CADDIS: Helping States and Tribes identify targets for management action

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The Goal

*Improve
the biological condition
of the Nation's waters
by identifying the stressors
most responsible for
degradation.*

Assess biological condition
↓
Assess cause
↓
Assess options
↓
Act
↓
Assess outcomes
↓
Desired condition restored
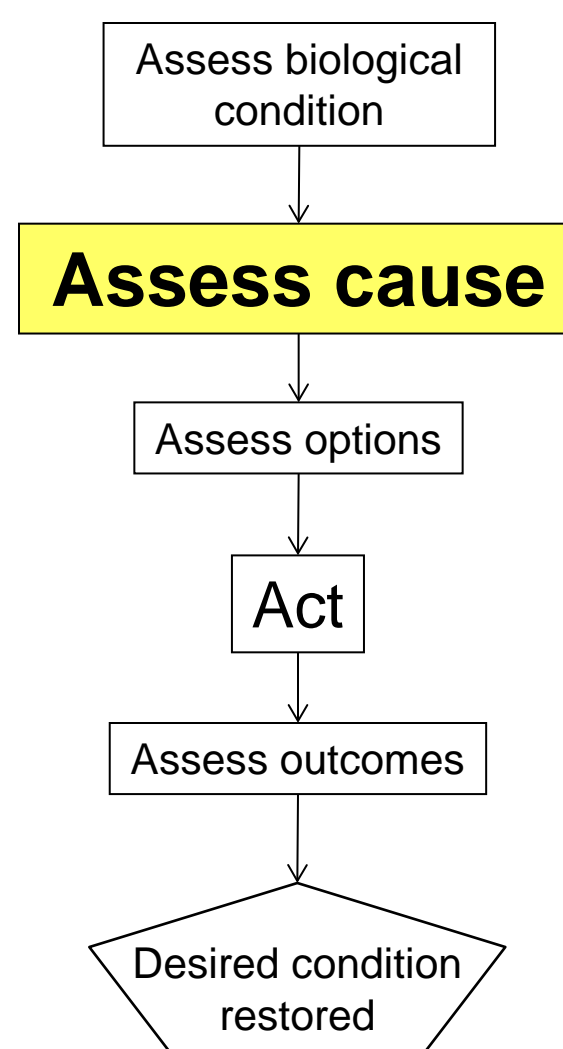
Causal assessment (yellow box) is typically one step in a sequence of assessments.

The Need

- Biological Indices are the principal monitoring tool for evaluating the biological condition of water bodies in all 50 states, many territories and tribal lands.
- Biological assessment indicates that there is a problem. It doesn't identify the cause or the fix.
- In 2015, over 5,000 waters with biological impairment listed as cause unknown.
- Over 36,000 waters are listed as impaired for failure to meet water quality criteria.
  - For most of those, attribution of causation is not backed by a formal causal assessment.
- Remediating sources without a causal assessment may not restore their designated use.

**Causes of Impairment
for 303(d) Listed Waters**

Rank	Impairment Group
1	Pathogens
2	Nutrients
3	Metals (other than Hg)
⋮	
9	Cause unknown: impaired biota
⋮	
15	Cause unknown
⋮	
31	Cause unknown: fish kills

The Response

*The Causal Analysis/Diagnosis Decision Information System (CADDIS):
a web-based technical support system that provides guidance, tools,
and useful information for identifying causes of biological degradation
of streams, rivers, and other bodies of water.*

The Website (www.epa.gov/caddis)

Stressor Identification (Volume 1)

CADDIS describes a step-by-step procedure for identifying probable causes of biological degradation. The process is derived from the **Stressor Identification Guidance Document**, published jointly by the Office of Water and the Office of Research and Development of the U.S. EPA (U.S. EPA 2000)
The method:

- Provides scientifically defensible evaluations that are neither arbitrary nor capricious.
- Prevents biases and other lapses of logic.
- Identifies causal relationships that are not immediately apparent.
- Increases confidence that management efforts can improve biological condition.
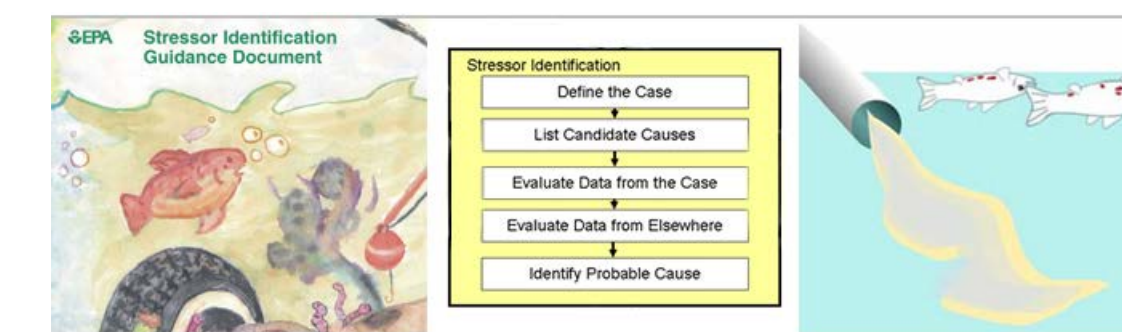
Sources, Stressors and Responses (Volume 2)

Volume 2 provides background information on commonly encountered stressors, sources and responses.
Each stressor module includes the following sections:

- **Introduction** provides a summary overview of the stressor, including a checklist of evidence that suggests including a given stressor in your assessment (i.e., listing it as a candidate cause).
- **When to List** provides more detailed information on the sources, activities, site evidence, and biological responses that suggest inclusion as a candidate cause.
- **Ways to Measure** details different methods for quantifying the stressor.
- **Conceptual Diagrams** illustrate hypothesized causal linkages among the stressor, its sources, and associated biotic responses.
- References and literature reviews.

Examples and Applications (Volume 3)

Volume 3 provides example analyses, case studies and applications.

- The **Analytical Examples** section provides examples illustrating the use of different data analyses to inform particular types of evidence.
- The **Worksheets** section provides examples from the Little Scioto River in Ohio, one of the first Stressor Identification-based causal analyses conducted. These examples are presented as "worksheets" that one might complete as one conducts a causal analysis.
- The **Case Studies** section provides brief summaries of completed causal assessments, as well as links to full case study reports.
- The **State & Other Regulatory Examples** section describes how different states have incorporated causal analysis and stressor identification (SI) in their water quality programs.
- The **Galleries** section provides examples of relationships that have been observed between common stressors and biological responses.

Data Analysis (Volume 4)

Data analysis is a key phase of a causal assessment.
Statistical analyses can be used to derive different types of evidence and strengthen confidence in results.
Volume 4 is organized in these major sections:

- Selecting an Analysis Approach: initial guidance for selecting appropriate analyses that can inform different phases of a causal analysis.
- Getting Started: things to think about before you start analyzing data.
- Basic Principles & Issues: basic concepts to keep in mind while analyzing observational data.
- Exploratory Data Analysis: techniques for becoming familiar with your data.
- Basic Analyses: "building block" statistical methods.
- Advanced Analyses: statistical methods requiring knowledge of one or more basic techniques.
- Download Software: implementations of some basic and advanced techniques.
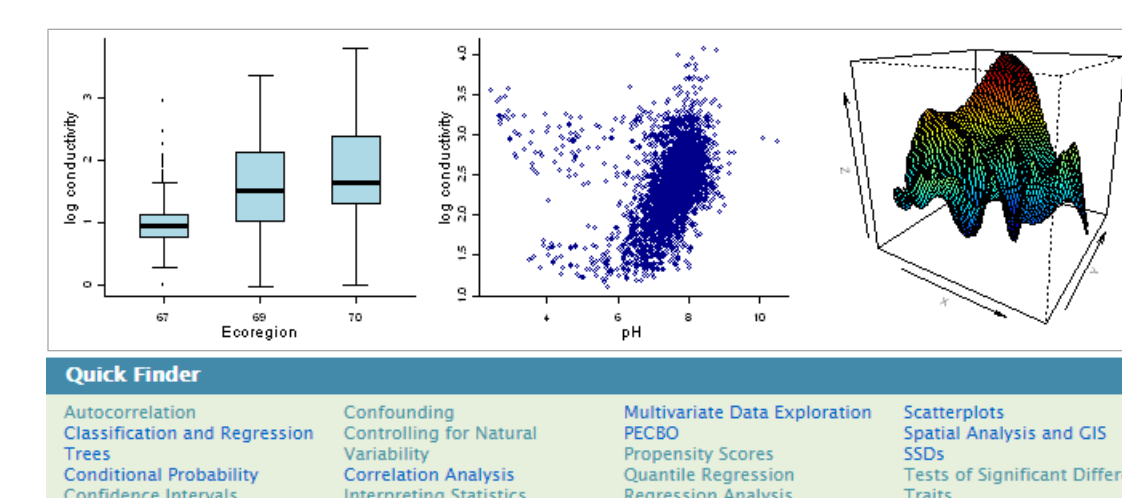
Causal Databases (Volume 5)

Volume 5 includes an interactive conceptual diagram tool and supporting literature database designed to help users access and apply literature-based evidence in their causal assessments.
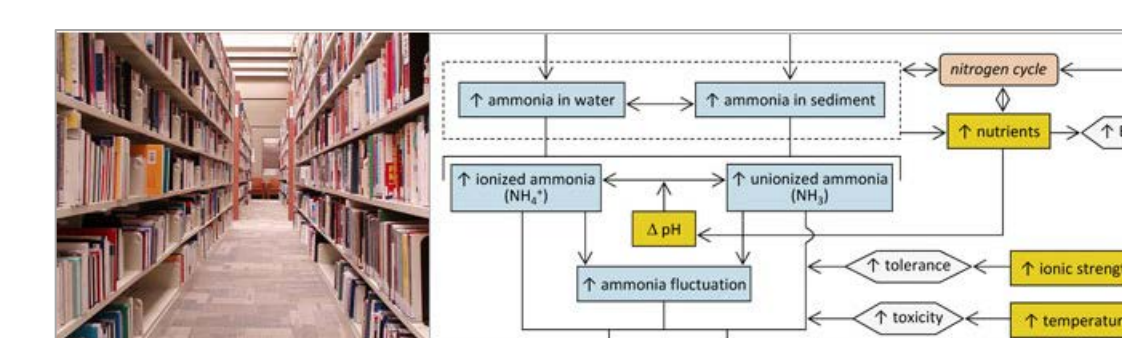
The Reviews

CADDIS is:

Visited

170,000 page visits from 85,000 users in 2014.
Top search engine keywords leading to CADDIS: what is urbanization; herbicide(s), insecticide(s); ionic strength; conceptual diagram; epa caddis; kochs postulates.

Used

Adapted for state-specific applications (e.g., guidance, case studies) in AZ, CA, CT, ID, IN, IO, ME, MD, MI, MN, MS, NC, OH, PA, VA, VT, TN, WA, and WV.

Emulated

- Environment Canada: Causality Assessment Module
- European Union: Managing aquatic ecosystems and water resources under multiple stress (MARS) Program
- South African River Health Programme
- South Korea National Aquatic Ecological Monitoring Program

Making a Difference

Minnesota
Stressor identification applied systematically to watersheds across the state.
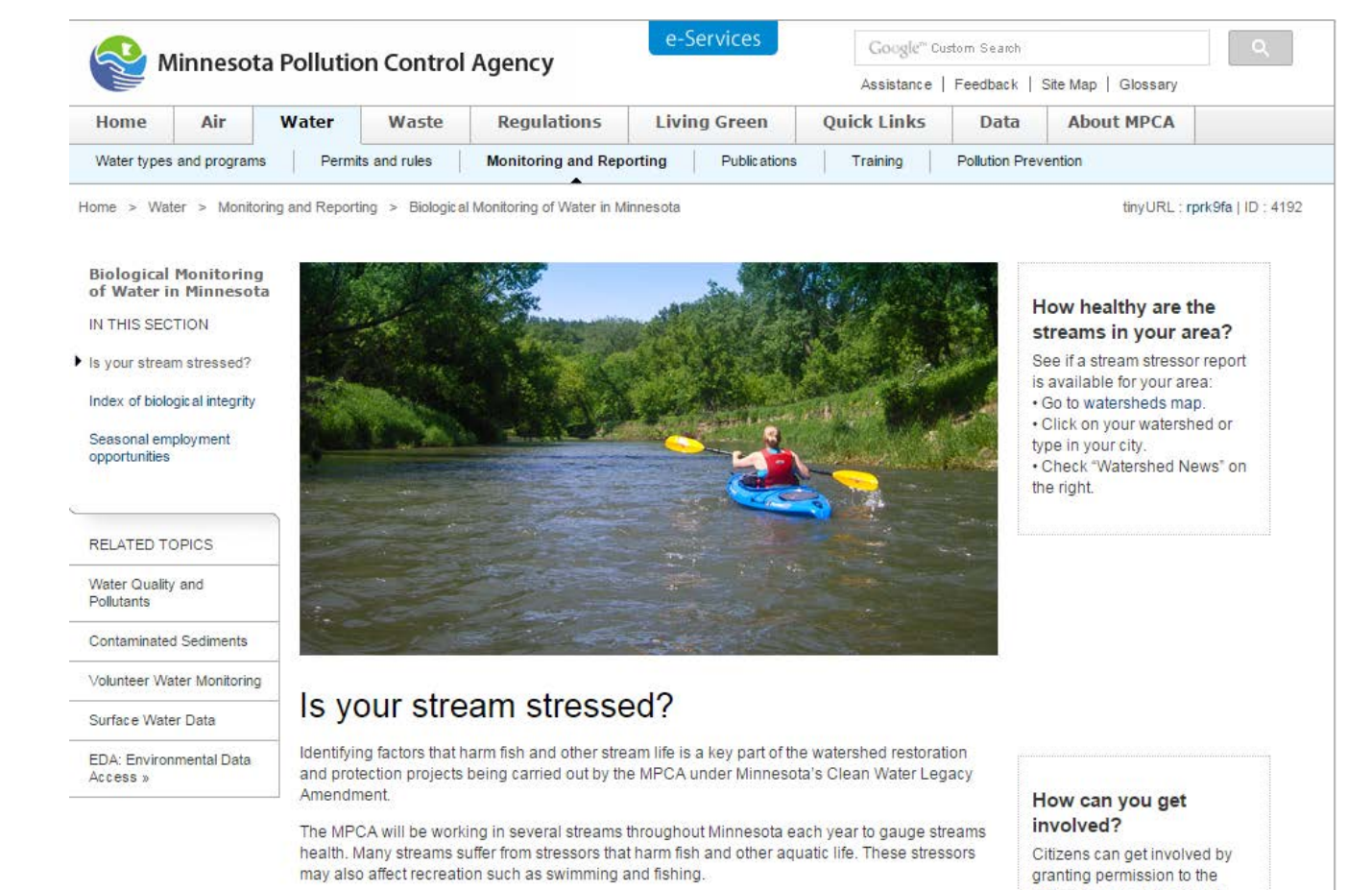
Virginia, West Virginia and Pennsylvania
Stressor identification steers data collection efforts in fish health investigations.

Connecticut and Maine
Stressor identification provides input to restoration decisions.

restored stream

www.youtube.com/watch?v=K2x20Q1df48

The Future

Updated Tools (anticipated release 2016-2017)

- Easier conceptual model diagram building with the revised ICD tool (anticipated release in 2016).
- Direct access to data analysis R scripts from CADStat.

Rapid Causal Assessment Methods (proposed 2016-2019)

- Automate comparison site selection to take advantage of large regional datasets and batch process analyses for multiple sites.
- Review progress and promise of biological stressor signatures.

Thoughts? Suggestions? Contact us at caddis@epa.gov.

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Office of Research and Development

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