Stressor Identification in the Dry Creek Watershed: Findings and Lessons Learned

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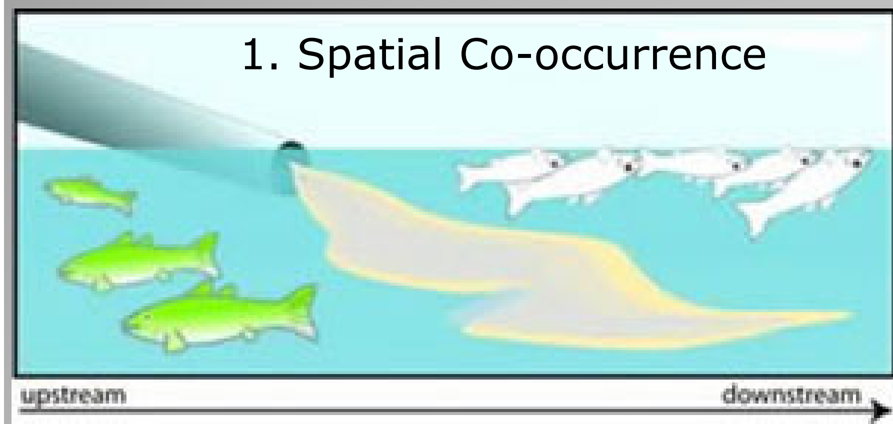
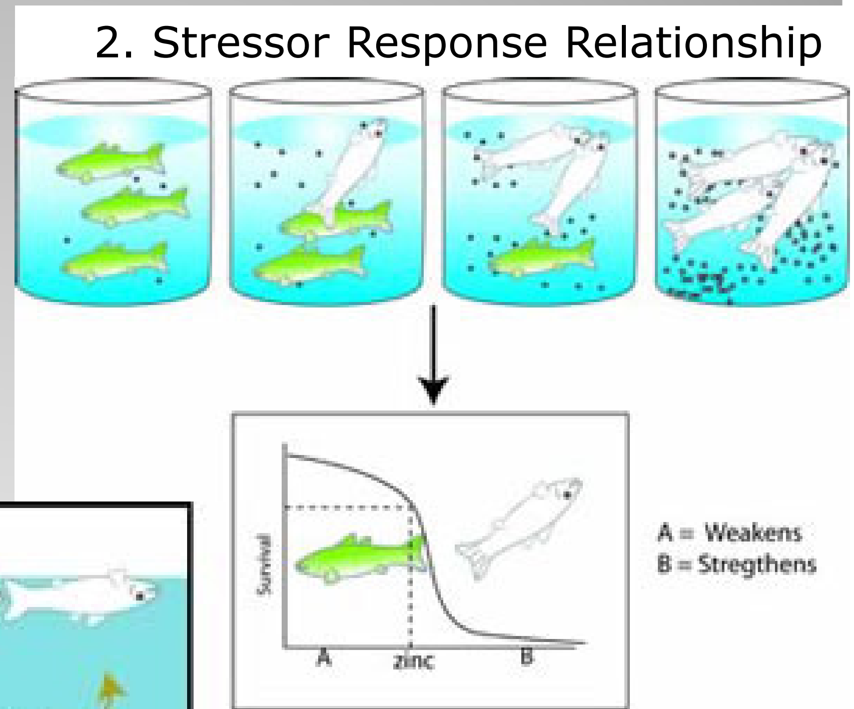
Outline

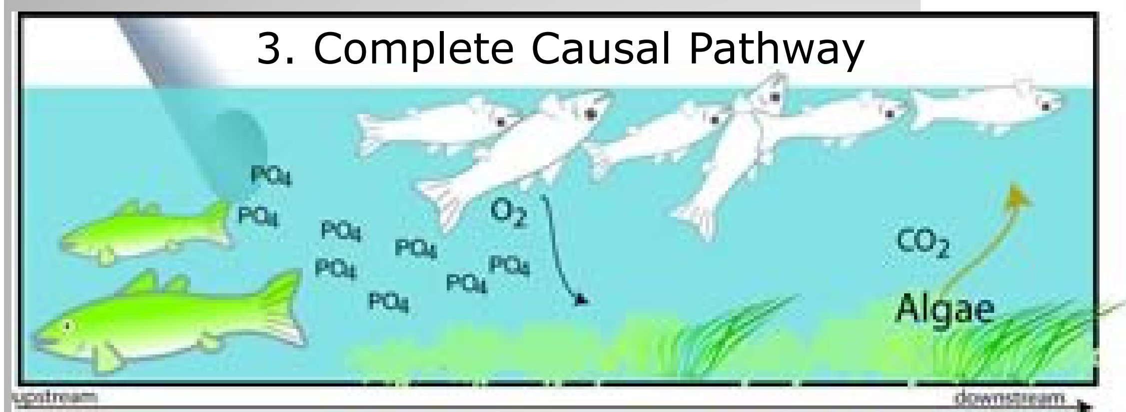
- Background on Stressor Identification (SI)
- Watershed Background
- Review of SI Process
- Preliminary results
- Lessons Learned
- References and Resources
- Questions

- Method based on epidemiological principles designed to identify **causes of impairment** to ecological endpoint of interest.
- Supported by the CADDIS website
  - Guidance on principles
  - Conceptual models
  - Statistical methods
  - Literature
  - Case studies

Overview - Stressor Identification

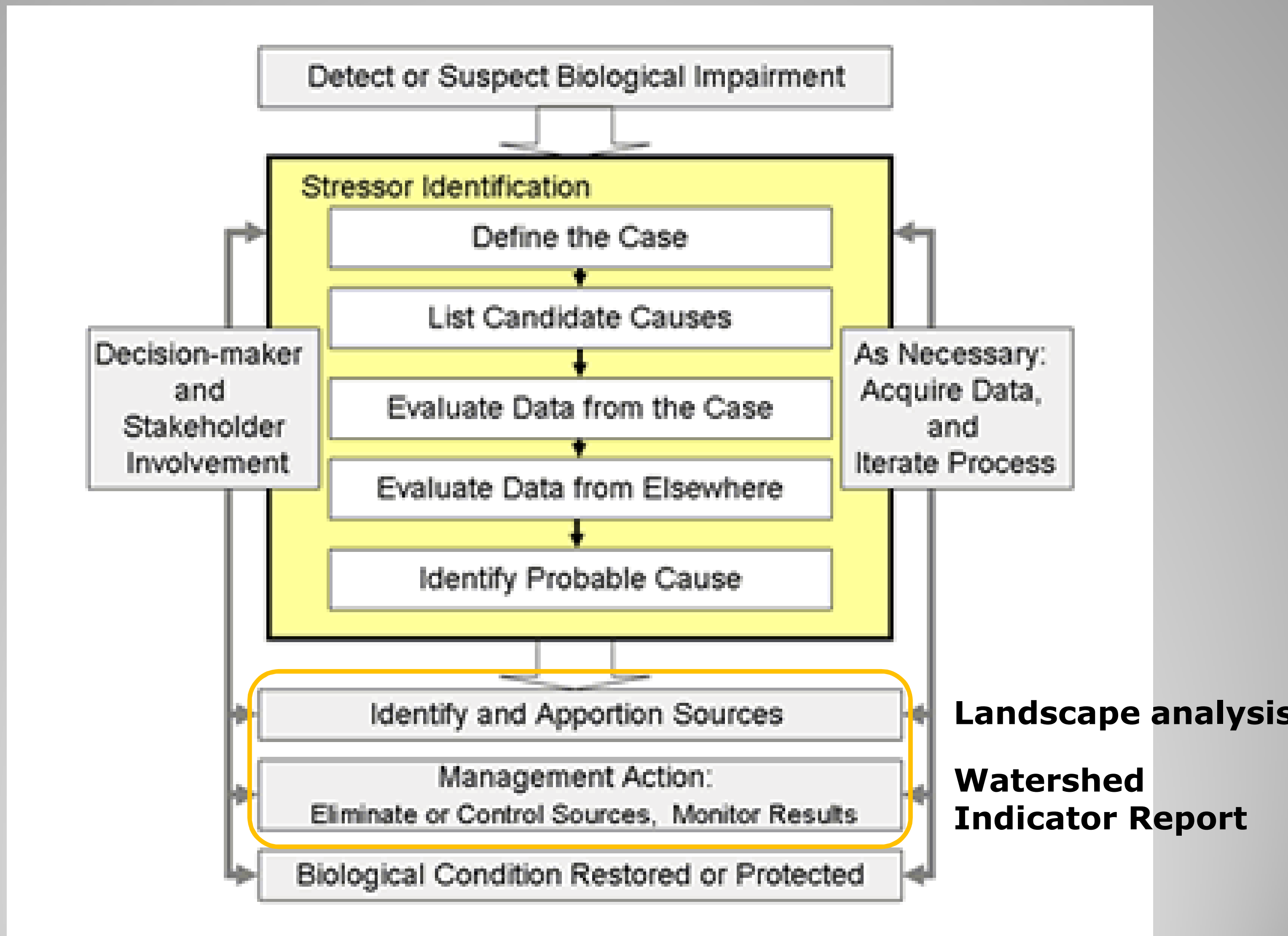






Additional criteria, we did not use

SI based on epidemiology principles of causation

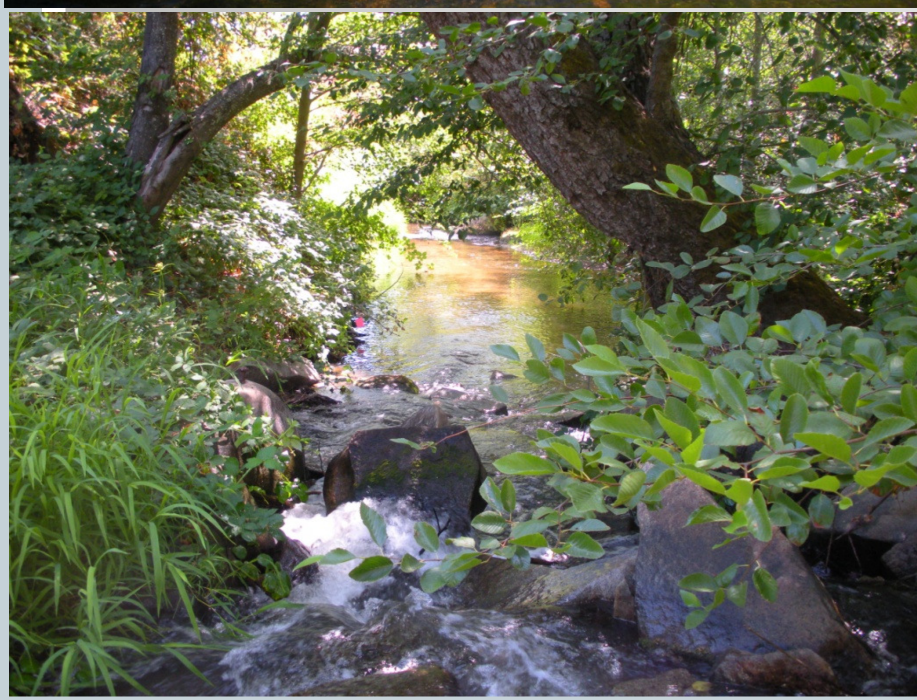

Detect or Suspect Biological Impairment
Stressor Identification
Define the Case
List Candidate Causes
Evaluate Data from the Case
Evaluate Data from Elsewhere
Identify Probable Cause
Decision-maker and Stakeholder Involvement
As Necessary: Acquire Data, and Iterate Process
Identify and Apportion Sources
Management Action: Eliminate or Control Sources, Monitor Results
Biological Condition Restored or Protected
Landscape analysis
Watershed Indicator Report

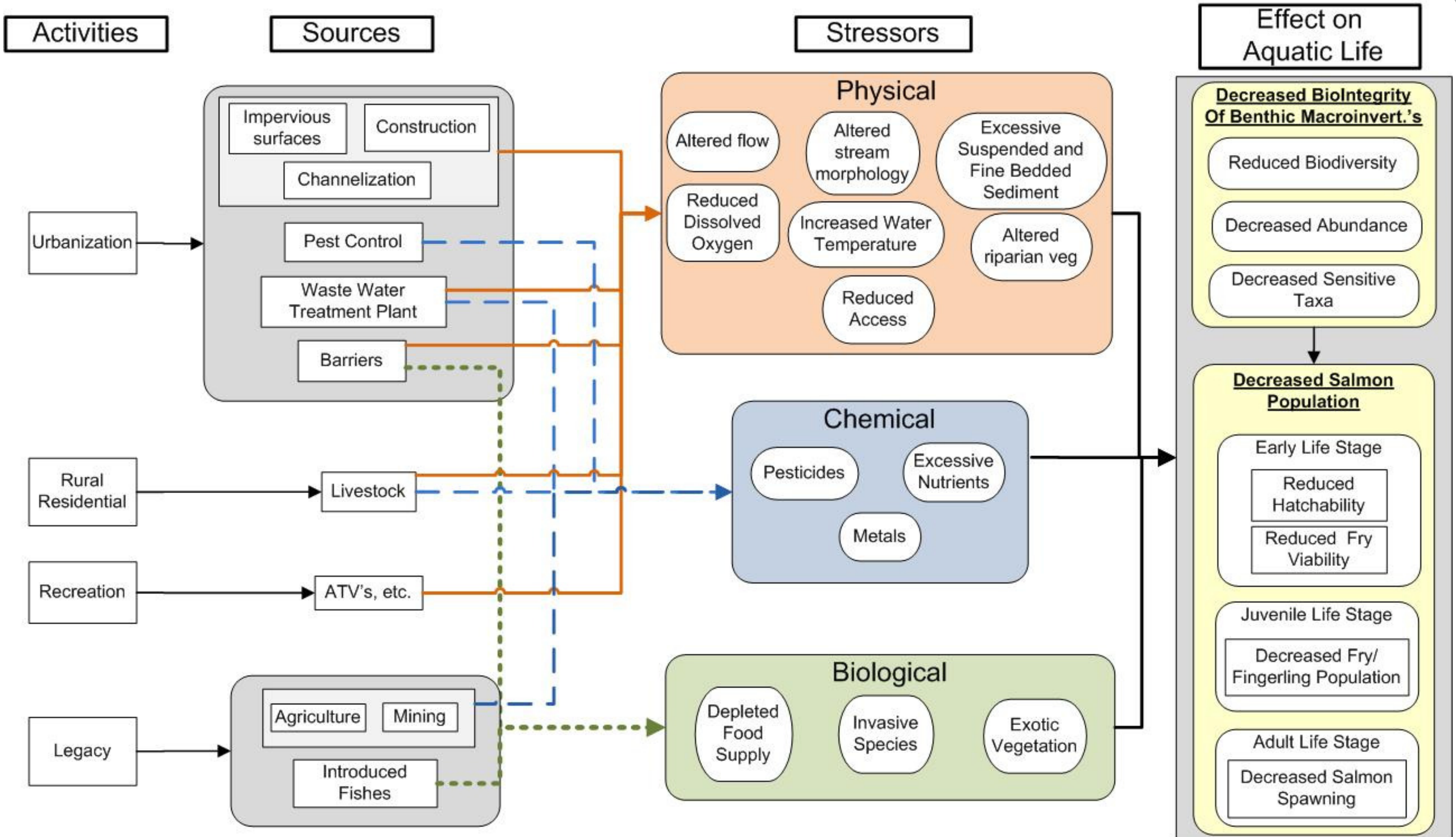
SI Process

About 100 sq. miles
Declining population of fall run chinook salmon

Dry Creek Watershed





Dry Creek Conceptual Model

- Data collected by Dry Creek Conservancy, a local watershed non-profit
- 6 years worth of grab sample
  - Contaminants
  - Conventional parameters
- Sonde and global water logger data at selected sites for 2 years
- Fish counts (carcass and live fish) for 10 years
- Bug metrics & PHAB – 6 years
- Aerial photographs
- Land Use data layers
- Analyses of impervious cover & GLU
- Other: pyrethroids, sediment toxicity, etc.

Data

Statisical Methods

- Guiding Principle: Statistical significance $\neq$ Biological significance
- Spatial Co-occurrence: Qualitative interpretation of box-whisker plots
- Stressor Response Relationships
  - Spearman’s correlations
    - Relationship between potential stressors and biological endpoints
    - Double check - Bonferroni’s correction for significant p value
  - Quantile Regression
    - Identify sampling sites specific explanatory variables affected bug metrics

STRESSOR IDENTIFICATION

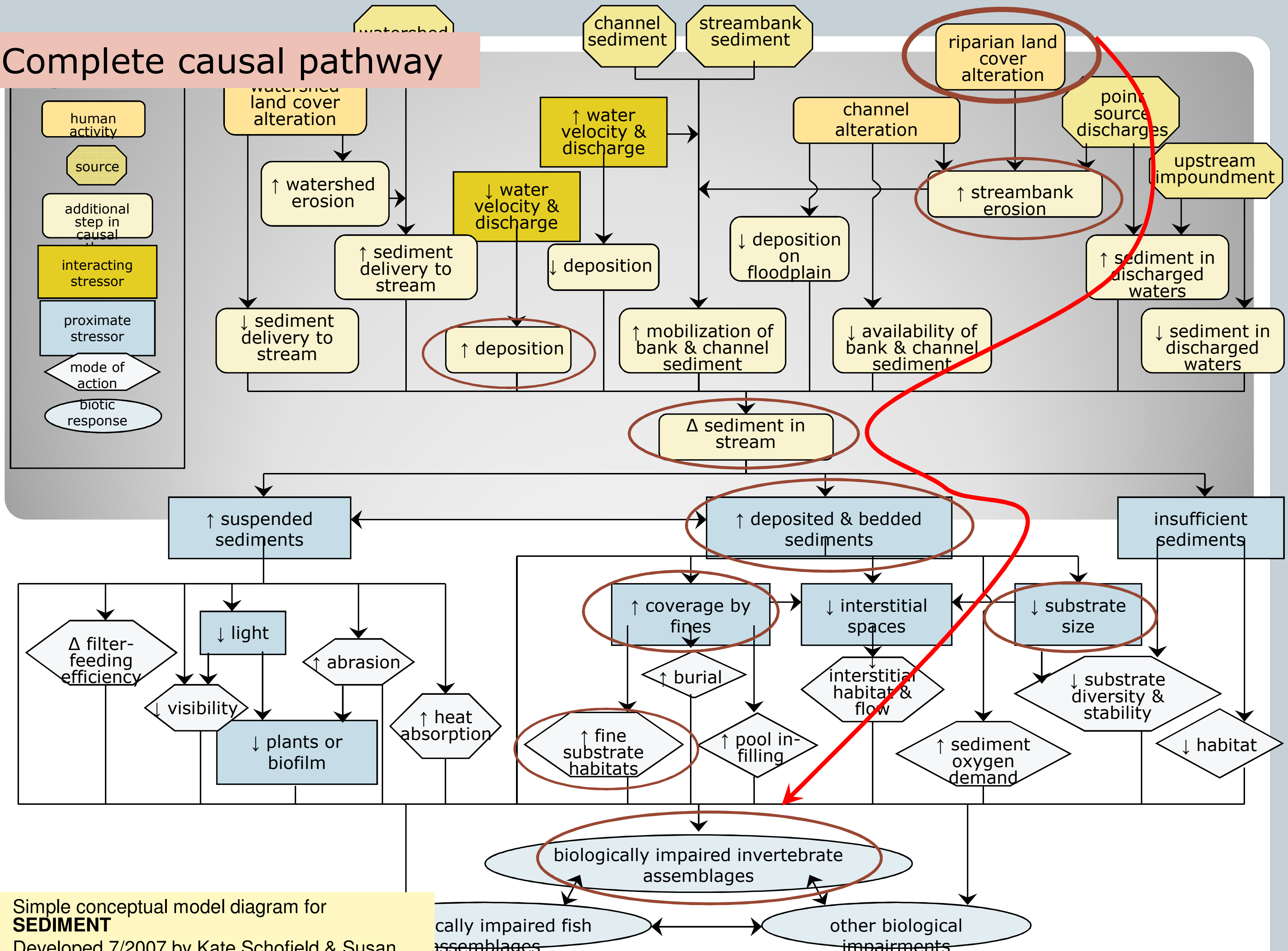
EVALUATION OF STRESSOR:

Strength of Evidence Criteria from the Case	Definition	Special Criteria	Score	Confidence in Score	FINAL SCORE (impact * weight)
Spatial co-occurrence or evidence of exposure (includes both spatial co-occur and evidence of exposure in CADDIS)	When the stressor is present, the effect is present. When the stressor is not present, the effect is not present. Effects decline as exposure declines over space. Considers high levels of cause associated with high levels of response and low levels of putative cause associated with low levels of response. Reference site is DCC 5.		3	2	6
Stressor-Response relationship (Biological Gradient)	Presence of a stressor response relationship using data from all 10 sites.	No. of R > 0.55 = 8 No. signif. p values ___9_____ Direction of Corr Appropriate?: Yes	5	3	15
Complete Causal Pathway (Data linking stressor and effect or providing supporting evidence)	Is there data that link the candidtate stressor with a pathway that would cause the effect. The causal pathway should include information/data on the source of the stressor (ex: landscape data), the stressor itself, and any intermediate data that links the sources to candidate stressor with the effect.	**Description of Linkage:**	5	3	15
Strength of Evidence from other situations				SUB TOTAL	36
Mechanistically Plausible Cause	Is the relationship between cause and effect consistent with known scientific principles? Include special studies or field/lab studies		5		4
Stressor-response relationship	What information is in the literature or from other studies at the site that support a S-R relationship	see summary below.	4		4
Specificity	Does the effects only occur as a result of a few causes		1		1
				TOTA	10

Erman & Erman, 1984, increasing d50, increase total # bugs, total taxa, EPT, and chironomids. Kaller & Hartman 2004, found inverse relationship between % fines >0.25 mm and EPT taxa. Garcia River TMDL finds >14% 0.85 mm impairs embryo survival. Andgradi et al 1999 2mm and less study. Stats sign but weak corr between fine sediment and EPT taxa (neg), % baetids of ephemetropera (pos), and % two chironomid sub families to fine sediment. Not very strong data. Tech Report on linkage of sed supply and bugs Cover et al 2006, they report neg relationships between EPT taxa and % fines neg, taxa rich & fines neg, chironmids & fines pos. 5 of 6 ephem decreased, 3 of 4 plecop incr, 5/6 tricop decreased, 3/4 dipteran increased. There is strong data from fish studies.
Data collected from CSUS study and Bren study CSUS - 2010, Bren 2003.
DCC5: Bren sampled from known redd sites: 14% fines < 0.85 mm, CSUS study, not in redd sites, but representatives cross sections, value was 13% < 0.85 mm. Very similar. Large number spawning salmon historically.
DCC6: Bren value was 18.9%, CSUS value was 9-10%. Big difference. Few spawning fish. Consistent with bug metrics seen at two sites.

GRAND TOTAL = 46

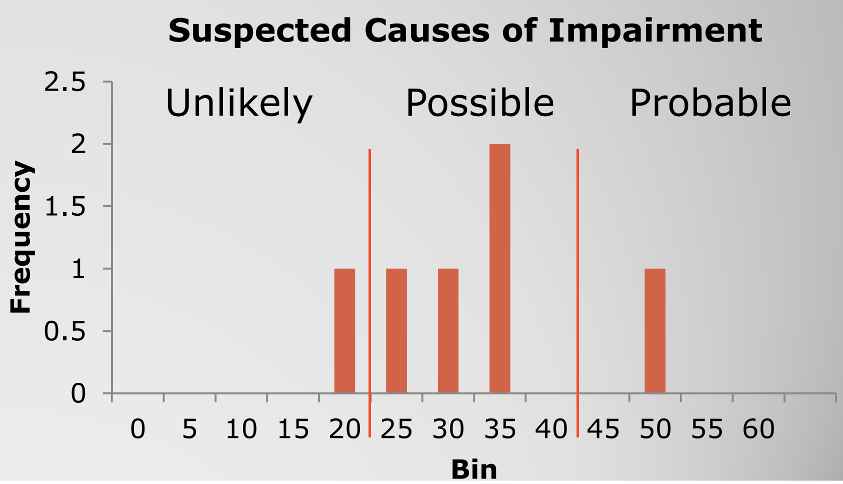
Complete causal pathway



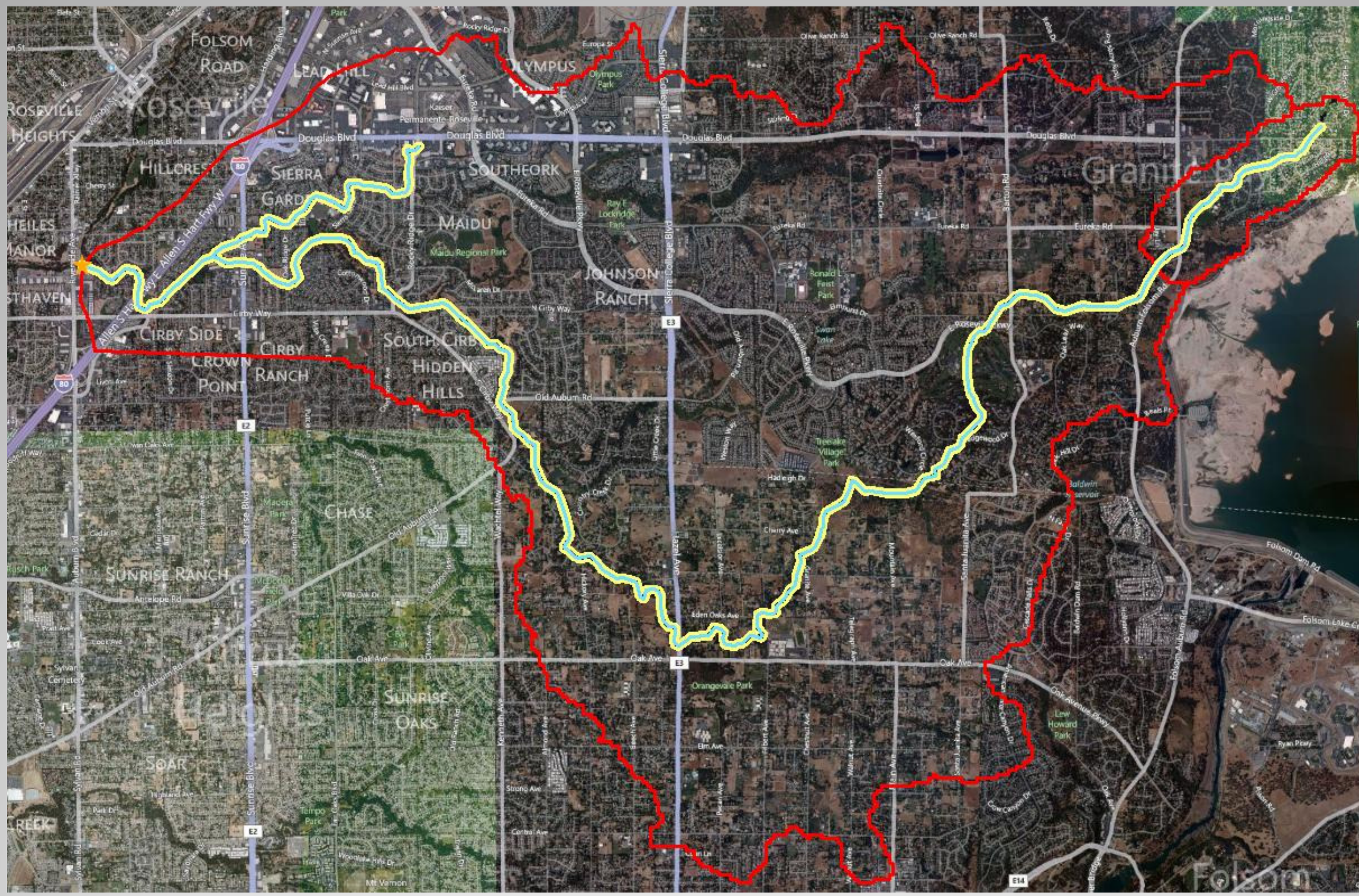
Simple conceptual model diagram for **SEDIMENT**
Developed 7/2007 by Kate Schofield & Susan Cormier; modified 7/2010

Stressor	Total Score
Copper	18
% Silt Sand Fine Gravel	46
Dissolved Oxygen	33
Epifaunal Substrate	28
Vegetative Cover	23
Velocity Depth Regime	32

3 groups:
-Unlikely stressor
-Possible stressor
-Probable stressor
Best method for grouping scores…natural breaks?



Preliminary results



Analysis of Landscape Factors within the sub-watershed

DCC 9

Land use within stream network buffer & in close proximity to sampling site had strongest relationship with bug metrics

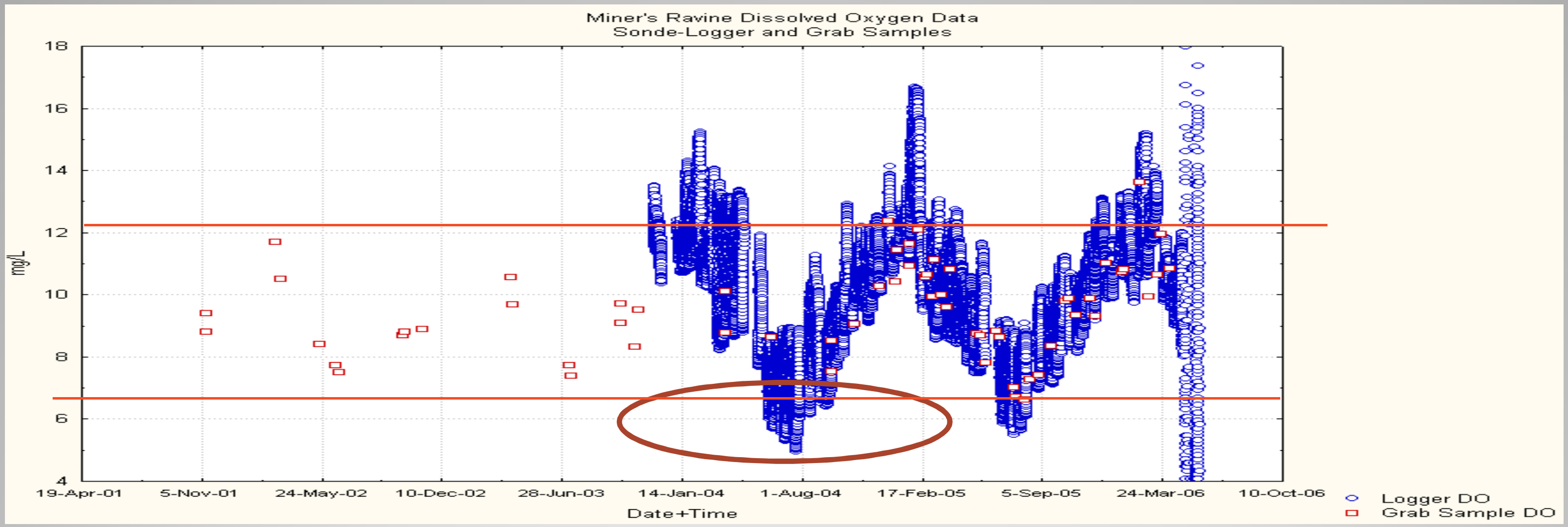
Landscape Factors within 1.5 km upstream of monitoring site

- Water quality: DO only measure that was influential (possibly secondary to nutrients), no contaminants, in general, few significant relationships.
- PHAB: %SSG and measures of instream habitat (e.g.,velocity/depth regime) most significant
- Landscape: Disturbance in close proximity to the sampling site and waterways had the strongest influences on response variables
  - Open space in100 ft. in buffer in stream network (+)
  - 1.5 km upstream drainage shed (+)
  - % impervious cover in 100 ft. buffer (-)
- More work to do

Preliminary findings

Lessons Learned

- Importance of high quality data (ex: grab samples vs. logger data).



- Inability to show causation doesn't mean stressor isn't important (spotty data - pyrethroids, metals in sediment)
- Value of identifying correlations between land uses/landscape metrics and BMI data
  - Helps in focusing on sources of problem, leads to solutions

Lessons Learned

- Unable to use all of US EPA's SI evaluation criteria due to lack of appropriate data:
  - Criteria: Manipulation of exposure, data from toxicity tests, temporality
  - Ex: temporality…our dataset did not go back far enough to capture differences in landscape conditions. No pre-development data.

- Approach to evaluating a stressor that may pose a problem for fish but not for bugs (or vice versa) at levels observed in the watershed
  - Ex: Temperature – salmon vs. bugs
- More thought needed for widespread use (NPDES permits):
  - Resource intensive effort
    - Interdisciplinary review team
    - Significant investment of time
  - One option: develop modules of characteristic urban and rural stressors
    - Urban module already exists. Module contains conceptual models, typical sources, stressors, and effects of urban stream syndrome, etc.
    - Rural/ag module could be developed
    - Recommended set of data for collection

Issues for further consideration

- CADDIS
  - http://www.epa.gov/caddis/index.html
- Stressor Identification Guidance Document
  - http://www.epa.gov/ost/biocriteria/stressors/stressorid.pdf

References and Resources

- Dry Creek Conservancy, Gregg Bates & David Baker
- City of Roseville, Delyn Ellison-Lloyd
- SACOG, Joe Concannon
- Placer County, Brian Keating & Ed Sullivan
- US EPA, ORD, Sue Norton
- OEHHA: Rose Cendak, Carmen Milanes, Karen Randles, Audra Heinzel, Ashley Cates, Katey Yancey
- State Water Board, Eric Bernsten
- cbec, Chris Bowles
- SFEI: Aroon Melwani
- DFG: Jim Harrington

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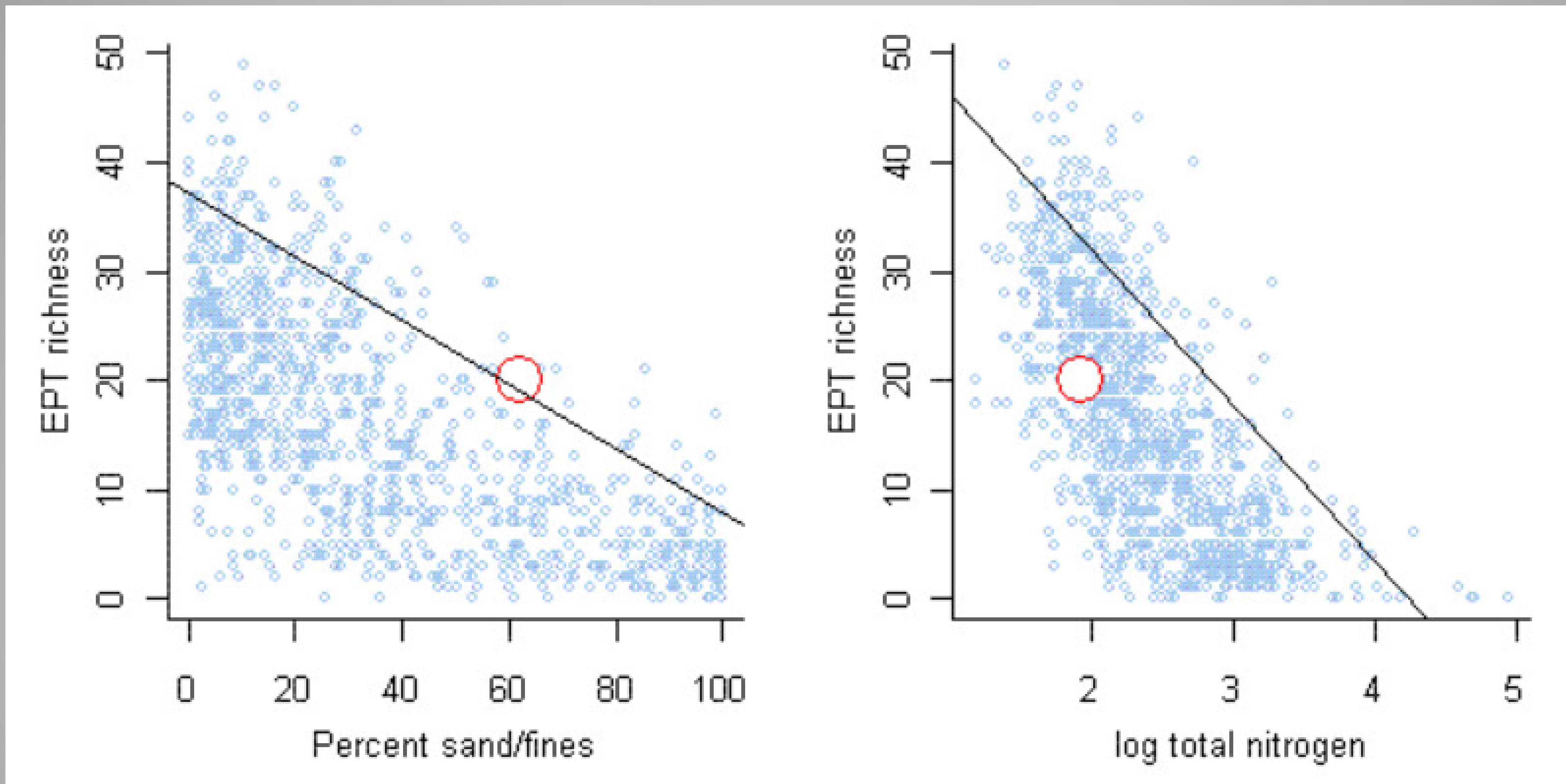
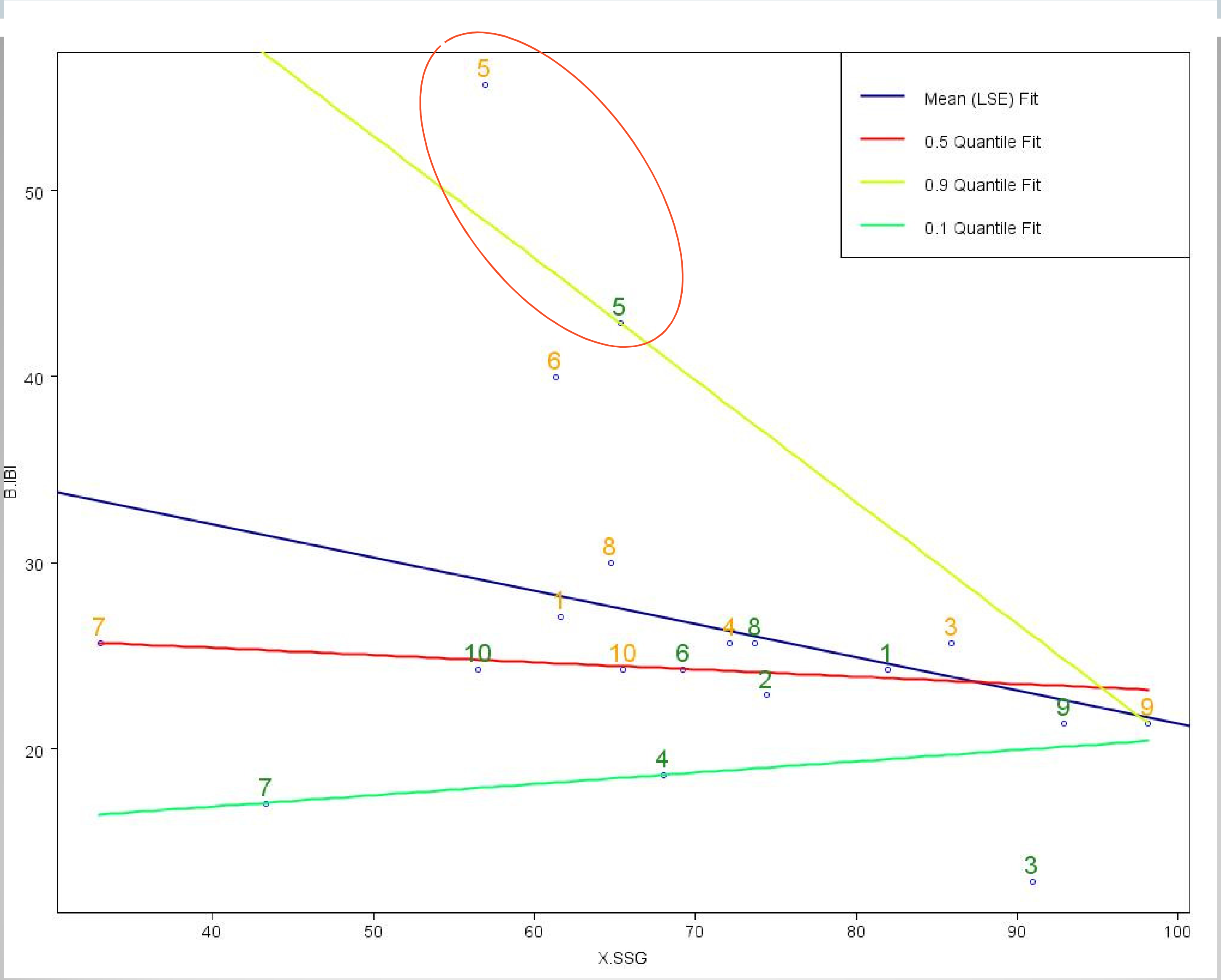


Quantile Regression

Helps to identify relationships when many factors influencing response variable.
EPT richness values around 90th percentile suggests that the explanatory variable (% sand/fines) played an important role at a particular sampling site or reach of waterway.



Quantile Regression: B-IBI as a function of % Silt, Sand, Fine Gravel

CADstat plug-in for R available to perform analysis