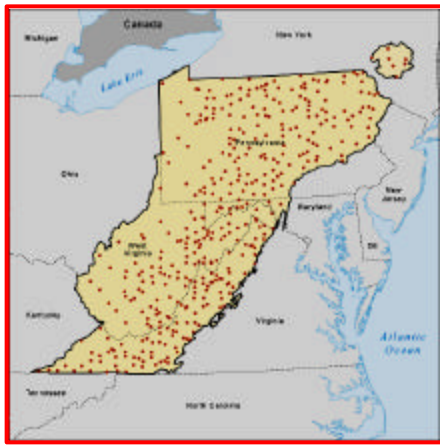
ORD's Environmental Monitoring and Assessment Program

Key Monitoring Questions

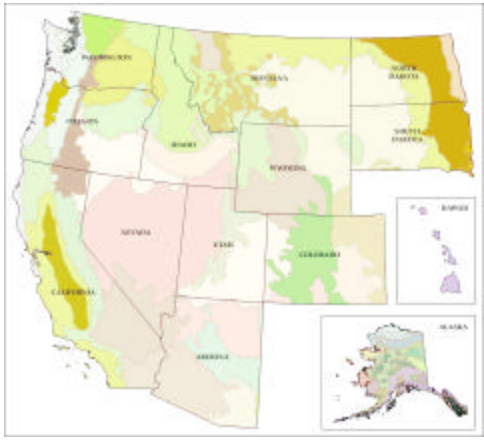
- What are the current conditions of our ecosystems?
- Where are the conditions improving or declining?
- What stresses are associated with declines?
- Are management programs and policies working?

GOALS of EMAP

- Develop the scientific basis for consistent, unbiased, cost-effective measurement of the condition of the Nation's aquatic ecosystems
  - Status
  - Trends



- Build state and tribal capacity for monitoring condition and transfer our technology
- Make our data generally available
- Develop an integrated monitoring approach



EMAP Approach

Indicators

Ecoregion Framework

⇧

Reference Condition

⇧

Index Regionalization

⇧

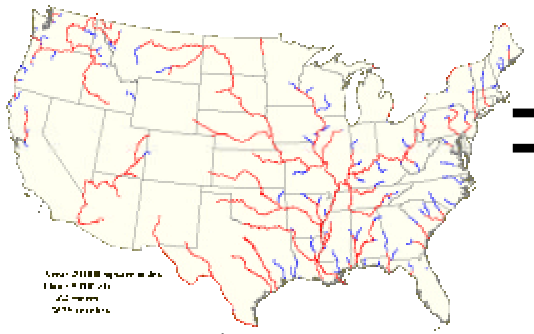
Index Calibration

⇧

Index Construction

+

Designs



Status (Trends)

⇧

Variance Estimation

⇧

Panel Rotation

⇧

Variable Density Approaches

⇧

Spatial Balance

⇧

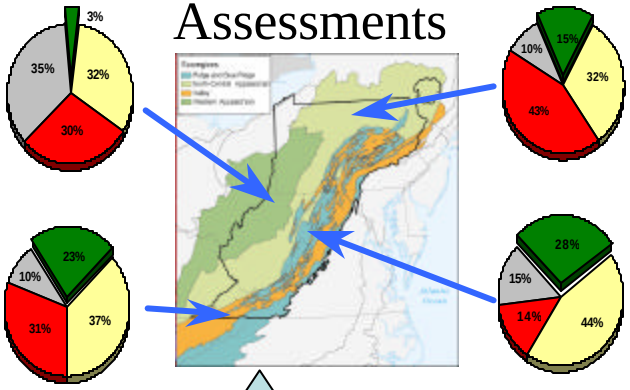
Frame Development

⇧

Population Identification

=

Assessments



Analysis

⇧

Data

⇧

Field Sampling

⇧

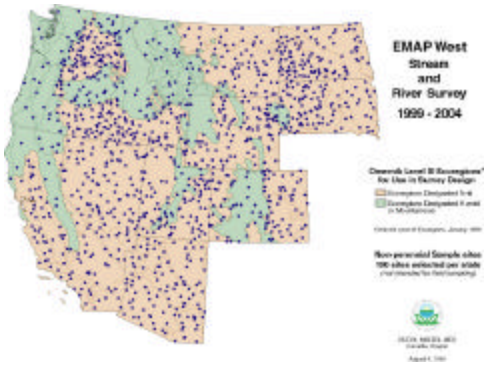
Training

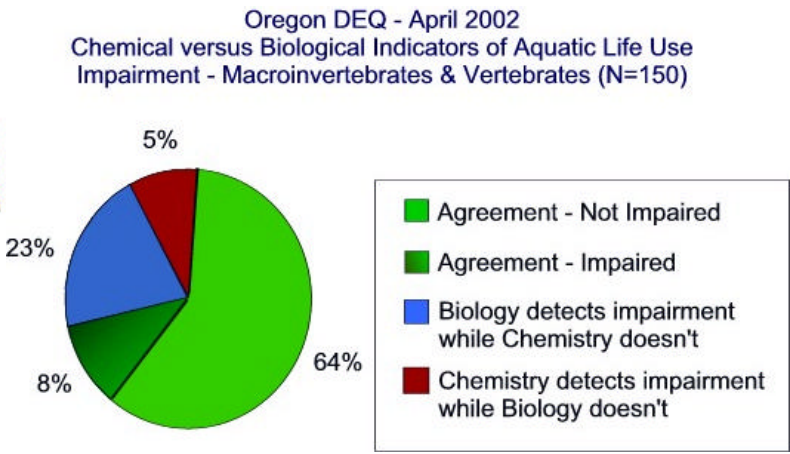
⇧

Partnerships

EMAP Design Approach

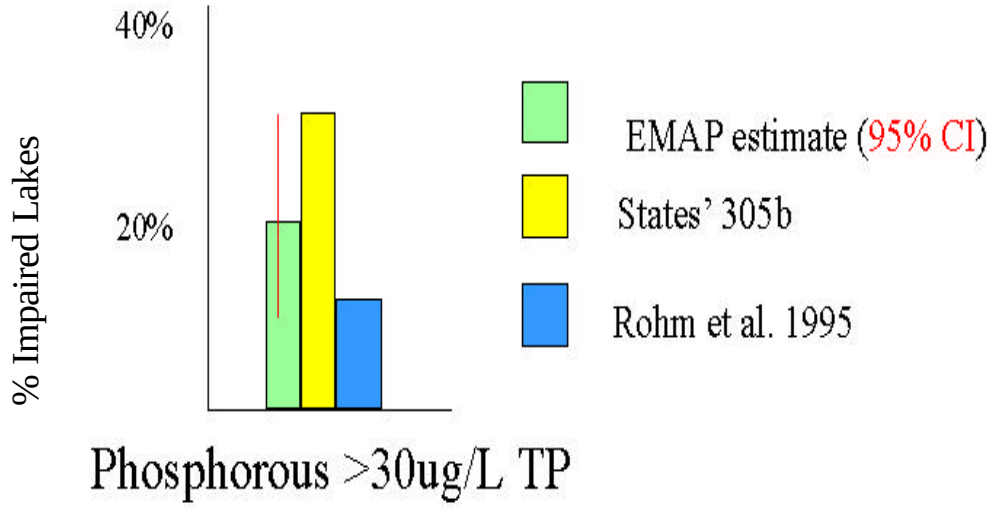
- **Probabilistic Design Framework** – Randomized statistical designs allow interpretation of monitoring data with known uncertainty, extrapolation to the entire population with a small sample size, and statistical aggregation of like data to larger geographic areas
- **Classification** - meaningful 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

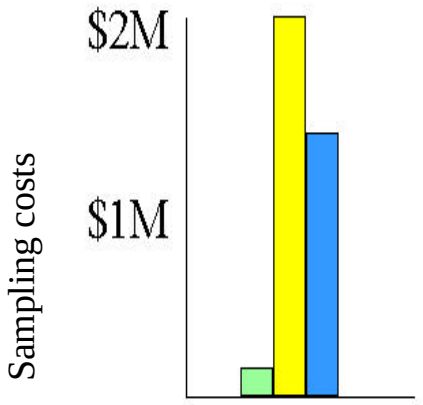




Effectiveness of Design

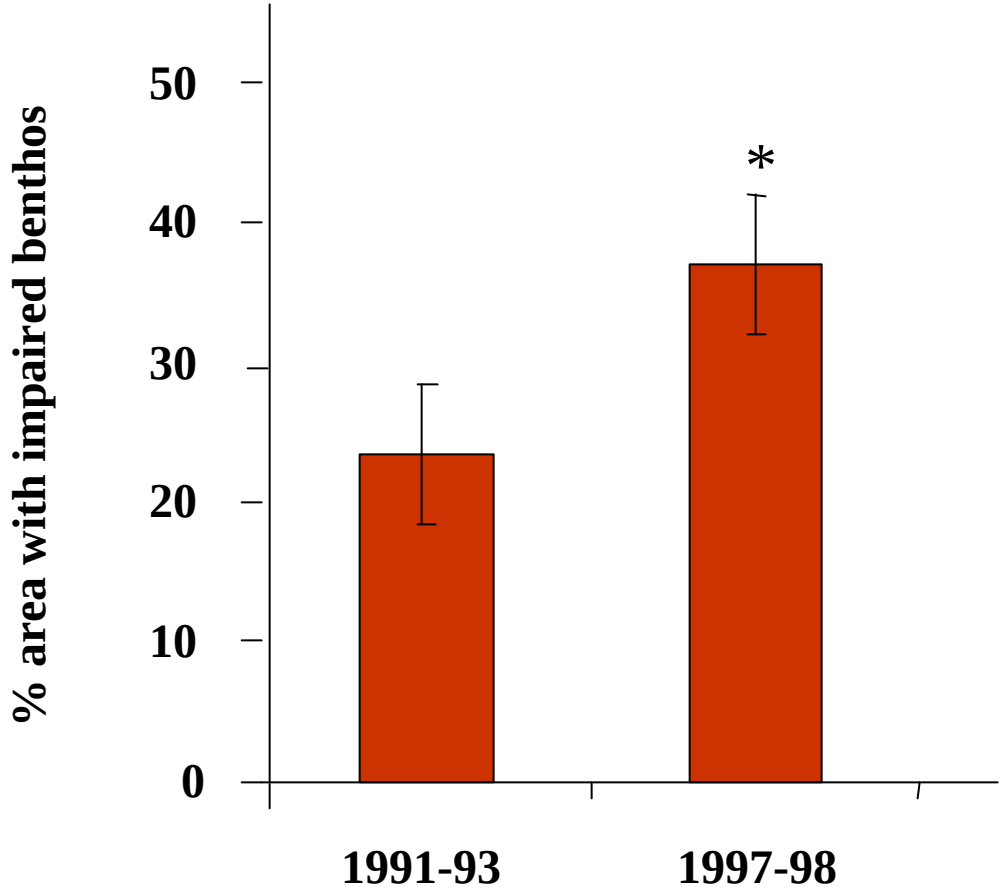
- Eutrophication of NE US lakes
  - 4219 mostly problem lakes sampled by states for 305(b)
  - 2756 non-random lakes censused (Rohm et al. 1995)
  - 344 lakes with EMAP probability design (11,076 lakes total)





Statistical Change Detection

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

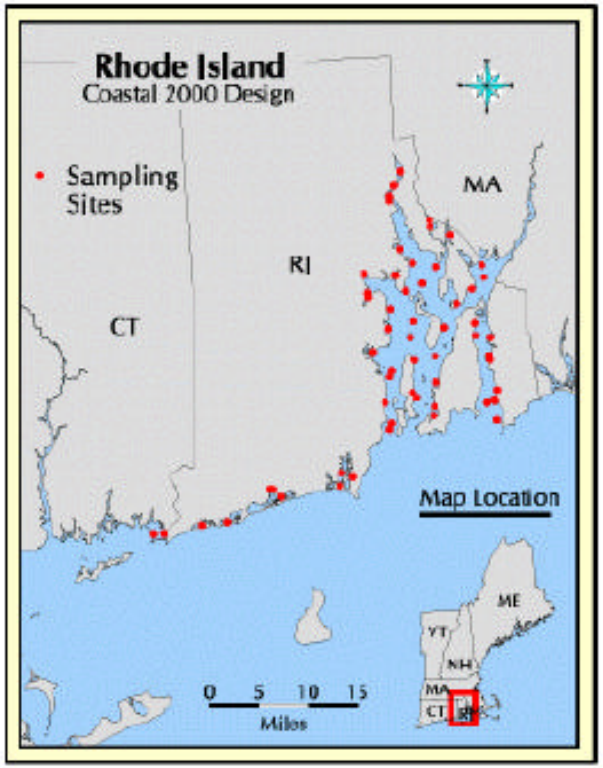


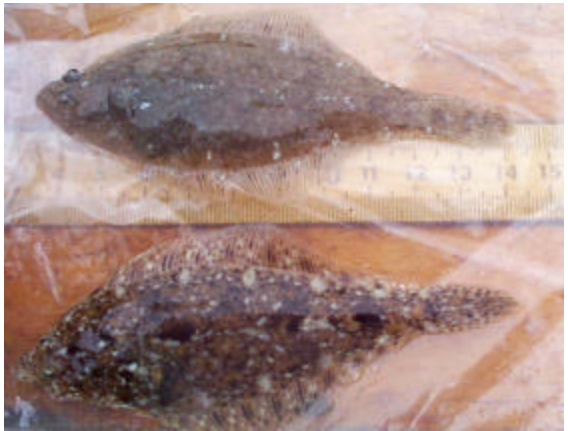
EMAP Geographic Research

- National Coastal Assessment – First statistically-based determination of condition for any national aquatic resource
- Western EMAP – Develop baselines for streams in western states
- Great River Ecosystems – Develop baselines for the large rivers of the Central Basin
- R-EMAP – Smaller-scale, Regional and State problem solving
- STAR Grants – University research

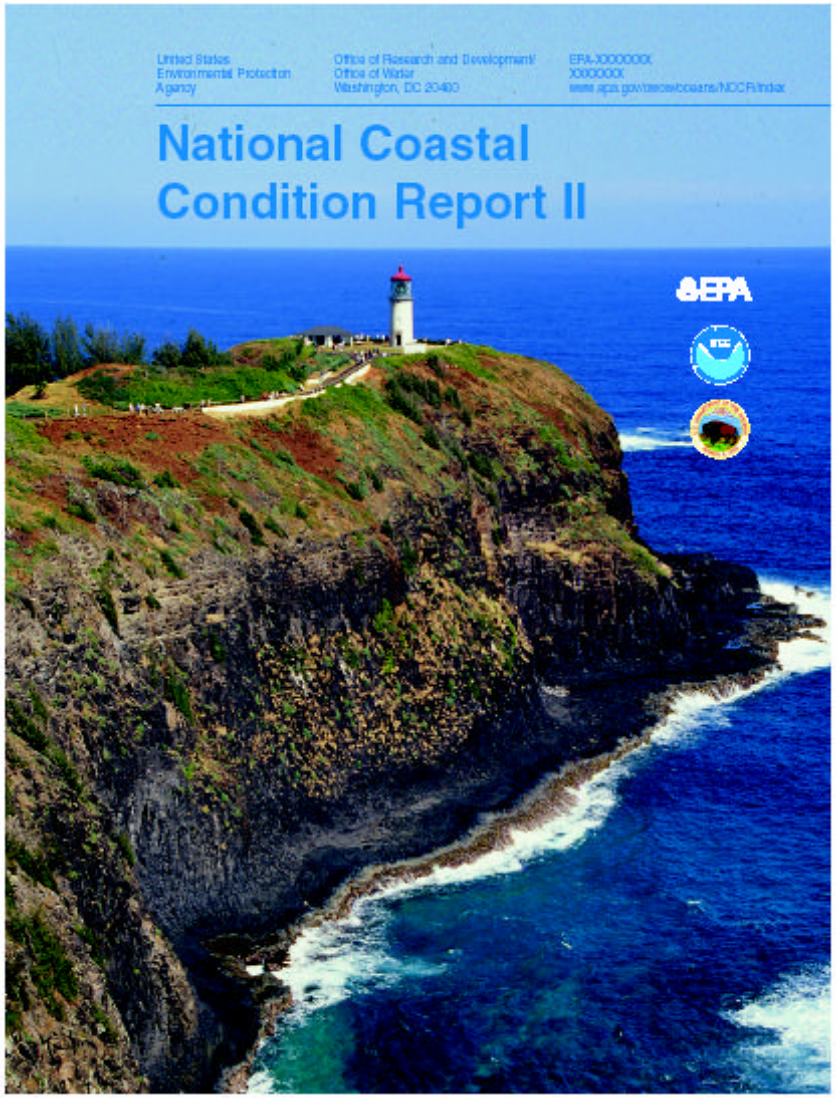
EMAP's National Coastal Assessment

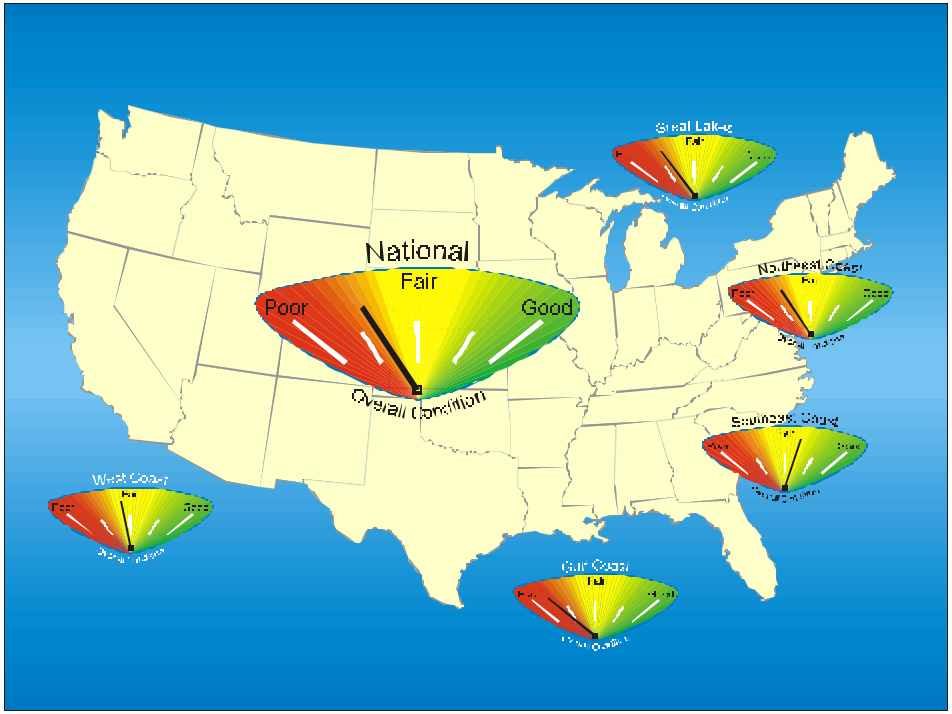
- 24 marine coastal states monitoring with core EMAP design and indicators





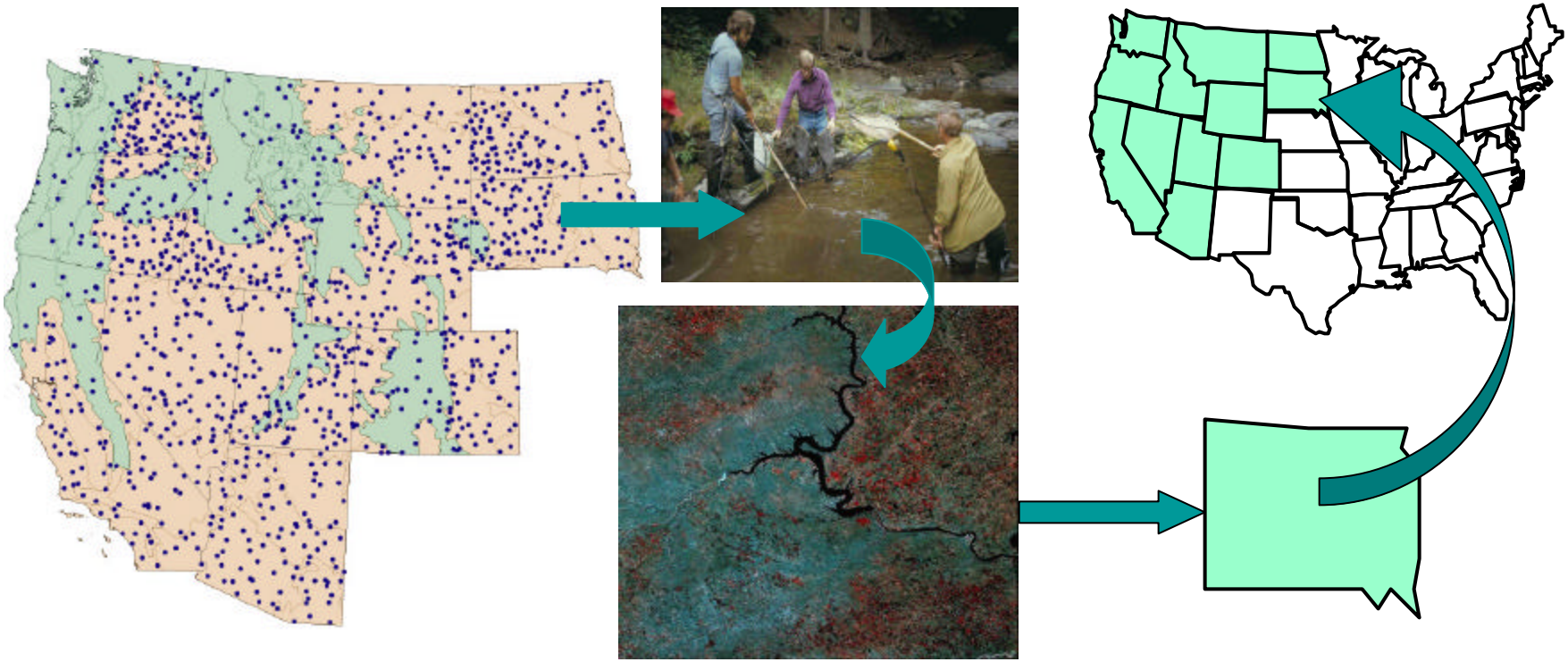
National Coastal Condition



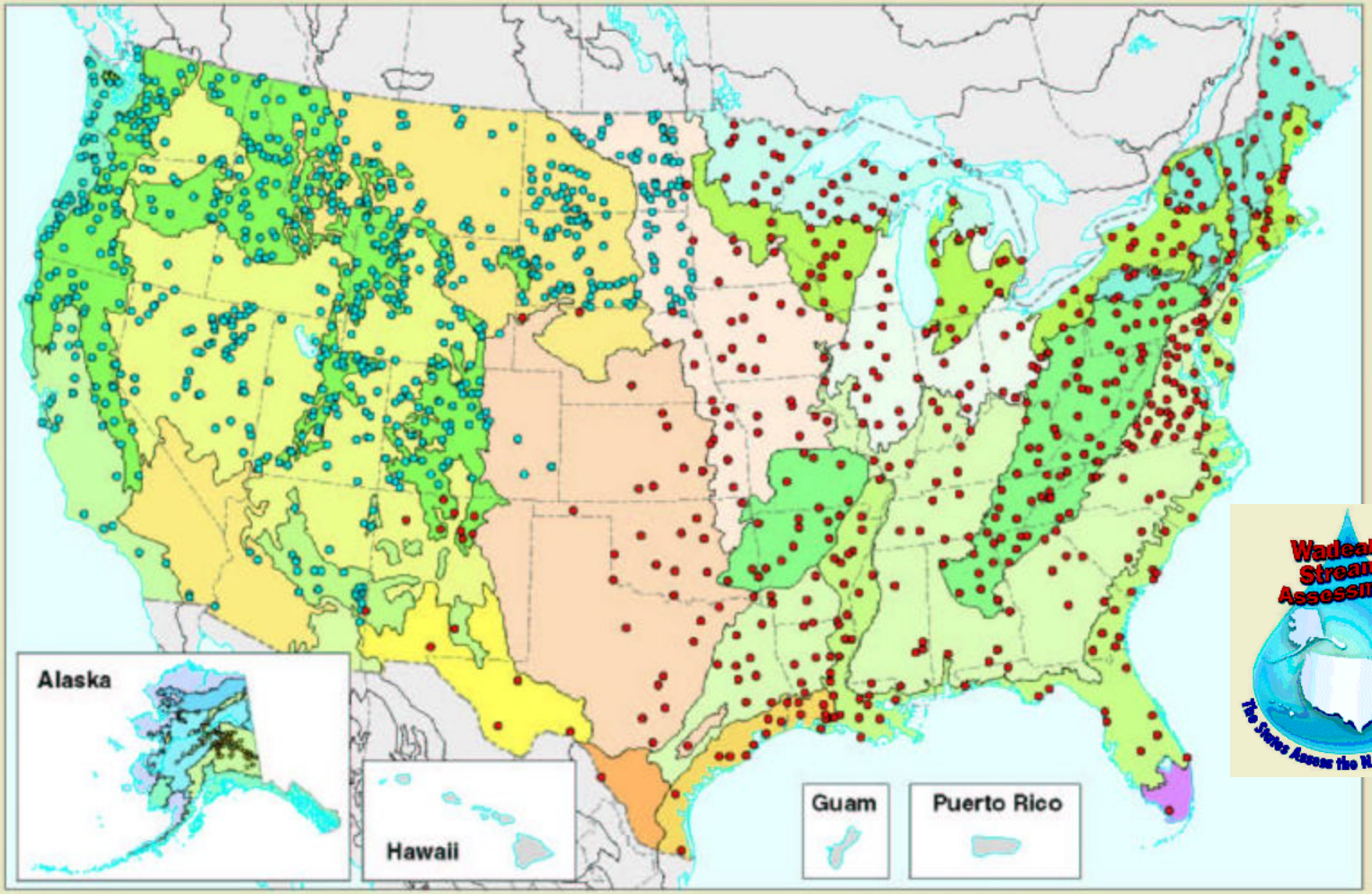


Western EMAP Streams

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



Sites for Wadeable Streams Assessment



Wadeable Streams Assessment

The States Assess the Nation's Streams

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

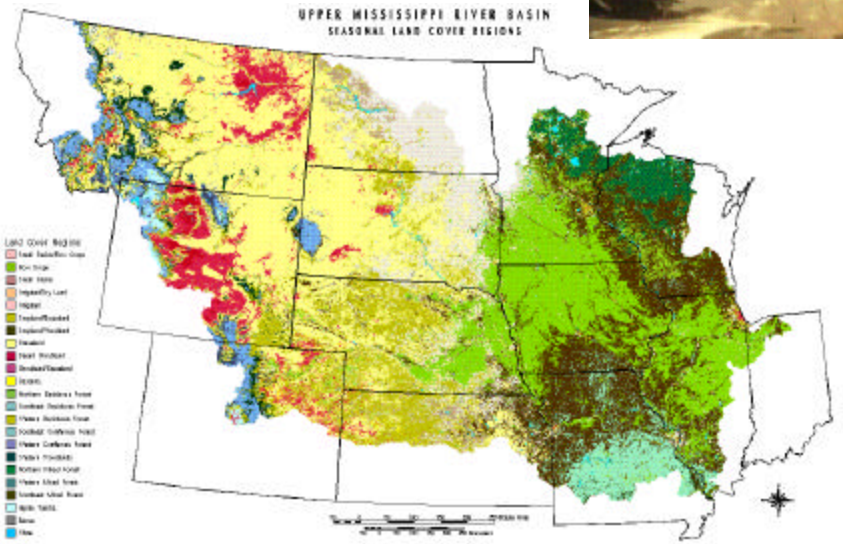
Sites sampled, 2000–2004

Sites to be sampled, 2004

Ecoregions
(North America Level II)

Great River Ecosystems

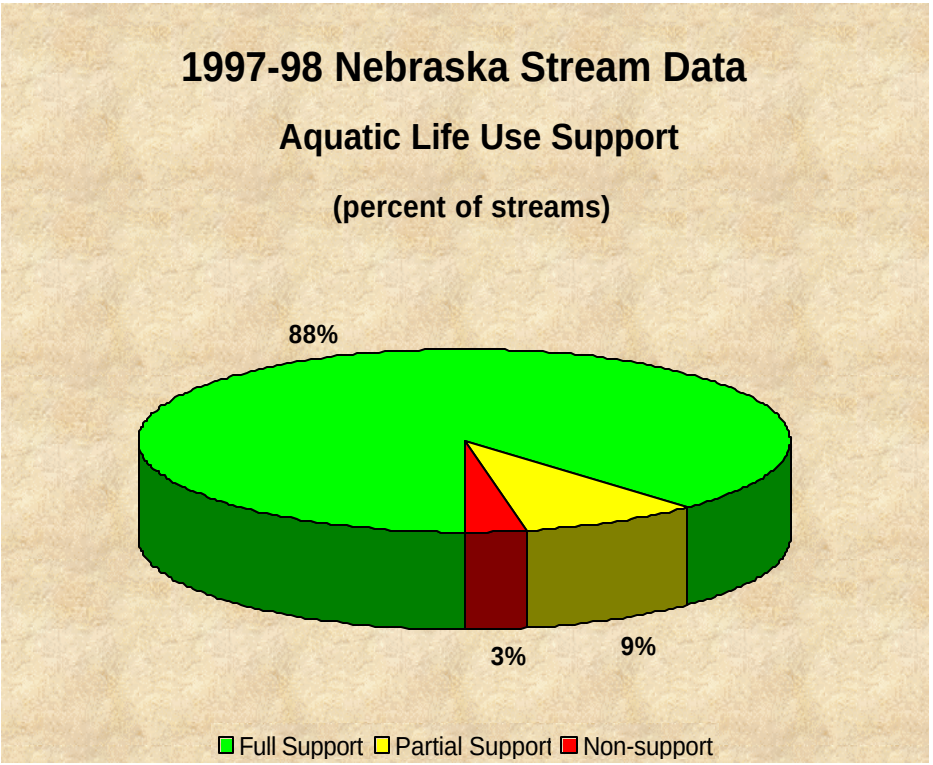
- Develop the scientific basis for assessing the condition of large rivers
  - Missouri, Ohio, Upper Mississippi Rivers

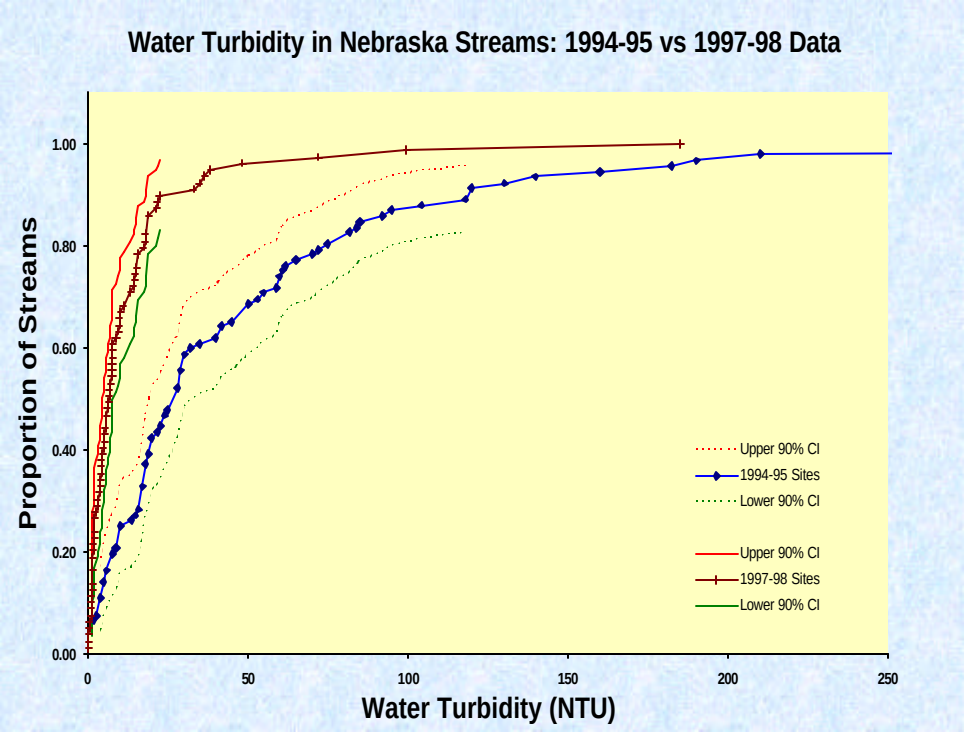


Regional EMAP

- Smaller-scale geographic demonstrations involving condition assessment at regional, state and local levels

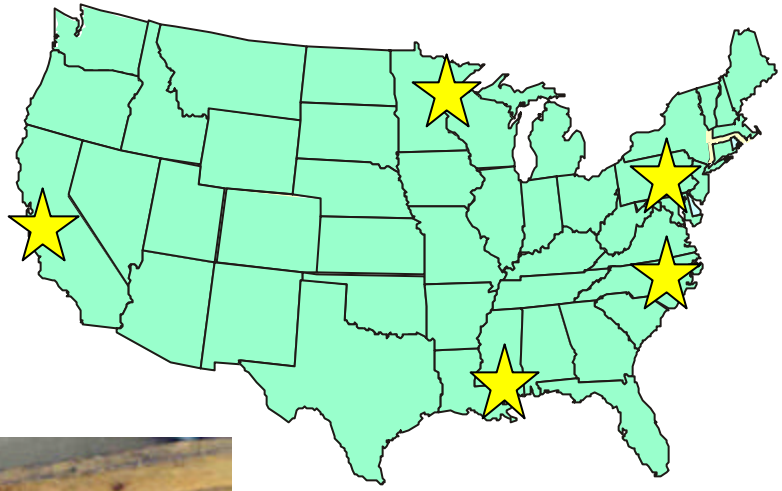
EPA Region 7 Example

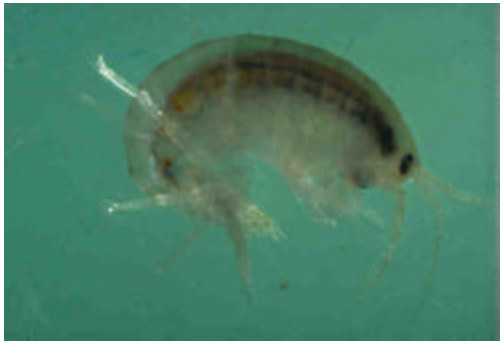




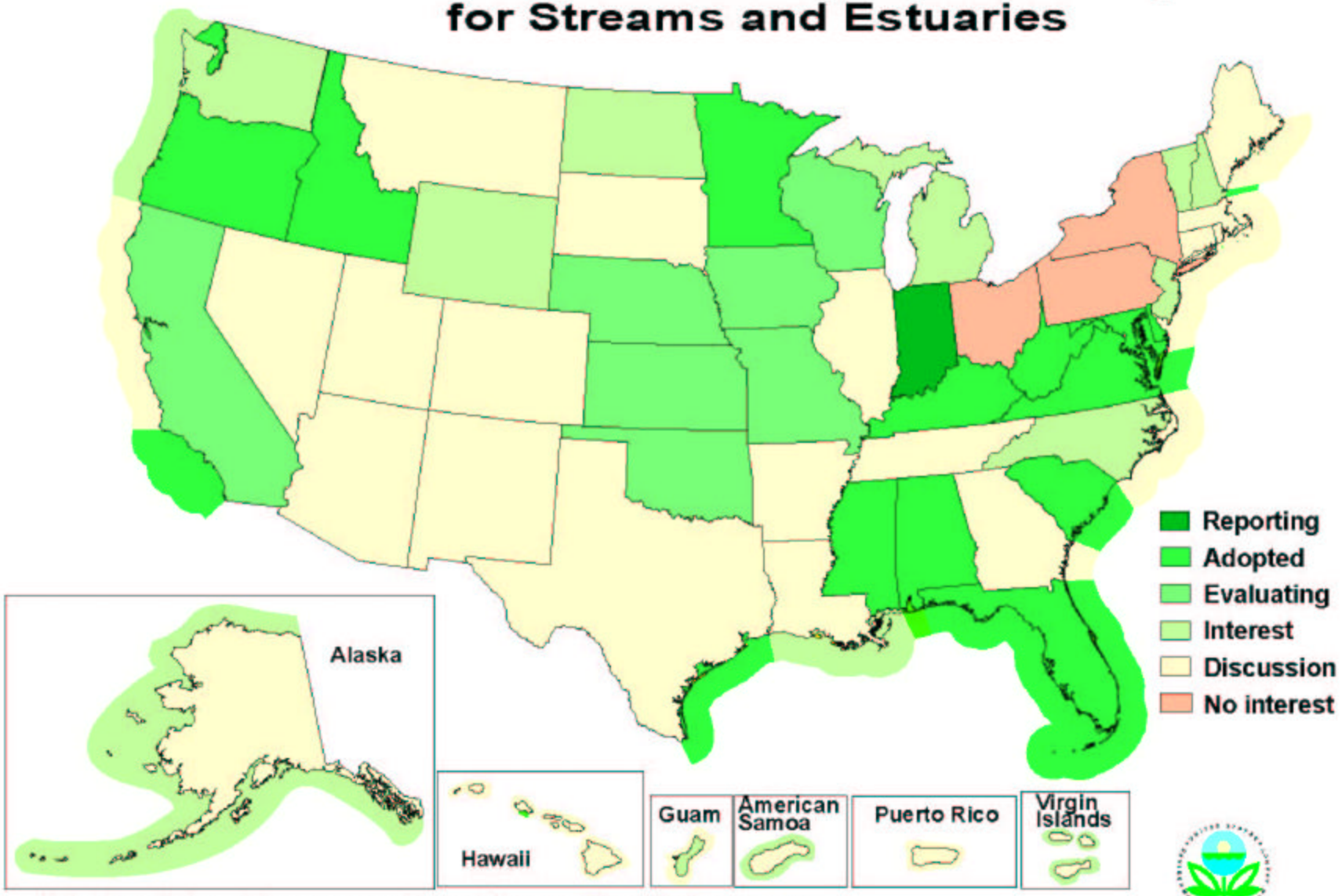
EMAP/STAR Academic Research

- EMAP is integrated with academic scientists through ORD's STAR Grants Program
  - Ecological Indicators
  - Statistical Designs





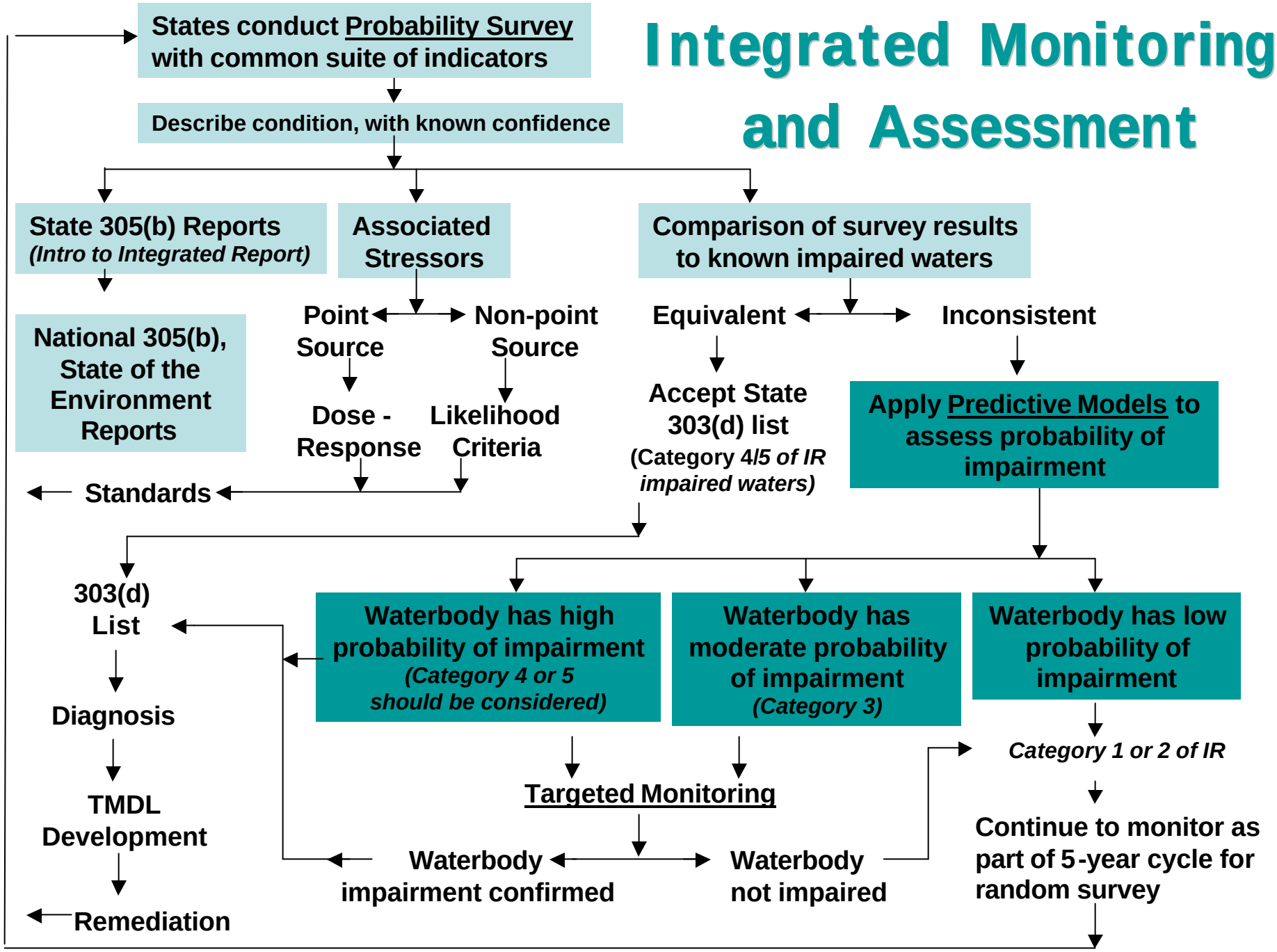
State Use of Probability Survey Designs for Streams and Estuaries



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

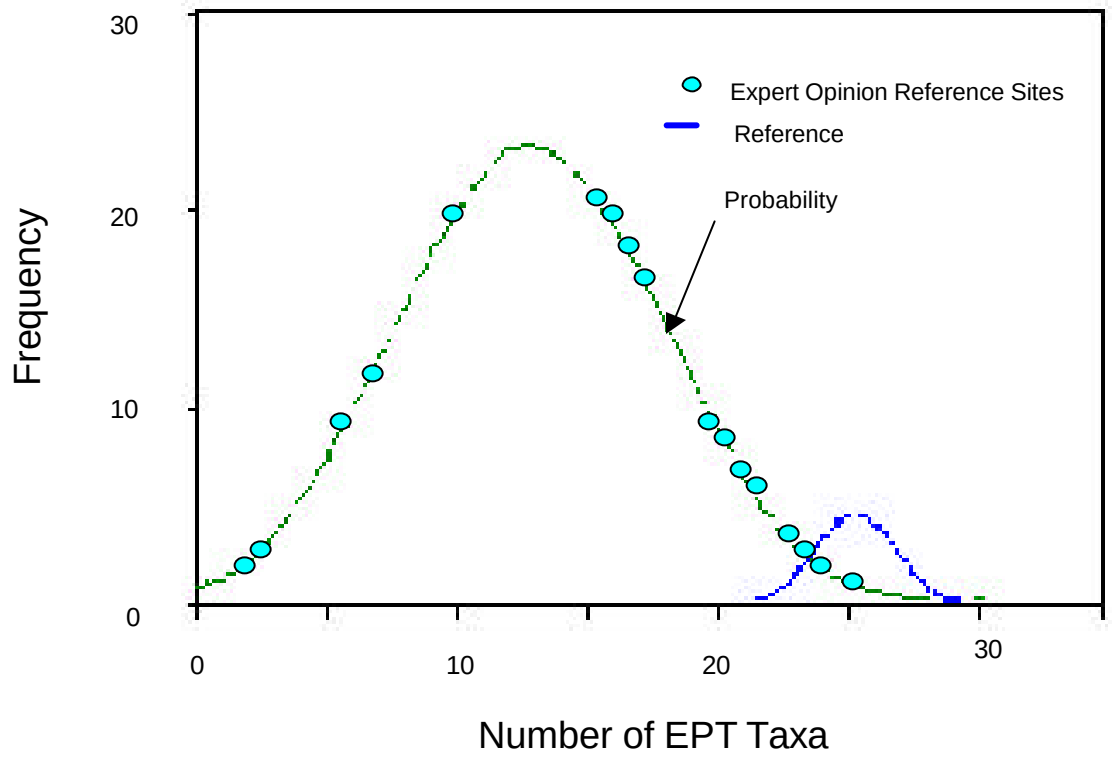
October 2003

Integrated Monitoring and Assessment

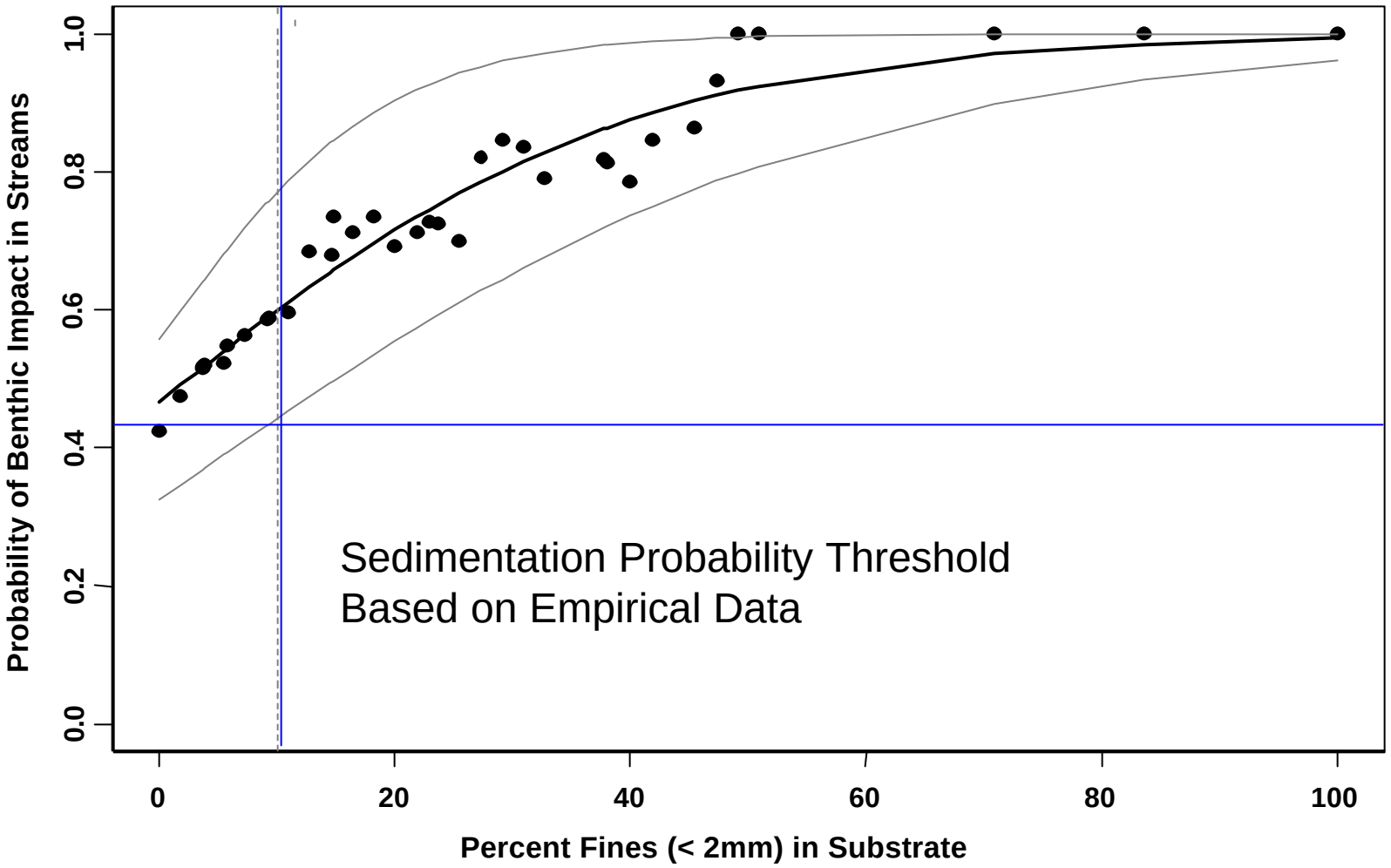


Quantitative Condition Measures

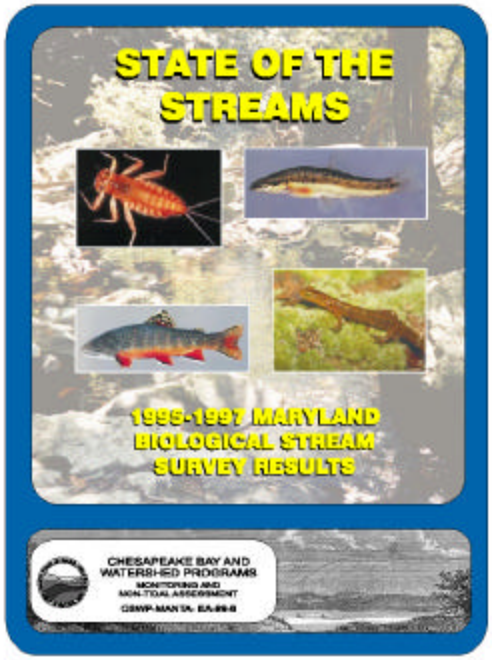
- Reference conditions - scientifically-defensible benchmark for measuring condition



Threshold for Biological Impact

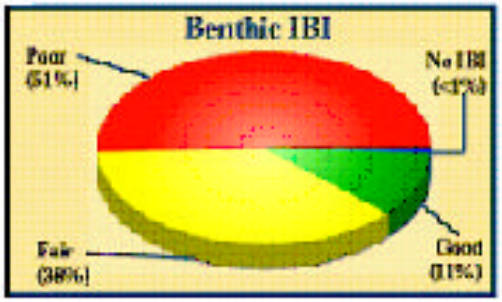


Stream Miles Impaired in Maryland



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

7304 miles in 1st and 2nd order streams

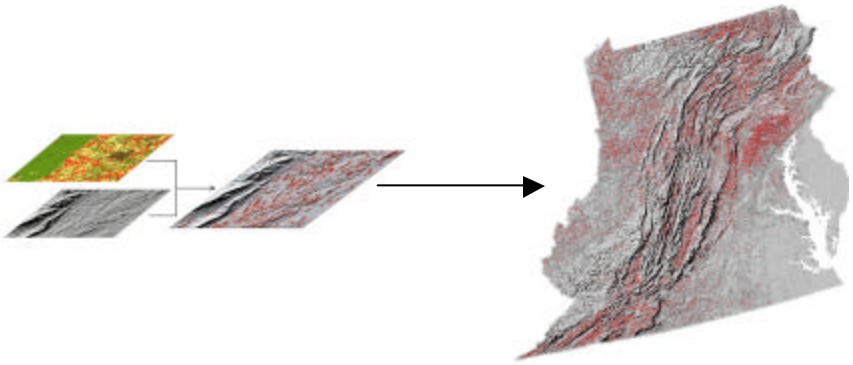


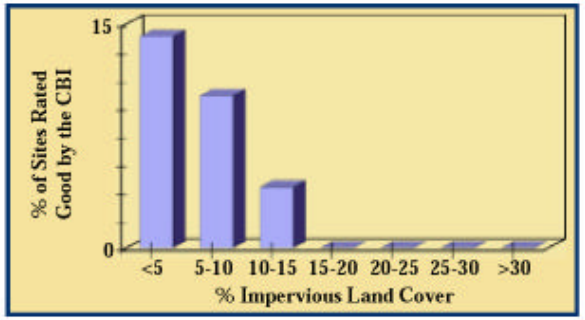
3725 miles of 1st and 2nd order streams should be on 303(d) List based on benthic impairment

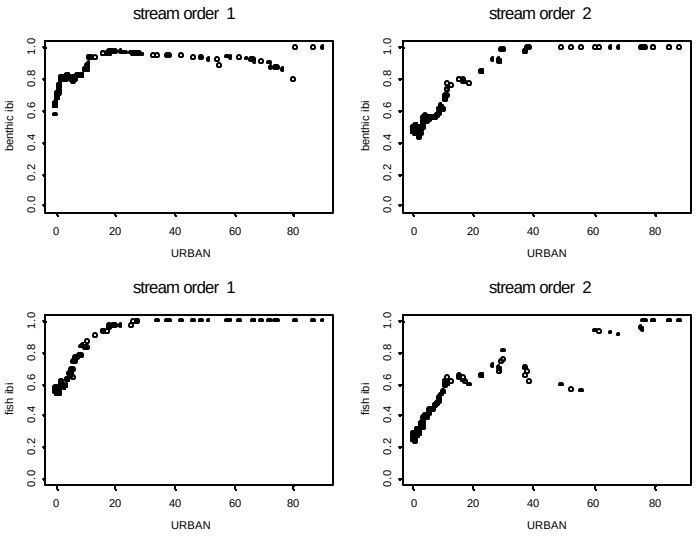
Probability of Impairment Models

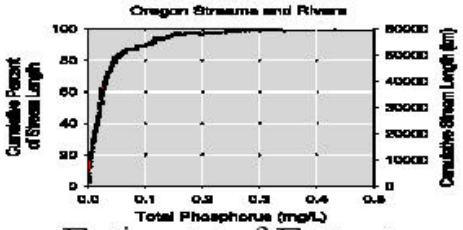
Combine condition information with other data to predict probability of impairment

Agriculture on >3% Slopes

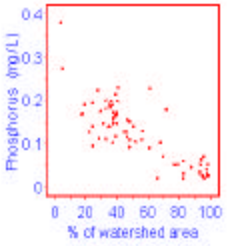






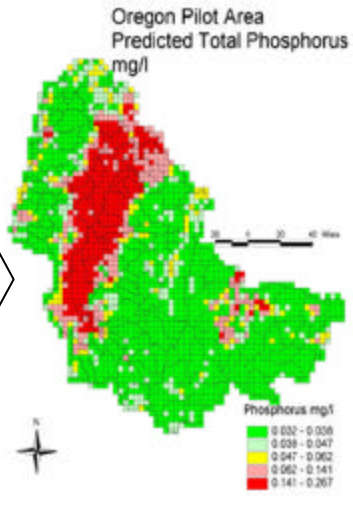


Estimate of Extent



Data to Drive Modeling

Spatial Models for Probability of Impairment



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 for determining condition of the large and Great Rivers
- Developing the science needed for implementing an integrated monitoring approach