National Biological Assessment and Criteria Workshop
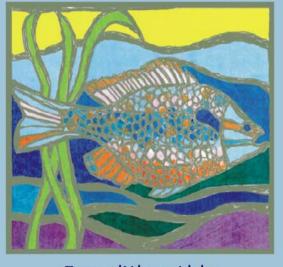
Advancing State and Tribal Programs

Coeur d'Alene, Idaho
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Case Study: Little Scioto River

Analyze Evidence & Characterize Cause

Step 2: Eliminate
Step 3: Diagnose
Step 4: Compare Strength of Evidence
Step 5: Identify Probable Cause

STEP 2:
Eliminate

a: Analyze Evidence

b: Characterize Cause by Eliminating Candidates

Step 2a: Analyze Evidence for Elimination:

1. Spatial co-location of candidate causes with Impairment A
2. Analysis of Exposure Pathway

Candidate Cause	Detected at Site A?	Decreased quality at Site A compared with Upstream Site?	Exposure pathway complete at Site A?
Habitat alteration			
PAHs			
Metals			
Ammonia			
Low-dissolved oxygen/BOD			
Nutrient enrichment			

Uncertainties: Measurement methods, sample size, data/time of sample, other?

Step 2b: Characterize Cause by Eliminating Candidates

Which candidate causes remain?

	RM 7.9 Impairment A
#1 Habitat alteration	
#2 PAH Contamination	
#3 Metal Contamination	
#4 Ammonia	
#5 Low DO/BOD	
#6 Nutrient Enrichment	

STEP 3:
Diagnose

a: Analyze Evidence for Diagnosis

b: Characterize Cause by Diagnosis

Step 3a: Analyze Evidence for Diagnosis

Are Causes Subject to Diagnosis?

Candidate Cause	Symptom or suite of measures specific to cause?	Observed at site?
Habitat Alt.		
Metal Contamination		
Nutrient Enrichment		

STEP 4:
Strength of Evidence

a: Analyze Evidence for SOE comparisons

b: Characterize Cause by Comparing Strength of Evidence

4a.   Analyze Evidence from the Case

- **Co-occurrence**
  - Use analysis conducted for elimination
- **Temporality**
  - No measurements available prior to the impairment
- **Consistency**
  - Used biological gradient instead, because variables are continuous
- **Biological Gradient**
  - Analyze correlations from the reach
- **Exposure Pathway**
  - Use analysis conducted for elimination
- **Experiment**
  - No experiments relevant to the remaining causes

4b: Compare strength of evidence for the three candidate causes of Impairment A

Causal Consideration	Evidence	Score	Evidence	Score	Evidence	Score
Case-Specific Considerations						
	Habitat Alteration		Metals Contamination		Nutrient Enrichment	
Co-occurrence						
Temporality	No evidence	NE	No evidence	NE	No evidence	NE
Consistency of Association	No evidence	NE	No evidence	NE	No evidence	NE

NE = no evidence; NA = not applicable/not available

Step 4a: Analyze Evidence from the Case for SOE: Biological Gradient

Correlations between selected measurements and biological responses.

Uncertainties: Sample size, Covariation, Other?

	Relative weight of fish	DELTA	Percent mayflies	Percent tolerant invertebrates
Cr[1]	-0.50	0.75*	-0.71*	0.61
Cu[1]	-0.29	0.64	-0.54	0.81*
Pb[1]	-0.39	0.54	-0.64	0.68
Zn[1]	-0.71*	0.75*	-0.89*	0.43
Nitrate and Nitrite[2]	-0.75*	0.86*	-0.75*	0.14
Total Phosphorus[2]	-0.75	0.96*	-0.86*	0.54
Minimum DO[2,3]	0.89*	-0.77*	0.94*	-0.6

[1]Concentrations measured in sediment. [2]Concentrations measured in water. [3]n=6

Correlations denoted with an asterisk are greater than 0.70.
All correlations for Channel, Silt, and Embeddedness scores, were less than 0.70 are not shown. N=7 except where noted.

4b: Compare strength of evidence for the three candidate causes of Impairment A (continued)

Causal Consideration	Evidence	Score	Evidence	Score	Evidence	Score
Case-Specific Considerations						
	Habitat Alteration		Metals Contamination		Nutrient Enrichment	
Biological Gradient	Increased relative weight:		Increased relative weight:		Increased relative weight:	
	Increased %DELT:		Increased %DELT:		Increased % DELT:	
	Decreased % mayflies:		Decreased % mayflies:		Decreased % mayflies:	
	Increased % tolerant organisms:		Increased % tolerant organisms:		Increased% tolerant organisms:	
Complete Exposure Pathway	Not applicable: No known intermediate steps.	NA	No evidence: Internal concentrations of metals were not measured.	NE	No evidence: concentrations of algae or chlorophyll *a* were not measured.	NE
Experiment	No evidence.	NE	No evidence.	NE	No evidence.	NE

NE = no evidence; NA = not applicable/not available

Step 4a. Analyze Evidence Using Other Situations or Biological Knowledge

Is Causal Mechanism Plausible?

- Habitat Alteration
- Metals
- Nutrient enrichment

4b. Compare strength of evidence for the three candidate causes of Impairment A (continued)

Causal Consideration	Evidence	Score	Evidence	Score	Evidence	Score
Considerations Based on Other Situations or Biological Knowledge						
	Habitat Alteration		Metals Contamination		Nutrient Enrichment	
Plausibility: Mechanism	Increased Relative Weight:		Increased Relative Weight:		Increased Relative Weight:	
	Increased DELT:		Increased DELT:		Increased DELT:	
	Decreased % Mayflies & Increased % Tolerant Organisms:		Decreased % Mayflies & Increased % Tolerant Organisms:		Decreased % Mayflies & Increased % Tolerant Organisms: Plausible:	

NE = no evidence; NA = not applicable/not available

Step 4a. Analyze Evidence for SOE
Using Other Situations or Biological Knowledge Plausibility: Stressor-Response

Uncertainties: Sample size, Covariation, Relevance of Test Endpoint, Other?

Chemical		Upstream Site	Site A
TEL	PEL		
Cu			
28	101.2		
Pb			
37.2	81.7		
Zn			
98.1	544		
Cumulative Toxic Units based on PEL			

TEL and PEL values are for *Hyalella azteca* and are normalized to sediment dry weight.

Step 4a. Analyze Evidence for SOE
Using Other Situations or Biological Knowledge
Plausibility: Stressor-Response

Comparison of the reported concentration of water quality parameters (mg/L) with available criteria.

Uncertainties: Sample size,   Covariation, Relevance of Test Endpoint, Other?

Criterion	Site A
Dissolved Oxygen[b] 3.0 mg/L for MWH	
Nitrate-nitrite[c] 1.6 mg/L	
Total phosphorus[d] 0.28 mg/L	

NA = No data for that year.

ND=not detected.

[b] OEPA (1994) dissolved oxygen criterion.

[c] Rankin et al. (1999) proposed nitrate-nitrite criterion

[d] Rankin et al. (1999) proposed total phosphorus criterion

[e] minimum dissolved oxygen concentrations from continuous monitoring over three days in 1987

Step 4a. Analyze Evidence for SOE
Using Other Situations or Biological Knowledge
Plausibility: Stressor–Response

Comparison of the reported concentration of water quality parameters (ug/L) with available criteria.

Uncertainties: Sample size, Covariation,
Relevance of Test Endpoint, Other?

Chemical AWQC (ug/l) @ 200 mg/L hardness	Upstream Site	Site A
Copper 21		
Lead 7.7		
Zinc 190		

4b. Compare strength of evidence for the three candidate causes of Impairment A (continued)

Causal Consideration	Evidence	Score	Evidence	Score	Evidence	Score
Considerations Based on Other Situations or Biological Knowledge						
	Habitat Alteration		Metals Contamination		Nutrient Enrichment	
Plausibility: Stressor-Response	Increased Relative Weight: No evidence.	NE	Increased Relative Weight: Not applicable: Implausible mechanism.	NA	Increased Relative	
	Increased DELT: No evidence.	NE	Increased DELT:		Increased DELT:	

NE = no evidence; NA = not applicable/not available

4b. Compare strength of evidence analysis for the three candidate causes of Impairment A (continued)

Causal Consideration	Evidence	Score	Evidence	Score	Evidence	Score
Considerations Based on Other Situations or Biological Knowledge						
	Habitat Alteration		Metals Contamination		Nutrient Enrichment	
Plausibility: Stressor-Response cont.	Decrease % Mayflies & Increased % Tolerant Organisms: No evidence.	NE	Decrease % Mayflies & Increased % Tolerant Organisms:		Decrease % Mayflies & Increased % Tolerant Organisms:	
Consistency of Association	No Evidence	NE	No Evidence	NE	No Evidence	NE

NE = no evidence; NA = not applicable/not available

Step 4a: Analyze Evidence for SOE

- Specificity – How many causes produce the effect?
  - Note: the score is the same across all candidates unless NA, but the score differs for each effect

Other evidence that would be nice to have:

- Temporality -- Historical or intermittent exposures

- Consistency of Association -- How consistently are these levels of stress associated with these effects?

- Experiment -- At the case, or elsewhere (e.g. mitigation of effects post-dredging)

- Predictive performance -- e.g., look at type of fin erosion

4b.   Compare strength of evidence analysis for the three candidate causes of Impairment A (continued)

Causal Consideration	Evidence	Score	Evidence	Score	Evidence	Score
Considerations Based on Other Situations or Biological Knowledge						
	Habitat Alteration		Metals Contamination		Nutrient Enrichment	
Specificity of Cause	Increased Relative Weight:		Increased Relative Weight:		Increased Relative Weight:	
	Increased DELT:		Increased DELT:		Increased DELT:	
	Decrease % Mayflies & Increased % Tolerant Organisms:		Decrease % Mayflies & Increased % Tolerant Organisms:		Decrease % Mayflies & Increased % Tolerant Organisms:	
Analogy	Not applicable	NA	Not applicable	NA	Not applicable	NA
Experiment	No evidence	NE	No evidence	NE	No evidence	NE
Predictive Performance	No evidence	NE	No evidence	NE	No evidence	NE

NE = no evidence; NA = not applicable/not available

4b. Compare strength of evidence for the three candidate causes of Impairment A (continued)

Causal Consideration	Evidence	Score	Evidence	Score	Evidence	Score
Considerations from Multiple Lines of Evidence						
	Habitat Alteration		Metals Contamination		Nutrient Enrichment	
Consistency of Evidence	Increased Relative Weight:		Increased Relative Weight:		Increased Relative Weight:	
	Increased DELT:		Increased DELT:		Increased DELT:	
	Decrease % Mayflies & Increased % Tolerant Organisms:		Decrease % Mayflies & Increased % Tolerant Organisms:		Decrease % Mayflies & Increased % Tolerant Organisms:	
Coherence of Evidence	Not applicable	NA	Increased Relative Weight, Increased DELT, Decrease % Mayflies & Increased % Tolerant Organisms:		Increased Relative Weight, Increased DELT, Decrease % Mayflies & Increased % Tolerant Organisms:	

NE = no evidence; NA = not applicable/not available

Step 4b: Causal Characterization: Strength of Evidence Summary Impairment A

Causal Consideration	Habitat	Metals	Nutrient
Case-Specific Considerations			
Co-occurrence			
Temporality	NE	NE	NE
Consistency of Association	NE	NE	NE
Biological Gradient			
Increased relative weight			
Increased % DELT			
Decreased % mayflies			
Increased % tolerant			
Complete Exposure Pathway	NA	NE	NE
Experiment	NE	NE	NE
Considerations Based on Other Situations or Biological Knowledge			
Plausibility: Mechanism			
Increased relative weight			
Increased % DELT			
Decreased % mayflies and Increased % tolerant			
Plausibility: Stressor-Response			
Increased relative weight	NE	NA	
Increased % DELT	NE		
Decreased % mayflies and Increased % tolerant	NE		
Consistency of Association	NE	NE	NE
Specificity of Cause			
Increased relative weight		NA	
Increased % DELT			
Decreased % mayflies and Increased % tolerant			
Analogy	NA	NA	NA
Experiment	NE	NE	NE
Predictive Performance	NE	NE	NE
Considerations from Multiple Lines of Evidence			
Consistency of Evidence			
Increased relative weight			
Increased %DELT			
Decreased % mayflies and Increased % tolerant			
Coherence of Evidence	NA	0	0

STEP 5:

Identify Probable Cause

Step 5: Identify Probable Cause of Impairment A

Confidence?

Increased fish weight?

Increased % DELT?

Increased % mayflies?

Increased % tolerant inv.?