EPA's Causal Analysis Framework

Causal Analysis/Diagnosis Decision Information System (CADDIS)

USEPA/ORD

National Center for Environmental Assessment

17 October 2012

Why Establish Causation?

Because we make mistakes about causality

- Overweigh chance events — Every time I wash my car it rains
- Have biases — All pollution is caused by industry
- Are "educationally" predisposed — Hydrologist think hydrology
- Use intuition — I have a hunch it is nitrogen
- Rely on experiences — A flood caused this last time

We are human. We tend to form conclusions quickly and, because we're smart, we can ably defend them.

Causal Assessment

- EPA's approach to Causal Assessments is Pragmatic (analysis guides actions).
- Centered on Abductive Inference, where the best hypothesis is identified to explain the available information rather than proving a hypothesis correct or incorrect.
- Aims to establish Specific Causation rather than General Causation (DID *x* cause *y* rather than CAN *x* cause *y*).
- The most likely cause is established by Causal Inference, the interpretation of available evidence:
  - Identify and compare alternative candidate causes
  - Logically eliminate when possible
  - Diagnose when possible
  - Use strength of evidence for remaining
  - Identify most likely cause

The Causal Analysis Framework

CADDIS: The Causal Analysis/Diagnosis Decision Information System

Contact Us Share

Quick Finder

CADLit
CADStat
Case Studies
Causal Assessment Background
Getting Started with Data Analysis
ICD Application
Step-by-step Guide

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

- **Volume 1: Stressor Identification** provides a step-by-step guide for identifying probable causes of impairment in a particular system, based on the U.S. EPA's Stressor Identification process. If you are interested in conducting a complete causal assessment, learning about different types of evidence, or reviewing a history of causal assessment theory, start with this volume.
- **Volume 2: Sources, Stressors & Responses** provides background information on many common sources, stressors, and biotic responses in stream ecosystems. If you are interested in viewing source- and stressor-specific summary information (e.g., for urbanization, physical habitat, nutrients, metals, pH and other stressors), start with this volume.
- **Volume 3: Examples & Applications** provides examples illustrating different steps of causal assessments. If you are interested in reading completed causal assessment case studies, seeing how Stressor Identification worksheets are completed, or examining example applications of data analysis techniques, start with this volume.
- **Volume 4: Data Analysis** provides guidance on the use of statistical analysis to support causal assessments. If you are interested in learning how to use data in your causal assessment, start with this volume.
- **Volume 5: Causal Databases** provides access to literature databases and associated tools for use in causal assessments. If you are interested in applying literature-based evidence to your causal assessment, start with this volume.

Basic Information
Recent Additions
Frequent Questions
Publications
Glossary
Related Links
Authors & Contributors
Site Map

Top Three Questions

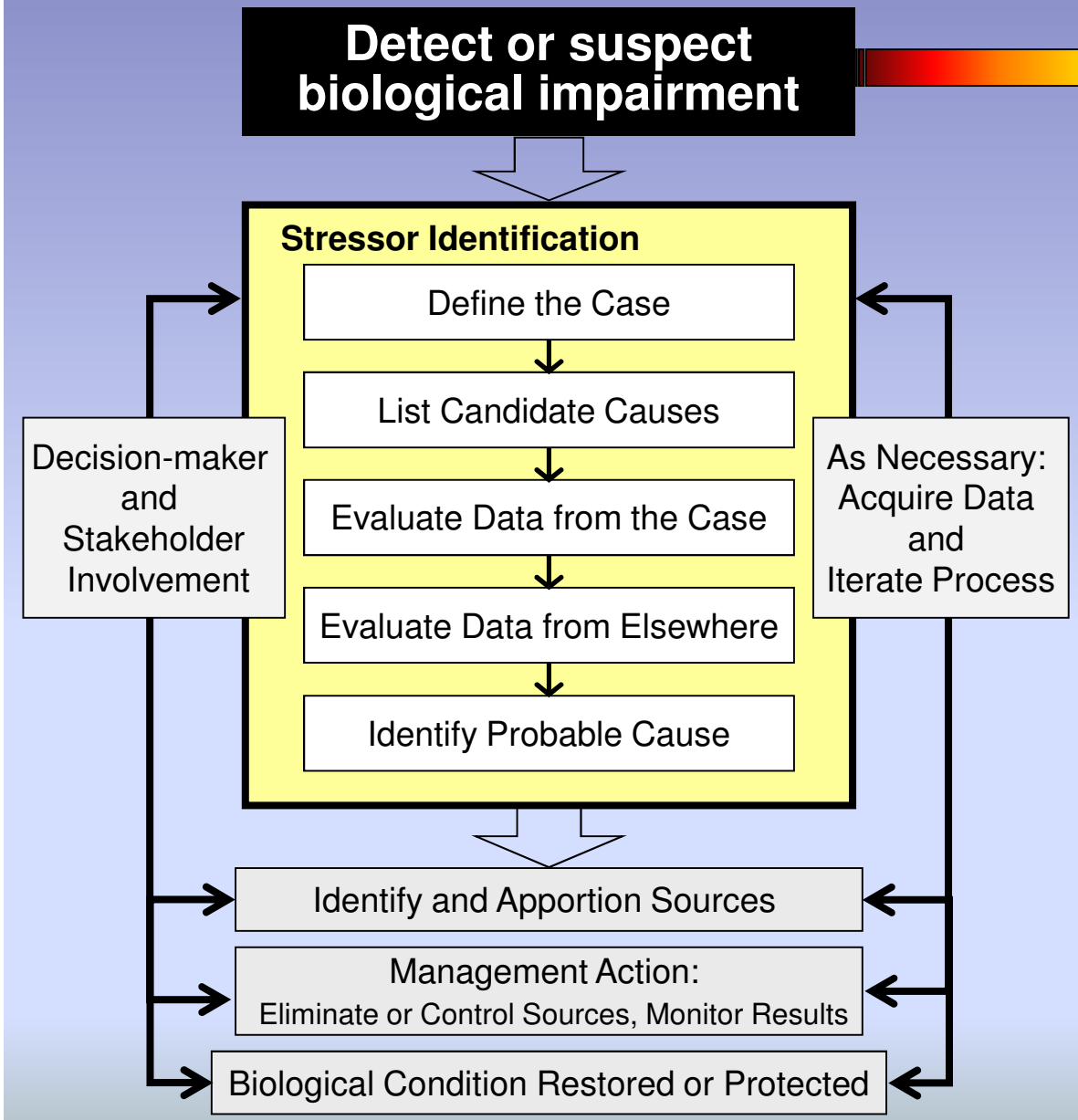
1. What's new in the 2010 release of CADDIS?
2. How do I cite CADDIS?
3. Where can I view a site map for CADDIS?

CADDIS Navigation

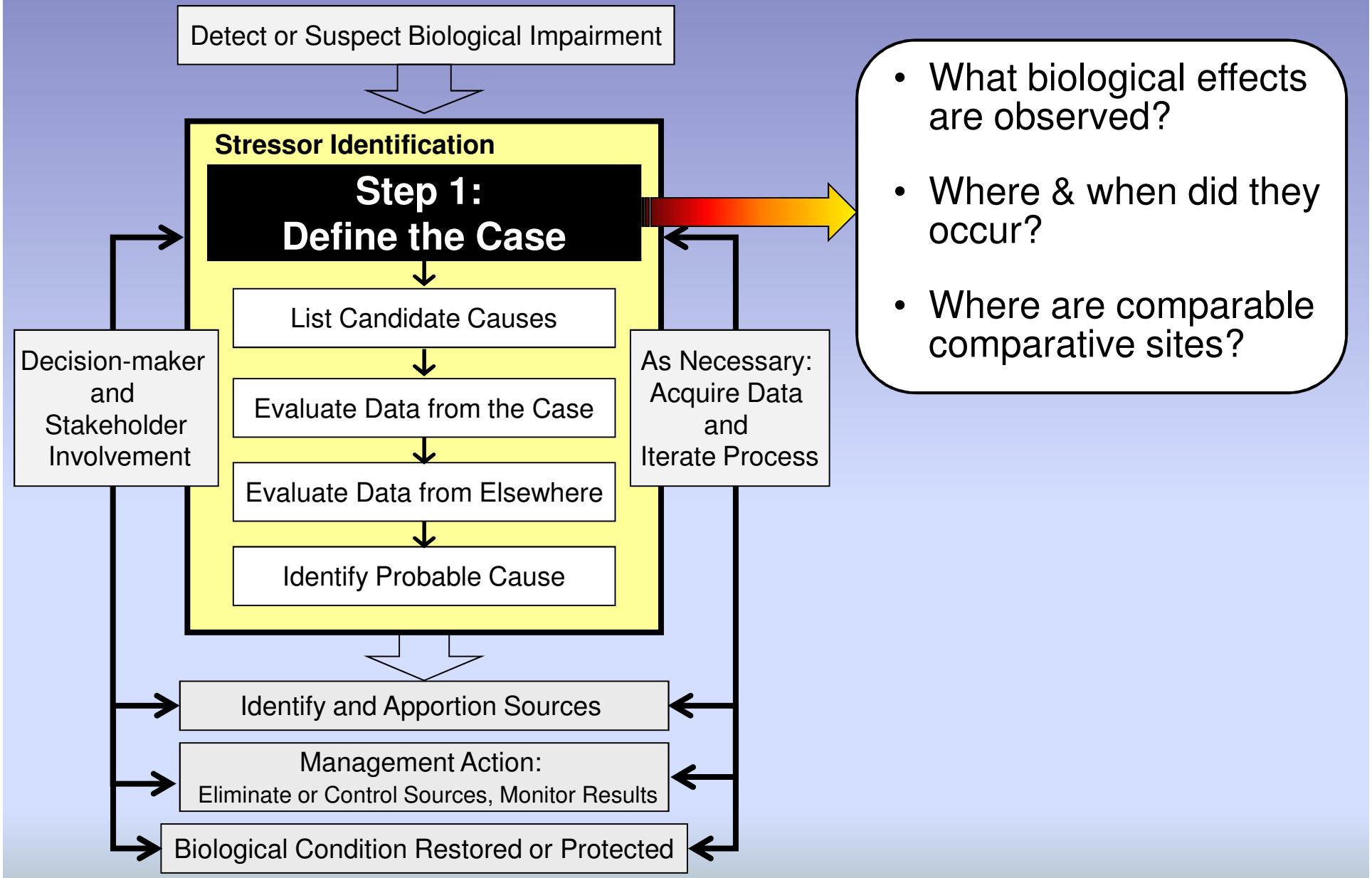
CADDIS Home
Volume 1: Stressor Identification
Volume 2: Sources, Stressors & Responses
Volume 3: Examples & Applications
Volume 4: Data Analysis
Volume 5: Causal Databases

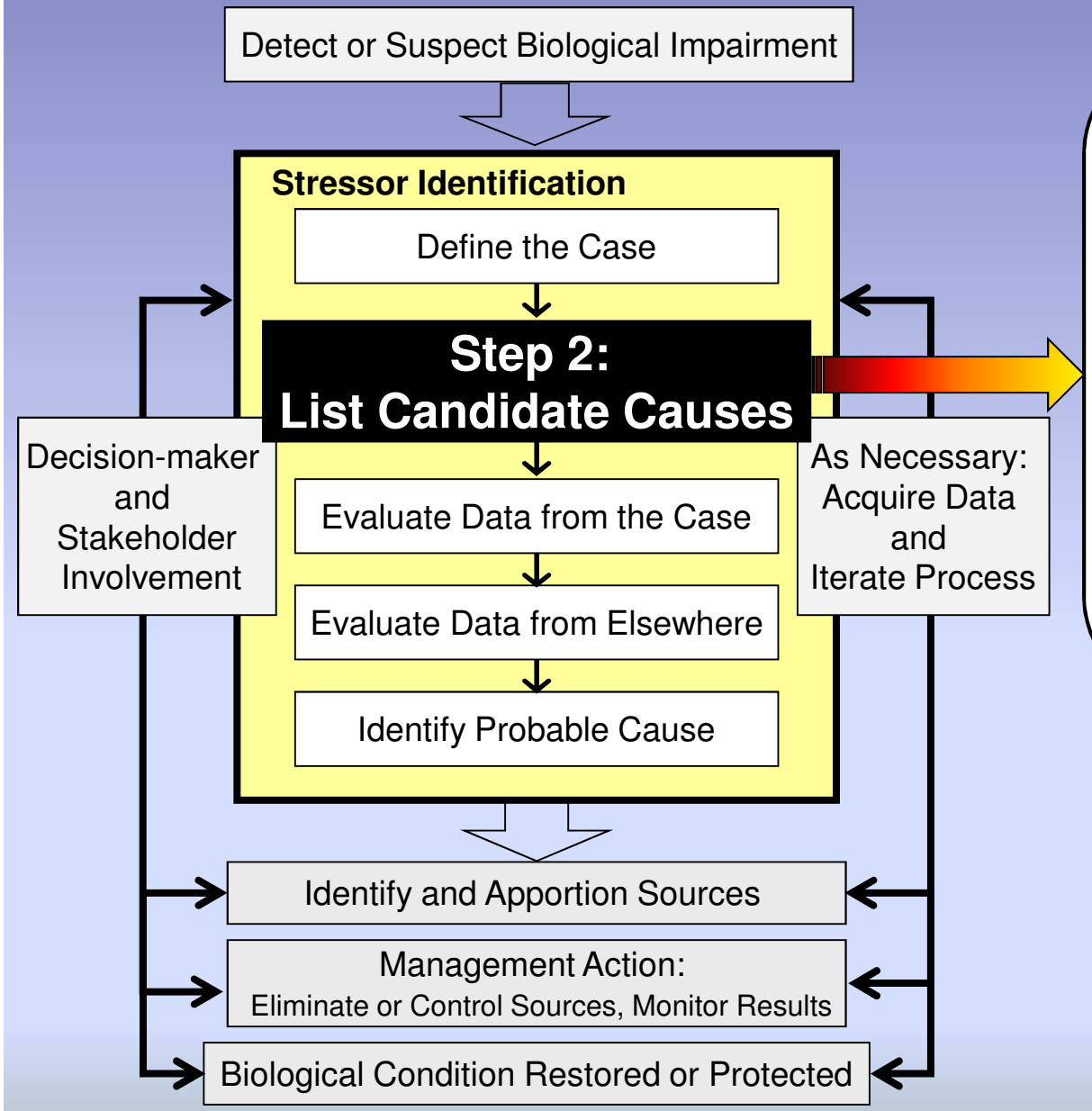
Recent Additions

1. New Causal Assessment Background section
2. New source & stressor modules
   - Urbanization
   - Ammonia
   - Herbicides
   - Insecticides
   - pH
   - Physical habitat
3. New causal assessment Case Studies
4. Revised Data Analysis section
5. Expanded Interactive Conceptual Diagram application

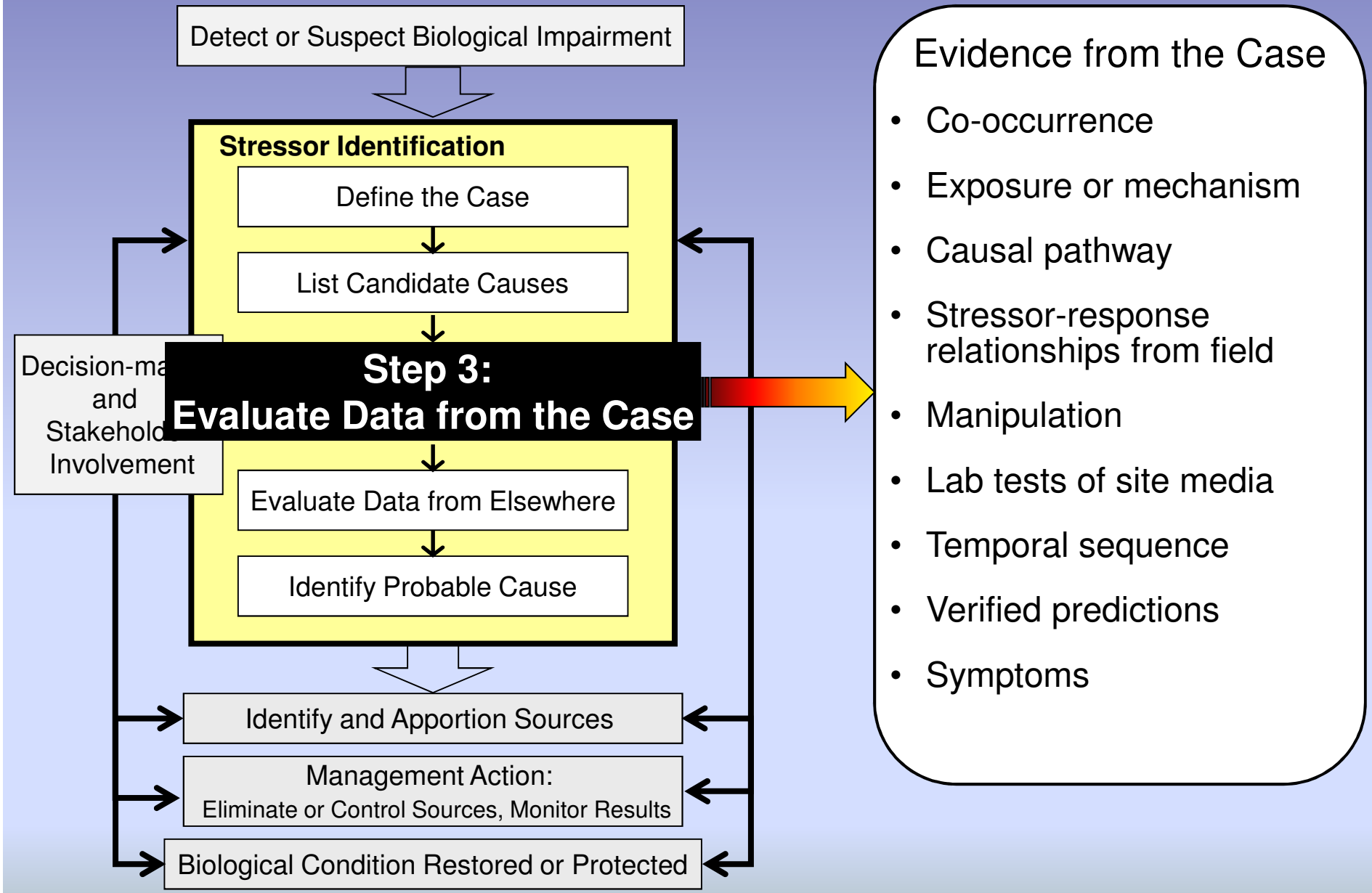


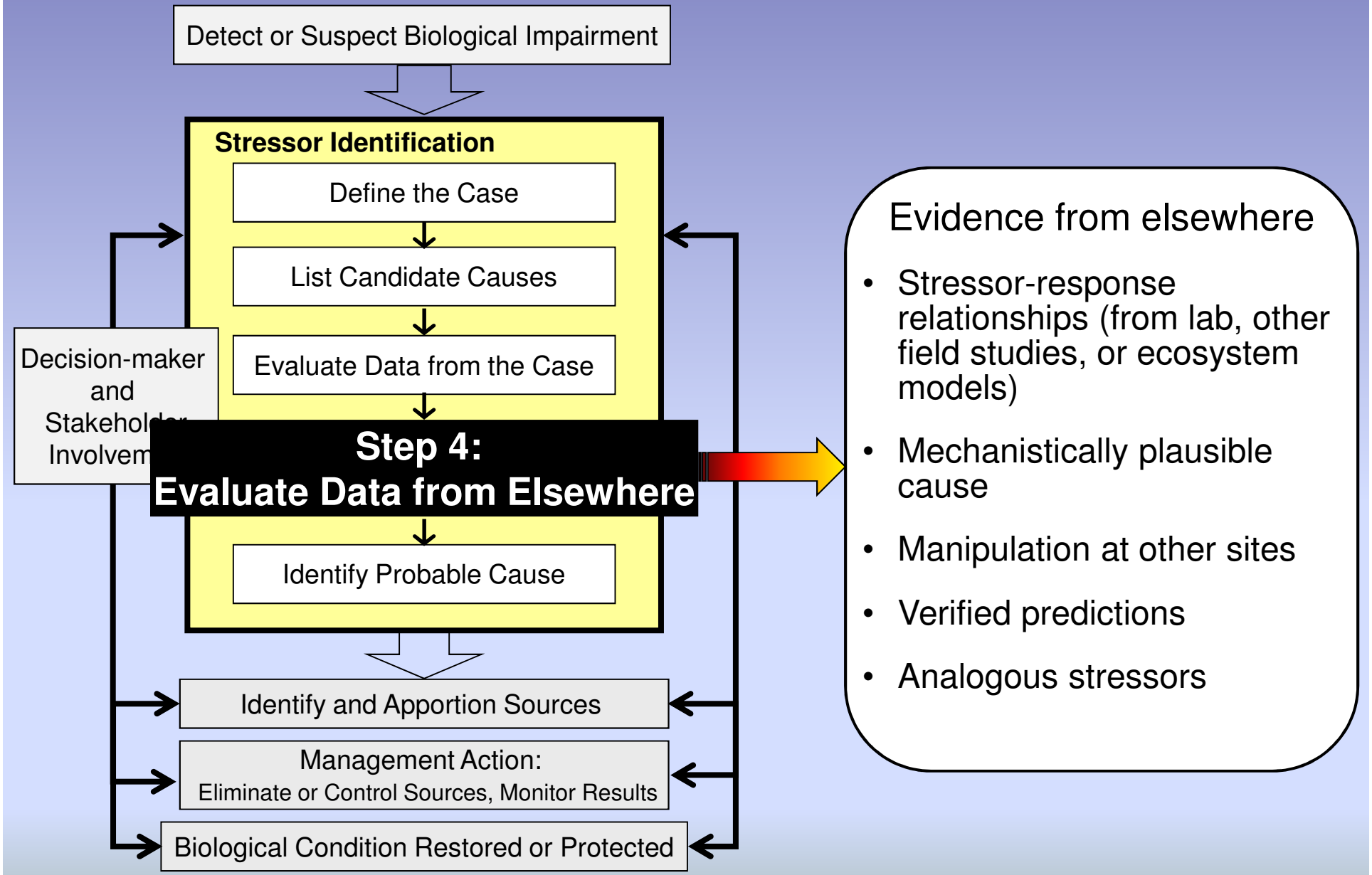
- Fish kills
- Organismal anomalies
- Changes in community structure
- Low biotic index values
- Violation of biocriteria

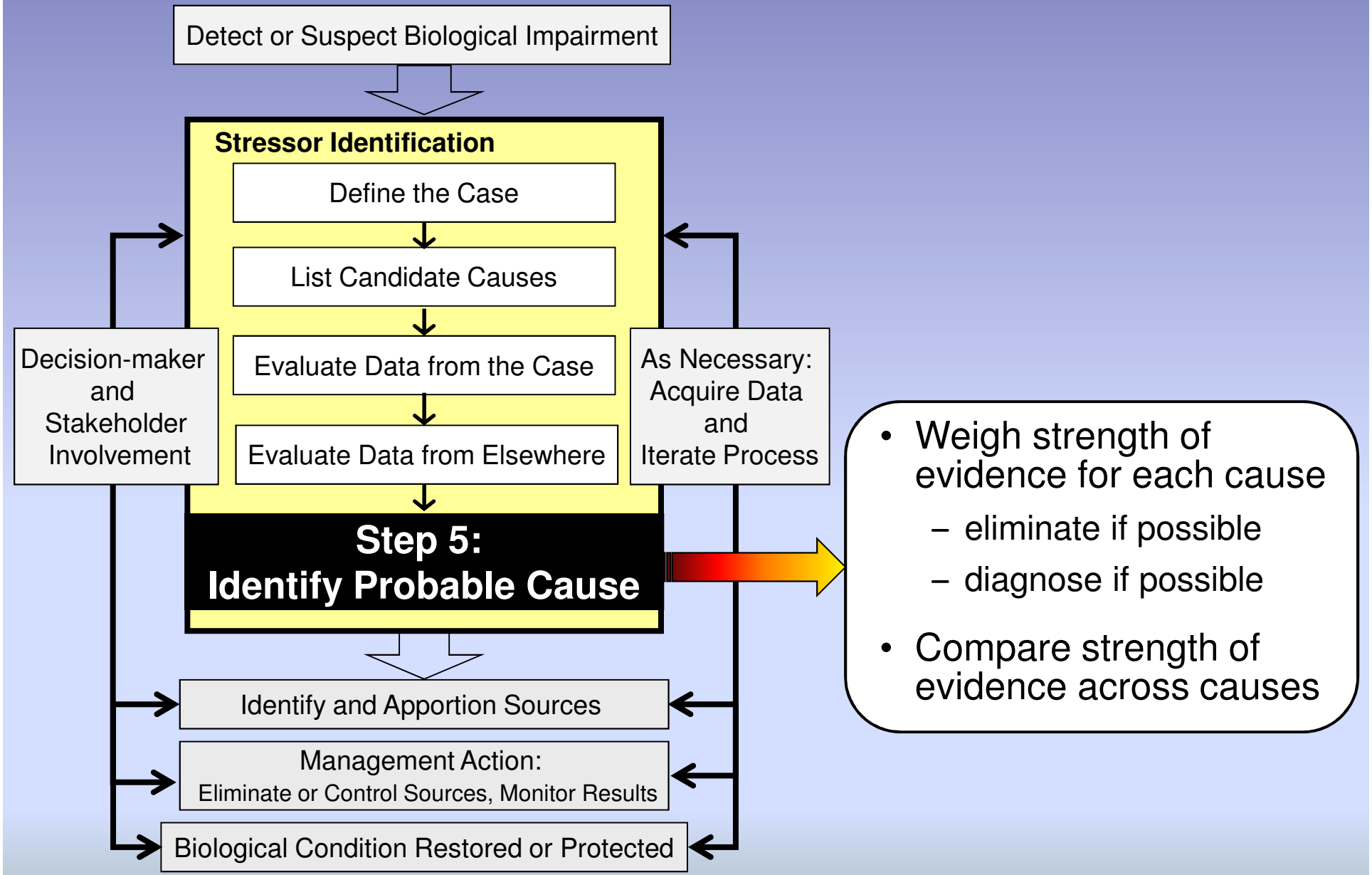

Detect or Suspect Biological Impairment
Stressor Identification
Step 1:
Define the Case
List Candidate Causes
Evaluate Data from the Case
Evaluate Data from Elsewhere
Identify Probable Cause
Decision-maker and Stakeholder Involvement
As Necessary: Acquire Data and Iterate Process
Identify and Apportion Sources
Management Action:
Eliminate or Control Sources, Monitor Results
Biological Condition Restored or Protected
• What biological effects are observed?
• Where & when did they occur?
• Where are comparable comparative sites?

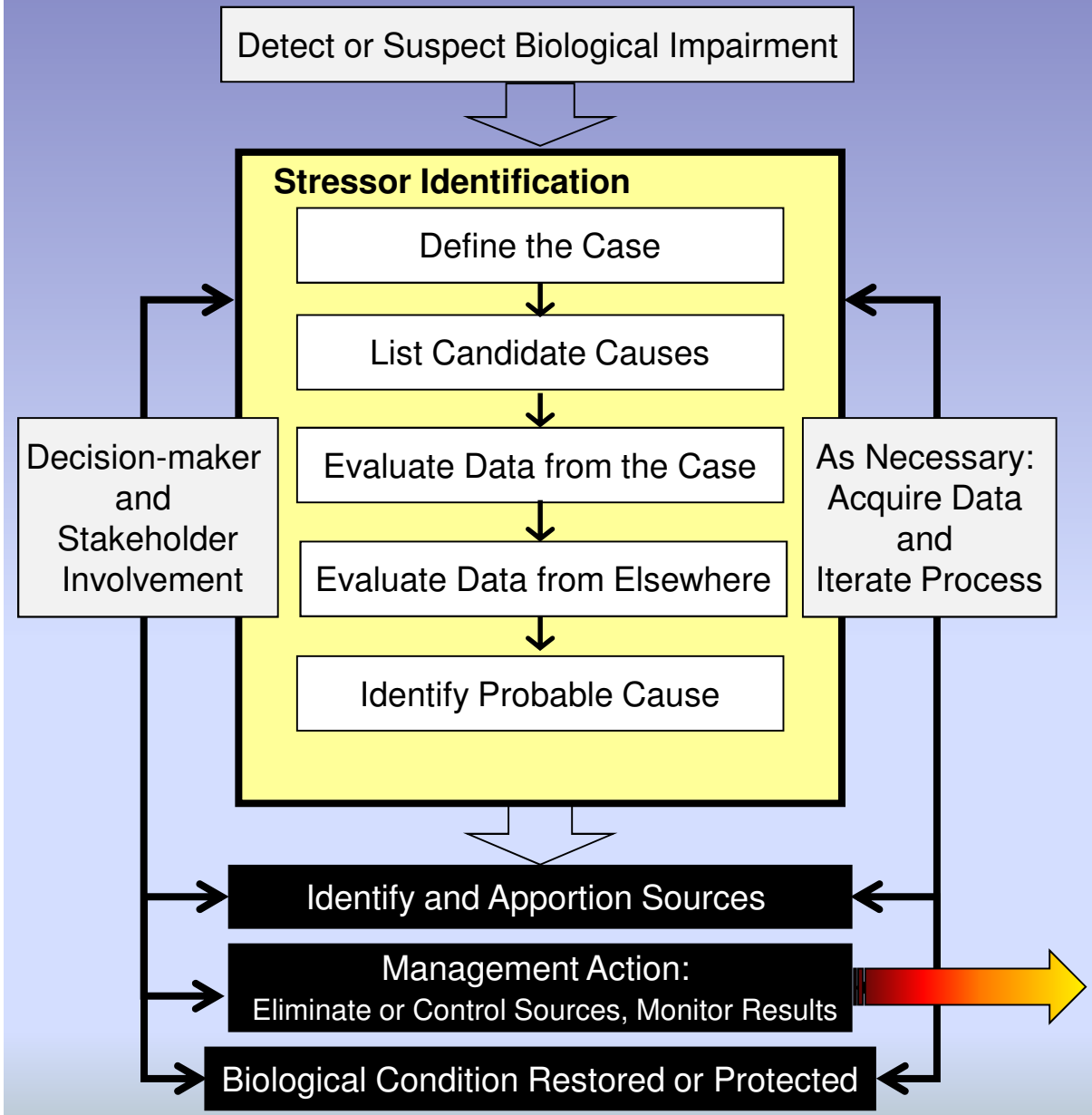


- Make a map
- Gather information on potential sources, stressors, and exposures
- Develop a conceptual diagram
- Engage stakeholders
- Develop “final” list


Detect or Suspect Biological Impairment
Stressor Identification
Define the Case
List Candidate Causes
Step 3:
Evaluate Data from the Case
Evaluate Data from Elsewhere
Identify Probable Cause
Decision-ma
and
Stakehold
Involvement
Identify and Apportion Sources
Management Action:
Eliminate or Control Sources, Monitor Results
Biological Condition Restored or Protected
Evidence from the Case
Co-occurrence
Exposure or mechanism
Causal pathway
Stressor-response relationships from field
Manipulation
Lab tests of site media
Temporal sequence
Verified predictions
Symptoms


Detect or Suspect Biological Impairment
Stressor Identification
Define the Case
List Candidate Causes
Evaluate Data from the Case
Decision-maker and Stakeholder Involvem
Step 4:
Evaluate Data from Elsewhere
Identify Probable Cause
Identify and Apportion Sources
Management Action:
Eliminate or Control Sources, Monitor Results
Biological Condition Restored or Protected
Evidence from elsewhere
• Stressor-response relationships (from lab, other field studies, or ecosystem models)
• Mechanistically plausible cause
• Manipulation at other sites
• Verified predictions
• Analogous stressors


Detect or Suspect Biological Impairment
Stressor Identification
Define the Case
List Candidate Causes
Evaluate Data from the Case
Evaluate Data from Elsewhere
Decision-maker and Stakeholder Involvement
As Necessary: Acquire Data and Iterate Process
Step 5: Identify Probable Cause
Identify and Apportion Sources
Management Action:
Eliminate or Control Sources, Monitor Results
Biological Condition Restored or Protected
• Weigh strength of evidence for each cause
– eliminate if possible
– diagnose if possible
• Compare strength of evidence across causes



Causal analysis is one step in management process

- After causes identified, sources & management actions must be identified
- Biological monitoring verifies that actions are effective

Causal Assessment

- The Up-Side…
  - A formal method that provides scientifically defensible results when the stressor is not readily apparent or obvious.
  - The evaluation is reproducible.
  - Prevents biases and other logic lapses.
  - May identify causal relationships that are not readily apparent.
  - Engages stakeholders & decision makers early in the process thereby reducing controversy.
  - Increases confidence in the selected management option.
- …and the Down-Side
  - Conducting Causal Assessments are not necessarily easy or straightforward.
  - Mechanisms of biological impacts can be complex.
  - There is no “one-size-fits-all” methodology.
  - Data are as data do (quantity and quality matter).
  - Net result, a smoking fish may not be found or multiple stressors remain probable causes.