A Framework for Determining Causes of Ecosystem Service Impairment at Contaminated Sites

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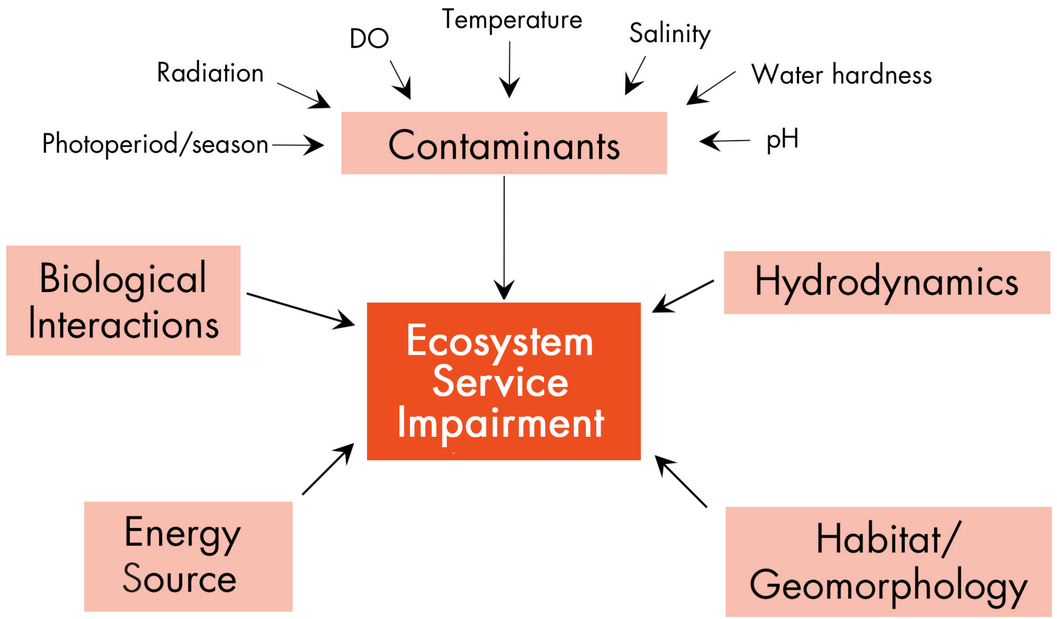
Expensive remediation decisions are often based on an assumption that a specific contaminant caused the impairment of services observed in an ecosystem. In order to ensure that remediation or management actions result in intended recovery of ecosystem services, it is essential that site investigations establish cause-and-effect relationships between stressors and responses.



Physical and Natural Factor Interactions with Chemical Stressors in an Aquatic Ecosystem

(Modified from Foran and Ference. Eds. Multiple Stressors in Ecological Risk and Impact Assessment, SETAC Press, Pensacola. FL 1997)

A framework for assessing causality was issued under Canada's Federal Contaminated Sites Action Plan (FCSAP) program. The objective of the framework is to provide guidance for evaluating causation, and to help differentiate ecosystem service impairment due to chemical stressors from impairments due to other biological or physical stressors. The approach is scaled to the complexity and relatively small size of most FCSAP sites. It is based on USEPA's Stressor Identification Guidance and is consistent with practices recommended by Suter, Cormier and other leaders in the field. Modifications were made to previously published methods to more fully extend its use to terrestrial sites, and to simplify the process so that it is better suited to the small sites that are prevalent under FCSAP.

CHARACTERISTICS OF CAUSATION

Co-Occurs	Gradient	Consistent	Plausible	Specific
Stressor and impairment	Effect increases with increasing exposure	Effect observed multiple places and times	Effect expected given known facts	Occurrence of one variable predicts occurrence of another

Causality assessment is comprised of the four steps illustrated in this poster.

- Step 1: List candidate causes
- Step 2: Gather evidence
- Step 3: Analyze data
- Step 4: Weigh the evidence

When applied, the framework provides an approach for qualitatively evaluating candidate causes based on the five characteristics of causation listed above. Although causality assessment is not warranted at every site, it is particularly valuable at sites where remediation for one stressor has the potential to exacerbate overall conditions. Thus, broader use and acceptance of systematic assessment of causality is encouraged.

EXAMPLE: QUALITATIVE CAUSAL ASSESSMENT

Candidate Cause	Co-Occurs	Gradient	Consistent	Plausible	Specific	Overall Evidence
Chemical release	+ +	+	+	+ + +	- -	Strong
Extreme weather	+	- -	0	+ +	- -	Weak
Habitat limitations	0	0	+	+	-	Moderate
Invasive species	+ + +	+ +	+	+	- -	Strong
Pathogens	+	- -	0	+	-	Weak

FRAMEWORK FOR CAUSALITY ASSESSMENT

IDENTIFY IMPAIRED SERVICES

- Kills
- Population decline
- Decreased yield

STEP 1: LIST CANDIDATE CAUSES

LITERATURE REVIEW

- Background information
- Biological processes and mechanisms
- Case studies
- Synthesize findings

BRAINSTORMING SESSION

- Background discussion
- Brainstorm possible causes
- Eliminate implausible causes
- Document outcome of session

STEP 2: GATHER EVIDENCE

INVENTORY EXISTING DATA

- Assemble site-specific data
- Literature review
- Determine if data gaps exist

STUDY DESIGN TO FILL DATA GAPS

- Schedule and budget
- Address confounding factors
- Suitable reference areas

EXECUTE STUDY

- Plan
- Execute
- Follow up

STEP 3: ANALYZE DATA FOR CAUSALITY

Know stakeholder preferences

Create database

Define rules for data interpretation

Create scatter plots

Graph temporal trends

Map spatial trends

Employ statistics

Beware of specious correlations

Document methods and results

STEP 4: WEIGH THE EVIDENCE

- Review documentation for each candidate cause
- Characterize evidence relative to scientific defensibility
- Tabulate findings and verify characterization
- Integrate findings, draw conclusions regarding most probable cause(s), need for further evaluation
- Document conclusions and recommendations (e.g., contamination likely causing majority of impairment, proceed to remediation)

Scan QR code to view the guidance module.

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