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Agency

An overview of CADDIS and ongoing systematic reviews of nutrient-stressor response relationships

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Office of Research and Development
National Center for Environmental Assessment

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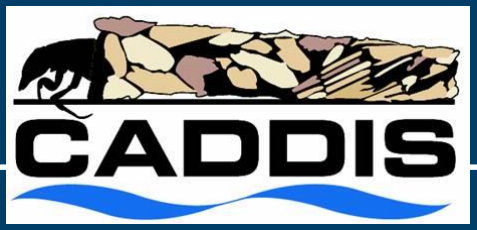
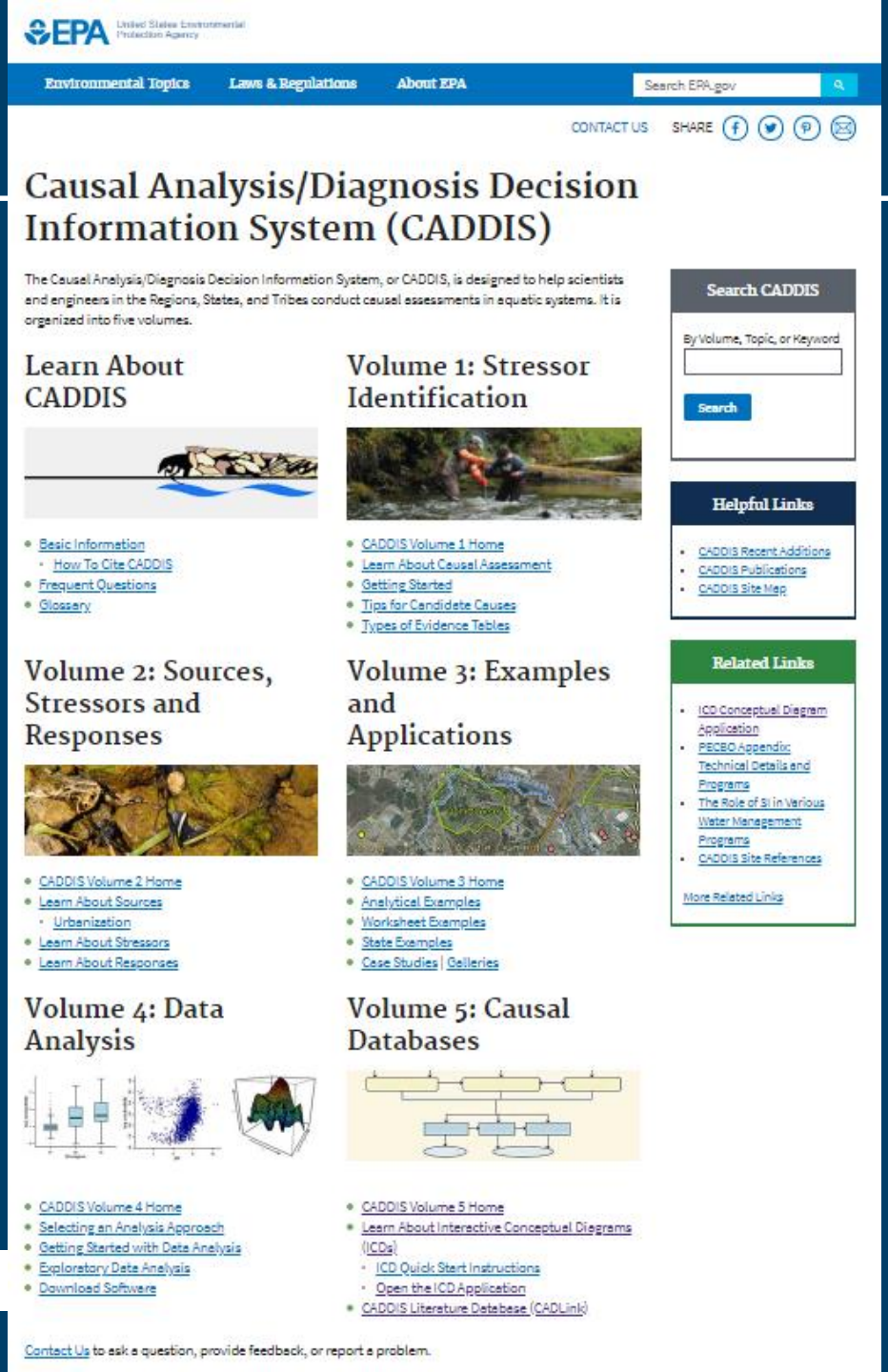
What is CADDIS?



- Causal Analysis/Diagnosis Decision Information System
- Website that helps users conduct causal assessments of stream biological impairment
  - Strength of evidence based framework for stressor identification
  - Information on specific stressors, data analysis methods, etc.
  - Case studies
  - Tools for data analysis and literature evaluation

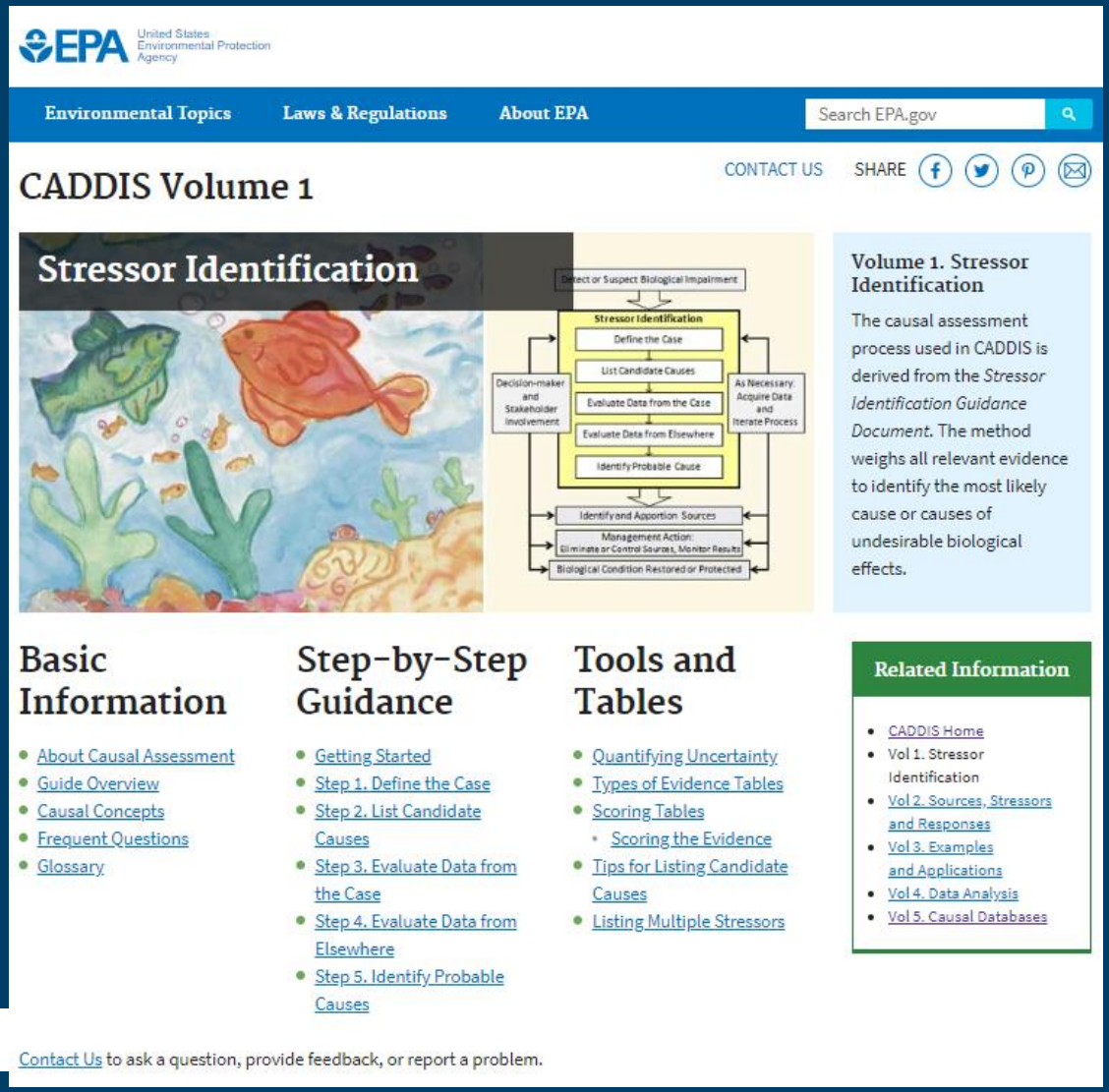
www.epa.gov/caddis



CADDIS

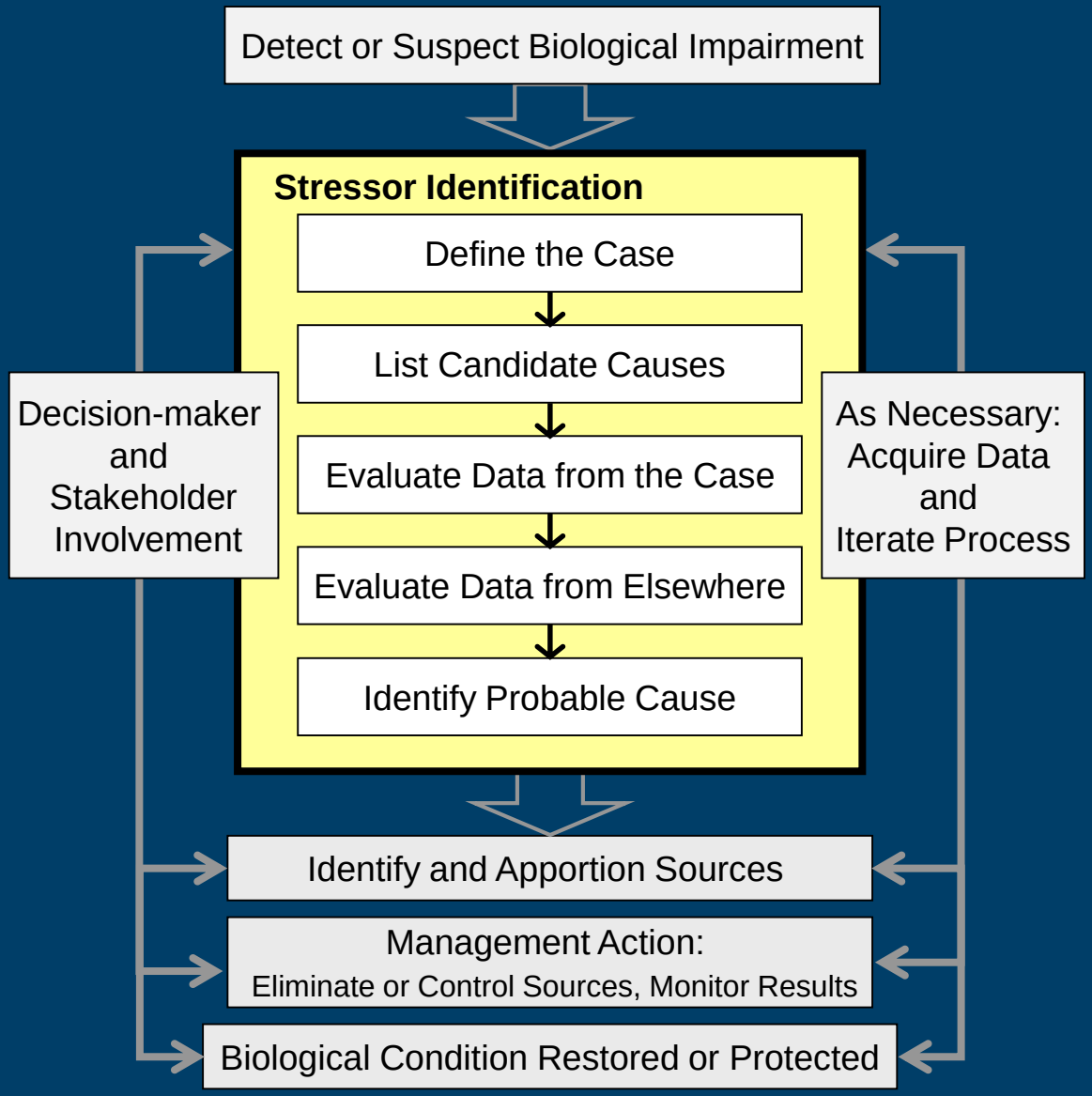
- Volume 1: Stressor Identification
- Volume 2: Sources, Stressors & Responses
- Volume 3: Examples & Applications
- Volume 4: Data Analysis
- Volume 5: Causal Databases

Vol 1: Stressor Identification



- Step-by-Step Guide
- Causal Assessment Background

The SI Process



CADDIS Volume 1

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.

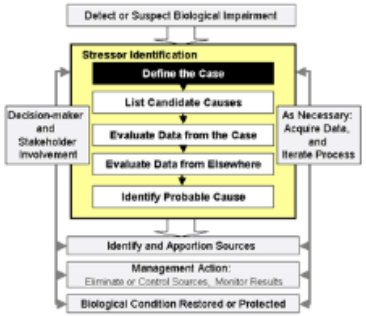


Figure 1-1. Illustration of where Step 1: Define the Case fits into the Stressor Identification process.

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

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 absent.

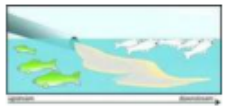


Figure 3-1a. Spatial/Temporal Co-occurrence with Upstream/Downstream Comparisons, Supports.

Click for more information

Figure 3-1b. Spatial/Temporal Co-occurrence with Upstream/Downstream Comparisons, Refutes.

Click for more information

Additional Illustrations of Spatial/Temporal Co-occurrence

Examples

Consider increased suspended solid concentrations as a candidate cause of reduced aquatic invertebrate abundance. What findings support or weaken the case for increased suspended solids as the cause, based on spatial/temporal co-occurrence?

- Supporting evidence (spatial co-occurrence) - Suspended solid concentrations are higher at the impaired site(s) than at unimpaired reference sites.
- Supporting evidence (temporal co-occurrence) - Suspended solid concentrations are episodic, and

Helpful Links

- Concept
- Examples
- How Do I Analyze the Data?
- What Evidence Would Support or Weaken the Case for a Candidate Cause?
- How Do I Score the Evidence?
- Helpful Tips

Additional Resources

- Types of Evidence that Use Data from the Case
- Types of Evidence that Use Data from the Elsewhere
- Summary Tables of Scores

- Back to Evaluate Data from the Case, In-Depth Look

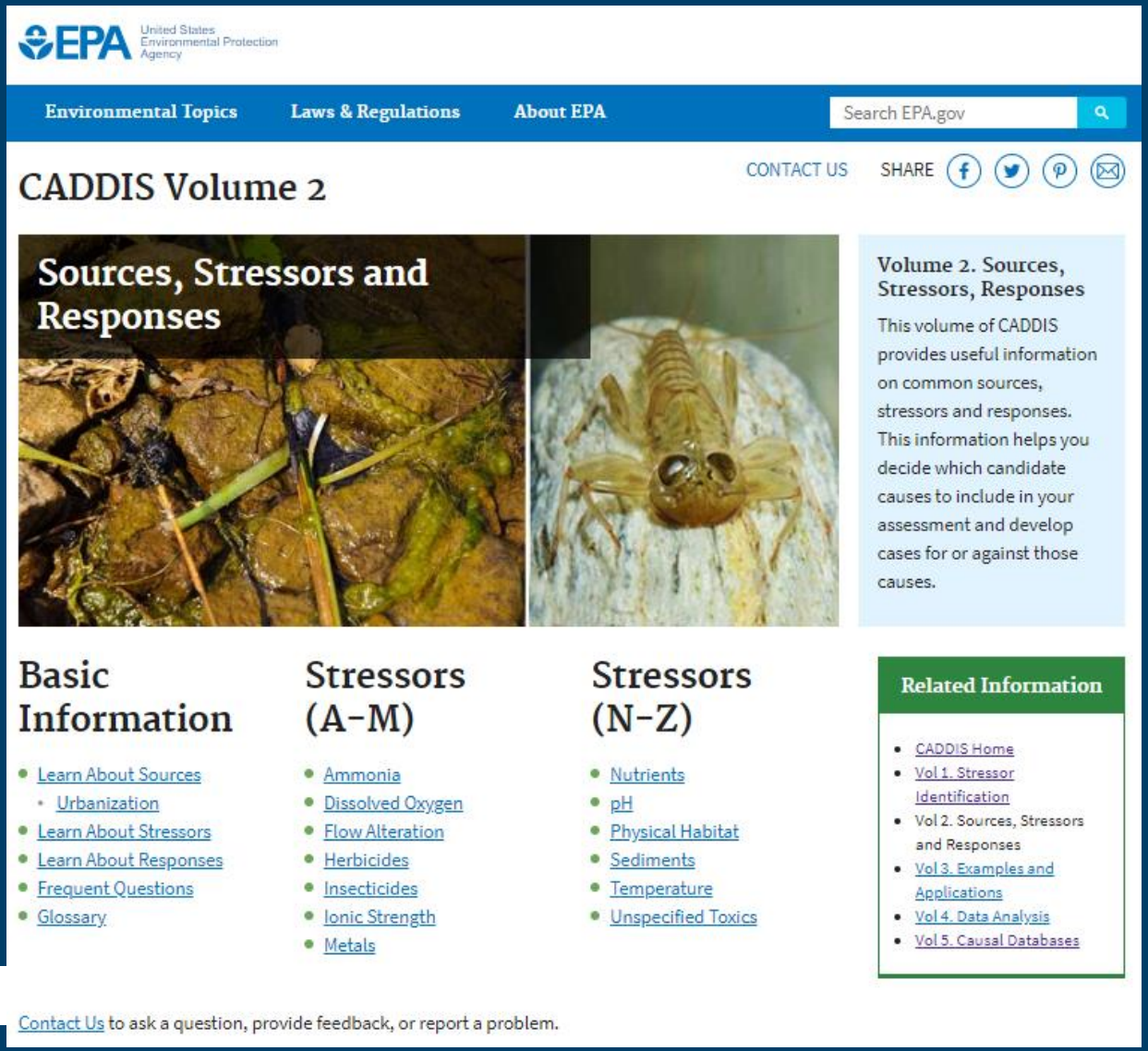
CADDIS Volume 1

Summary Tables of Scores

Types of Evidence that Use Data from the Case | Types of Evidence that Use Data from Elsewhere | Evaluating Multiple Types of Evidence

Type of Evidence	Finding	Interpretation	Score
Spatial/Temporal Co-occurrence	The effect occurs where or when the candidate cause occurs, **OR** the effect does not occur where or when the candidate cause does not occur.	This finding *somewhat supports* 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 *neither supports nor weakens* the case for the candidate cause, because the evidence is ambiguous.	0
	The effect does not occur where or when the candidate cause occurs, **OR** the effect occurs where or when the candidate cause does not occur.	This finding *convincingly weakens* 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, **OR** the effect occurs where or when the candidate cause does not occur, and the evidence is indisputable.	This finding *refutes* the case for the candidate cause, because causes must co-occur with their effects.	R

Vol 2: Sources, Stressors & Responses



- Ammonia
- Dissolved oxygen
- Flow alteration
- Herbicides
- Insecticides
- Ionic Strength
- Metals
- Nutrients
- pH
- Physical Habitat
- Sediments
- Temperature
- Unspecified Toxics
- Urbanization

Temperature

On this Page

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.

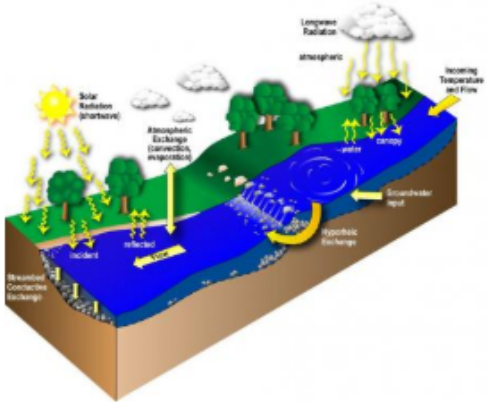


Figure 1. Major heat flux processes in streams. Click diagram to view a larger version.

Adapted from Moore et al. (2005) and Johnson and Jones (2000)

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

Vol 3: Examples & Applications

EPA United States Environmental Protection Agency

Environmental Topics | Laws & Regulations | About EPA | Search EPA.gov

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CADDIS Volume 3

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

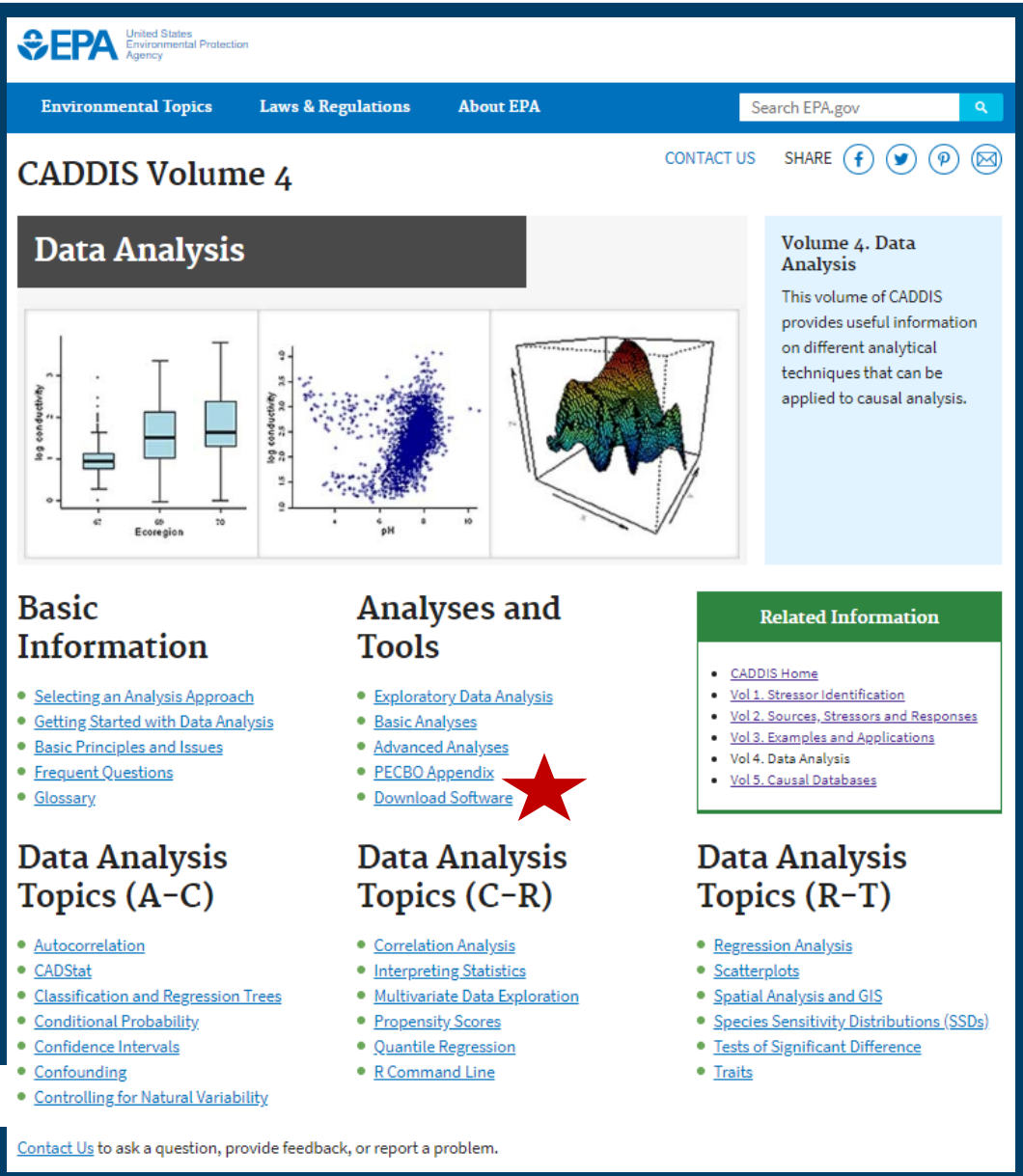
- Worksheet Examples
- State Examples
- Case Studies
- Galleries

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

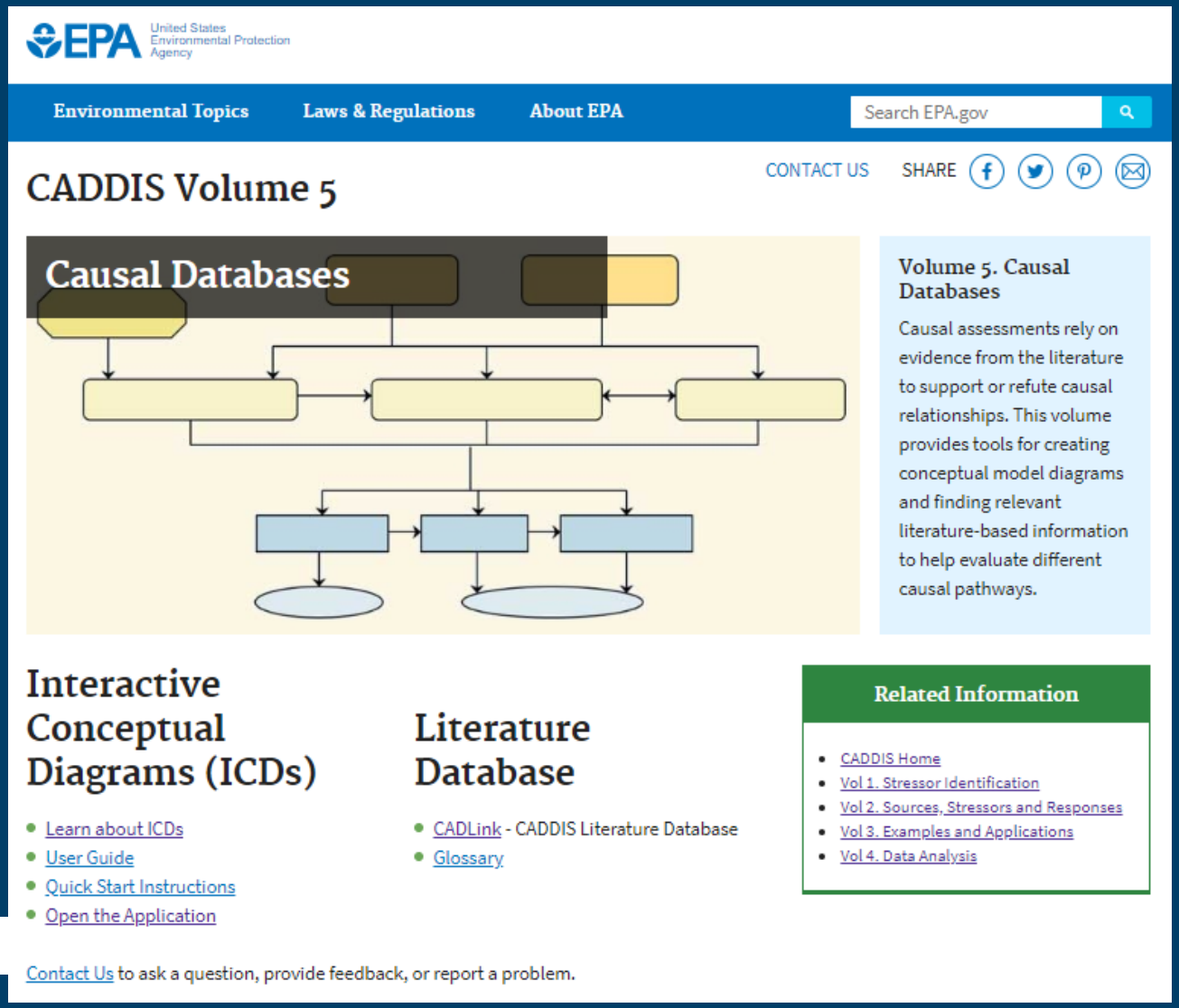
Contact Us to ask a question, provide feedback, or report a problem.

Vol 4: Data Analysis



- CADStat
- SSD Generator
- R Command Line Tutorial

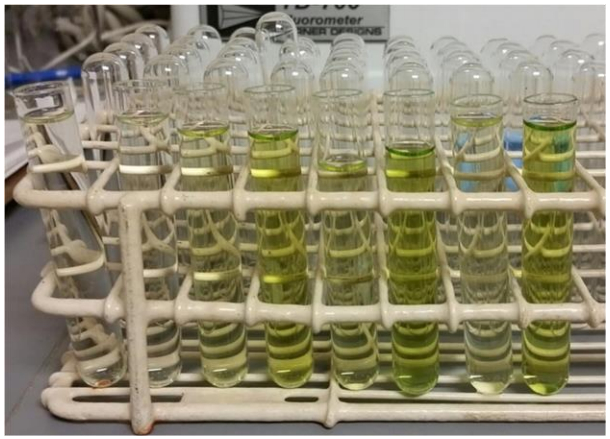
Vol 5: Causal Databases

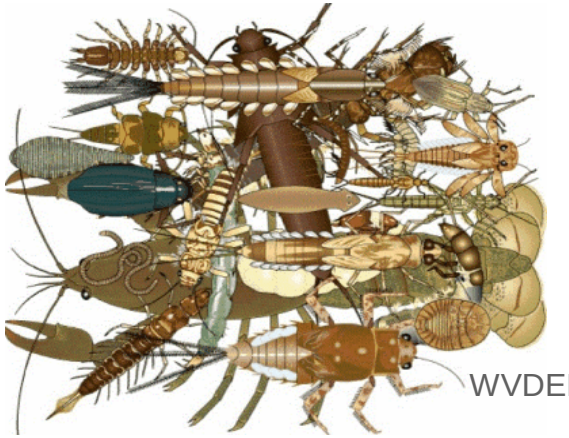


- CADLink
- ICD (*)

Systematic review of nutrient stressor-response relationships

- What are the responses of chlorophyll-*a*, diatoms, and macroinvertebrates to total nitrogen (TN) and total phosphorus (TP) concentrations in lotic ecosystems?
- How are these relationships affected by other factors?





Search

ProQuest ES Ingenta ScienceDirect Greenfile AGRICOLA Scopus JSTOR CAB Wiley BioOne Web of Science ProQuest D&T AGRIS

22,488 from academic databases

3,398 from 'snowball' searches

State/fed/int'l env agencies Google NGOs OpenGrey NTRL DART

691 from website searches

ResearchGate Twitter ECOLOG-L

83 from expert requests

TOTAL INPUT = 26,660 citations

Screen

>25,000 excluded

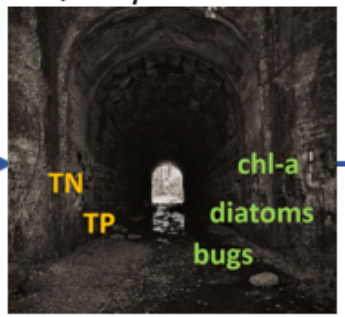
~1000 w/ no clear effect size

Extract & Synthesize

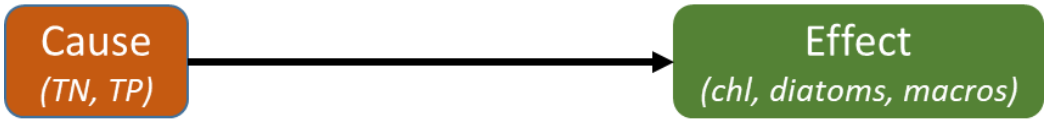
DRAFT

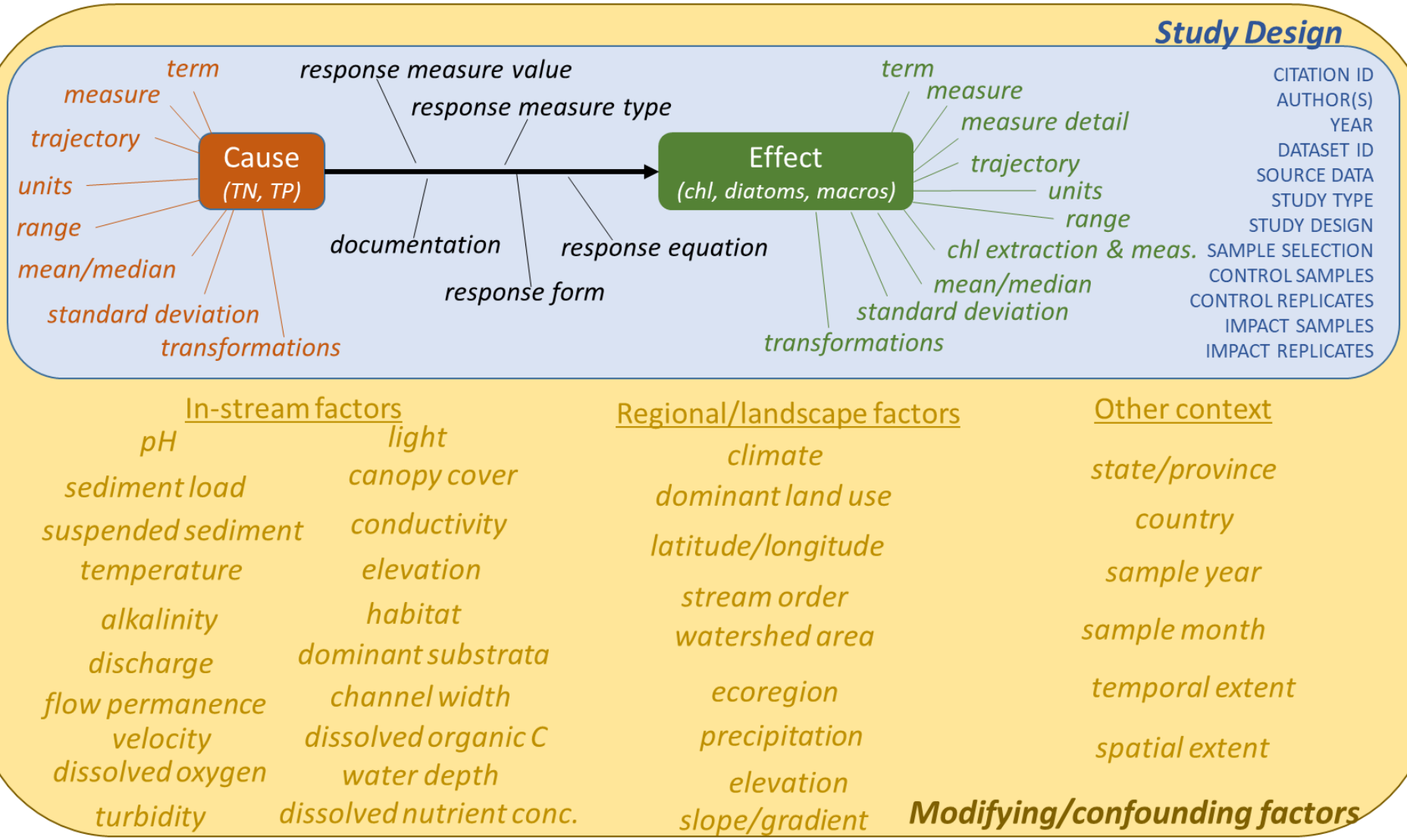
306 Full-text articles w/ effect sizes for data extraction & quality evaluation

Data extraction
Quality evaluation

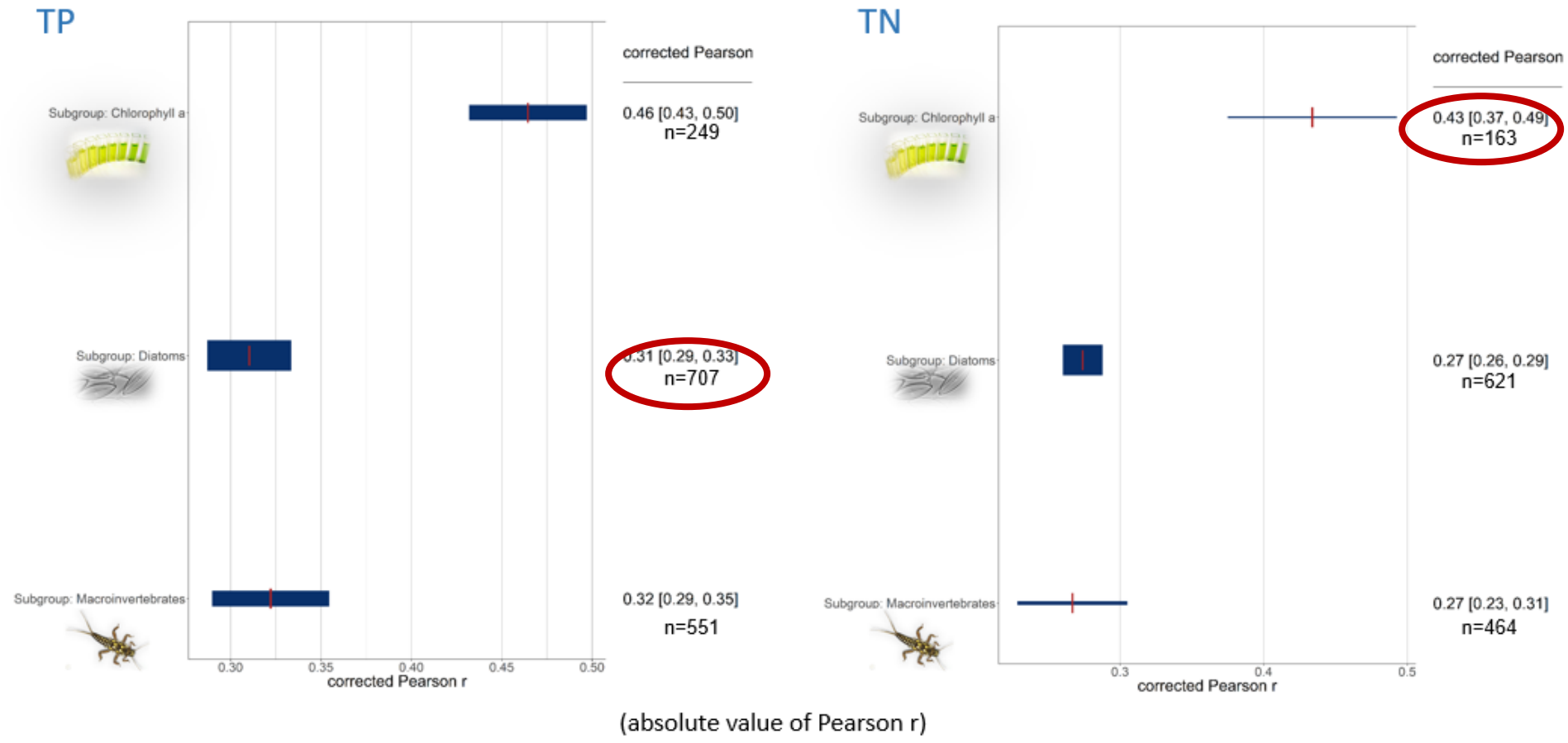


Meta-analysis
Synthesis


Cause
(TN, TP)
Effect
(chl, diatoms, macros)


Study Design
term
measure
trajectory
units
range
mean/median
standard deviation
transformations
Cause
(TN, TP)
response measure value
response measure type
documentation
response form
response equation
Effect
(chl, diatoms, macros)
term
measure
measure detail
trajectory
units
range
chl extraction & meas.
mean/median
standard deviation
transformations
CITATION ID
AUTHOR(S)
YEAR
DATASET ID
SOURCE DATA
STUDY TYPE
STUDY DESIGN
SAMPLE SELECTION
CONTROL SAMPLES
CONTROL REPLICATES
IMPACT SAMPLES
IMPACT REPLICATES
In-stream factors
pH
sediment load
suspended sediment
temperature
alkalinity
discharge
flow permanence
velocity
dissolved oxygen
turbidity
light
canopy cover
conductivity
elevation
habitat
dominant substrata
channel width
dissolved organic C
water depth
dissolved nutrient conc.
Regional/landscape factors
climate
dominant land use
latitude/longitude
stream order
watershed area
ecoregion
precipitation
elevation
slope/gradient
Other context
state/province
country
sample year
sample month
temporal extent
spatial extent
Modifying/confounding factors

How do biota respond to stressors?



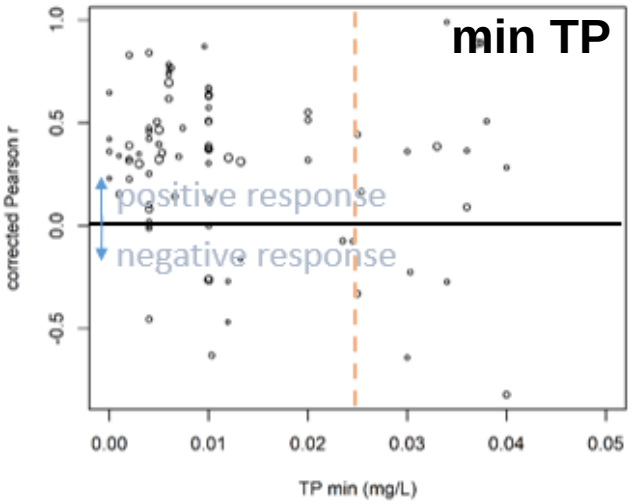
(absolute value of Pearson r)

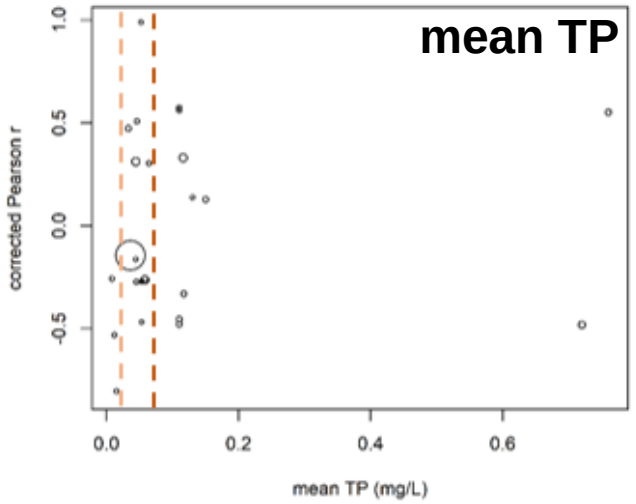
How do nutrient stressor-response relationships vary geographically?

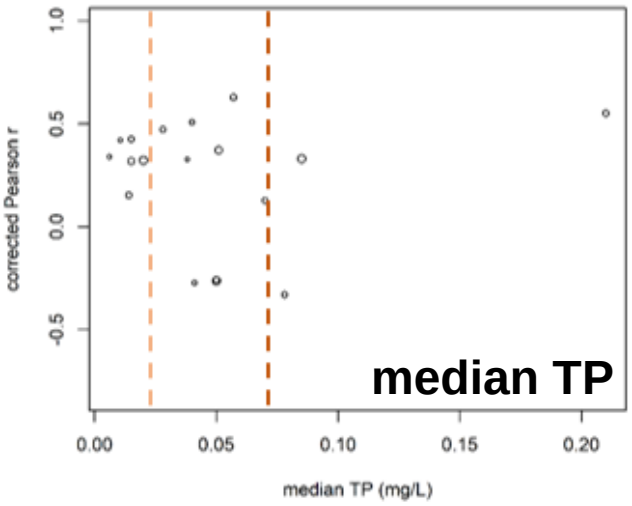
Benthic & sestonic chl

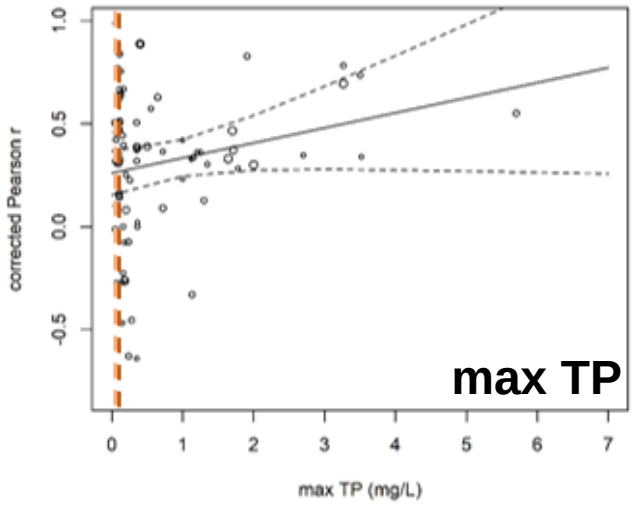
Chl-a relationships
- 1 to 5
- 5 to 10
- 10 to 25
- 25 to 50
- 50 to 75
- 75 to 100
- No data

How does response strength change across a stressor gradient?



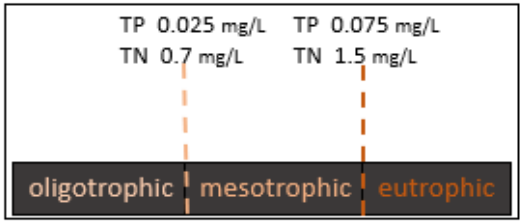




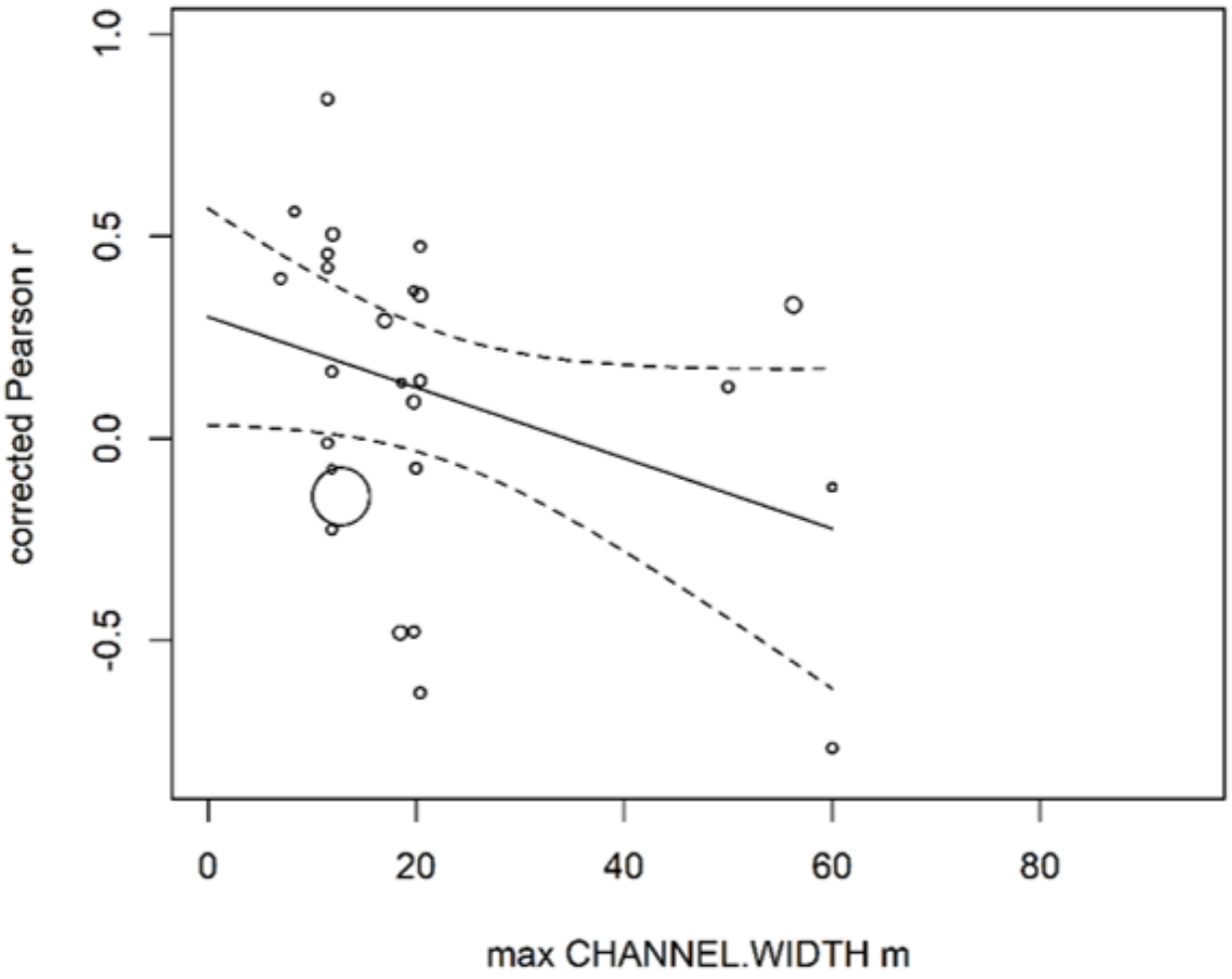


Benthic chl & TP

Stream Trophic Classification - Dodds et al. 1998

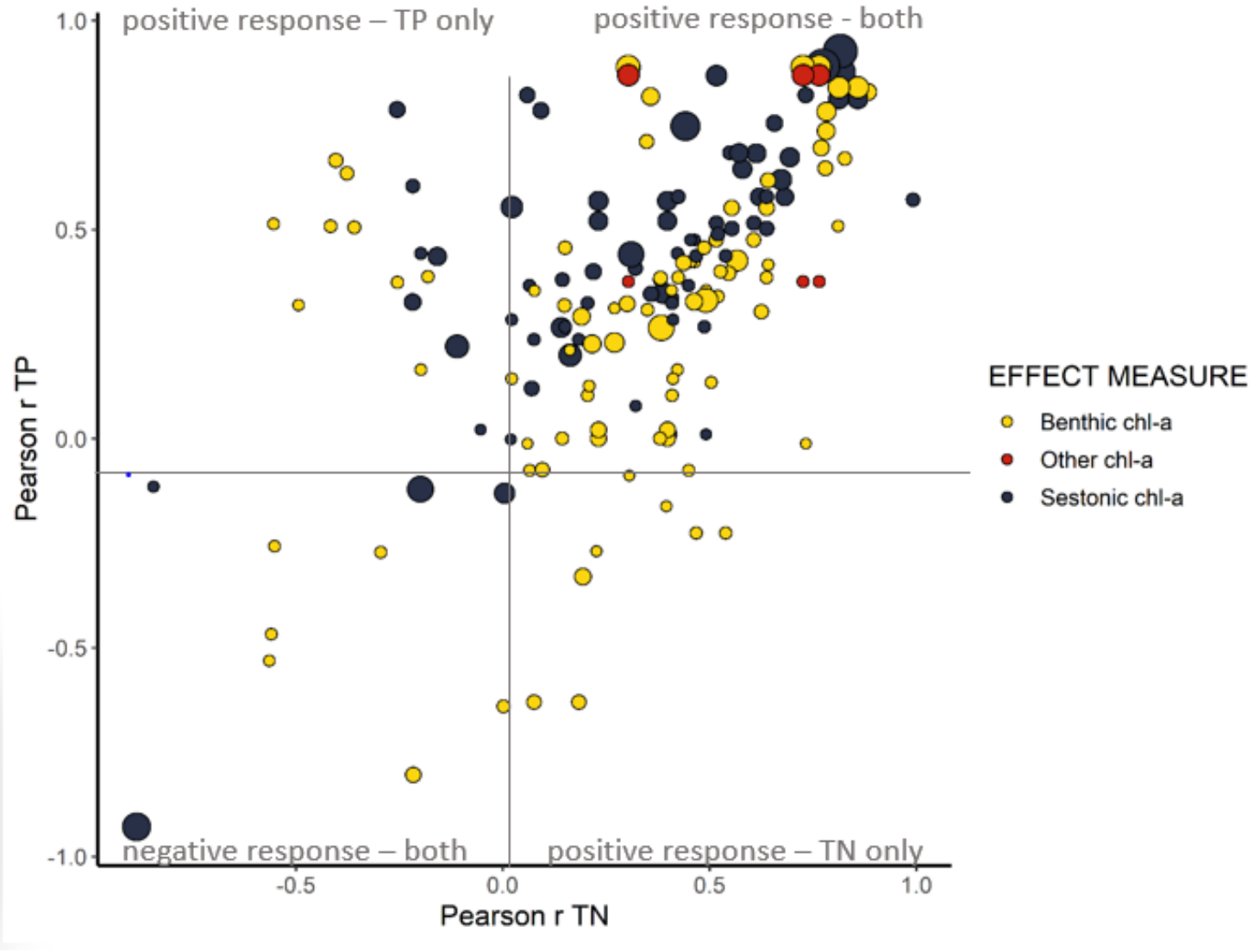


How do other factors affect stressor-response relationships?



Benthic chl & TP

Do biota respond similarly to TN and TP?



Next steps – and questions

- Conduct similar analyses for diatom and macroinvertebrate endpoints
- Make extracted raw data available to states/regions
- Questions
  - What are the most useful formats for making info available?
  - What are the most important relationships, contextual variables, etc.?