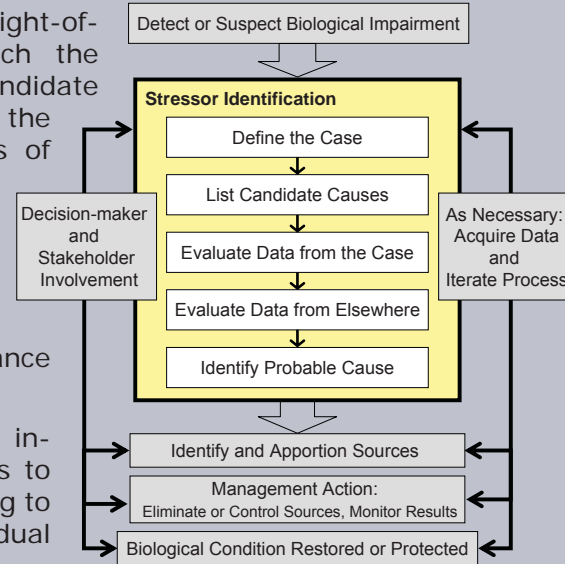


Step-by-Step Guide

The SI process is a weight-of-evidence approach, in which the evidence for and against candidate causes is assessed to identify the most likely cause or causes of impairment. It involves five steps (right), anchored within the broader management context.

The Step-by-Step Guide provides detailed technical guidance for the entire SI process.

- The **Guide Overview** introduces SI, from issues to consider before beginning to a summary of the individual steps.
- **Fundamentals of Causal Analysis** summarizes the principles and methodology underlying CADDIS.
- **Individual sections for each step** describe Steps 1-5 in detail.
- **Summary Tables** explain the types of evidence and scoring methodology used to evaluate candidate causes.
- **Examples** of completed worksheets from actual CADDIS case studies can be viewed and downloaded.



Steps 3 and 4 comprise the analytical core of the SI process, in which you build the body of evidence for and against each candidate cause. This evidence is organized into types of evidence, or categories of relationships providing a logically distinct way to support, weaken, or refute the case for a candidate cause. These types of evidence are based on two kinds of data:

- Step 3 focuses on data from the case, collected at the specific sites (impaired and reference) of interest.
- Step 4 draws on data from elsewhere, collected at other relevant field sites or in laboratory studies.

Links to Types of Evidence that Use Data from Elsewhere

- 4.2.1. Stressor-Response Relationships from Other Field Studies
- 4.2.2. Stressor-Response Relationships from Laboratory Studies
- 4.2.3. Stressor-Response Studies from Ecological Simulation Models
- 4.2.4. Mechanistically Plausible Cause
- 4.2.5. Manipulation of Exposure at Other Sites
- 4.2.6. Analogous Stressors

Links to Types of Evidence that Use Data from the Case

- 3.2.1. Spatial/Temporal Co-occurrence
- 3.2.2. Evidence of Exposure or Biological Mechanism
- 3.2.3. Causal Pathway
- 3.2.4. Stressor-Response Relationships from the Field
- 3.2.5. Manipulation of Exposure
- 3.2.6. Laboratory Tests of Site Media
- 3.2.7. Temporal Sequence
- 3.2.8. Verified Predictions
- 3.2.9. Symptoms

Where can CADDIS be used?

CADDIS currently focuses on impairments in stream ecosystems. However, because the Stressor Identification process is based on fundamental principles of causal analysis, the Step-by-Step Guide is directly applicable to any impaired ecosystem. Case studies in terrestrial habitats are now under development.



Contact us

Your input is important to us. Please email us with your feedback on how to improve the material and tools currently available, as well as suggestions for new content.

caddis@epa.gov

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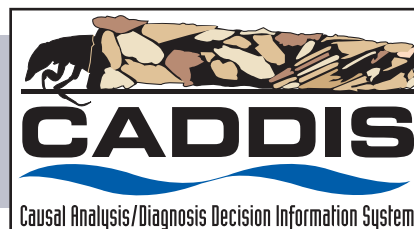
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A rigorous process for ecological causal assessment—and the technical content to help you do it

Last updated 12/2007



CADDIS

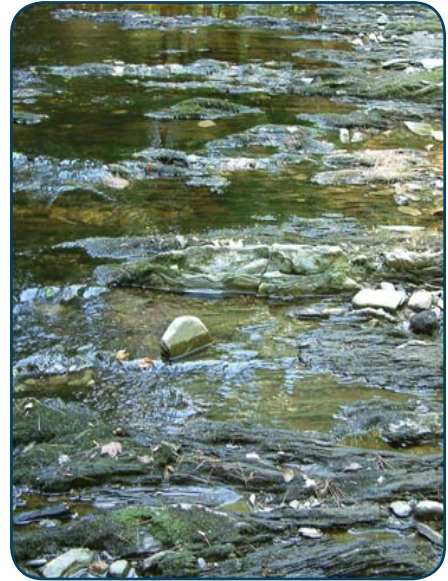
Causal Analysis/Diagnosis Decision Information System

What is it?

CADDIS is an online application that helps users find, access, organize, use, and share information for causal evaluations in streams, rivers, and other waterbodies. It is based on the U.S. Environmental Protection Agency's Stressor Identification (SI) process, a formal weight-of-evidence approach to identifying causes of biological impairment in aquatic systems.

This brochure highlights some of the features currently available in CADDIS:

- A **Step-by-Step Guide** to conducting causal analyses;
- Introductory material on commonly encountered **candidate causes**, including conceptual model diagrams linking sources, stressors, and effects;
- Information on **data analysis**, including downloadable tools; and
- **Databases** of stressor-response information.



Visit CADDIS at www.epa.gov/caddis

Who is it for?

CADDIS contains technical information for use by scientists involved in causal assessments. However, anyone dealing with stressors in aquatic systems, including resource managers, watershed groups, and teachers, may find the information in CADDIS interesting and useful.

Why use it?

Determining probable causes of impairment is crucial for directing management efforts towards effective solutions—you can't fix a problem until you identify what the problem is!

Accurate and defensible identification of causes is an essential element of many regulatory and water quality management programs at the state and federal levels, including:

- 303(d) listings and setting TMDLs, under the Clean Water Act;
- State and local watershed management programs; and
- Restoration and preservation programs.



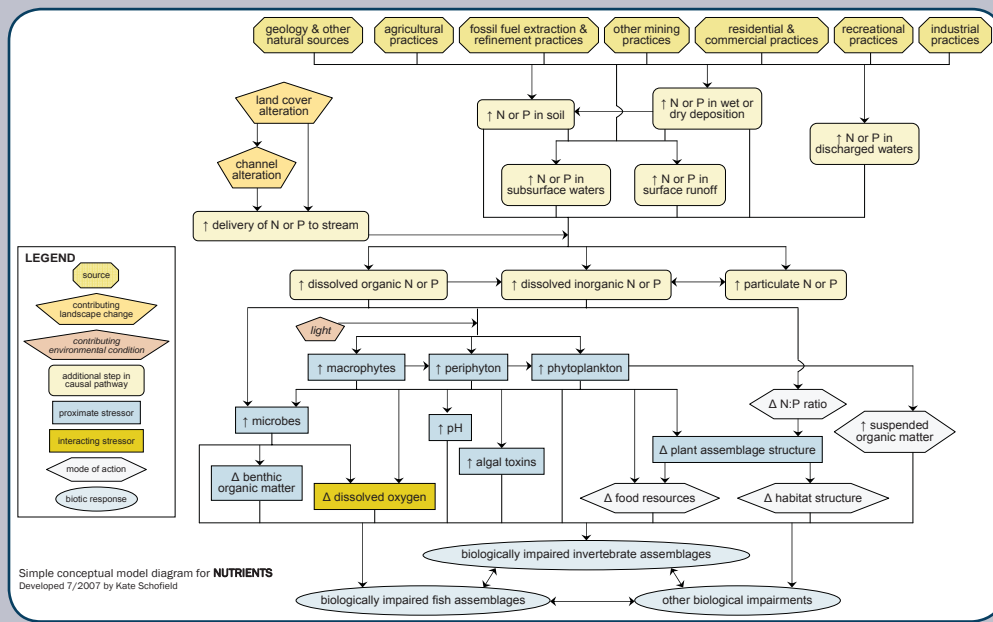
Candidate Causes

CADDIS provides **basic information on eight common candidate causes** of biological impairment:

Common Candidate Causes

- CC.1. Metals
- CC.2. Sediments
- CC.3. Nutrients
- CC.4. Dissolved Oxygen
- CC.5. Temperature
- CC.6. Ionic Strength
- CC.7. Flow Alteration
- CC.8. Unspecified Toxic Chemicals

- What to consider (e.g., sources, site evidence) when deciding whether to include stressors as candidate causes
- Ways to measure stressors
- Relevant literature reviews
- Conceptual model diagrams showing linkages among stressors and their potential sources and effects



This section of CADDIS also contains an Interactive Conceptual Model (ICM), a visual tool which uses a conceptual model diagram (above) as the structural framework for organizing and accessing stressor-specific information. This ICM currently provides supporting literature information for phosphorus—you can click on shapes in the diagram to view citation information for references supporting the selected linkage.

Analyzing Data

This section of CADDIS contains information and tools designed to help you apply field and laboratory data to your causal assessment.

- **Data Analysis Methods** describes nine graphical and statistical techniques useful for causal data analysis. Examples are provided for each method, and three topics are addressed:

What is it?

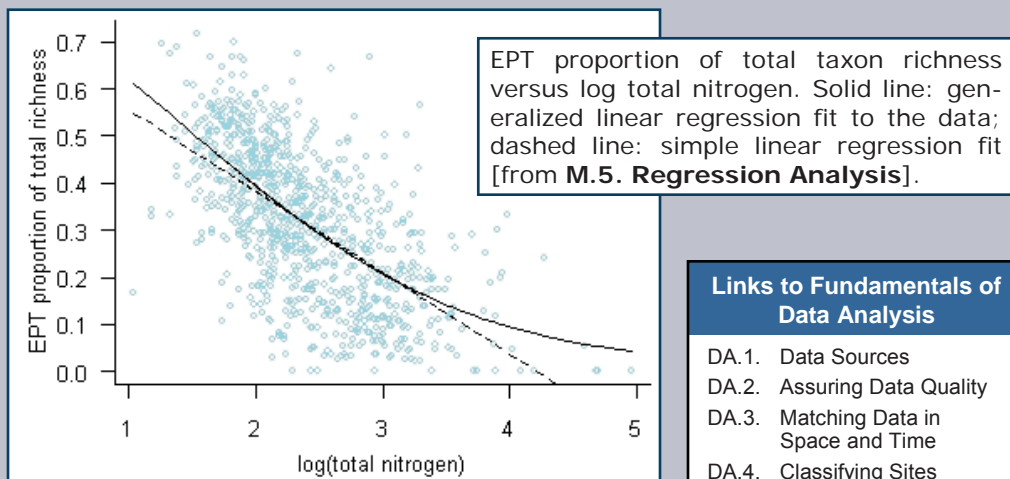
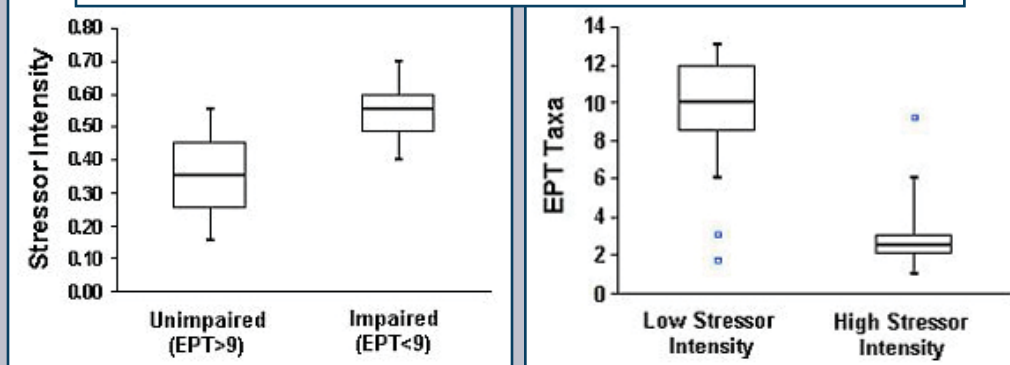
How do you use it in the SI process?

Can you use it with your data?

Links to Methods

- M.1. Scatter Plots
- M.2. Correlation Analysis
- M.3. Box Plots
- M.4. Conditional Probability Analysis
- M.5. Regression Analysis
- M.6. Predicting Environmental Conditions from Biological Observations
- M.7. Quantile Regression
- M.8. Classification and Regression Trees
- M.9. Species Sensitivity Distributions

Box plots with data grouped according to biological impairment (left) and stressor intensity (right); points indicate observations outside the interquartile range [from **M.3. Box Plots**].



Links to Fundamentals of Data Analysis

- DA.1. Data Sources
- DA.2. Assuring Data Quality
- DA.3. Matching Data in Space and Time
- DA.4. Classifying Sites
- DA.5. Normalizing Data
- DA.6. Using Statistics Responsibly
- DA.7. Extrapolation
- DA.8. Organizing Data Along Causal Pathways

- **Fundamentals of Data Analysis** presents advice on how to handle and analyze data to provide a sound foundation for causal analyses.
- **Get Data Analysis Tools** provides access to downloadable tools you can use to analyze your own data:

A Species Sensitivity Distribution generator

CADStat, a menu driven package of data visualization and statistical methods

A tutorial on the freeware statistical package R

Command-line R scripts for predicting environmental conditions from biological observations

Databases

This section of CADDIS contains four graphic galleries, and links to useful databases outside of CADDIS.

- The **Conceptual Model Library** contains diagrams and associated narratives describing hypothesized relationships among sources, stressors, and biotic responses. It includes two model types:

Site-specific models developed during CADDIS case studies

Generic overview models, illustrating linkages among common candidate causes and their potential sources and biological effects

- The **Metals Chronic Concentration-Response Gallery** contains plots and source data describing responses of aquatic organisms to chronic metal exposures.

- The **Metals Species Sensitivity Distribution (SSD) Gallery** contains SSDs (below), calculated from data in the ECOTOX database (www.epa.gov/ecotox).

- The **Field Stressor-Response Association Gallery** contains examples of stressor-response relationships (below) based on field data from several datasets, using methods described in the Analyzing Data section.

An SSD plot showing LC₅₀s for arthropods exposed to dissolved cadmium; dotted lines: 95% prediction intervals [from **D.3. Metals SSD Gallery**].

