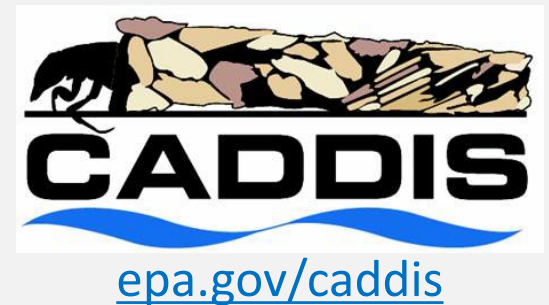


# EPA Training Webinar: CADDIS – Causal Assessment & Stressor Identification

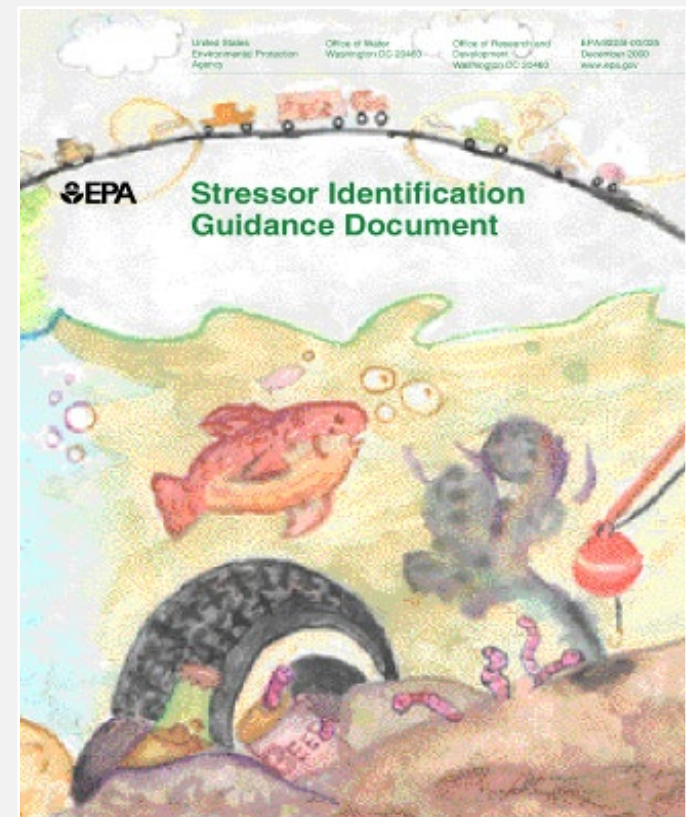


*Kate Schofield, PhD*  
*Center for Public Health and Environmental Assessment*  
US EPA Office of Research and Development

**October 8, 2020**



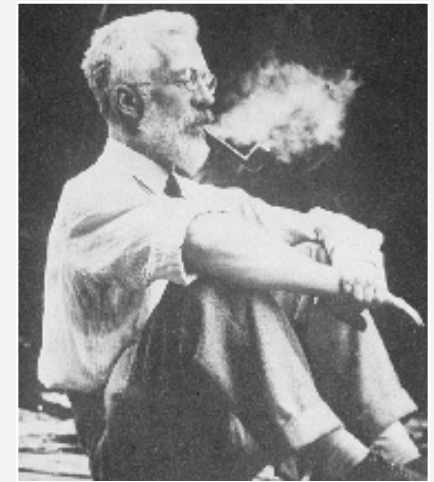
- Introduction to CADDIS – EPA’s Causal Analysis/  
Diagnosis Decision Information System
  - Intro to causal assessment  
(including how CADDIS, causal  
assessment, and stressor  
identification are related)
  - CADDIS tour
  - How CADDIS can be used, in  
causal assessment and beyond



# Causal assessment, Stressor Identification & CADDIS

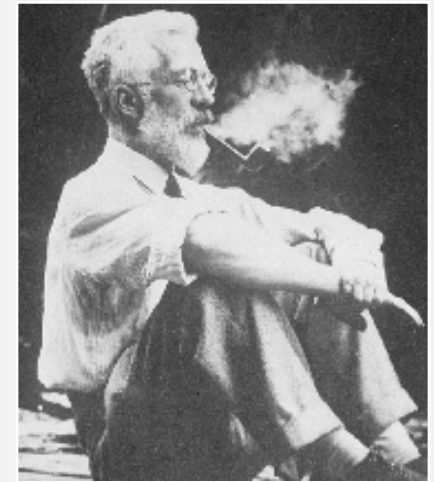
- **Causal assessment**
  - Process to determine likely cause of an observed effect
- **Stressor Identification (SI)**
  - Method for determining most likely cause of observed biological impairments in aquatic systems
- **CADDIS**
  - Causal Analysis/Diagnosis Decision Information System
  - [Website](#) that provides information, methodology and tools to help users implement SI and conduct causal assessments of biological impairment

# Three tiers of causal assessment



- **General** – Can C cause E?
  - Can smoking cause lung cancer?
  - Can Chemical Z cause fish lesions?
- **Contextual** – Under what conditions can C cause E?
  - Does smoking cause lung cancer when certain genetic factors are also present?
  - Does Chemical Z cause fish lesions only when it exceeds a particular concentration?
- **Specific** – Did C cause E in this case?
  - Did smoking cause lung cancer in Ronald Fisher?
  - Did Chemical Z cause fish lesions in my stream?

# Three tiers of causal assessment



- **General** – Can C cause E?
  - Can smoking cause lung cancer?
  - Can Chemical Z cause fish lesions?
- **Contextual** – Under what conditions can C cause E?
  - Does smoking cause lung cancer when certain genetic factors are also present?
  - Does Chemical Z cause fish lesions only when it exceeds a particular concentration?
- **Specific** – Did C cause E in this case?
  - Did smoking cause lung cancer in Ronald Fisher?
  - Did Chemical Z cause fish lesions in my stream?

# Why is specific causation important?

- Biological assessments are commonly used to identify if streams are impaired
- In many cases, causes of impairment are unknown
- To fix the problem, you have to know what to fix

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

Rank	Impairment Group
1	Pathogens
2	Sediment
3	Nutrients
11	Cause unknown
12	Cause unknown: impaired biota
33	Cause unknown: fish kills

~ 90,000 river/stream miles

# Why use a formal method?

## Because we can make mistakes about causality, by...

- Forming initial impressions quickly, based on readily available information. This can result in:

Overweighting chance events

Every time I wash my car it rains.

Having biases

All pollution is caused by industry.

Being “educationally”  
predisposed

Hydrologists think hydrology.

Relying on intuition and past  
experience

I have a hunch that it’s nitrogen.  
Last time I saw this, it was nitrogen.

# Why use a formal method?

**Because we can make mistakes about causality, by...**

- Gathering information that supports our initial impression

**HYPOTHESIS TENACITY**

- Confidently reaching conclusions based on incomplete information

**WYSIATI**

**“what you see is all there is”**

*“Science is a way of trying not to fool yourself. The first principle is that you must not fool yourself – and you are the easiest person to fool.” [Feynman 1964]*



## THE GOOD...

- Provides formal method that allows defensible & transparent evaluation
- Identifies causal relationships that may not be immediately apparent
- Minimizes biases and other lapses of logic
- Helps identify all available evidence
- Increases confidence that remedial or restoration actions can improve biological condition

# The CADDIS causal assessment approach

## ...THE BAD...

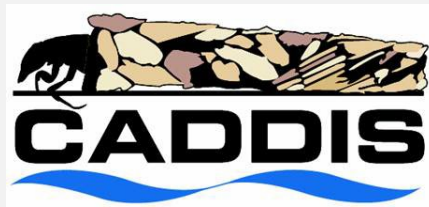
- Conducting causal assessments is not necessarily easy or straightforward
- Mechanisms driving biological impacts can be complex
- The method relies on data – quantity and quality matter
- Ultimately, a “smoking fish” may not be found, or multiple stressors may remain as likely causes



## ...AND BACK TO THE GOOD

- Even when one likely cause is not identified, a causal assessment can narrow the universe of possible causes and point to promising data and analyses

- ~~1. Low dissolved oxygen~~
2. Gill damage
3. Nitrate exposure
4. Infections
- ~~5. High pH~~
- ~~6. pH fluctuations~~
- ~~7. Ammonia toxicity~~
8. Other, unspecified toxic substances
- ~~9. Inadequate food resources~~



- **Volume 1:** Stressor Identification
- **Volume 2:** Sources, Stressors & Responses
- **Volume 3:** Examples & Applications
- **Volume 4:** Data Analysis
- **Volume 5:** Causal Databases

## Causal Analysis/Diagnosis Decision Information System (CADDIS)

The Causal Analysis/Diagnosis Decision Information System, or CADDIS, is designed to help scientists and engineers in the Regions, States, and Tribes conduct causal assessments in aquatic systems. It is organized into five volumes.

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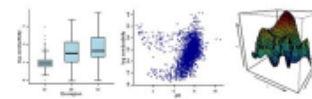
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- [Frequent Questions](#)
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- [CADDIS Volume 2 Home](#)
- [Learn About Sources](#)
  - [Urbanization](#)
- [Learn About Stressors](#)
- [Learn About Responses](#)

### Volume 4: Data Analysis



- [CADDIS Volume 4 Home](#)
- [Selecting an Analysis Approach](#)
- [Getting Started with Data Analysis](#)
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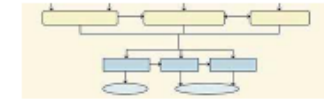
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- [Getting Started](#)
- [Tips for Candidate Causes](#)
- [Types of Evidence Tables](#)

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- [CADDIS Volume 3 Home](#)
- [Analytical Examples](#)
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- [PECBD Appendix Technical Details and Programs](#)
- [The Role of SI in Various Water Management Programs](#)
- [CADDIS Site References](#)

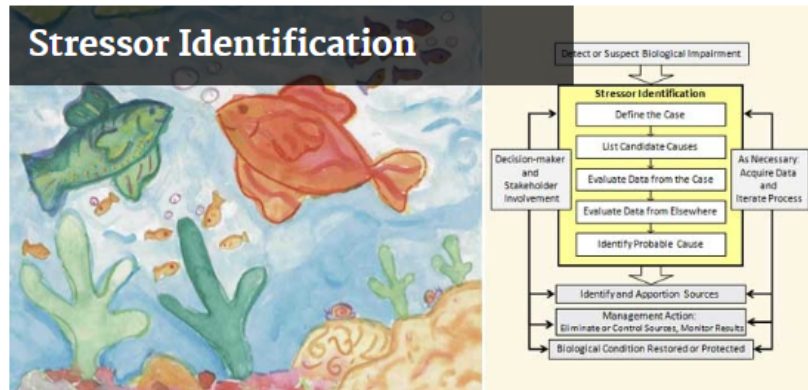
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## CADDIS Volume 1

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**Stressor Identification**

The diagram illustrates a flowchart for stressor identification. It begins with 'Detect or Suspect Biological Impairment', leading to 'Stressor Identification'. This central box contains five steps: 'Define the Case', 'List Candidate Causes', 'Evaluate Data from the Case', 'Evaluate Data from Elsewhere', and 'Identify Probable Cause'. This central process is supported by 'Decision-maker and Stakeholder Involvement' on the left and 'As Necessary, Acquire Data and Iterate Process' on the right. Below the central box, the process continues to 'Identify and Apportion Sources', 'Management Action: Eliminate or Control Sources, Monitor Results', and finally 'Biological Condition Restored or Protected'.

### Volume 1. Stressor Identification

The causal assessment process used in CADDIS is derived from the *Stressor Identification Guidance Document*. The method weighs all relevant evidence to identify the most likely cause or causes of undesirable biological effects.

- Step-by-Step Guide
- Causal Assessment Background

### Basic Information

- [About Causal Assessment](#)
- [Guide Overview](#)
- [Causal Concepts](#)
- [Frequent Questions](#)
- [Glossary](#)

### Step-by-Step Guidance

- [Getting Started](#)
- [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](#)

### Tools and Tables

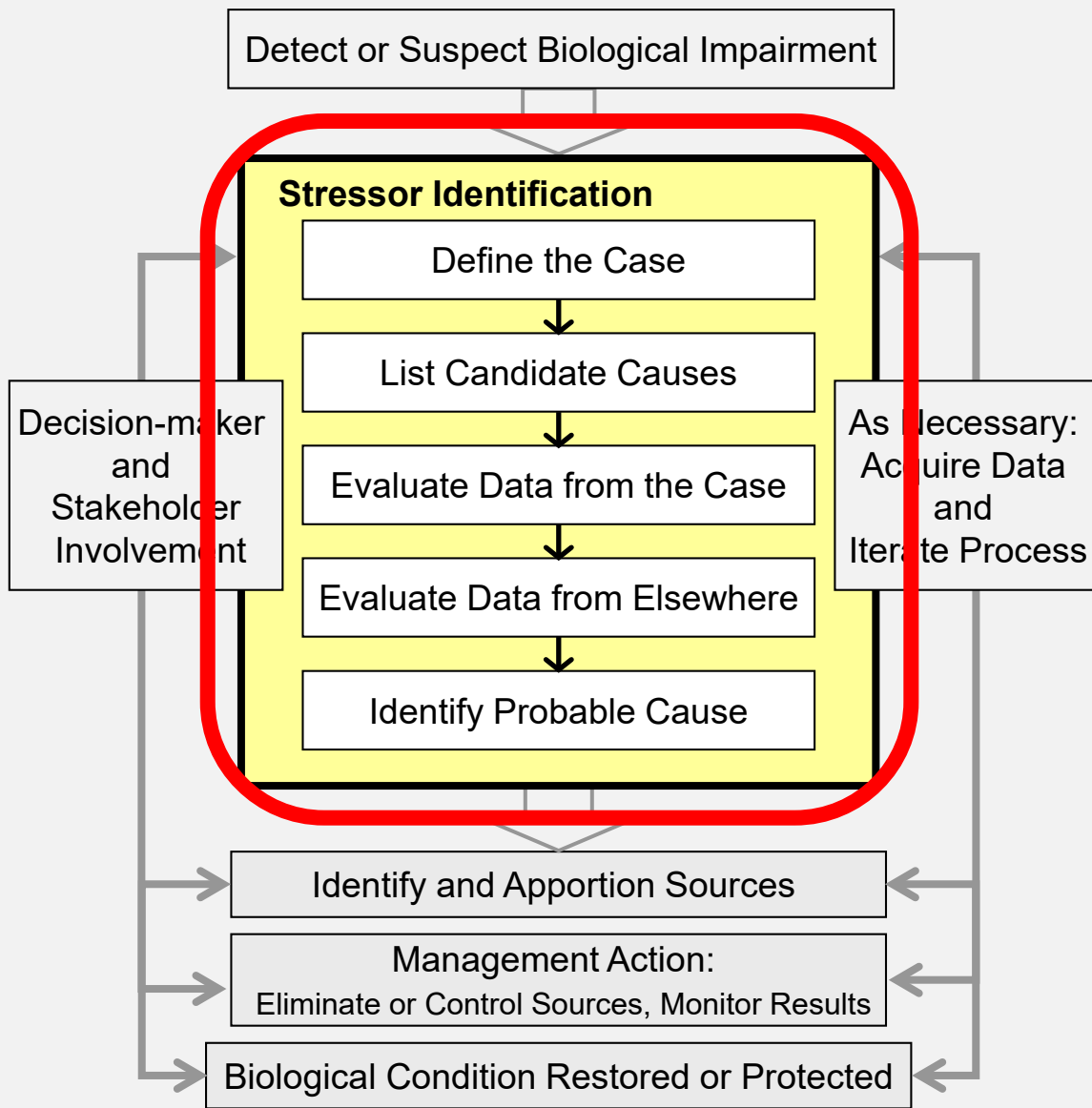
- [Quantifying Uncertainty](#)
- [Types of Evidence Tables](#)
- [Scoring Tables](#)
  - [Scoring the Evidence](#)
- [Tips for Listing Candidate Causes](#)
- [Listing Multiple Stressors](#)

### Related Information

- [CADDIS Home](#)
- [Vol 1. Stressor Identification](#)
- [Vol 2. Sources, Stressors and Responses](#)
- [Vol 3. Examples and Applications](#)
- [Vol 4. Data Analysis](#)
- [Vol 5. Causal Databases](#)

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# 5 Steps of Stressor Identification



# Step 1 – Define the case

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

Identify and Apportion Sources

Management Action:  
Eliminate or Control Sources, Monitor Results

Biological Condition Restored or Protected

As Necessary:  
Acquire Data  
and  
Iterate Process

Decision-maker  
and  
Stakeholder  
Involvement

- What specific biological effects were observed?
- Where and when did they occur?
- Where are the effects absent or different (i.e., where are comparison sites located)?



# Step 2 – List candidate causes

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

As Necessary:  
Acquire Data  
and  
Iterate Process

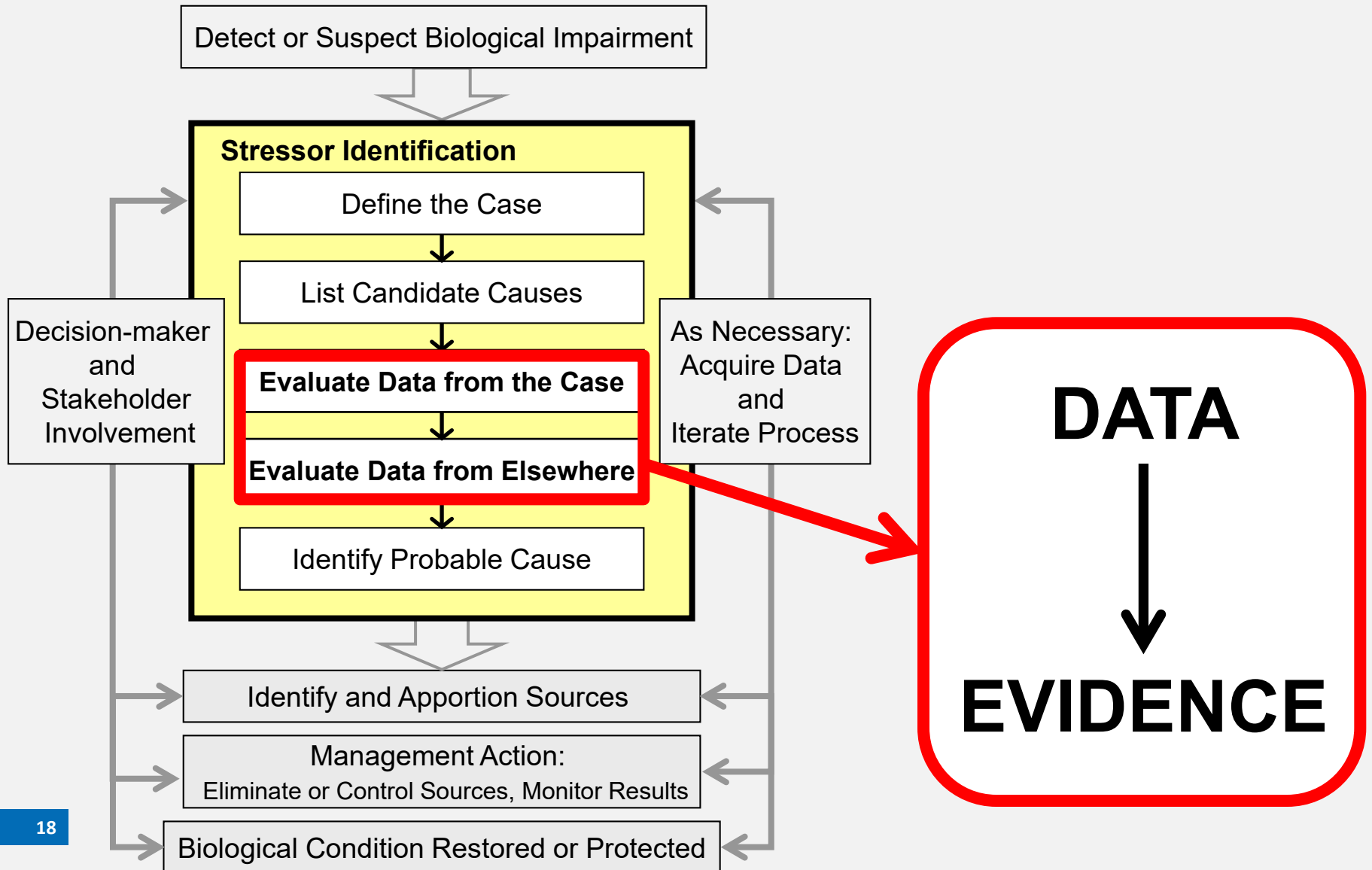
Identify and Apportion Sources

Management Action:  
Eliminate or Control Sources, Monitor Results

Biological Condition Restored or Protected

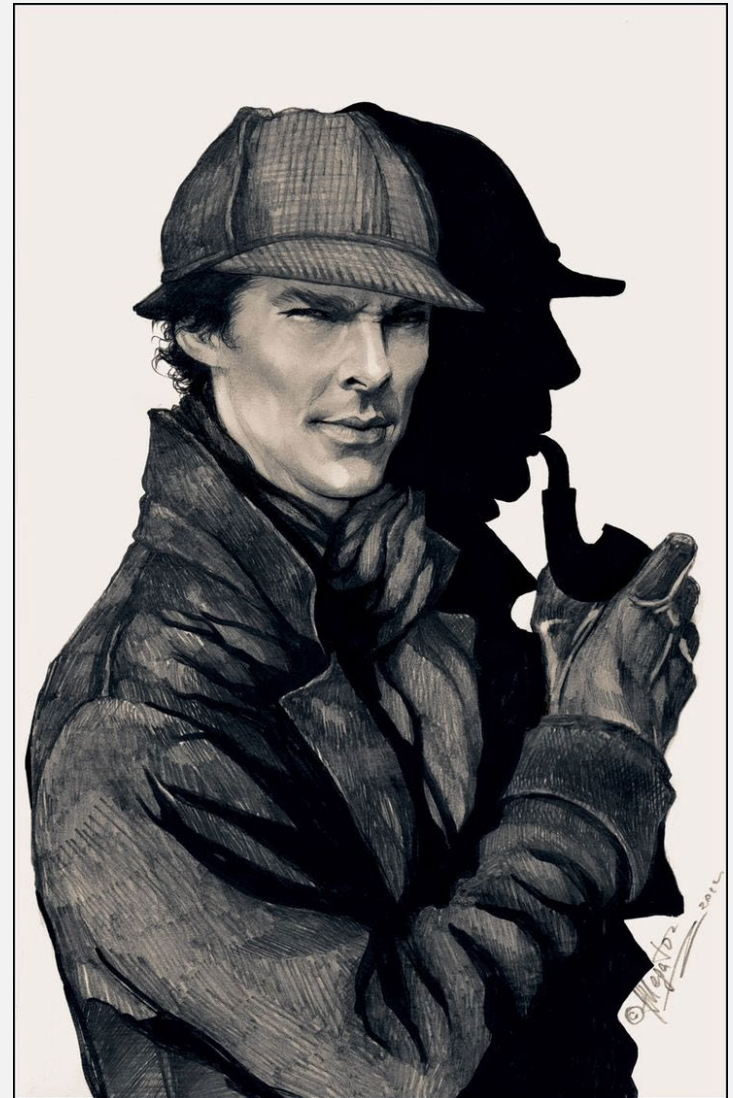
- Generate an initial list
- Gather information on potential sources, stressors, and exposures
- Develop conceptual model
- Develop the “final” list

# Steps 3 & 4 – Evaluating the data



# Let's talk about evidence...

- What is evidence?
  - Available information that indicates whether belief or proposition is valid
  - If Cause X produced Effect Y, then we would expect to observe Result Z
  - Information used to determine whether we actually observe Result Z is a piece of evidence
  - Individual pieces of evidence are combined into the overall body of evidence



# “From the case” vs. “from elsewhere”

- **“From the case”** = data collected from affected location and nearby comparison sites
  - Most relevant evidence
  - Best chance of isolating causal processes, minimizing confounding factors
- **“From elsewhere”** = data collected from other field locations, the laboratory, or model simulations
  - Compare data from the case to data from elsewhere to derive pieces of evidence

# Types of evidence in CADDIS

## Data from the case

- *Spatial/temporal co-occurrence*
- Evidence of exposure or biological mechanism
- *Causal pathway*
- *Stressor-response relationships from the field*
- Manipulation of exposure
- Laboratory tests of site media
- Temporal sequence
- Verified predictions
- Symptoms

## Data from elsewhere

- *Stressor-response relationships from other field studies*
- *Stressor-response relationships from laboratory studies*
- Stressor-response relationships from ecological simulation models
- Mechanistically plausible cause
- Manipulation of exposure at other sites
- Verified predictions
- Analogous stressors

# Step 5 – Identify probable cause

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**

As Necessary:  
Acquire Data  
and  
Iterate Process

Identify and Apportion Sources

Management Action:  
Eliminate or Control Sources, Monitor Results

Biological Condition Restored or Protected

- Weigh the evidence for each cause
  - Eliminate if possible
  - Diagnose if possible
- Compare evidence across all causes

# CADDIS Scoring System

- +++ convincingly supports (or weakens – – –)
- ++ strongly supports (or weakens – –)
- + somewhat supports (or weakens –)
- 0 neither supports nor weakens
- R refutes
- D diagnoses
- NE no evidence

# General principles for scoring evidence

- First + or – or 0
  - Based on logical implication of evidence that passes basic quality and relevance test
- Second + or –
  - Based on strength of association (e.g., large differences)
- Third + or –
  - Based on reliability of association (e.g., high sample sizes, excellent study design, control of confounders)
- Each type of evidence has strengths and weaknesses, which are reflected in the CADDIS scoring system



# Weighing the evidence

- Weigh the body of evidence for each candidate cause
  - Evaluate quantity and quality of evidence
  - Identify compelling evidence
  - Evaluate consistency and credibility of evidence

Consistency of Evidence	All available types of evidence support the case for the candidate cause.	+++
	All available types of evidence weaken the case for the candidate cause.	---
	All available types of evidence support the case for the candidate cause, but few types are available.	+
	All available types of evidence weaken the case for the candidate cause, but few types are available.	-
	The evidence is ambiguous or inadequate.	0
	Some available types of evidence support and some weaken the case for the candidate cause.	-

# Comparing evidence and forming conclusions

- Compare the evidence across candidate causes, even when there is a “smoking gun”
  - Determine if there is more than one likely cause
  - Determine your level of confidence in the results
- Identify cause(s) best supported by the evidence
- Classify causes (e.g., likely, unlikely, uncertain)
- Refine and iterate, as needed

## CADDIS Volume 1

CADDIS Home

Vol 1. Stressor Identification

About Causal Assessment

Getting Started

**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

Summary Tables of Types of Evidence

Summary Tables of Scores

Vol 2. Sources, Stressors and Responses

Vol 3. Examples and Applications

Vol 4. Data Analysis

Vol 5. Causal Databases

Glossary

## Step 1. Define the Case

Overview

In-Depth Look

Results and Next Steps

The Stressor Identification process begins by **defining the subject** for analysis (i.e., the case, Figure 1-1). This is accomplished by determining the investigation's geographic scope and the effects to be analyzed. The case definition is foundational for causal analysis: it influences what information is assembled, which causes are considered and how conclusions are presented. For this reason, it is important to get input from managers and stakeholders at this early stage.

Causal analysis is triggered by the observation of a biological effect, including:

- Kills of fish, invertebrates, plants, domestic animals, or wildlife;
- Anomalies in any life form, such as tumors, lesions, parasites, or disease;
- Changes in community structure, such as loss of species or shifts in species abundance (e.g., increased algal blooms, loss of mussel species, increases in tolerant species);
- Response of indicators designed to monitor or detect biological condition, such as the Index of Biotic Integrity (IBI) or the Invertebrate Community Index (ICI);
- Changes in organism behavior;
- Changes in population structure, such as population age or size distribution;
- Changes in ecosystem function, such as nutrient cycles, respiration, or photosynthetic rates;
- Changes in the area or pattern of different ecosystems, such as shrinking wetlands or increased sandbar habitats.

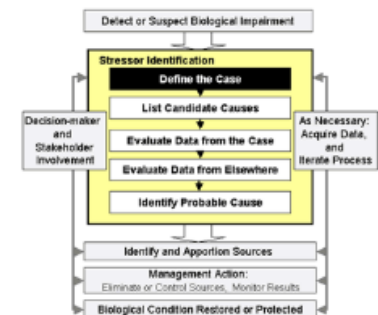


Figure 1-1. Illustration of where Step 1: Define the Case fits into the Stressor Identification process.

- Overview
- In-Depth Look
- Results and Next Steps



# CADDIS Volume 1

CADDIS Home

Vol 1. Stressor Identification

About Causal Assessment

Getting Started

Step 1. Define the Case

Step 2. List Candidate Causes

Step 3. Evaluate Data from the Case

Spatial/Temporal Co-occurrence

Evidence of Exposure

Causal Pathway

Stressor-Response Relationships

Manipulation of Exposure

Laboratory Tests

Temporal Sequence

Verified Predictions

Symptoms

Step 4. Evaluate Data from Elsewhere

Step 5. Identify Probable Causes

Summary Tables of Types of Evidence

Summary Tables of Scores

Vol 2. Sources, Stressors and Responses

## Spatial/Temporal Co-occurrence

### Concept

Spatial/Temporal Co-occurrence: The biological effect must be observed where and when the cause is observed, and must not be observed where and when the cause is not observed.

#### Helpful Links

- [Concept](#)
- [Examples](#)



Figure 3-1a. Spatial/Temporal Co-occurrence with Upstream/Downstream Comparisons, Supports.

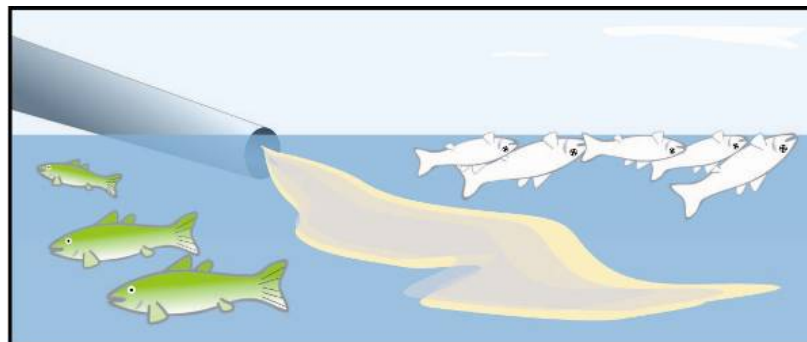
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### Examples

Consider increased suspended solids cause of reduced aquatic life support or weaken the causal link between the cause, based on spatial, temporal, or both comparisons.

- Supporting evidence (spatial co-occurrence) - Suspended solid concentrations are high in the unimpaired reference reach and low in the impaired reach.
- Supporting evidence (temporal co-occurrence) - Suspended solid concentrations are episodic, and

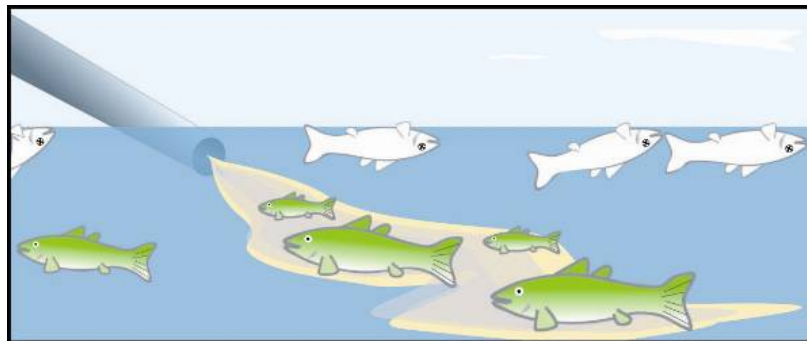


upstream

downstream

**SUPPORTS**

Impairment occurs where or when exposure to stressor occurs



upstream

downstream

**WEAKENS**

Impairment does not occur where or when exposure to stressor occurs

# CADDIS Volume 1

CADDIS Home

Vol 1. Stressor Identification

About Causal Assessment

Getting Started

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

Summary Tables of Types of Evidence

Summary Tables of Scores

Vol 2. Sources, Stressors and Responses

Vol 3. Examples and Applications

Vol 4. Data Analysis

Vol 5. Causal Databases

Glossary

## Summary Table of Scores

Type of Evidence	Finding	Interpretation	Score
<b>Types of Evidence that Use Data from the Case</b>			
Spatial/Temporal Co-occurrence	The effect occurs where or when the candidate cause occurs, <b>OR</b> the effect does not occur where or when the candidate cause does not occur.	This finding <i>somewhat supports</i> the case for the candidate cause, but is not strongly supportive because the association could be coincidental.	+
	It is uncertain whether the candidate cause and the effect co-occur.	This finding <i>neither supports nor weakens</i> the case for the candidate cause, because the evidence is ambiguous.	0
	The effect does not occur where or when the candidate cause occurs, <b>OR</b> the effect occurs where or when the candidate cause does not occur.	This finding <i>convincingly weakens</i> the case for the candidate cause, because causes must co-occur with their effects.	- - -
	The effect does not occur where and when the candidate cause occurs, <b>OR</b> the effect occurs where or when the candidate cause does not occur, and the evidence is indisputable.	This finding <i>refutes</i> the case for the candidate cause, because causes must co-occur with their effects.	R

# Causal Analysis/Diagnosis Decision Information System (CADDIS)

The Causal Analysis/Diagnosis Decision Information System, or CADDIS, is designed to help scientists and engineers in the Regions, States, and Tribes conduct causal assessments in aquatic systems. It is organized into five volumes.

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- [Glossary](#)

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- [CADDIS Volume 1 Home](#)
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- [Getting Started](#)
- [Tips for Candidate Causes](#)
- [Types of Evidence Tables](#)

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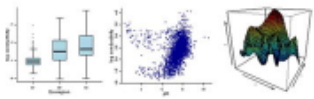
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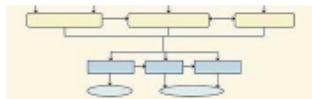
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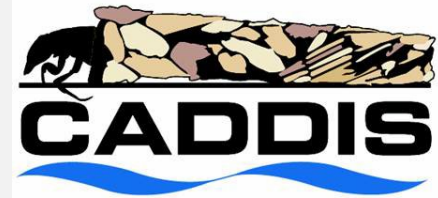
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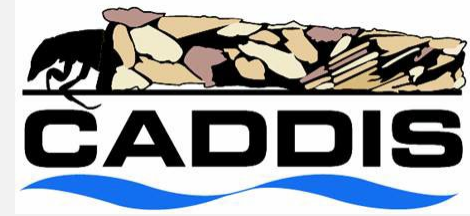
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- **Volume 2:** Sources, Stressors & Responses
- **Volume 3:** Examples & Applications
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# Vol 2: Sources, Stressors & Responses



**EPA** United States Environmental Protection Agency

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## Sources, Stressors and Responses

**Volume 2. Sources, Stressors, Responses**  
This volume of CADDIS provides useful information on common sources, stressors and responses. This information helps you decide which candidate causes to include in your assessment and develop cases for or against those causes.

### Basic Information

- [Learn About Sources](#)
  - [Urbanization](#)
- [Learn About Stressors](#)
- [Learn About Responses](#)
- [Frequent Questions](#)
- [Glossary](#)

### Stressors (A-M)

- [Ammonia](#)
- [Dissolved Oxygen](#)
- [Flow Alteration](#)
- [Herbicides](#)
- [Insecticides](#)
- [Ionic Strength](#)
- [Metals](#)

### Stressors (N-Z)

- [Nutrients](#)
- [pH](#)
- [Physical Habitat](#)
- [Sediments](#)
- [Temperature](#)
- [Unspecified Toxics](#)

### Related Information

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- [Vol 1. Stressor Identification](#)
- [Vol 2. Sources, Stressors and Responses](#)
- [Vol 3. Examples and Applications](#)
- [Vol 4. Data Analysis](#)
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- Ammonia
- Dissolved oxygen
- Flow alteration
- Herbicides
- Insecticides
- Ionic Strength
- Metals
- Nutrients
- pH
- Physical Habitat
- Sediments
- Temperature
- Unspecified Toxics
- Urbanization

# CADDIS Volume 2

CADDIS Home

Vol 1. Stressor Identification

Vol 2. Sources, Stressors and Responses

About Sources

About Stressors

Ammonia

Dissolved Oxygen

Flow Alteration

Herbicides

Insecticides

Ionic Strength

Metals

Nutrients

pH

Physical Habitat

Sediments

**Temperature**

Unspecified Toxic Chemicals

About Responses

Vol 3. Examples and Applications

Vol 4. Data Analysis

Vol 5. Causal Databases

Glossary

## Temperature

Overview

When to List

Ways to Measure

Conceptual Diagrams

References

### On this Page

- [Checklist of Sources, Site Evidence and Biological Effects](#)
  - [Consider Listing Temperature as a Candidate Cause](#)
  - [Consider Contributing, Modifying and Related Factors as Candidate Causes](#)

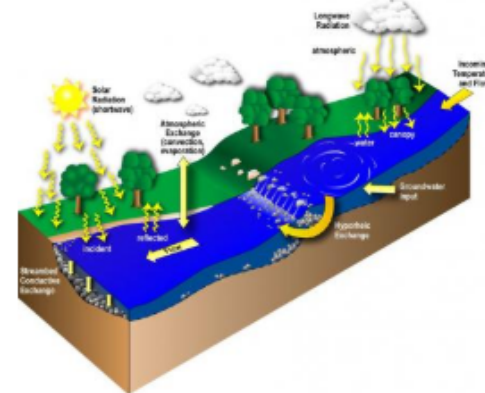


Figure 1. Major heat flux processes in streams. Click diagram to view a larger version.

Adapted from Moore et al. (2008) and Johnson and Jones (2000)

Temperature is the concentration of thermal energy in a substance such as water. The phrase "thermal regime" is used when emphasizing the temporal and spatial distribution of temperature.

Temperatures in streams and rivers are influenced by many atmospheric and hydrologic processes affecting the movement of heat (see Figure 1). In turn, temperature plays a fundamental role in shaping the structure and function of aquatic systems (see Table 1). It is frequently used as a basis for classifying streams (e.g., coldwater, warmwater).

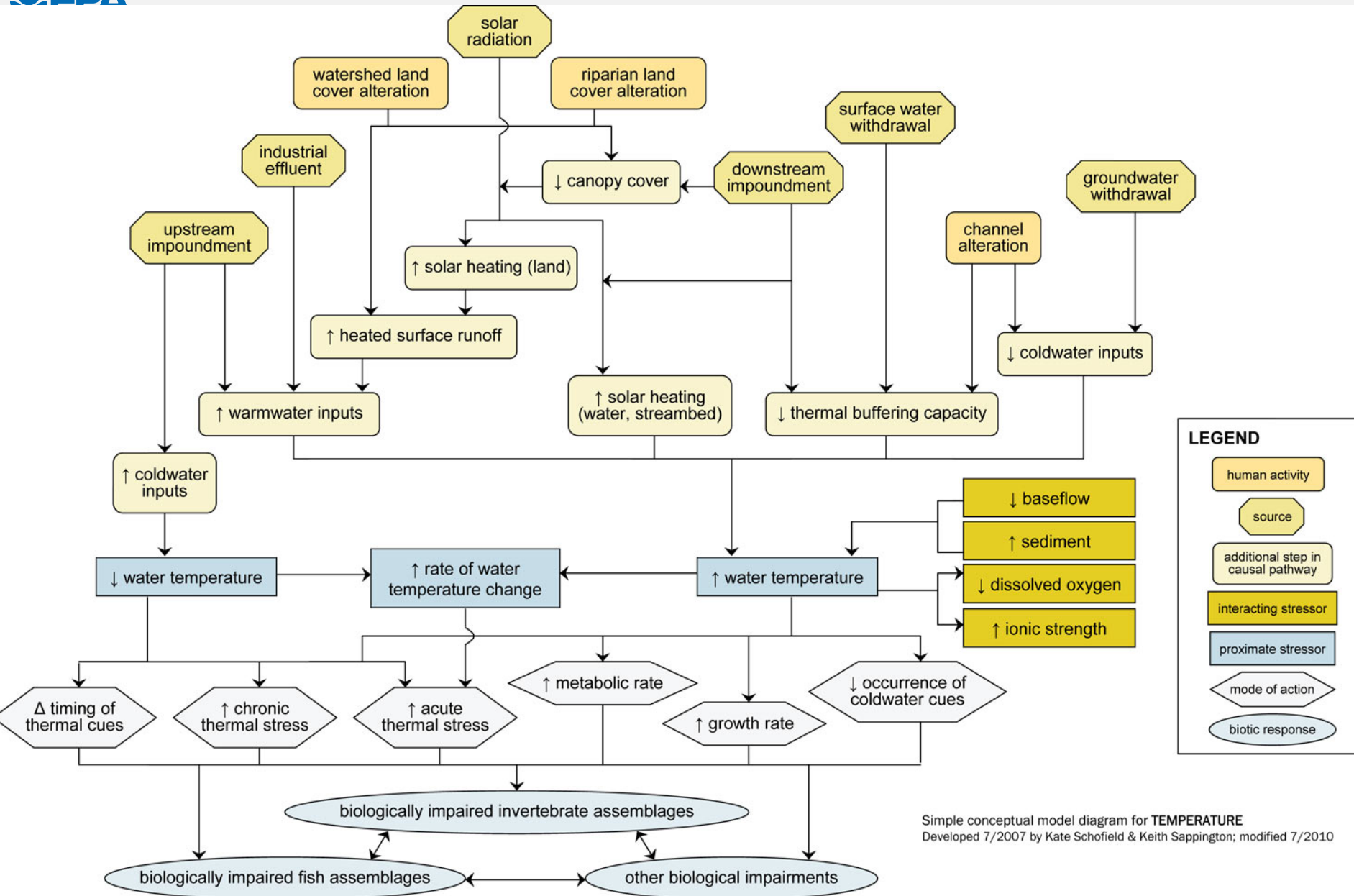
This module provides advice for deciding whether to include temperature in your list of candidate causes. You may go directly to a specific section of interest by clicking on the tabs above.

Table 1. Example Attributes of Aquatic Ecosystems Affected by Temperature

Category	Example Attributes
Physical	Water density, thermal stratification, solubility of oxygen and other chemicals

- Overview
- When to List
- Ways to Measure
- Conceptual Diagrams
- References



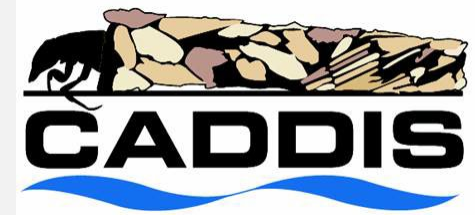


**LEGEND**

- human activity
- source
- additional step in causal pathway
- interacting stressor
- proximate stressor
- mode of action
- biotic response

Simple conceptual model diagram for **TEMPERATURE**  
 Developed 7/2007 by Kate Schofield & Keith Sappington; modified 7/2010

# Vol 3: Examples & Applications



## CADDIS Volume 3

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### Examples and Applications



#### Volume 3. Examples and Applications

The examples in this section show how the CADDIS framework has been applied to both aquatic and terrestrial effects. They illustrate applications representing a variety of locations, stressors, and affected species or communities.

### Analytical Examples

- [Analytical Examples](#)
  - [Spatial Co-occurrence](#)
  - [Verified Prediction \(PECBO\)](#)
  - [Stressor-Response from the Field](#)
  - [Stressor-Response from the Lab](#)
  - [Verified Prediction \(Traits\)](#)

### Case Studies and Examples

- [Worksheet Examples](#)
- [State Examples](#)
- [Case Studies](#)
- [Galleries](#)

#### Related Information

- [CADDIS Home](#)
- [Vol 1. Stressor Identification](#)
- [Vol 2. Sources, Stressors and Responses](#)
- [Vol 3. Examples and Applications](#)
- [Vol 4. Data Analysis](#)
- [Vol 5. Causal Databases](#)

# Analytical Examples

## Example 1. Spatial Co-occurrence with Regional Reference Sites

### On this Page

- [Introduction](#)
- [Data](#)
- [Analysis and Results](#)
- [How Do I Score This Evidence?](#)

### Introduction

We would like to determine whether stream temperatures observed at an Oregon test site are higher than those at regional reference sites. If temperatures at the test site are higher than reference expectations, then we can conclude that increased temperature spatially co-occurs with the observed impairment. Conversely, temperatures at the test site that are comparable to temperatures at regional reference sites would suggest that increased temperature does not spatially co-occur with the observed impairment.

### Data

The Oregon Department of Environment Quality (ORDEQ) deployed continuous temperature monitors in streams from 1997-2002. These temperature monitors recorded hourly temperature measurement which were then summarized as seven day average maximum temperatures in degrees C (7DAMT). Sites were also characterized by the geographic location (latitude and longitude), elevation, and catchment area. Reference sites were designated in Oregon based on land use characteristics.

### Analysis and Results

Scatter plots are first used to examine the variation of stream temperature with different natural factors. The factors that are chosen (e.g., elevation, geographic location) must not be associated with local human activities. This initial data exploration suggests that stream temperature in reference sites are inversely related with both elevation and latitude (Figure 1). Next, regression analysis is used to model stream temperature as a function of elevation and latitude.

Overview

**Example 1**

Example 2

Example 3

Example 4

Example 5

- Introduction
- Data
- Analysis and Results
- How Do I Score this Evidence?

### Related Information

#### Analytical Techniques Used

- [Scatterplots](#)
- [Regression Analysis](#)
- [Controlling for Natural Variability](#)

#### Type of Evidence Supported

- [Spatial/Temporal Co-occurrence](#)

Vol 4: Data Analysis

Vol 1: Stressor Identification

# Applications to the Clean Water Act 303d/Total Maximum Daily Load (TMDL) Program

TMDL Program

Criteria

Waste Site(s)

Endangered Species

References

CADDIS Home

Vol 1. Stressor Identification

Vol 2. Sources, Stressors and Responses

Vol 3. Examples and Applications

Analytical Examples

Worksheet Examples

State Examples

Case Studies

Galleries

Vol 4. Data Analysis

Vol 5. Causal Databases

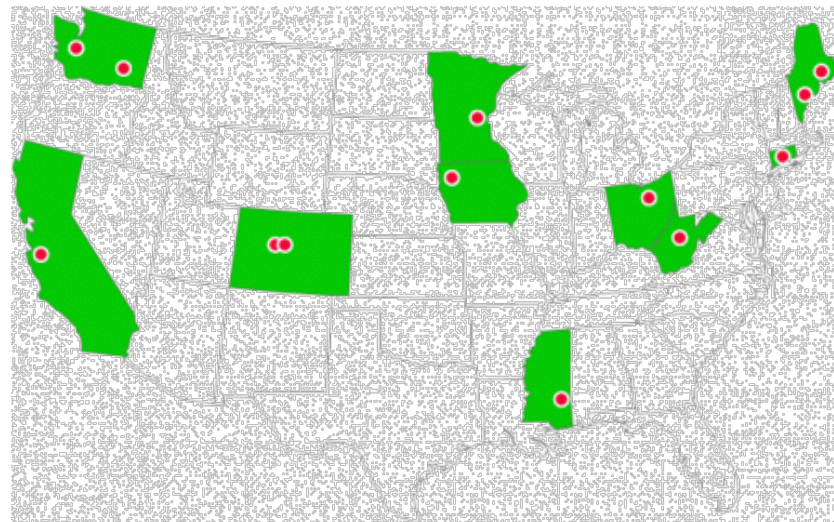
Glossary



Figure 1. States that have used or are currently using methods from the Stressor Identification process, shown in green.

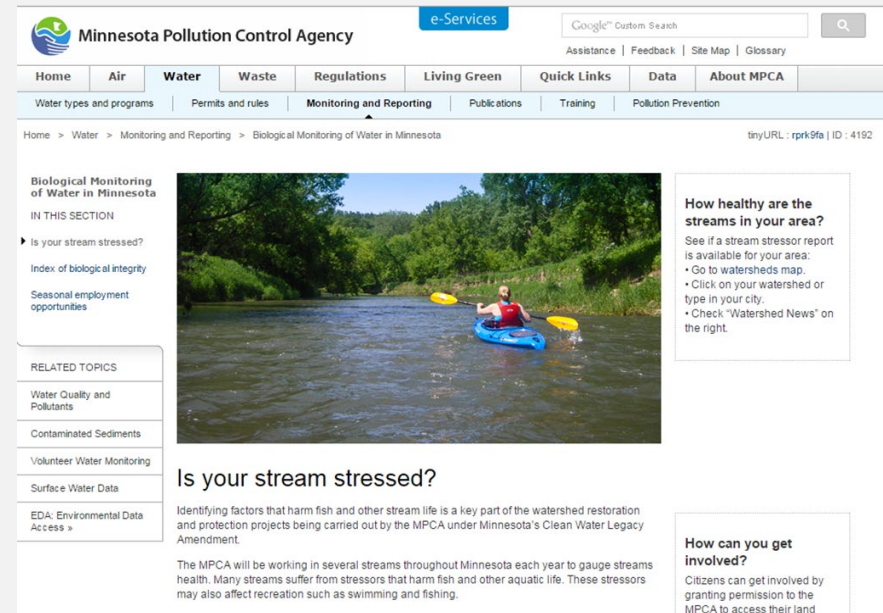
Stressor Identification typically occurs after a water body is listed as impaired by biological or unknown causes. This is typically before the development of a TMDL or watershed management plan. U.S. EPA does not require documentation of how pollutants or watershed management targets are identified. However, we have found some evidence of the adoption of our methods (see Figure 1). This list does not include states which have conducted full stressor

identification case studies.



## Adapted for state-specific applications in 19 states

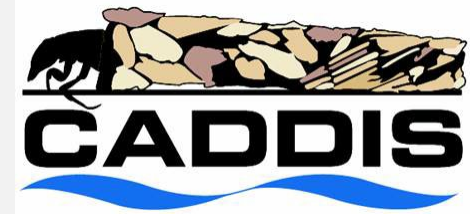
- **Minnesota:** causal assessment applied systematically to watersheds across the state
- **Pennsylvania, West Virginia and Virginia:** causal assessments steer data collection efforts in fish health investigations
- **Connecticut and Maine:** causal assessments provide input to restoration decisions
- **California:** collaborating with ORD to make causal assessments faster, cheaper and routine



The screenshot shows the Minnesota Pollution Control Agency (MPCA) website. The main navigation bar includes Home, Air, Water, Waste, Regulations, Living Green, Quick Links, Data, and About MPCA. The 'Water' section is active, with sub-links for Water types and programs, Permits and rules, Monitoring and Reporting, Publications, Training, and Pollution Prevention. The current page is 'Biological Monitoring of Water in Minnesota'. It features a sidebar with 'IN THIS SECTION' (Is your stream stressed?, Index of biological integrity, Seasonal employment opportunities) and 'RELATED TOPICS' (Water Quality and Pollutants, Contaminated Sediments, Volunteer Water Monitoring, Surface Water Data, EDA: Environmental Data Access). The main content area has a header 'Biological Monitoring of Water in Minnesota' and a large image of a person kayaking on a river. Below the image is the section 'Is your stream stressed?' with a sub-header 'How healthy are the streams in your area?' and a list of links: 'Go to watersheds map', 'Click on your watershed or type in your city', and 'Check "Watershed News" on the right'. Another section 'How can you get involved?' is also visible.



[youtube.com/watch?v=K2x20Q1df48](https://youtube.com/watch?v=K2x20Q1df48)

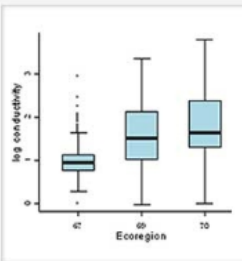
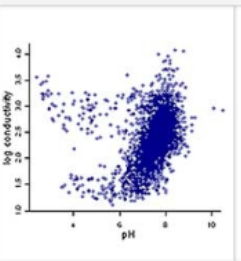
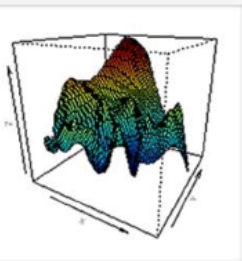


Environmental Topics    Laws & Regulations    About EPA

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## CADDIS Volume 4

### Data Analysis

**Volume 4. Data Analysis**

This volume of CADDIS provides useful information on different analytical techniques that can be applied to causal analysis.

### Basic Information

- [Selecting an Analysis Approach](#)
- [Getting Started with Data Analysis](#)
- [Basic Principles and Issues](#)
- [Frequent Questions](#)
- [Glossary](#)

### Analyses and Tools

- [Exploratory Data Analysis](#)
- [Basic Analyses](#)
- [Advanced Analyses](#)
- [PECBO Appendix](#)
- [Download Software](#)

### Related Information

- [CADDIS Home](#)
- [Vol 1. Stressor Identification](#)
- [Vol 2. Sources, Stressors and Responses](#)
- [Vol 3. Examples and Applications](#)
- [Vol 4. Data Analysis](#)
- [Vol 5. Causal Databases](#)

### Data Analysis Topics (A-C)

- [Autocorrelation](#)
- [CADStat](#)
- [Classification and Regression Trees](#)
- [Conditional Probability](#)
- [Confidence Intervals](#)
- [Confounding](#)
- [Controlling for Natural Variability](#)

### Data Analysis Topics (C-R)

- [Correlation Analysis](#)
- [Interpreting Statistics](#)
- [Multivariate Data Exploration](#)
- [Propensity Scores](#)
- [Quantile Regression](#)
- [R Command Line](#)

### Data Analysis Topics (R-T)

- [Regression Analysis](#)
- [Scatterplots](#)
- [Spatial Analysis and GIS](#)
- [Species Sensitivity Distributions \(SSDs\)](#)
- [Tests of Significant Difference](#)
- [Traits](#)

[Contact Us](#) to ask a question, provide feedback, or report a problem.

- Selecting an Analysis Approach
- Getting Started
- Basic Principles & Issues
- Exploratory Data Analysis
- Basic & Advanced Analyses
- Download Software

## Getting Started with Data Analysis

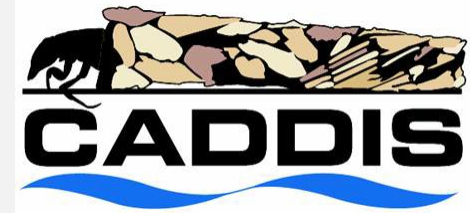
- Assembling, matching, organizing data
- Data quality
- Links to relevant databases

## Exploratory and Basic Data Analysis

- Variable distributions, scatterplots, correlation analysis, conditional probability, multivariate approaches
- Significance tests, regression analysis, quantile regression, classification and regression tree (CART) analysis

## Download Software

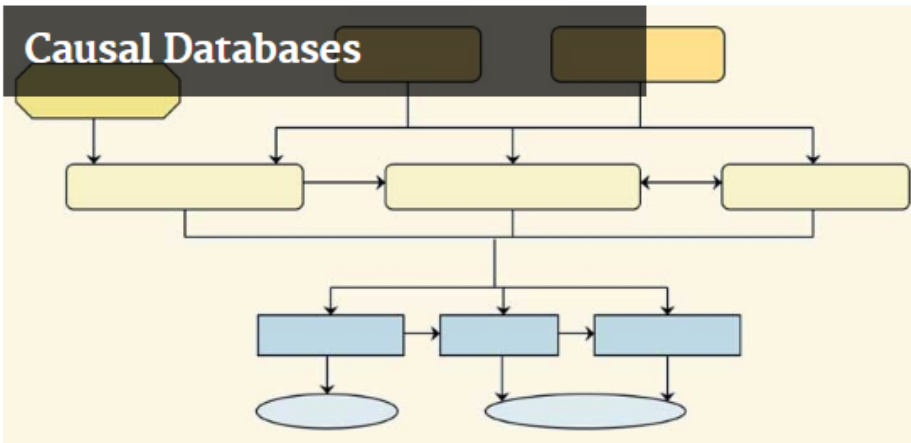
- CADStat
- Species Sensitivity Distribution (SSD) Generator
- R Command Line Tutorial



## CADDIS Volume 5

### Volume 5. Causal Databases

Causal assessments rely on evidence from the literature to support or refute causal relationships. This volume provides tools for creating conceptual model diagrams and finding relevant literature-based information to help evaluate different causal pathways.



### Interactive Conceptual Diagrams (ICDs)

- [Learn about ICDs](#)
- [User Guide](#)
- [Quick Start Instructions](#)
- [Open the Application](#)

### Literature Database

- [CADLink](#) - CADDIS Literature Database
- [Glossary](#)

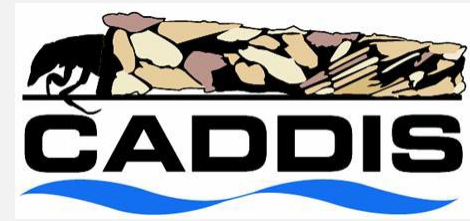
### Related Information

- [CADDIS Home](#)
- [Vol 1. Stressor Identification](#)
- [Vol 2. Sources, Stressors and Responses](#)
- [Vol 3. Examples and Applications](#)
- [Vol 4. Data Analysis](#)

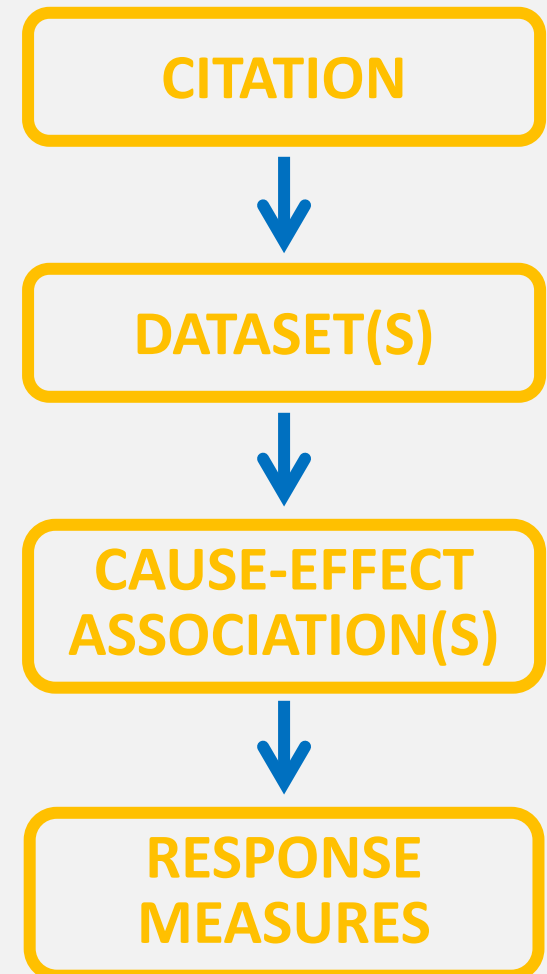
[Contact Us](#) to ask a question, provide feedback, or report a problem.

- CADLink
- ICD (\*)

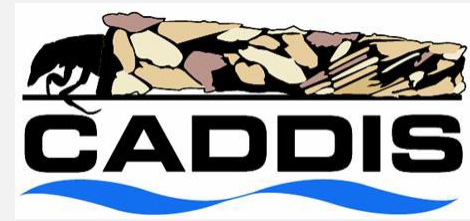




- Database of evidence extracted from published literature
- Focused on cause-effect associations
- Includes information on study design, location, analytical results
- “Public” users can search existing records, “registered” users can enter new/modify existing records

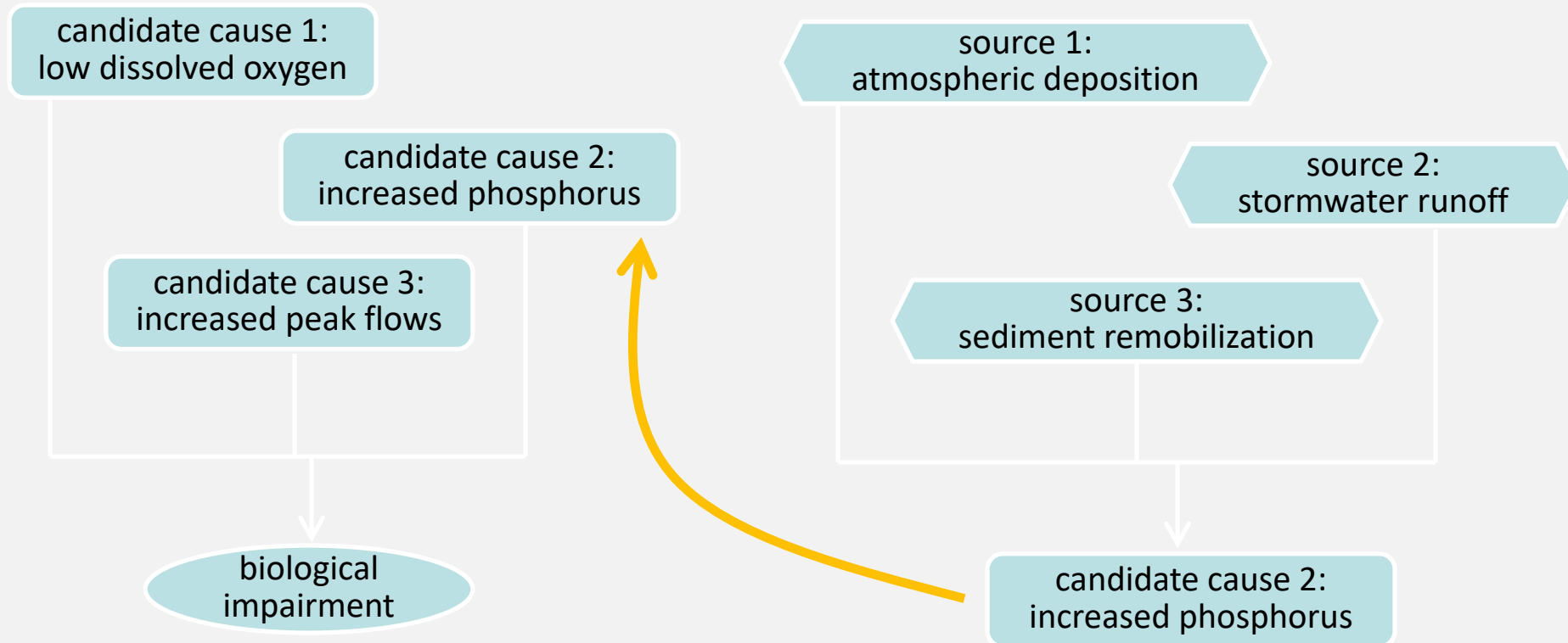


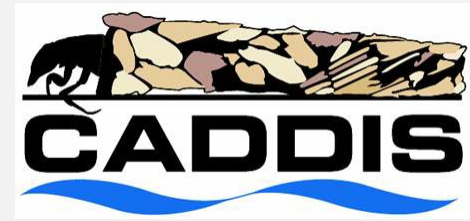
# What's next for CADDIS?



- Develop methods for “rapid” causal assessment
- Develop evidence databases
  - CADLink
  - EcoEvidEx (Ecological Evidence Exchange)
- Link evidence databases to visualization applications
  - EcoDIVER (Ecological Database and Interactive Visualizations of Evidence Records)
- Other suggestions?
  - Let us know what would be most useful for you (via email or CADDIS Contact Us page)

# Causal assessment (and CADDIS) can be applied more broadly...





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