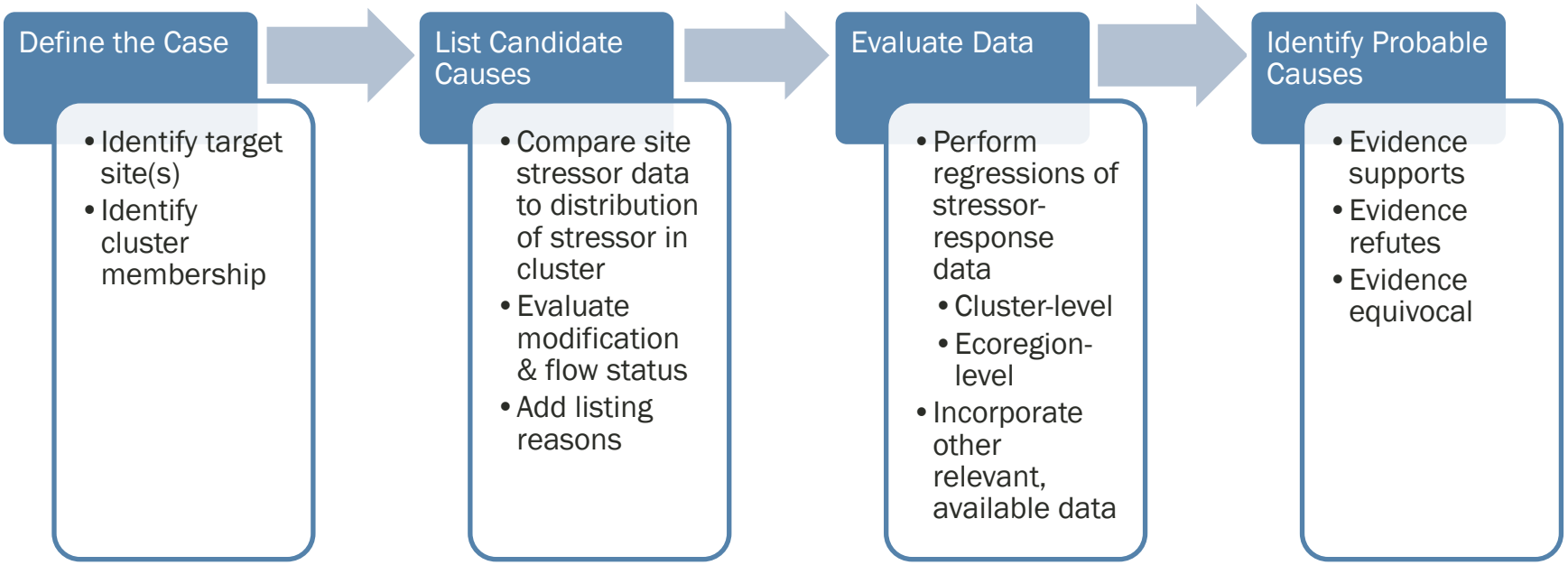
- **Incorporate current science in the approach**
  - New way of establishing appropriate comparator sites
  - Species tolerance information for certain types of stressors
  - Flow ecology models and indicators of hydrologic alteration
  - Indicators of physically modified sites

- **Incorporate as much available data as feasible**

Objectives

- Rapidly rule out unlikely stressors
- Include relevant analyses that help identify likely causes of biological impairment
- Provide an objective tool to help prioritize sites where restoration efforts are best spent
- Provide a tool that could help identify vulnerable sites in need of further protection

Causal Assessment Screening Approach



Tool components

- **Required data**
  - Predictor (geological, climatological, etc.) (StreamCat, CSCI predictors)
  - Stressor (water chemistry, physical habitat, flow & modification status)
  - Response (biological indices, metrics, taxa lists)
  - Supportive (stressor-specific tolerance values, SSDs, relevant criteria)
- **Required operations**
  - Step 1: Cluster reaches and identify reach cluster for target site(s)
  - Step 2: Identify potential stressor(s)
  - Step 3: Graphical analysis of stressors vs. responses
  - Step 4: Generate weight-of-evidence/graphical & summary output

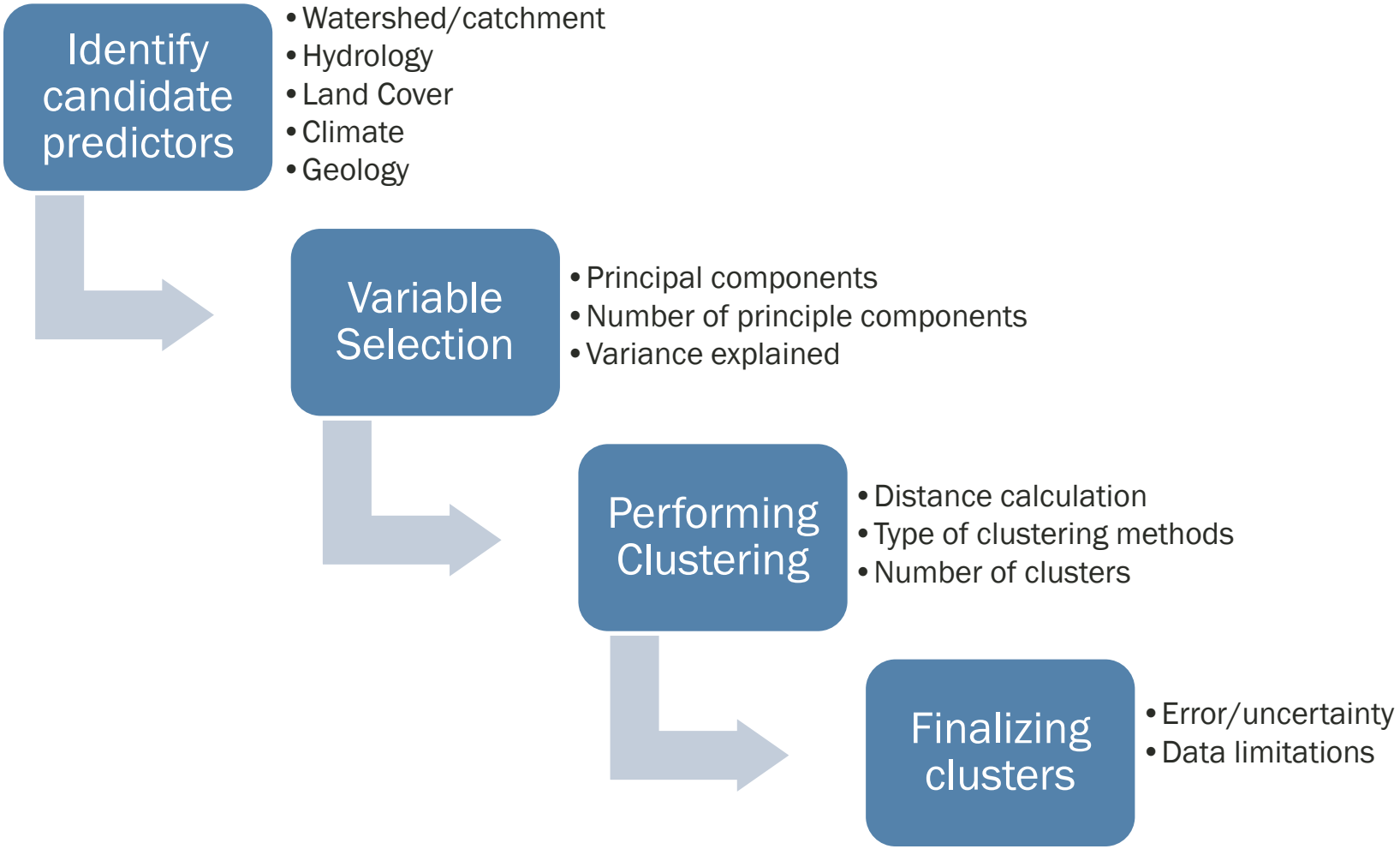
Step 1: Define the Case

Define the Case

- Identify target site(s)
- Identify cluster membership

- **Identify target sites**
  - What sites might be target sites?
    - Sites on impaired reaches from the 303(d) list
    - Specific sites with low CSCI scores
  - What data are required from the site?
    - Location (reach ID)
    - Available stressor and biological data
      - Includes taxa lists, calculated metrics, and calculated indices
- **Cluster sites**
  - Identify sites with similar biological expectations to the target

Step 1. Clustering Process

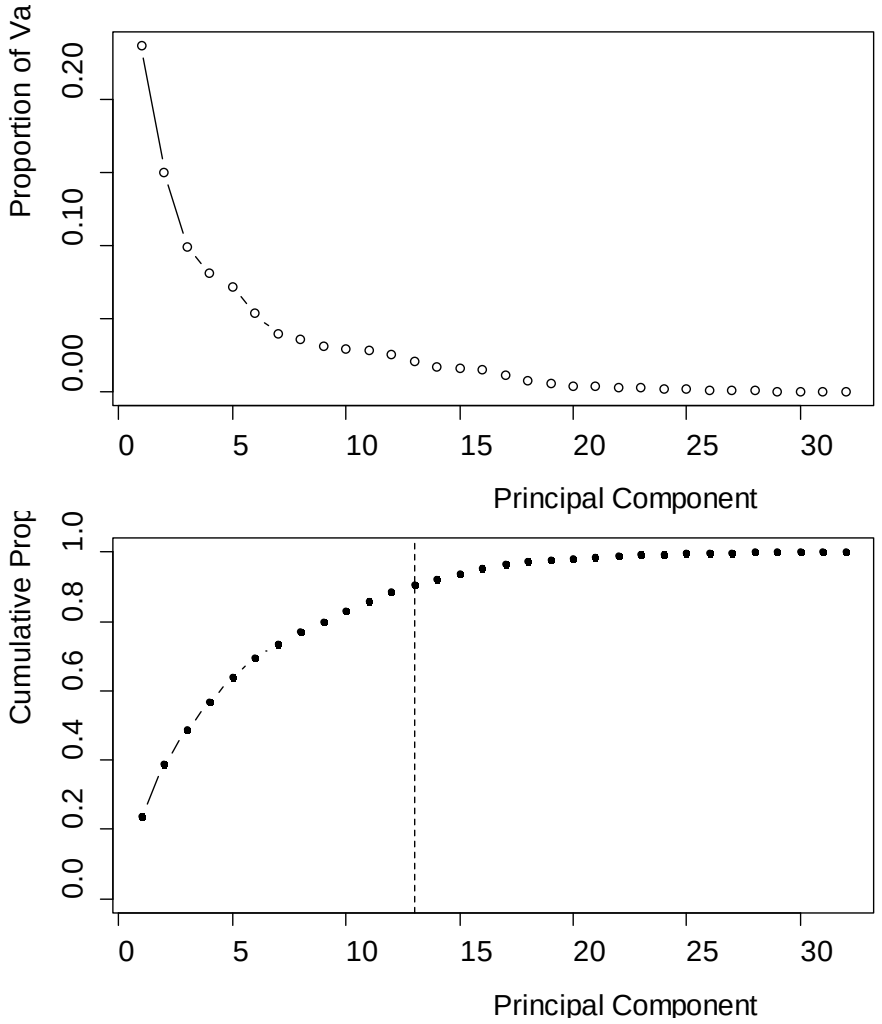


Candidate data for clustering

- **NHD+ version 2, all reaches within Southern California/Northern Baja Coast ecoregion (Ecoregion 85)**
- **StreamCat predictive data**
  - Reach characteristics (latitude, longitude, watershed area, elevation, slope)
  - Hydrological (baseflow)
  - Climatological (temperature, precipitation, runoff)
  - Geological (soil type, lithology)
- **Optional data**
  - Land cover (percent agriculture, forest, urban, impervious surface
  - Modifications (dams, mines, road crossings)

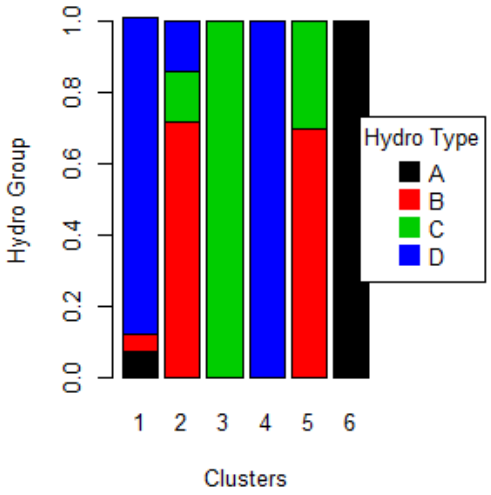
Variable Selection

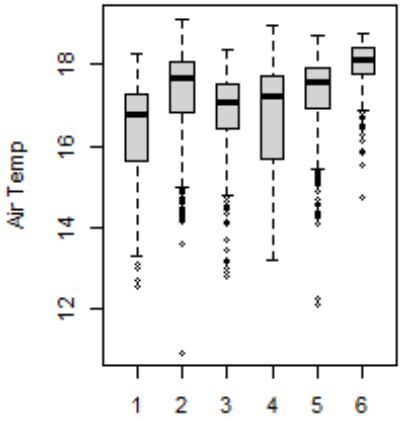
- **Numeric variables**
  - Principal component loadings
  - Select number of axes
    - 13 with land cover, 9 without
  - 90% variance explained
  - Select highest loading for each axis
- **Categorical variables**
  - Rock
  - Soil
  - Landscape position

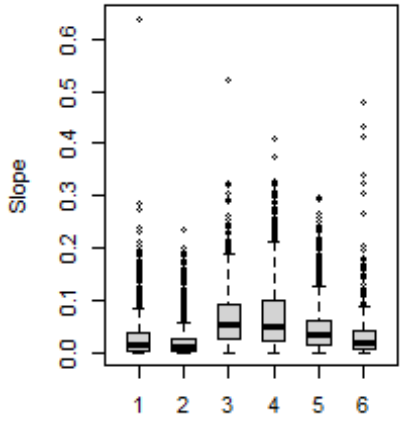


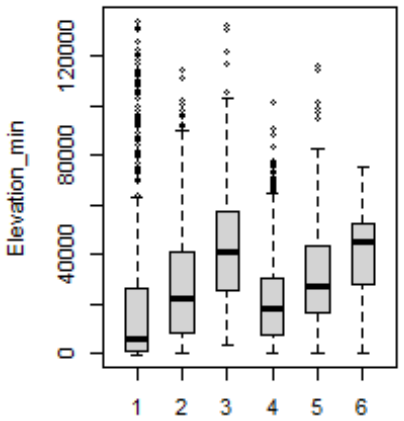
Clustering method

- **Calculate distance (R cluster)**
  - Numeric variables – interval scaled variables
  - Categorical variables – Gower's distance
- **Identify clusters**
  - Hierarchical clustering (connectivity-based)
  - K-means clustering (centroid based)

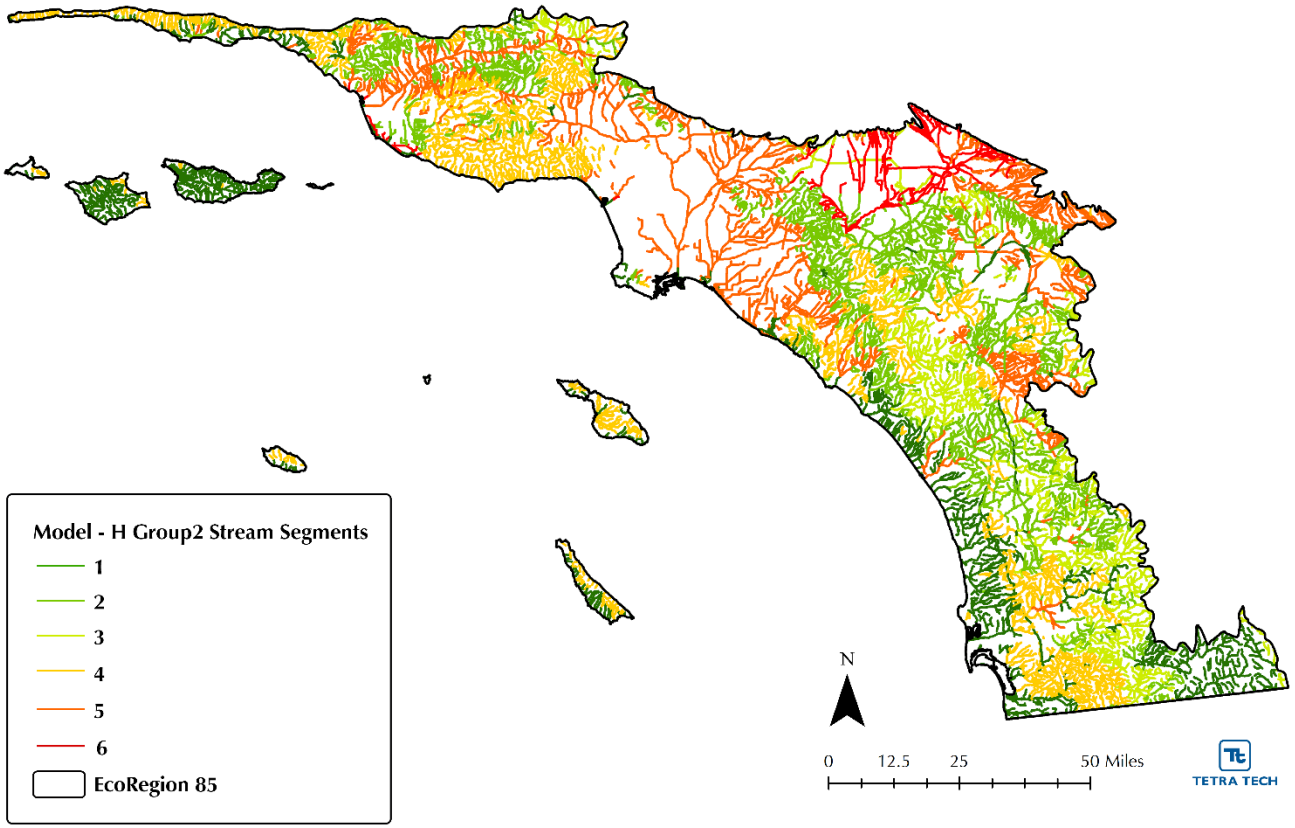








Cluster analysis results – reaches



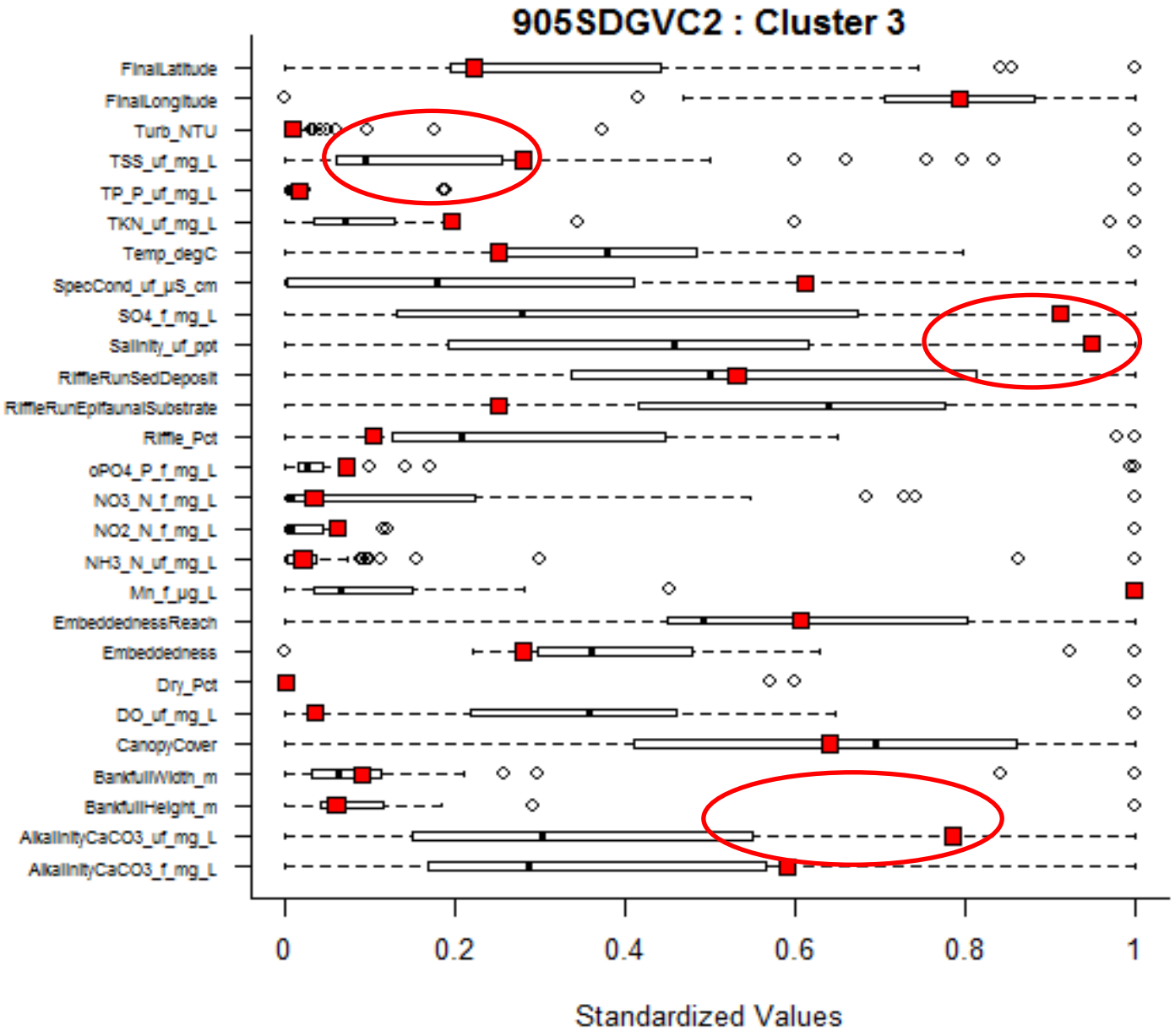
Step 2. Compare stressors to cluster data

List Candidate Causes

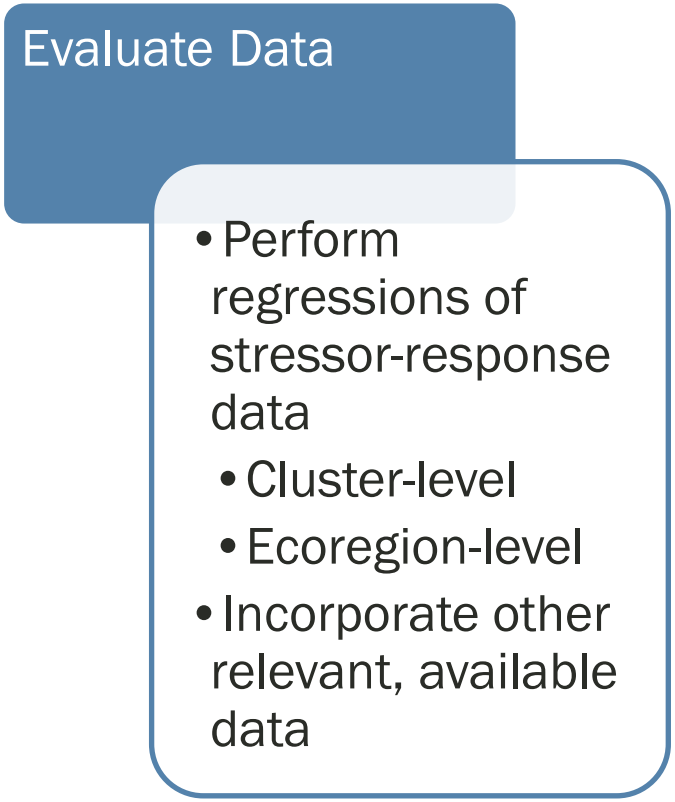
- Compare site stressor data to distribution of stressor in cluster
- Evaluate modification & flow status
- Add listing reasons

Step 2: Compare stressors to cluster data

- **Stressors with values in the extremes of the stressor distribution for the cluster**
  - ≤ 5th percentile
  - ≥ 95th percentile
  - Others as specified by the analyst
- **Physical modifications**
  - Based on physical habitat data OR
  - Based on location on a modified or likely modified stream reach
- **Hydromodification**
  - Based on differences between "reference" and current flow status
- **"Listed pollutants (303(d) list)"**

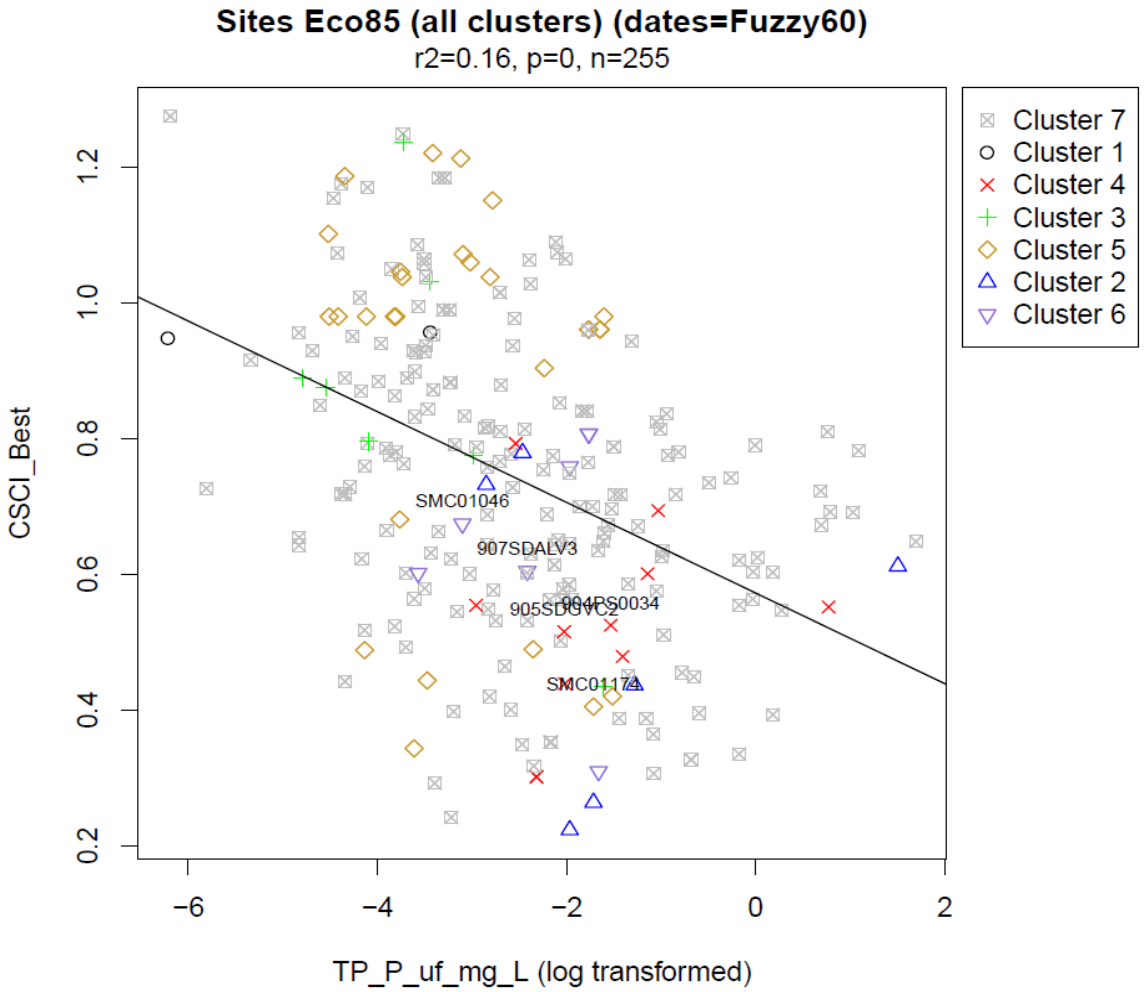

905SDGVC2 : Cluster 3
FinalLatitude
FinalLongitude
Turb_NTU
TSS_uf_mg_L
TP_P_uf_mg_L
TKN_uf_mg_L
Temp_degC
SpecCond_uf_µS_cm
SO4_f_mg_L
Salinity_uf_ppt
RiffleRunSedDeposit
RiffleRunEpifaunalSubstrate
Riffle_Pct
oPO4_P_f_mg_L
NO3_N_f_mg_L
NO2_N_f_mg_L
NH3_N_uf_mg_L
Mn_f_µg_L
EmbeddednessReach
Embeddedness
Dry_Pct
DO_uf_mg_L
CanopyCover
BankfullWidth_m
BankfullHeight_m
AlkalinityCaCO3_uf_mg_L
AlkalinityCaCO3_f_mg_L
0
0.2
0.4
0.6
0.8
1
Standardized Values

Step 3: Stressor-response analysis

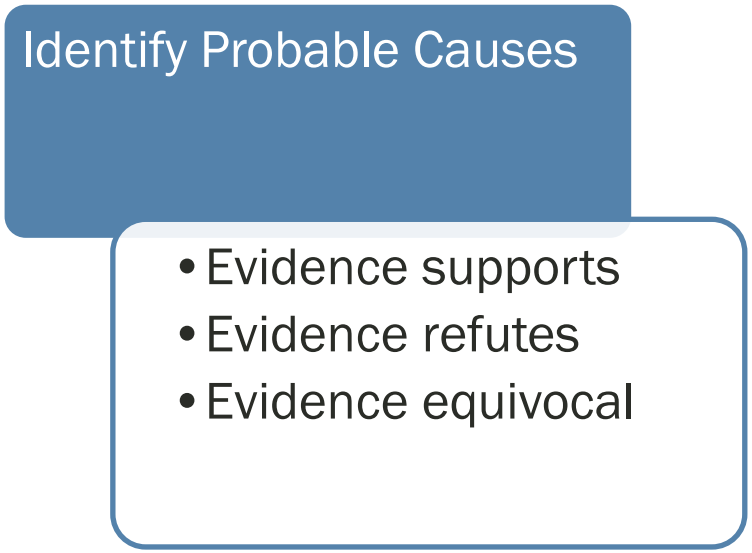


Step 3: Stressor-response analysis

- **Graphical analysis**
- **Stressor-specific data**
  - Species tox values
  - Species-sensitivity distributions
  - Tolerance values
    - Conductivity
    - Fine sediment
    - Nutrients



Step 4: Summarize weight-of-evidence



Provide preliminary scores

- Report either: ↑ (supports), ↓ (refutes), or ↔ (equivocal); not detailed CADDIS scores
- Not all lines of evidence can be evaluated

Causal Considerations	Conductivity			TSS			Turbidity		
	CSCI	% EPT	% intol	CSCI	% EPT	% intol	CSCI	% EPT	% intol
Co-occurrence (spatial & temporal)	↑	↑	↑	↑	↑	↑	↓	↓	↓
Biological Gradient	↑	↑	↓	↑	↑	↓	↑	↑	↓
Consistency of Association	↑	↑	↑	↑	↑	↑	↑	↑	↑

Current Status

- **Proof of concept completed**
- **Prototype tool in development**
  - Refining clustering methods and data
  - Refining graphical analysis options
    - Confidence intervals vs predictions
  - Identifying and incorporating additional supporting data (criteria, SSDs, stressor-specific tolerance values)
  - Formulating report formats and other requirements
  - Designing user interface

THE END

Extra slides follow

How can we streamline?

- **Identify steps that can be performed on many sites at once**
- **Eliminate lines of evidence that provide limited value in the analysis, often due to lack of information**
  - Experimental evidence (on site media or from field experiments)
  - Specificity of cause (except in limited cases)
  - Predictive performance
- **Provide specific tools that are valuable as diagnostic indicators for particular stressors, e.g.:**
  - Conductivity-specific tolerance values
  - Species-sensitivity distributions

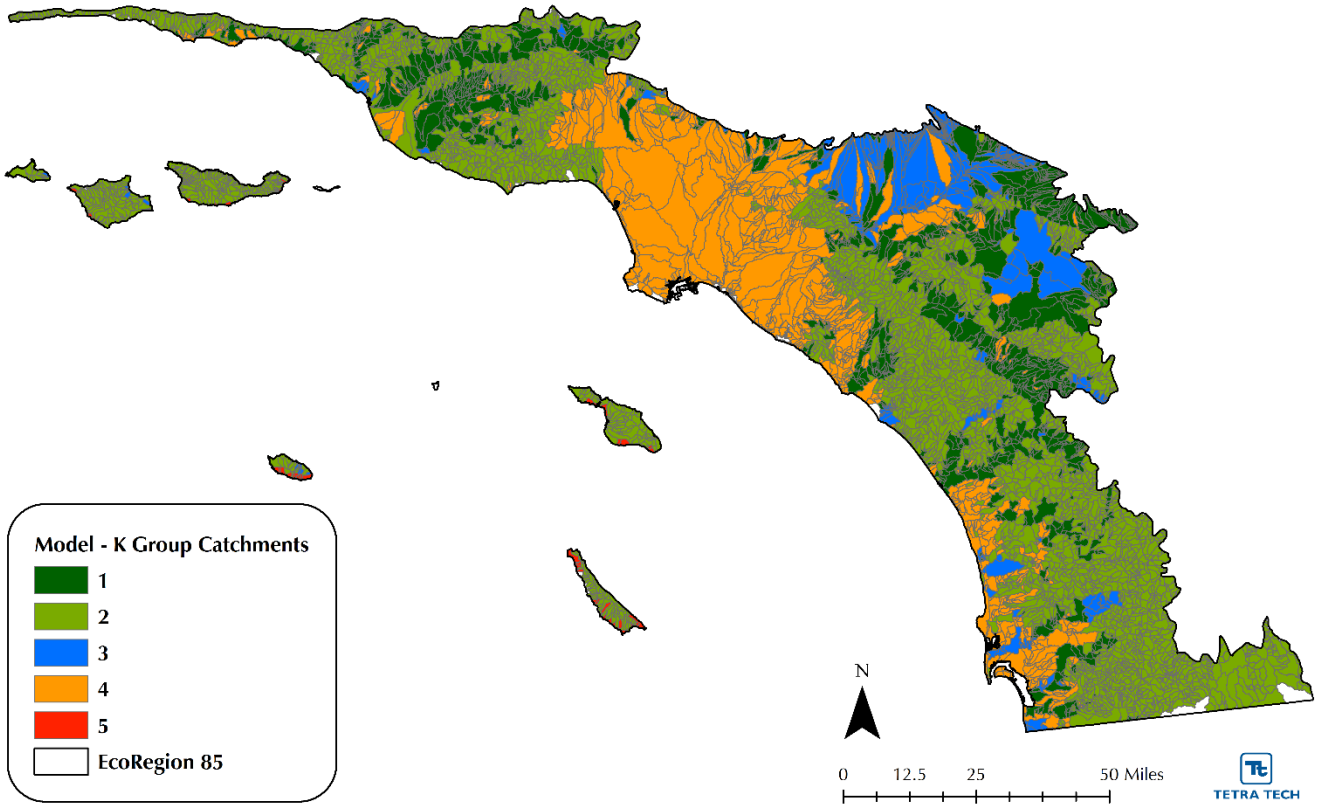
Stressor Identification steps

- Step 1: Define the case
- Step 2: List candidate causes
- Step 3: Evaluate data from the case
- Step 4: Evaluate data from elsewhere
- Step 5: Identify probable causes

Obtain required data

- **Base layer: NHD+ version 2**
- **Predictor data**
  - StreamCat
  - CSCI Predictors
- **Analysis data**
  - CEDEN (water quality, chemistry, physical habitat, biology)
  - Tt's modified streams
  - SCCWRP's flow ecology data (modeled reference)
  - Tt's perennial/non-perennial streams (current)
  - Additional relevant data
    - Tolerance values, SSDs, criteria, etc.

Cluster analysis results – catchments



Match target sites to reach clusters

- **Show target sites on a map relative to cluster**
- **Show measures of similarity/dissimilarity:**
  - Target site “defining characteristics” compared to most similar and most dissimilar reaches
    - What are “defining characteristics?”
  - Prefer graphical output
    - Bar charts for specific variables
    - Maps showing gradients for specific variables

Flow and modified stream status

- **Is the reach considered modified or likely modified?**
  - Use modified stream GIS layer/COMID
  - Identifies reaches likely to be physically modified due to dams, channelization,
- **Has the flow regime changed?**
  - SCCWRP's flow ecology model outputs "reference" flow status
  - Tt's flow status screening tool estimates current flow status
  - If these don't agree, the flow regime may have been modified and hydromodification should be listed as a potential stressor