EPA's EMAP Probability Monitoring Approach: More Than Just 305(b)?

Or Why Do We Need Both Probability and Targeted Monitoring?

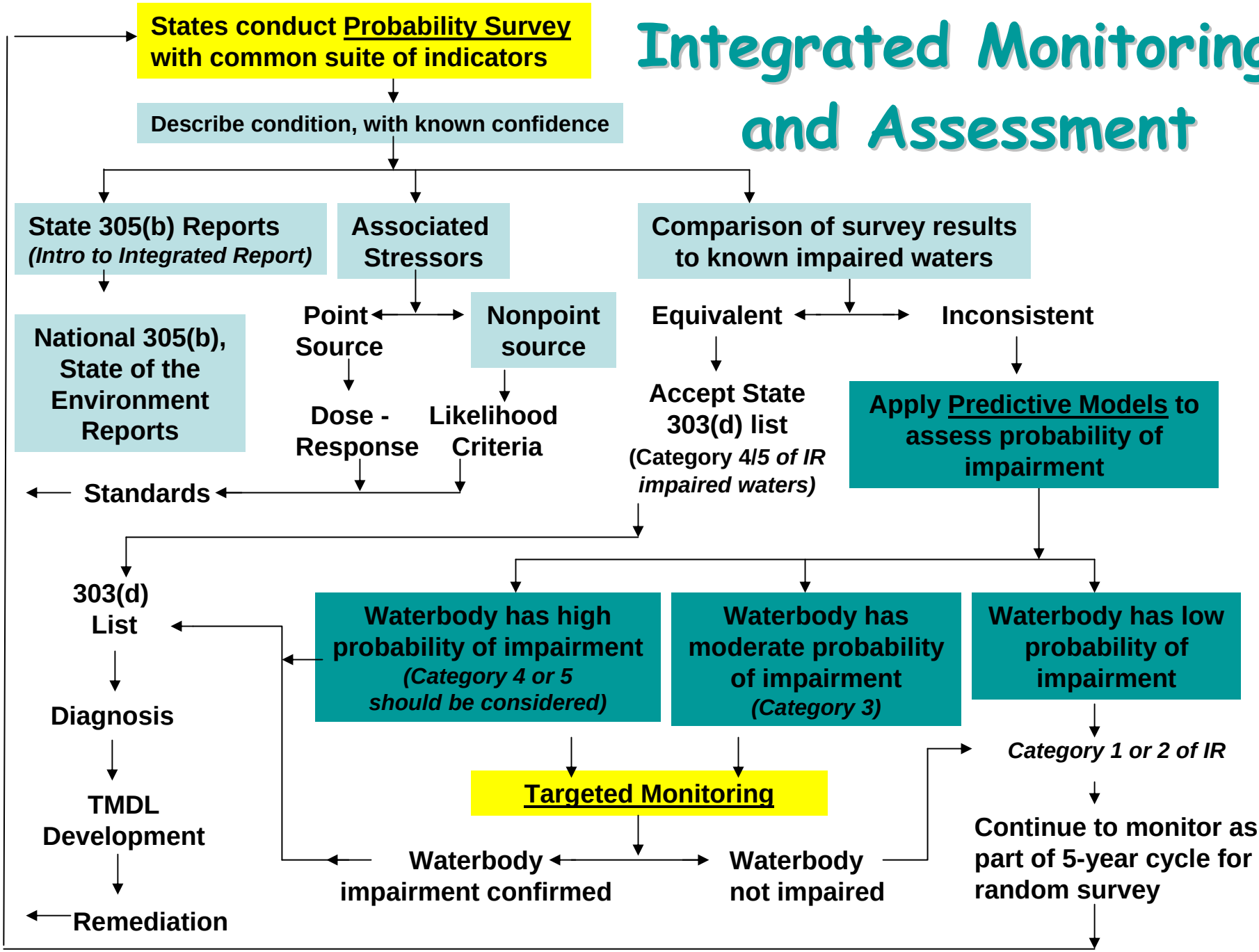
Why Monitor for Water Quality?

- CWA Section 305(b) – Condition
- CWA Section 303(d) – Listing of Impaired waters
- Congress and the public want to know the effectiveness of protection and restoration programs and policies (>$1B/y spent on monitoring)

Public's Questions

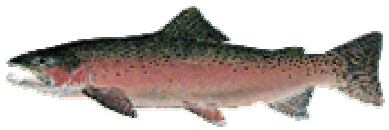
- What are the current conditions of our ecosystems?
- Where are the conditions improving or declining?
- What stresses are associated with declines?
- Are management programs and policies working?

Integrated Monitoring and Assessment



EMAP Approach

Indicators



Ecoregion Framework

Reference Condition

Index Regionalization

Index Calibration

Index Construction

+

Designs

Status (Trends)

Variance Estimation

Panel Rotation

Variable Density Approaches

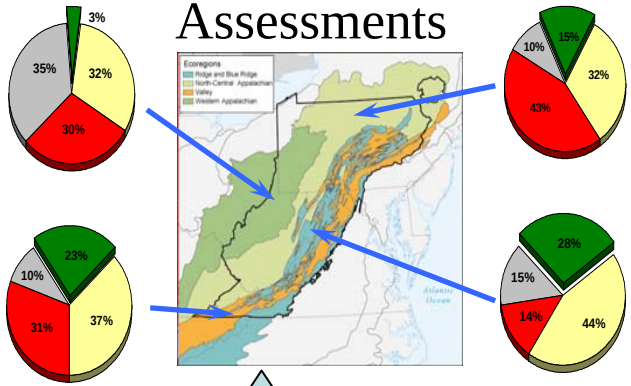
Spatial Balance

Frame Development

Population Identification

=

Assessments



Analysis

Data

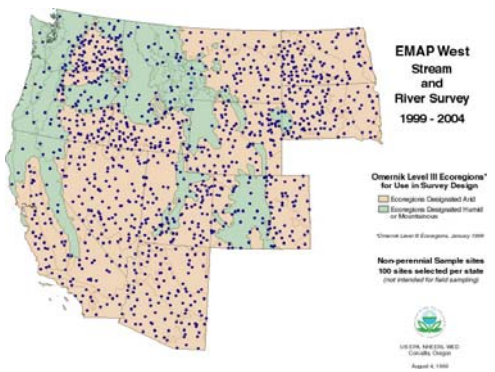
Field Sampling

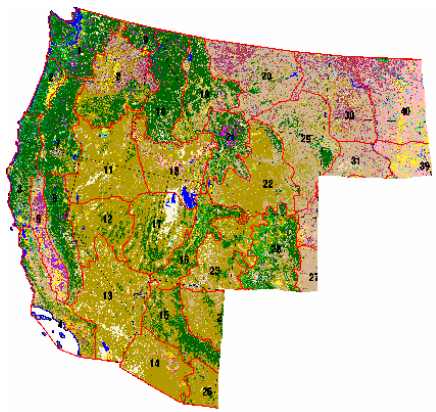
Training

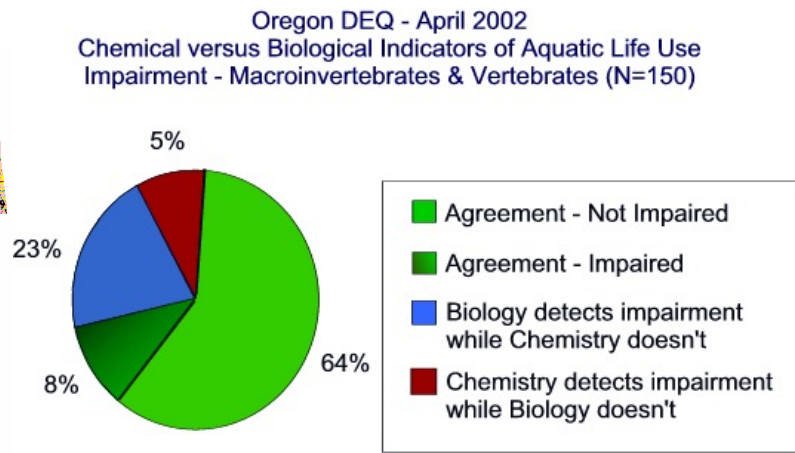
Partnerships

EMAP Design

- **Probabilistic Design Framework** – Randomized statistical designs allow interpretation of monitoring data with known uncertainty, extrapolation to the entire population with a small sample size, and statistical aggregation of like data to larger geographic areas
- **Classification** - meaningful groupings within resource types and/or ecosystem types to allow better statistical design and analysis
- **Biological Indicators** - Direct measures of aquatic ecosystem condition, integrates stressors, and more sensitive

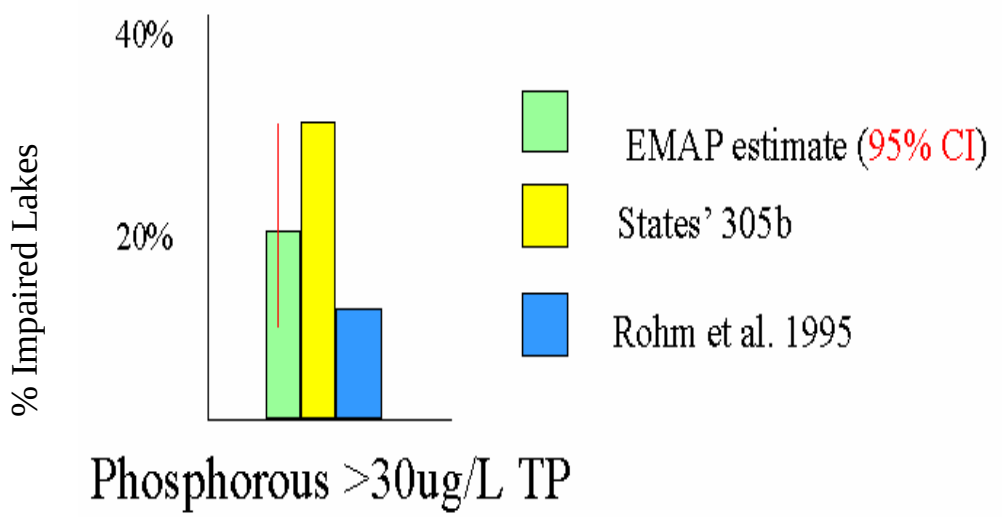


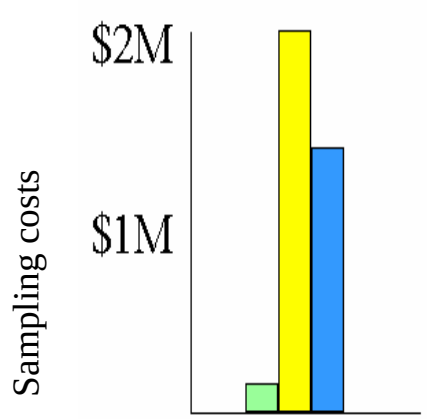




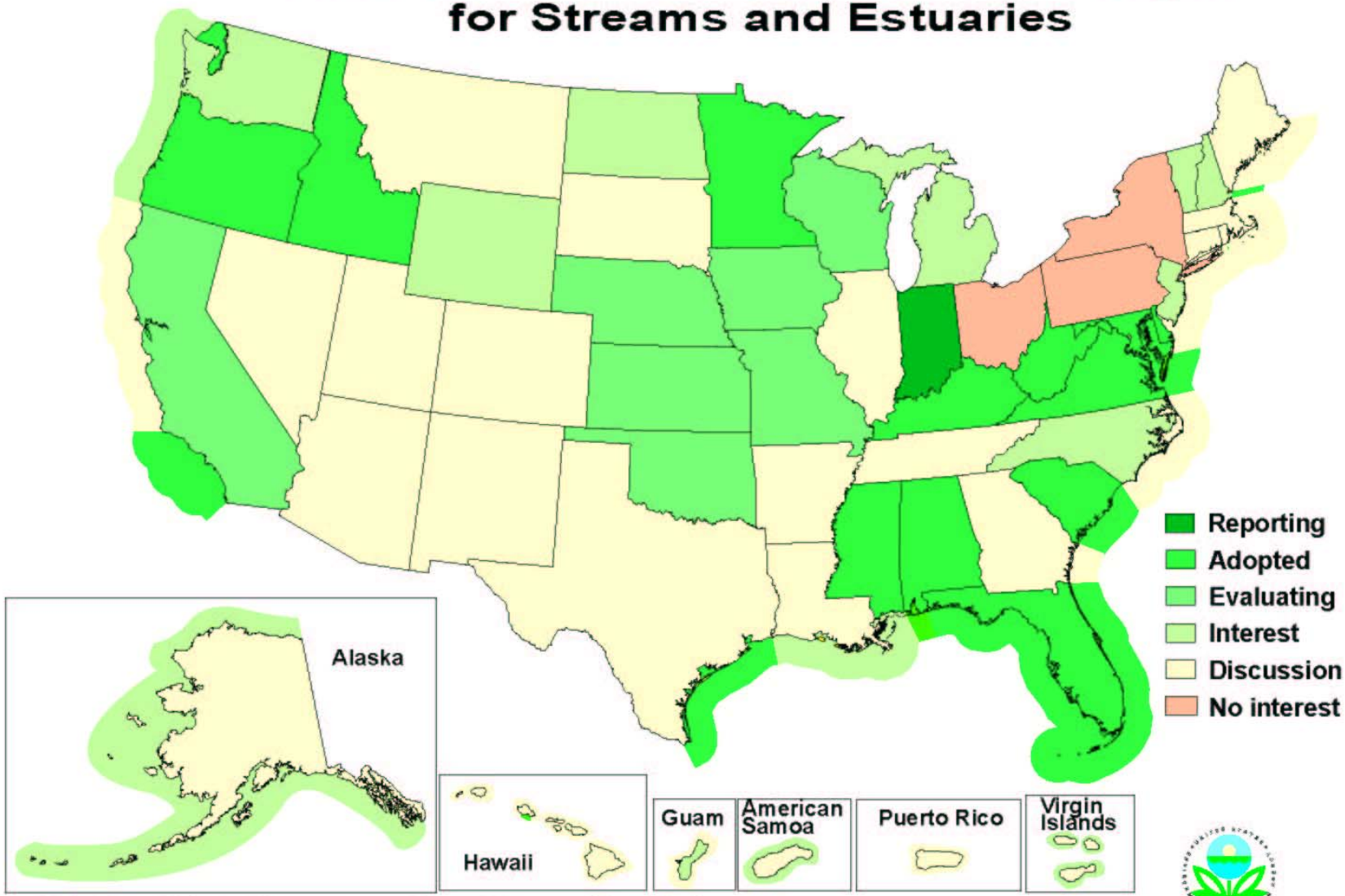
Effectiveness of Design

- Eutrophication of NE US lakes
  - 4219 mostly problem lakes sampled by states for 305(b)
  - 2756 non-random lakes censused (Rohm et al. 1995)
  - 344 lakes with EMAP probability design (11,076 lakes total)





State Use of Probability Survey Designs for Streams and Estuaries

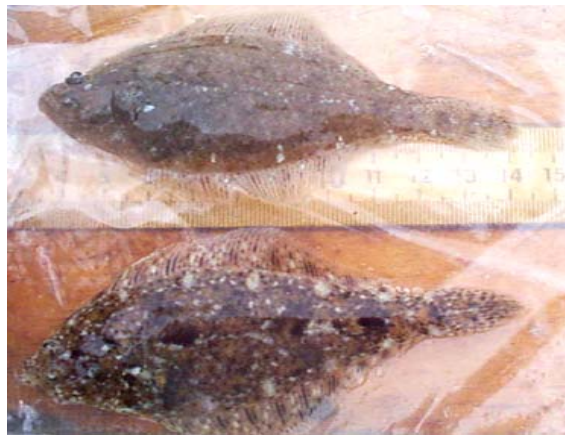


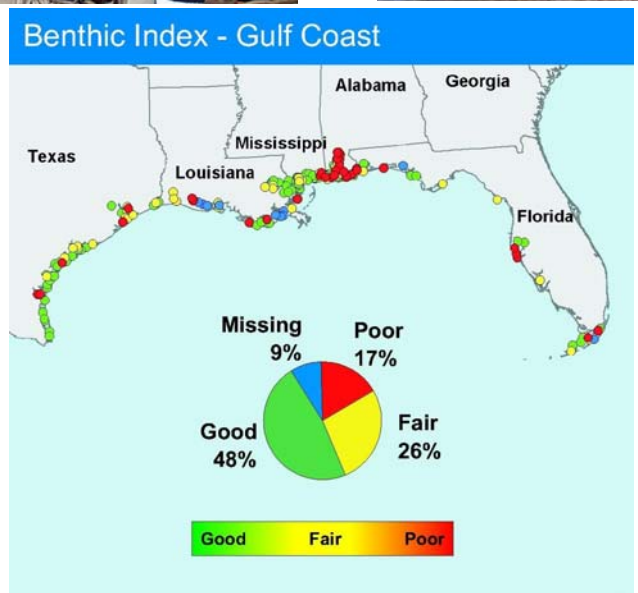
Note: Combining state survey results requires consistent state coverage of streams and rivers, indicators measured, or criteria for impairment.

October 2003

EMAP's National Coastal Assessment

- 24 marine coastal states monitoring with core EMAP design and indicators

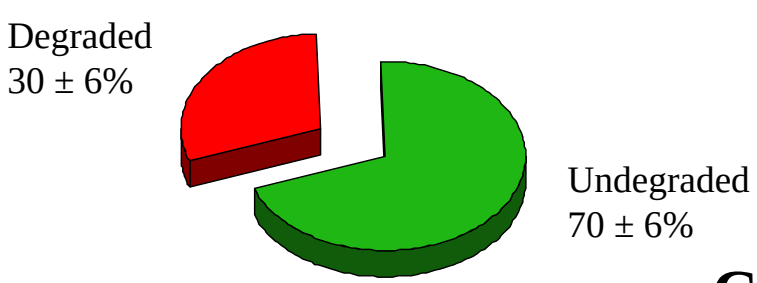




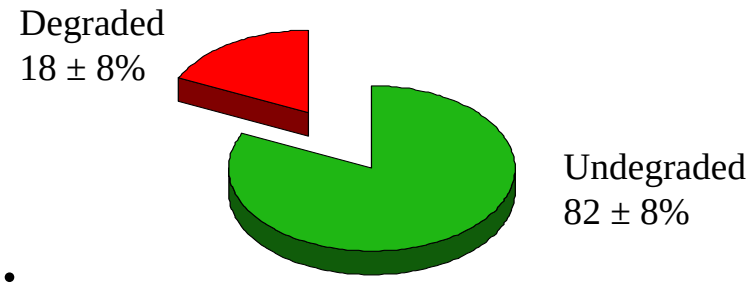
Comparison of Estuarine Conditions

Estuarine Benthic Invertebrate IBI

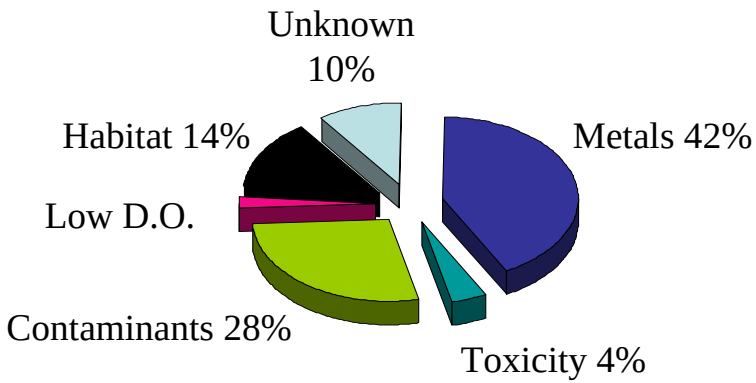
Louisianian Province

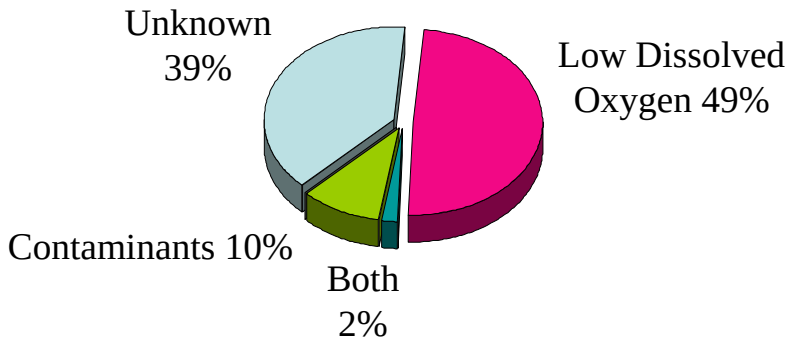


Virginian Province



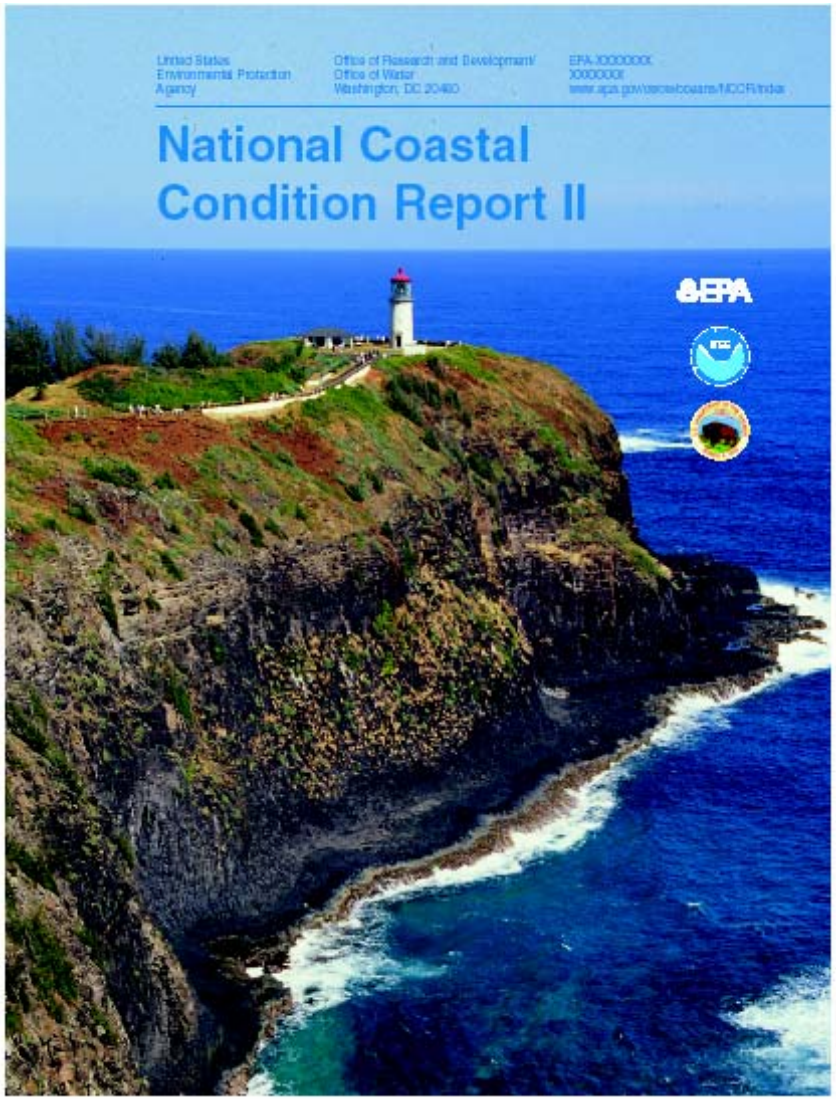
Condition

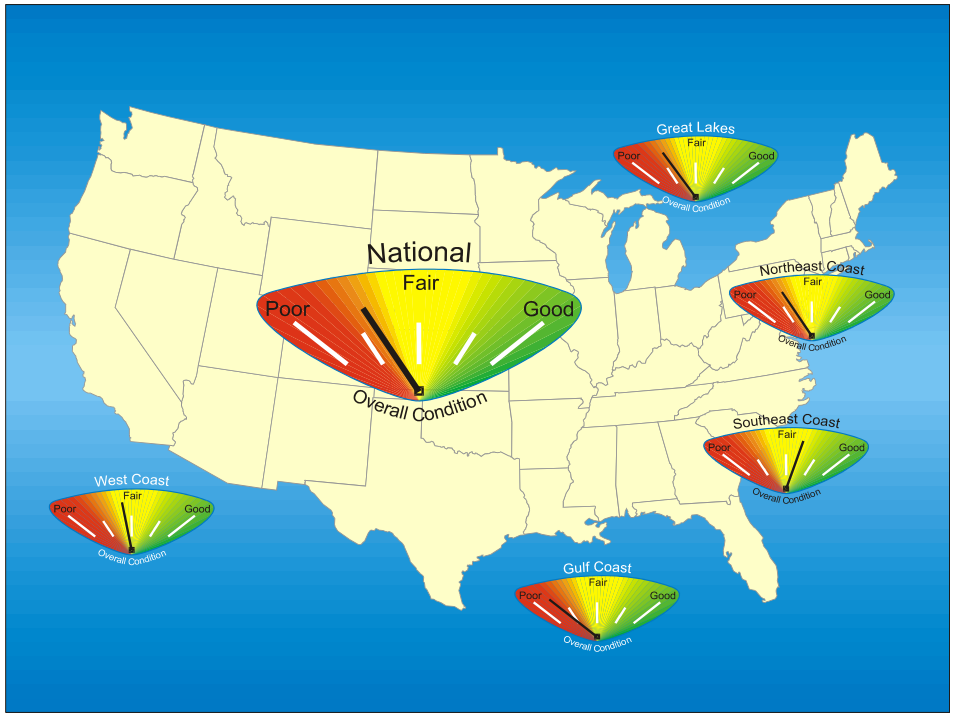




Stressors Associated with Degraded Condition

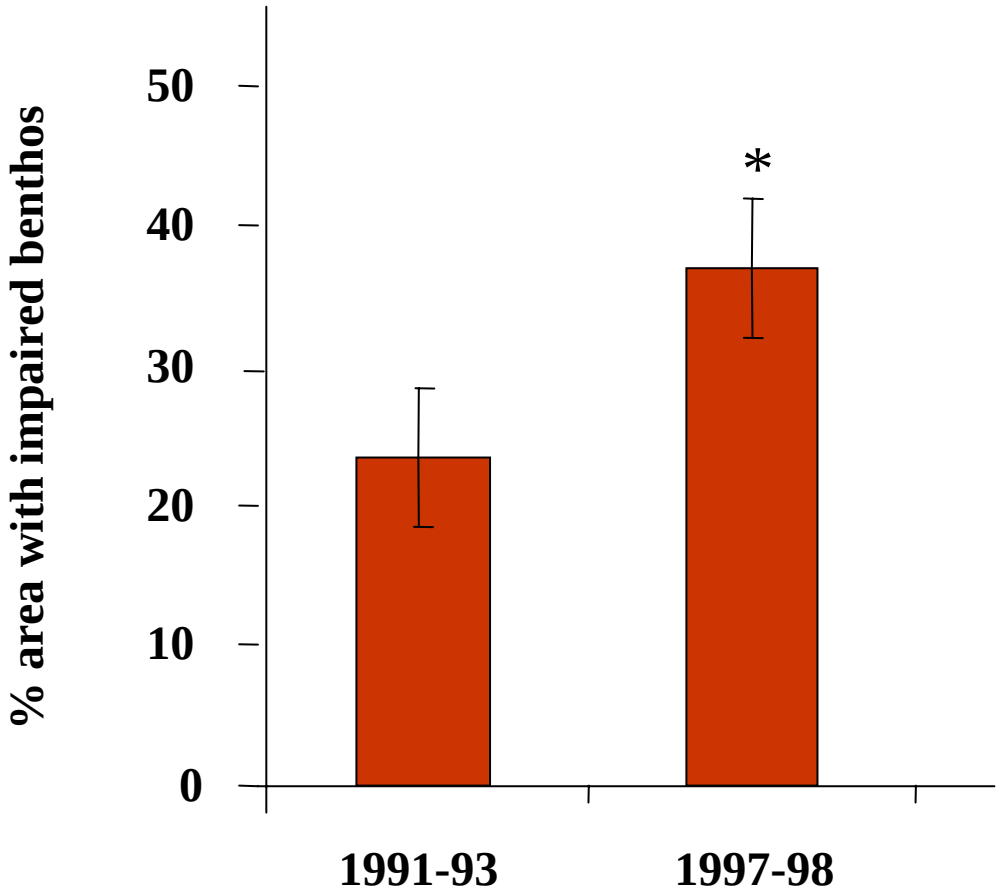
National Coastal Assessment





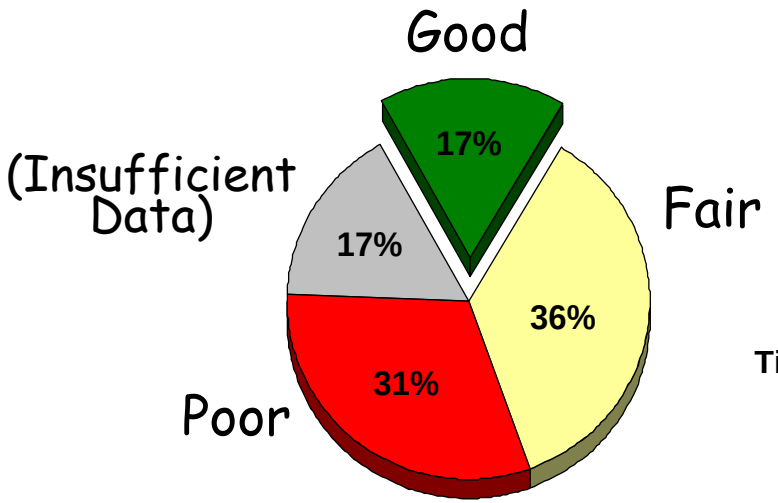
Statistical Change Detection

- Change in Percent Area of Chesapeake Bay with Impaired Benthic Community



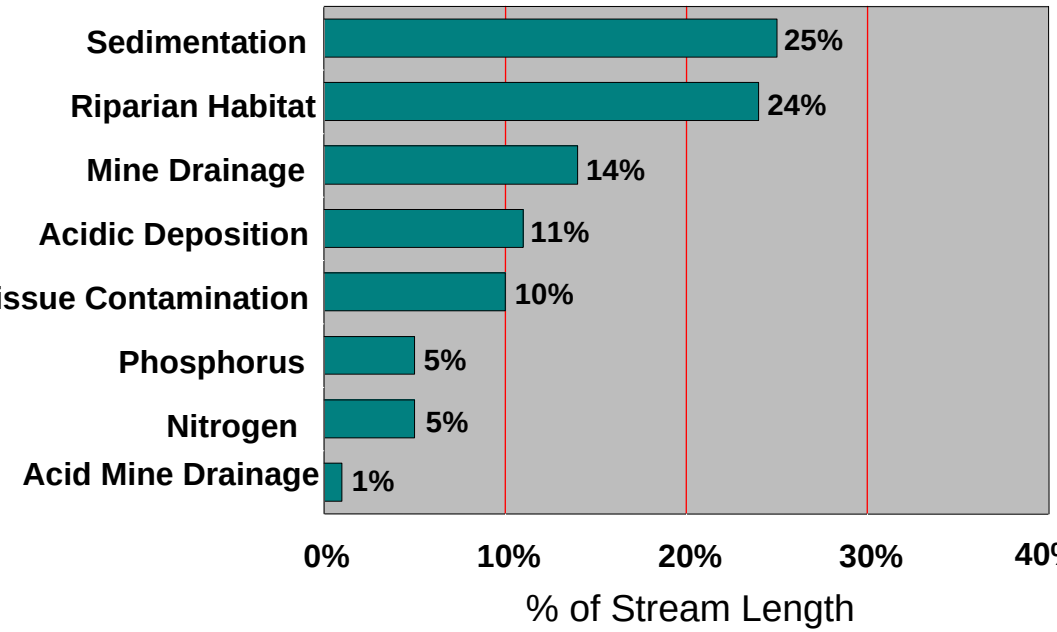
Stream Conditions in MAHA

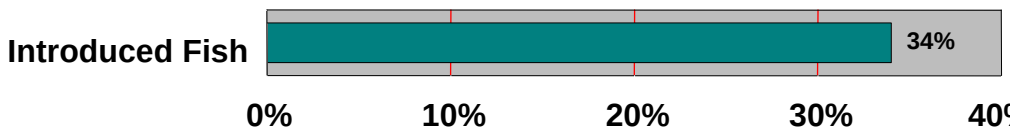
Fish IBI



Proportion of Stream Length

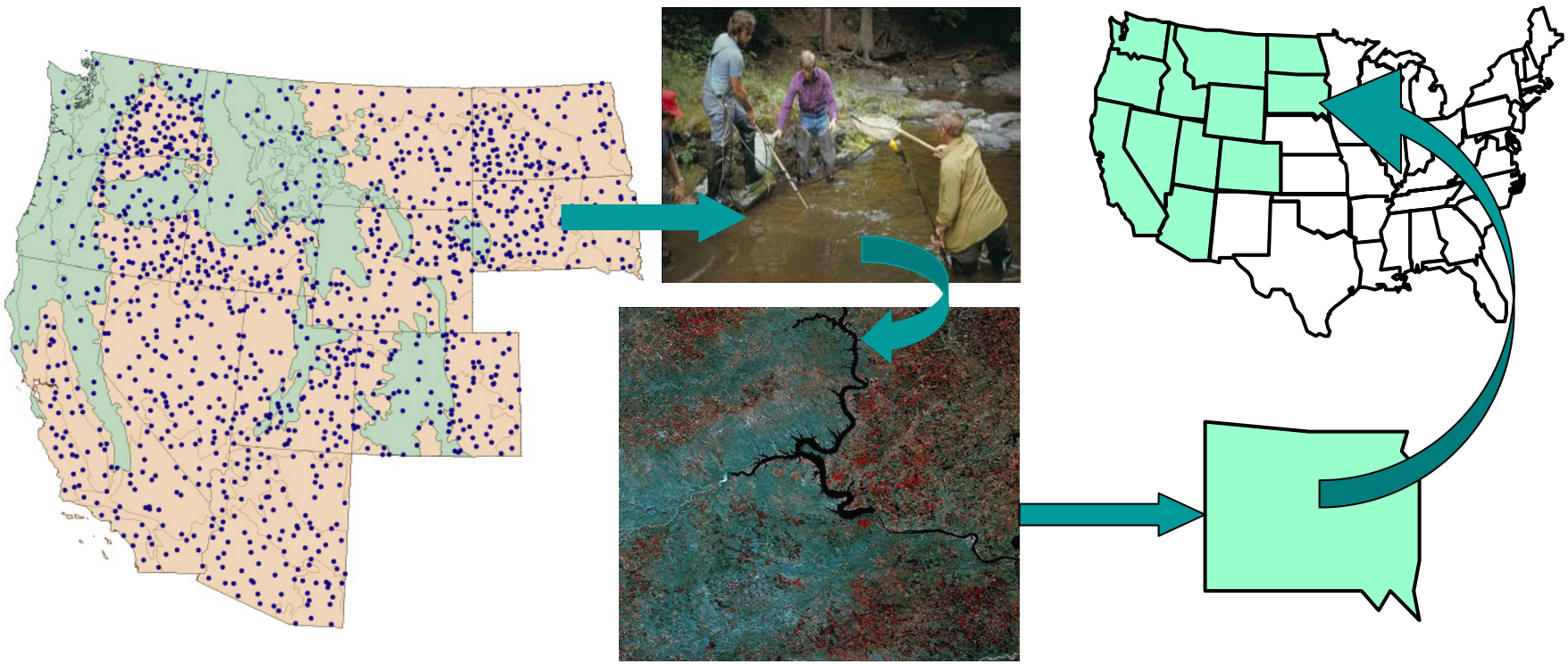
Potential Stressors



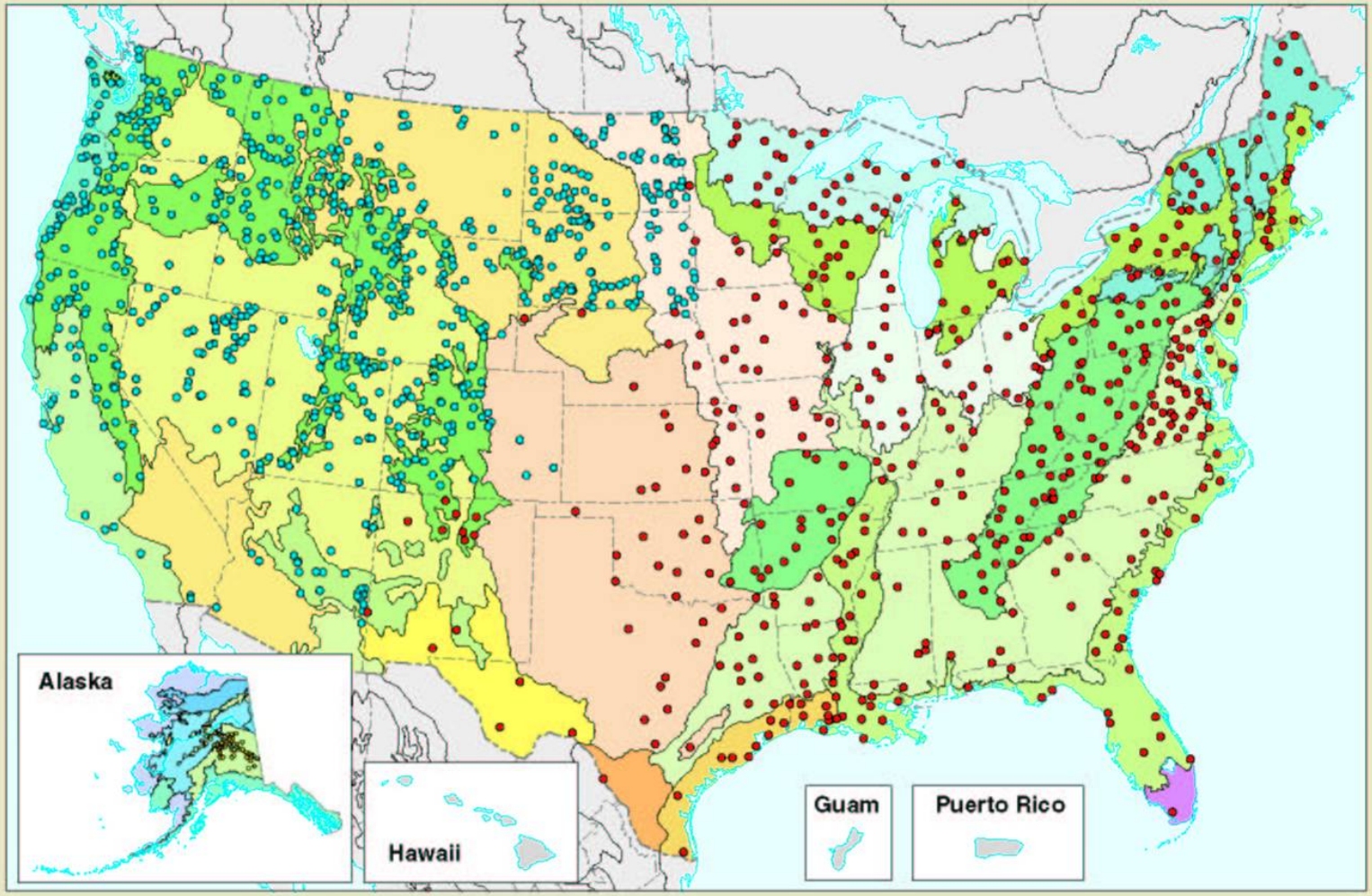


Western EMAP Streams

- Develop the science for a national state-based probabilistic condition assessments of streams
  - Design and analysis
  - Indicators
  - Reference Conditions



Sites for Wadeable Streams Assessment

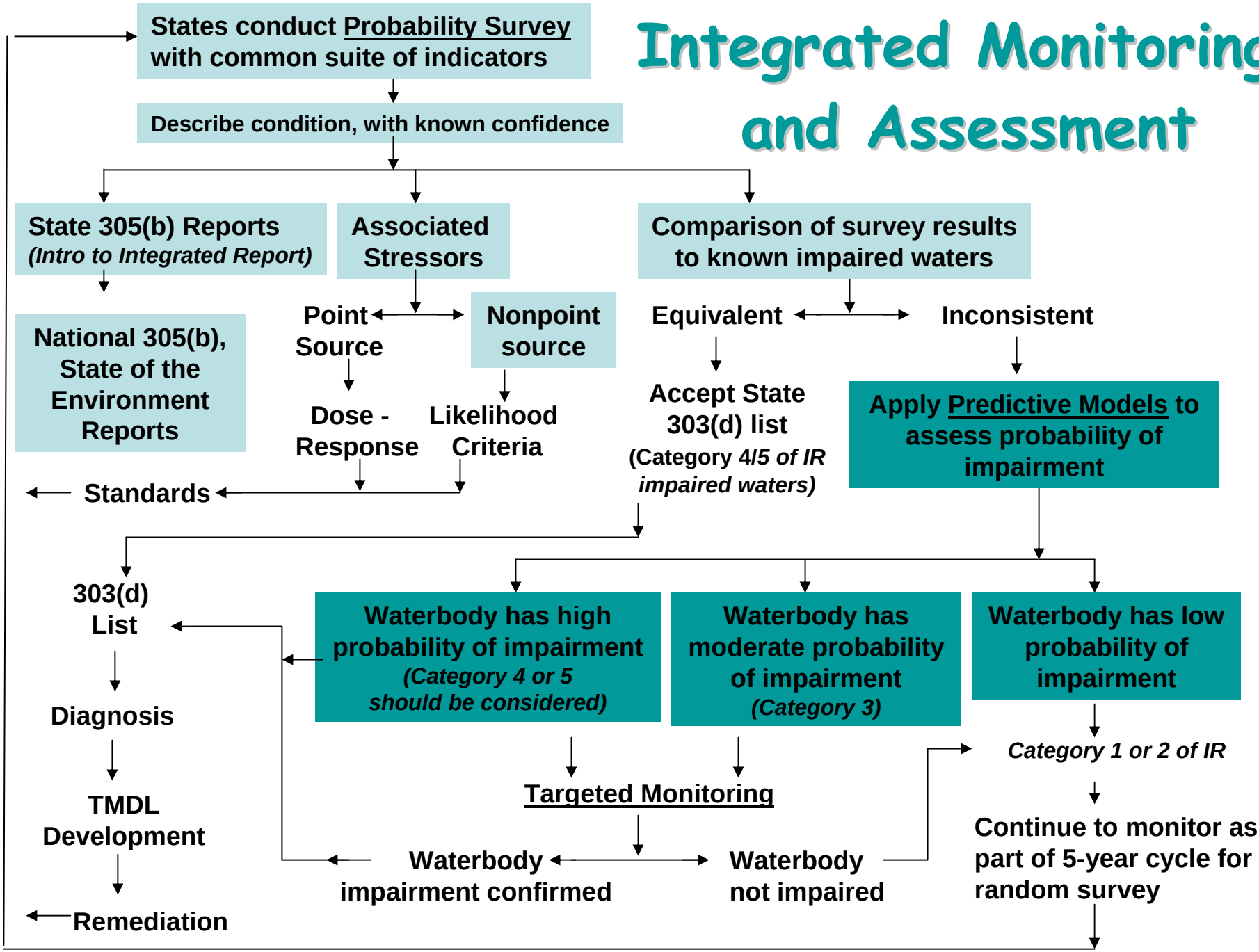


- 5.2 Mixed Wood Shield
- 5.3 Atlantic Highlands
- 6.2 Western Cordillera
- 7.1 Marine West Coast Forest
- 8.1 Mixed Wood Plains
- 8.2 Central Plains
- 8.3 Southeastern Plains
- 8.4 Ozark, Ouachita-Appalachian Forests
- 8.5 Mississippi Alluvial / Southeast Coastal Plains
- 9.2 Temperate Prairies
- 9.3 West-Central Semi-Arid Prairies
- 9.4 South-Central Semi-Arid Prairies
- 9.5 Texas-Louisiana Coastal Plain
- 9.6 Tamaulipas-Texas Semi-Arid Plain
- 10.1 Western Interior Basins and Ranges
- 10.2 Sonoran and Mohave Deserts
- 10.4 Chihuahuan Desert
- 11.1 Mediterranean California
- 12.1 Western Sierra Madre Piedmont
- 13.1 Upper Gila Mountains
- 15.4 Everglades

- Sites sampled, 2000–2004
- Sites to be sampled, 2004

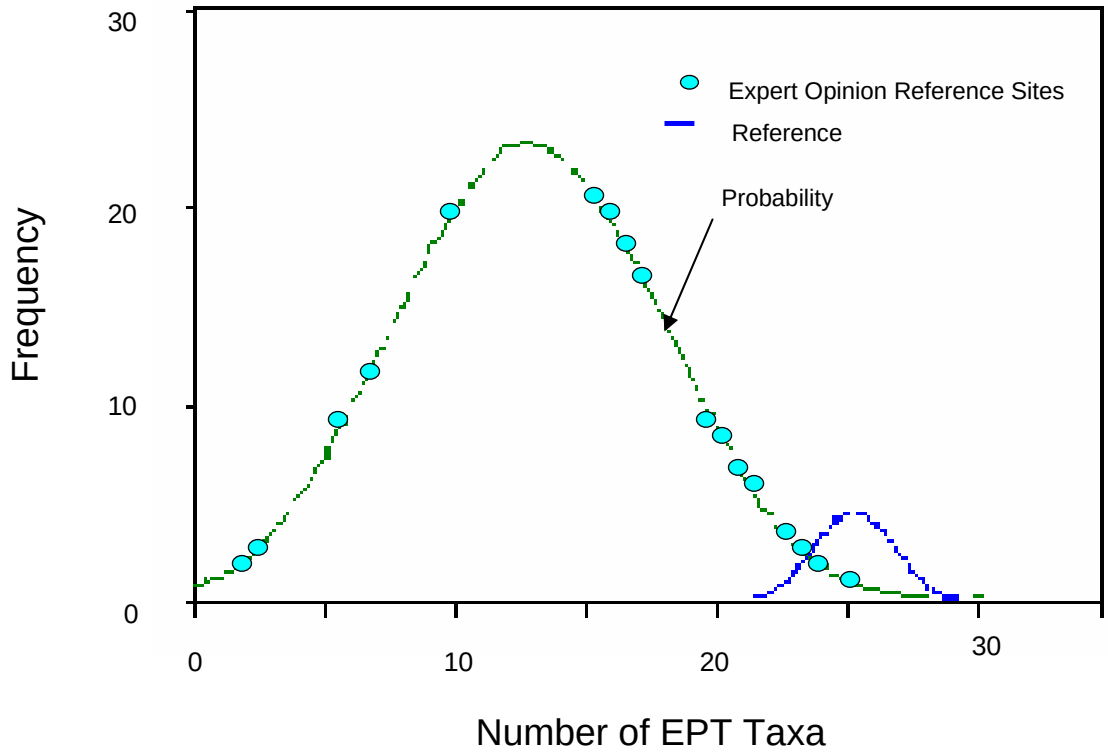
Ecoregions (North America Level II)

Integrated Monitoring and Assessment

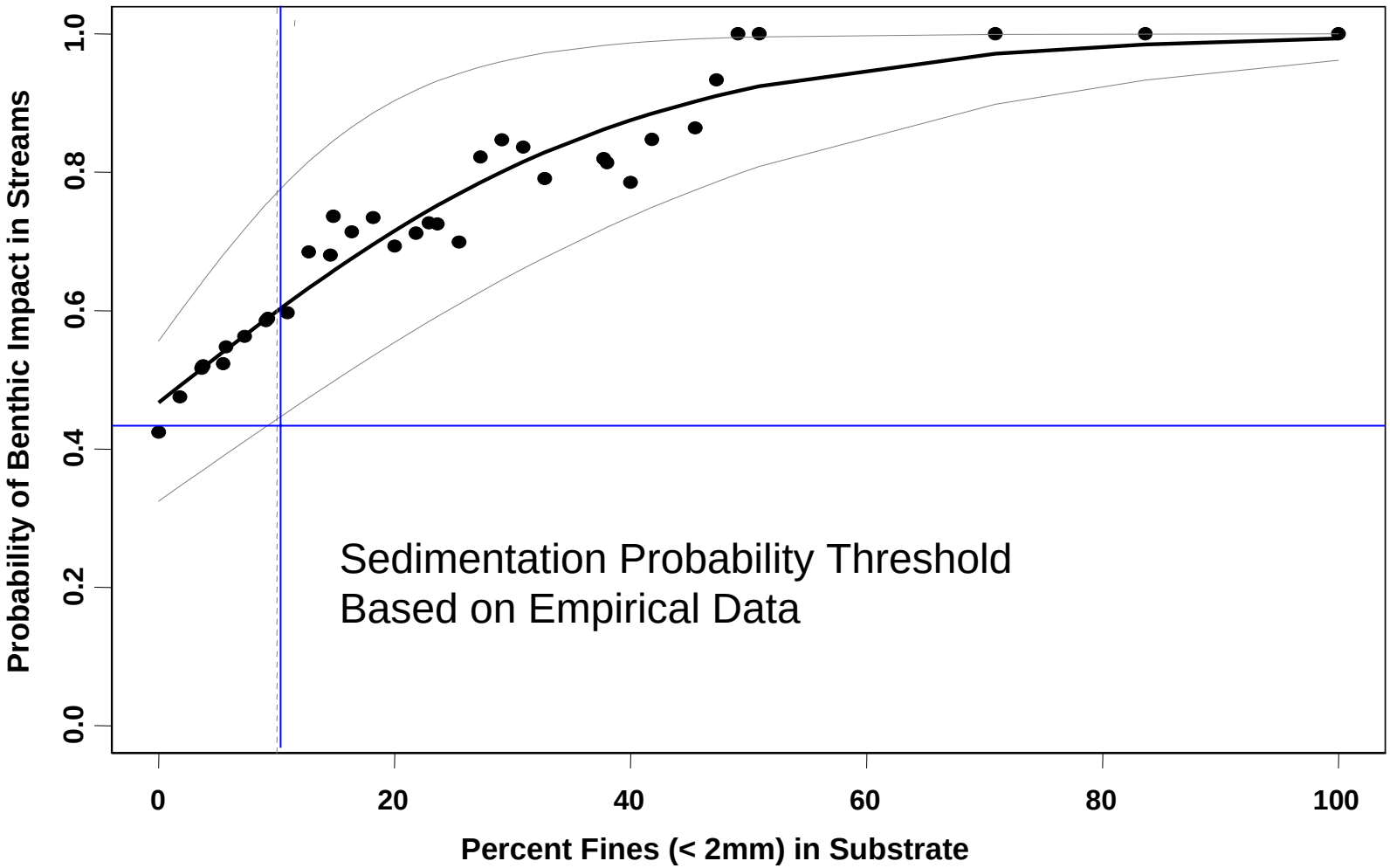


Quantitative Condition Measures

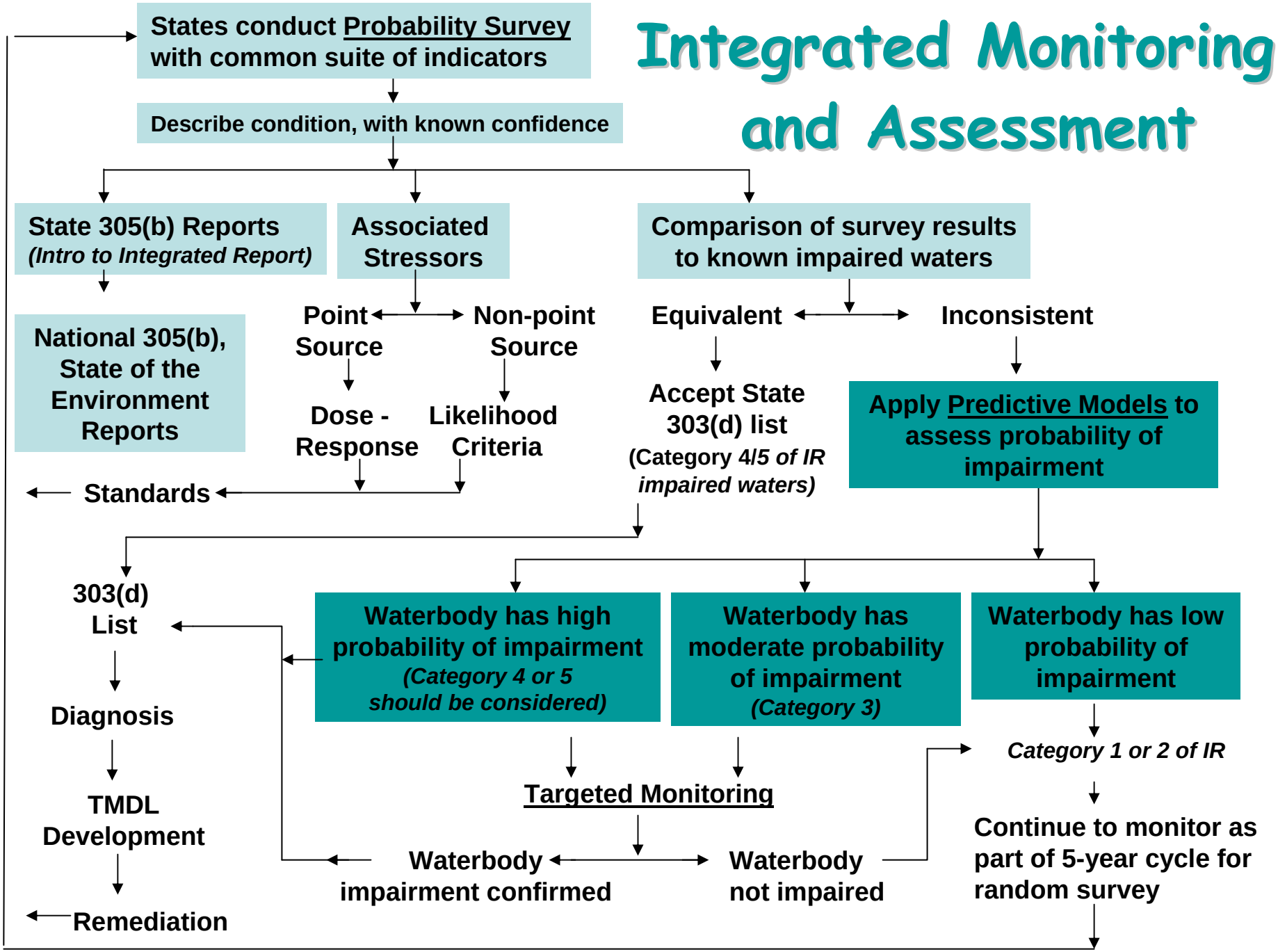
- A scientifically-defensible reference conditions as a benchmark



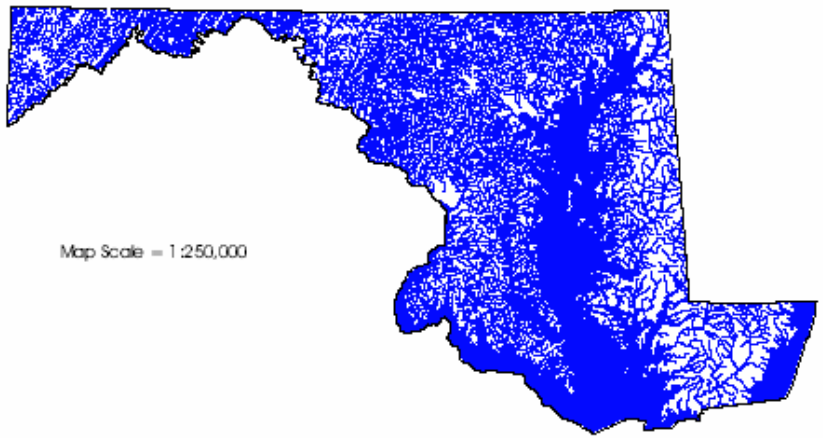
Threshold for Biological Impact



Integrated Monitoring and Assessment

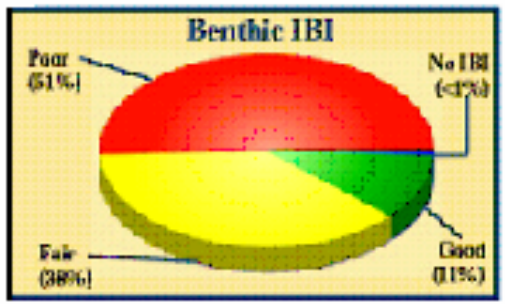


Stream Miles Impaired in Maryland



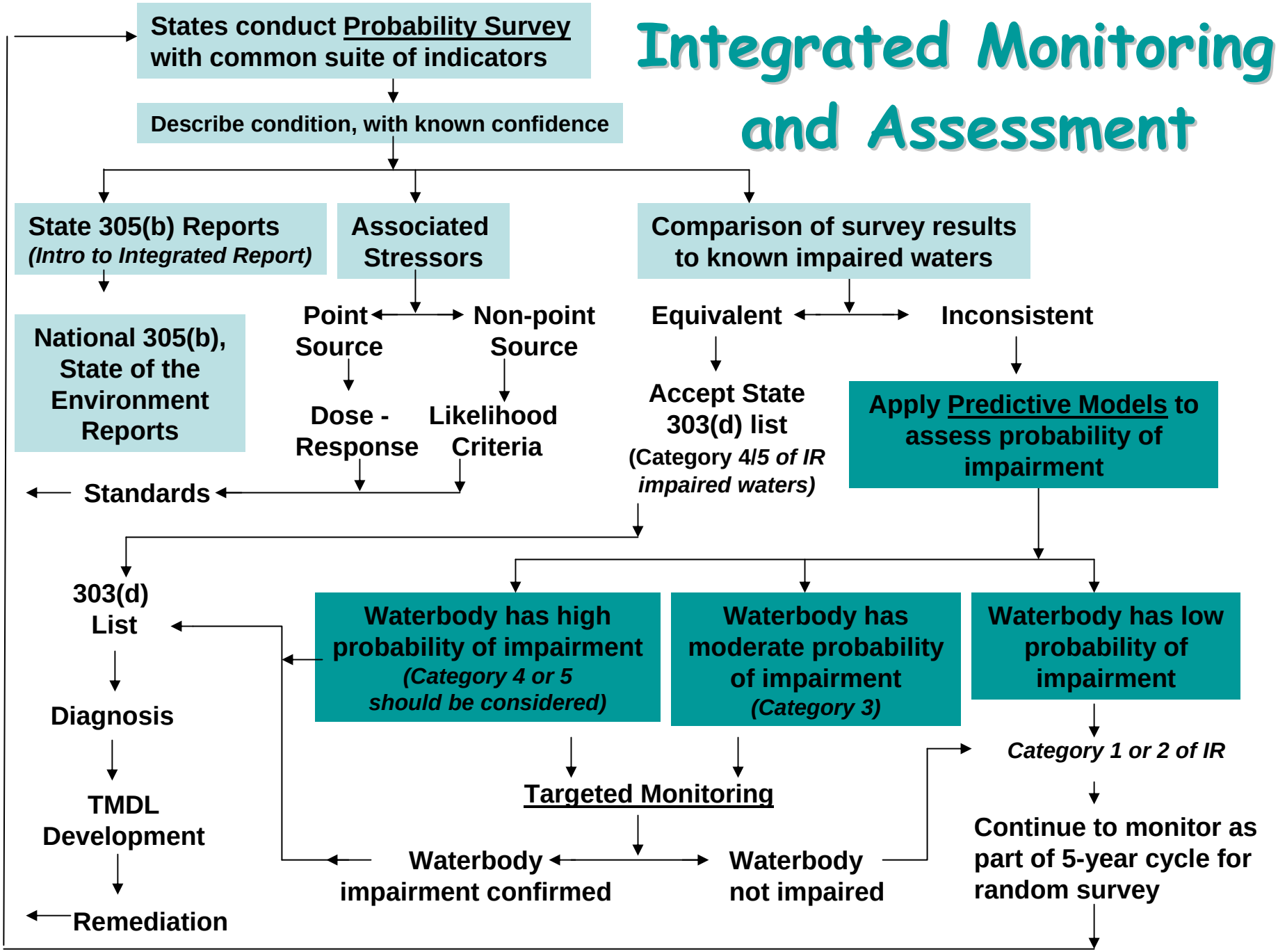
8800 stream miles stream miles in MD
MD 66% 1st order and 17% 2nd order

7304 miles in 1st and 2nd order streams



3725 miles of 1st and 2nd order streams should be on 303(d) List based on benthic impairment

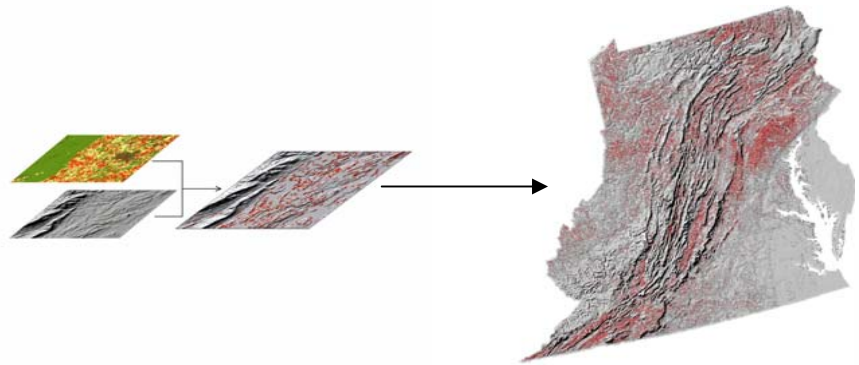
Integrated Monitoring and Assessment

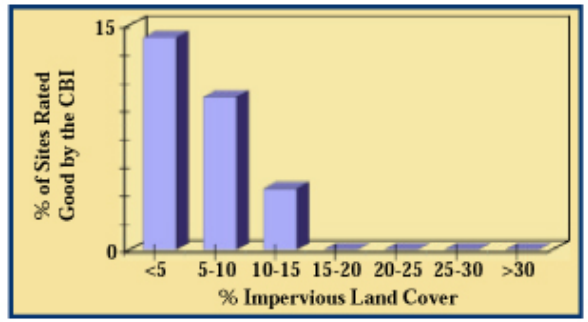


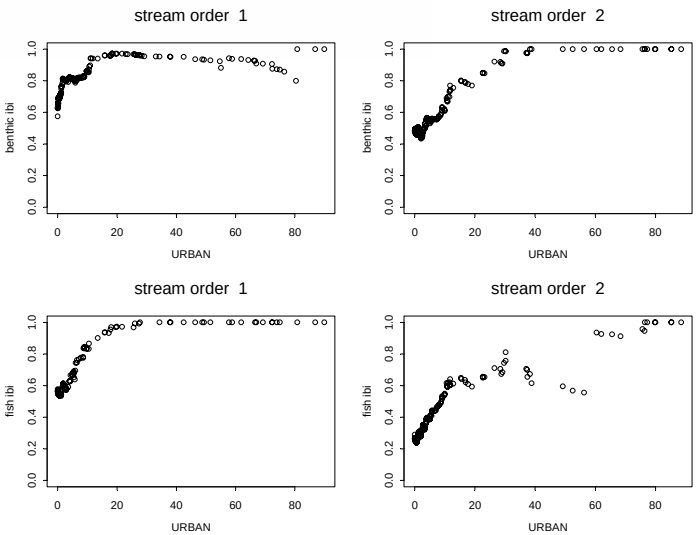
Probability of Impairment Models

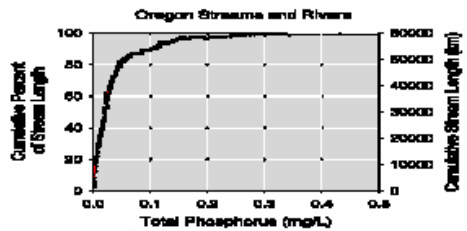
Combine condition information with land cover data to predict probability of impairment

Agriculture on >3% Slopes

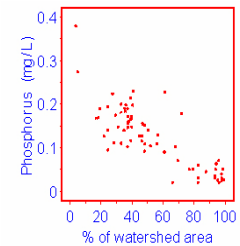






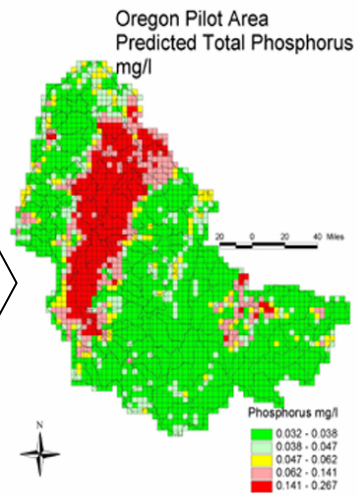


Estimate of Extent

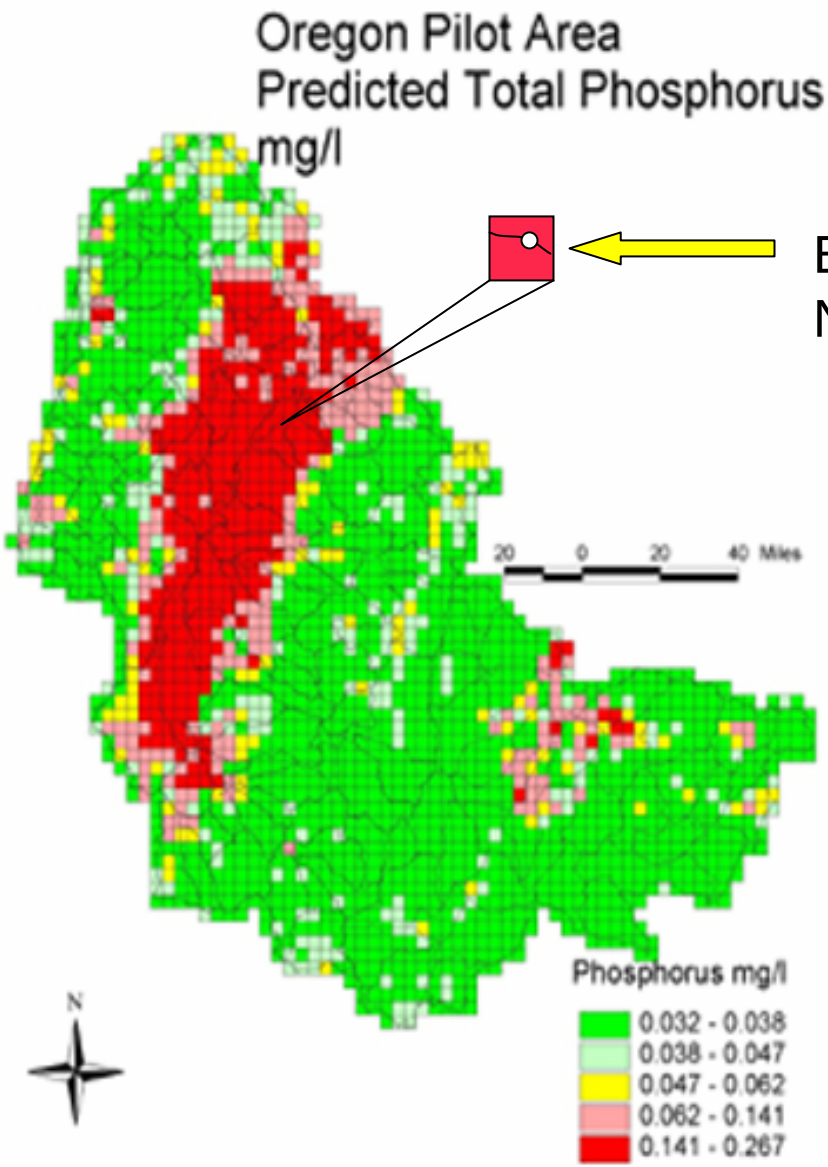


Data to Drive Modeling

Spatial Models for Probability of Impairment



Probabilistic Monitoring Approaches Can Get You Close – Faster and Cheaper



But to Get Here, You Still Need Targeted Sampling!

EMAP

- Nationally consistent approach for monitoring streams and estuaries is available
- Statistical detection of changes and trends in ecological condition is possible
- Developing the science needed for implementing an integrated monitoring approach