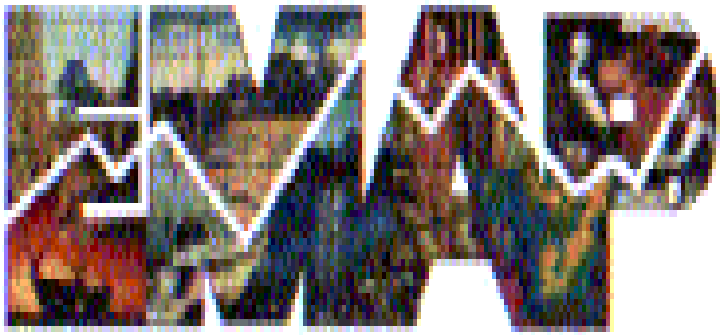


ORD's Environmental Monitoring and Assessment Program

Office of Research and Development

EPA

EMAP Overview

- State and EPA monitoring needs
- Monitoring research questions
- ORD's EMAP approach
- Selected major accomplishments
- EMAP's new geographic research areas
  - Western Pilot
  - Coastal Initiative

Monitoring Aquatic Resources

- 3.6 million miles of streams (19%)
- 41.7 million acres of lakes (40%)
- 303 million acres of wetlands (3%)
- 61,000 miles of coastline (6%)
- 40,000 square miles of estuaries (72%)

Conventional Monitoring

- > $650M/y spent on environmental monitoring by Federal Government
- Most is targeted to individual chemicals and to physical conditions at specific sites
- Point source problems have been greatly reduced

Unanswered Monitoring Questions

- How much of our state/national aquatic ecosystems are healthy?
- Are we targeting the right problems to make a difference?
- How do we measure trends in the condition of aquatic ecosystems?
- How do we determine this in a cost-effective, scientifically-defensible, and credible way?
- How do we aggregate this information from the local to the state to the national levels?

EMAP's GOAL

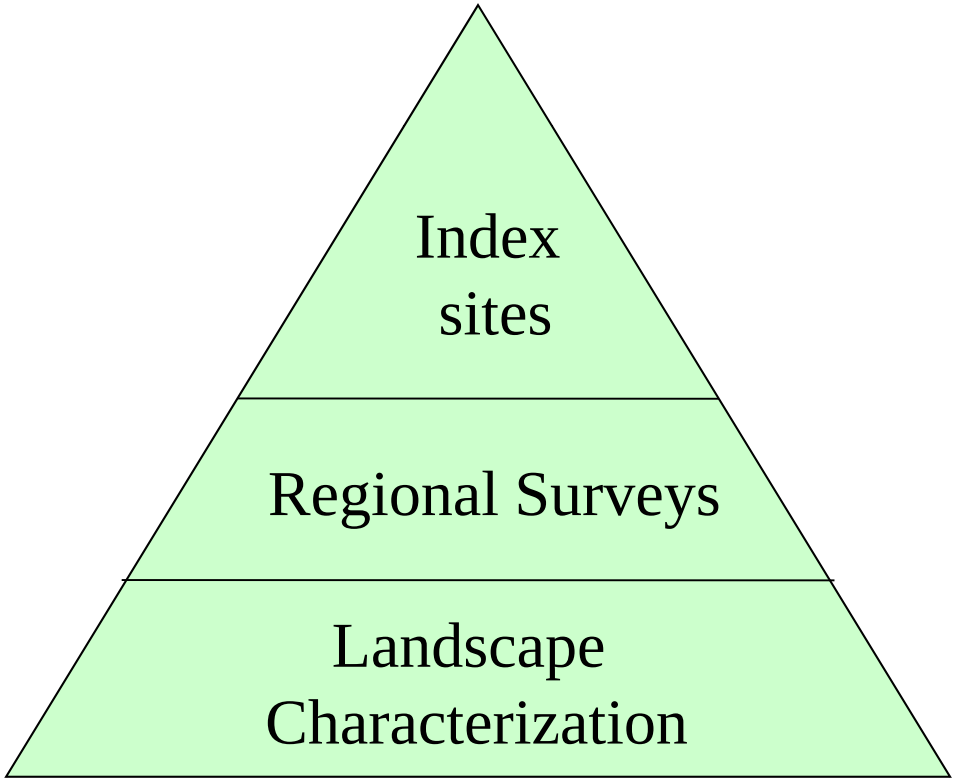
- Build the scientific basis, and the local, state, and tribal capacity, to monitor for status and trends in the condition of the Nation's aquatic ecosystems
  - Cost-effective
  - Scientifically-defensible and representative
  - Quantifiable trends
  - Supports performance-based management (GPRA)

Why an EMAP Approach?

- Only statistically-valid approach to determining state and national aquatic ecosystem condition
  - uses biological indicators (e.g., fish and benthic community structure) as integrators of aquatic ecosystem condition
  - establishes measurable baselines for health of aquatic ecosystems and assesses trends in condition
  - reduces costs and identifies most important areas and stressors
  - provides monitoring designs for consistent aggregation of data from local to national levels
- Already being used by states for improved assessments and better decision-making

EMAP Design Components

- Multi-Tier Monitoring Designs - scale defined design that allows aggregation and interpretation of monitored data

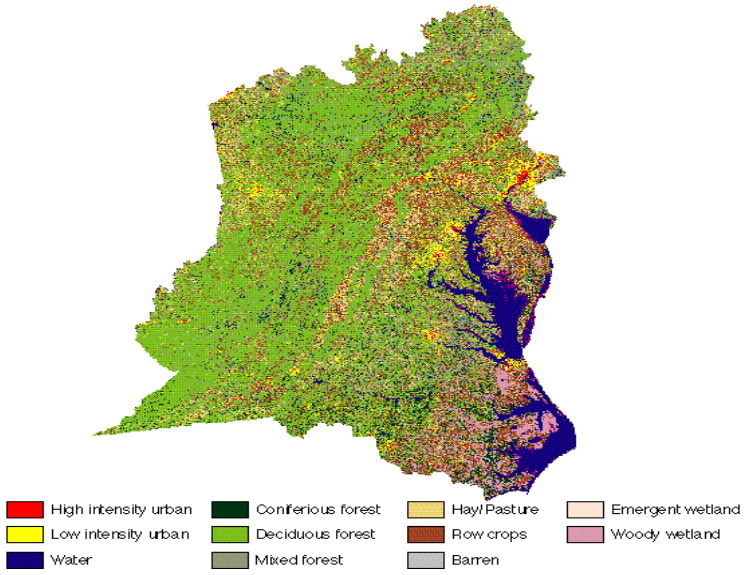


Sound Scientific Basis for EMAP Approach

- Publications
  - >600 peer reviewed EMAP publications
- Recent peer review by Ecological Society of America and American Statistical Association
  - "...panel strongly supports the use of probability-based sample designs…GIS-based approaches provide important pattern and connectivity information…REMAP demonstration programs have put EMAP at the forefront of having solid data from both probability sampling and a GIS-based design…"(ESA and ASA 1998)
- Integrated with STAR Grants Program to maximize use of university research

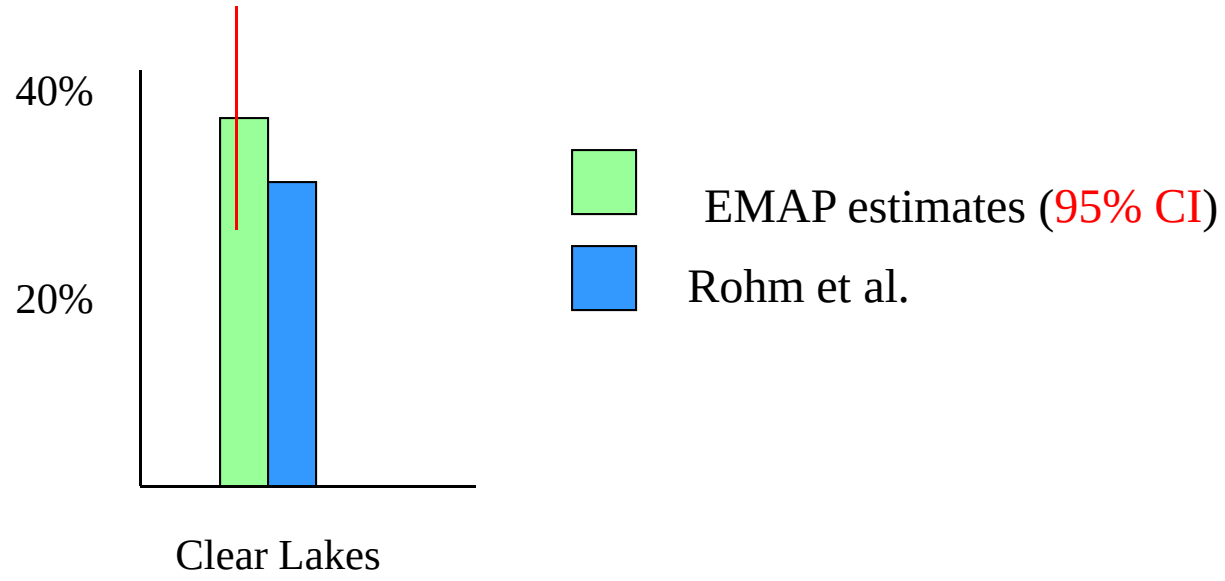
EMAP's Proof of Concept: Mid-Atlantic Integrated Assessment (MAIA)

- Large-scale, regional monitoring feasible
  - Biological and landscape indicators developed and tested
  - Statistically-based sampling design for regional resources developed and tested
- First assessments of regional environmental condition:
  - An Ecological Assessment of the United States Mid-Atlantic Region: A Landscape Atlas (EPA 600/R-97/130)
  - Condition of the Mid-Atlantic Estuaries (EPA 600-R-98-147)
  - Mid-Atlantic Highlands State of the Streams (EPA XXX-R-00-XX)

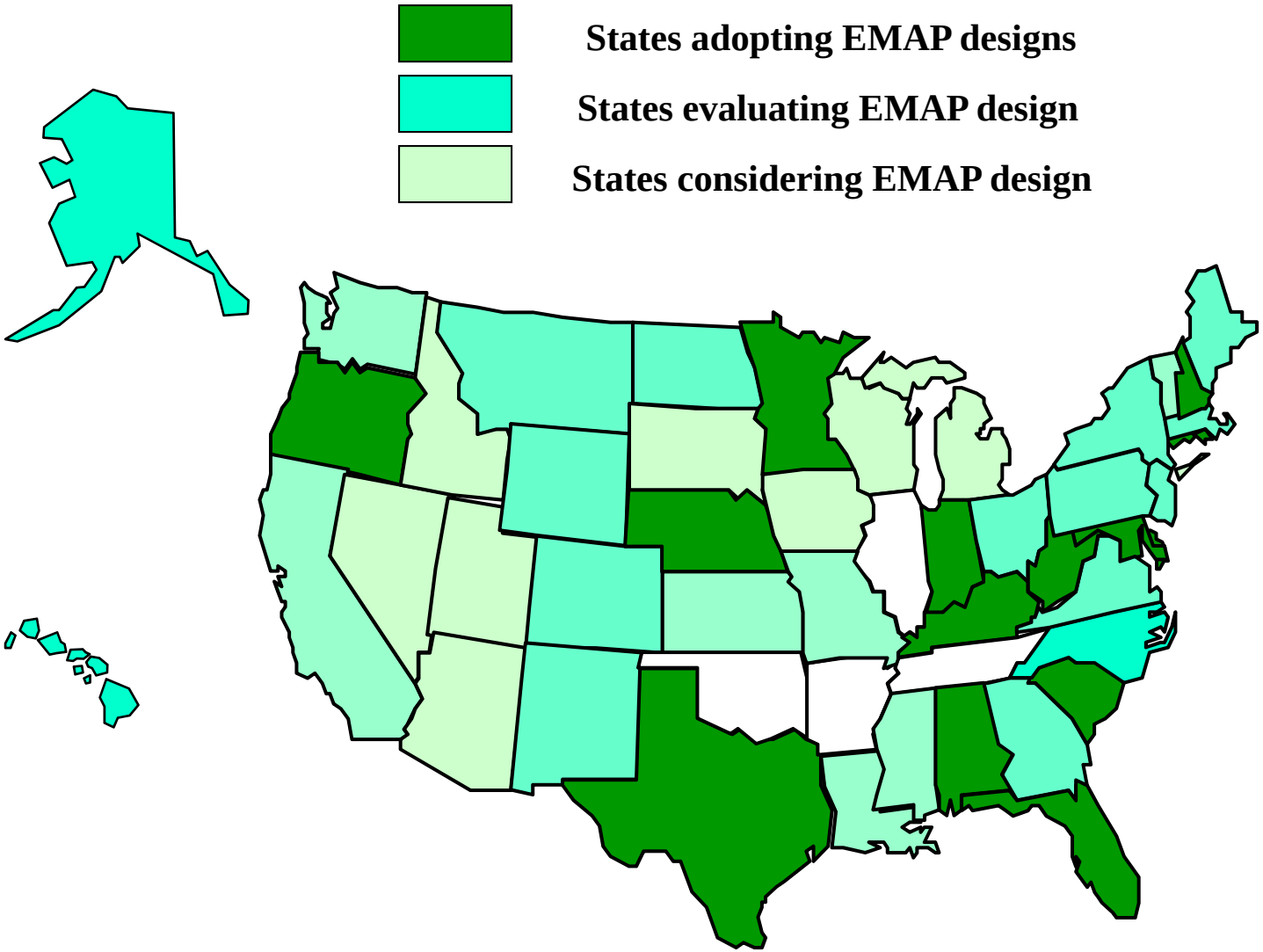


Cost Effectiveness of EMAP Approach

- Alabama monitoring costs 25% less, with more and better information
- Eutrophication of NE US lakes
  - –2756 non-random lakes censused (Rohm et al. 1995)
  - – EMAP reached same conclusion with only 344 lakes



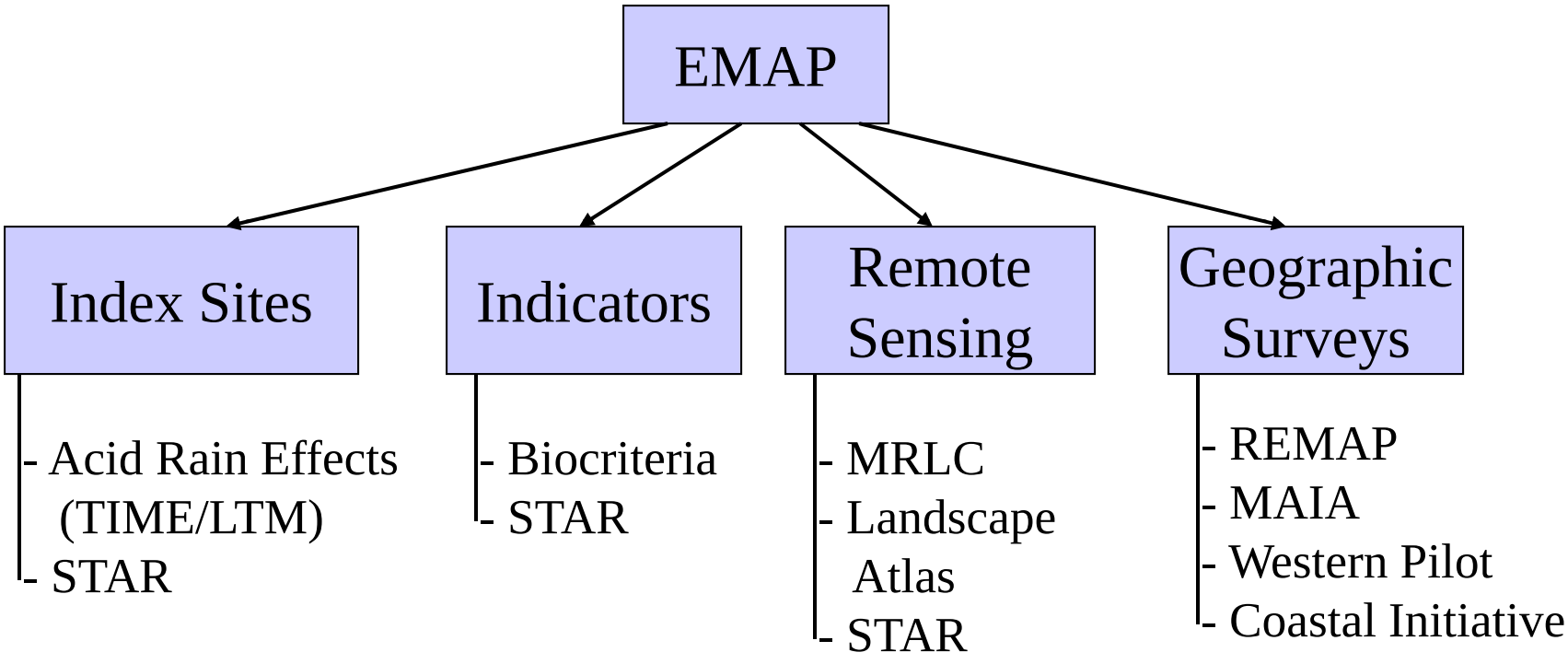
State Capacity Building



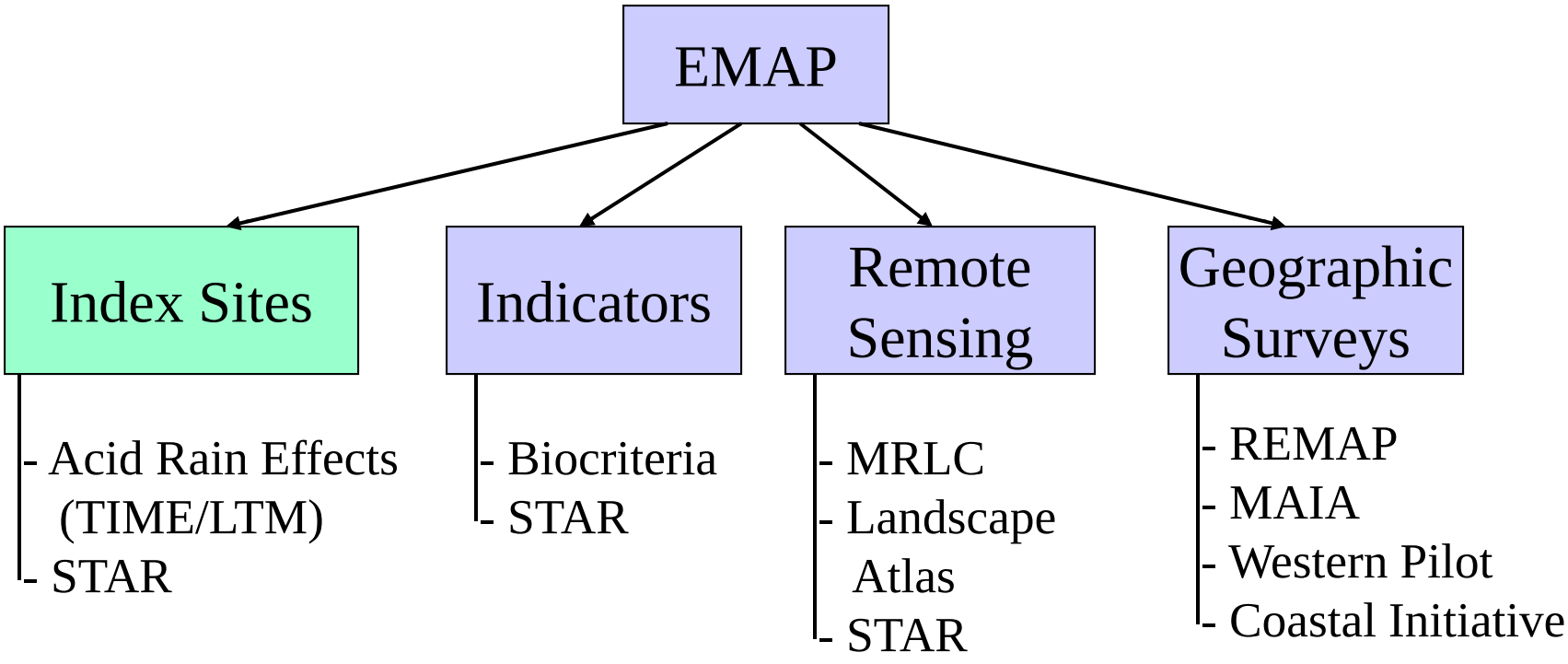
Environmental Decisions Using EMAP Science

- Region 3 - Mountain-top removal mining impacts
- Maryland - State of the Streams Report
- Oregon - Revised coho salmon assessment program
- Maine - Fish consumption advisory for Mercury

EMAP Research



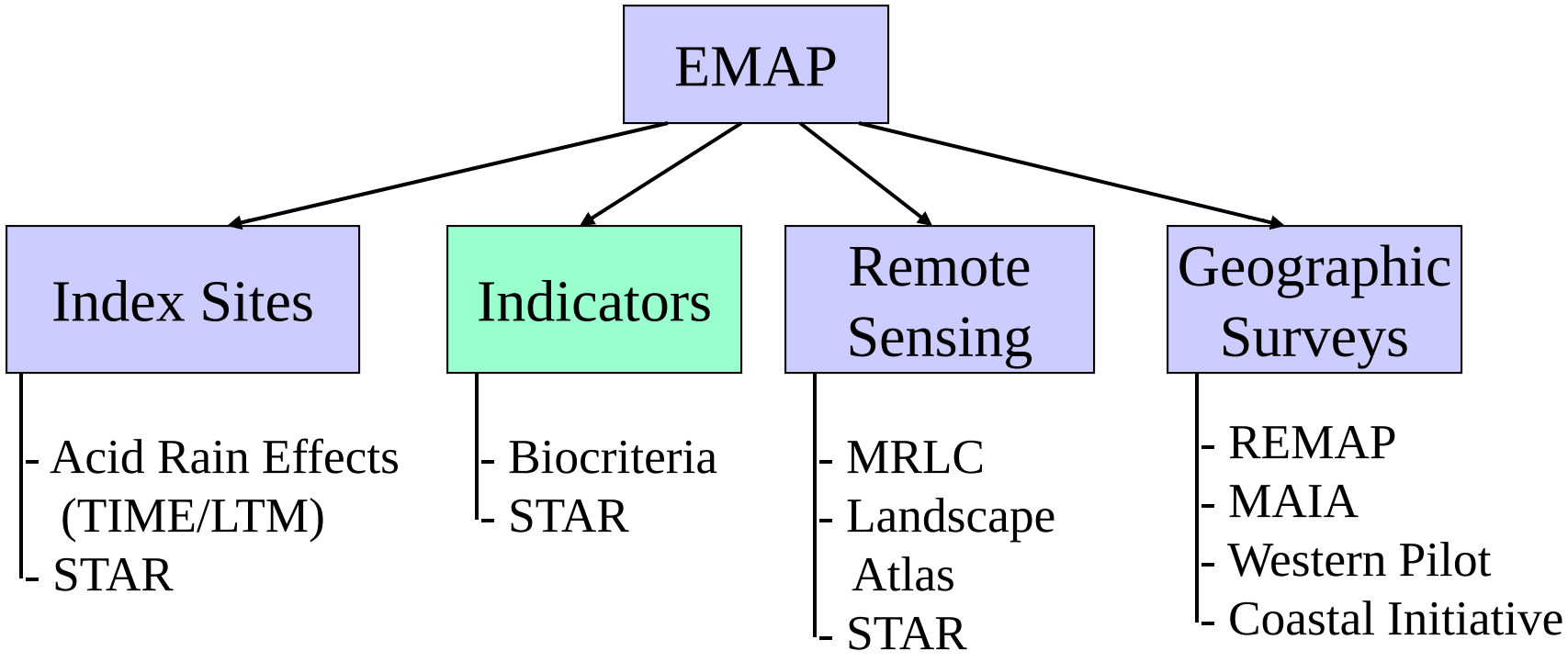
EMAP Research



EMAP Index Sites

- STAR
  - CISNet
  - EaGL Programs
- Reference sites
  - Biocriteria
    - R-EMAP
    - Western Pilot

EMAP Research

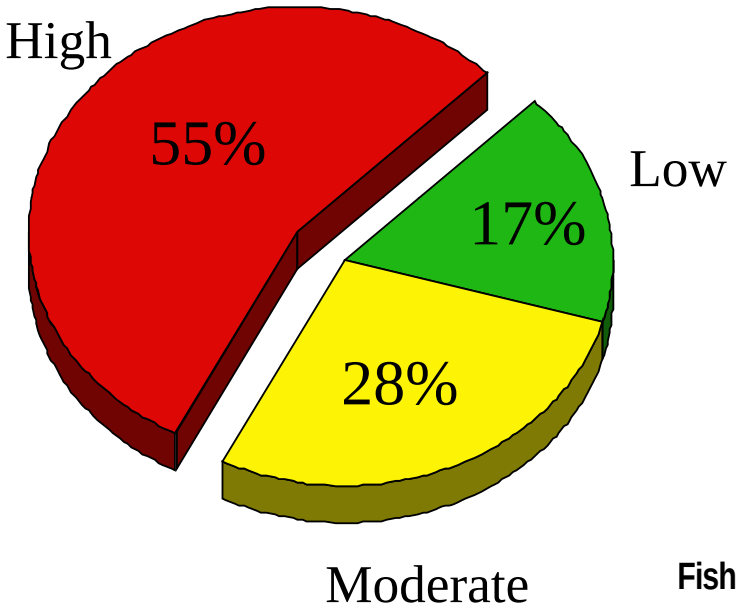


Indicator Research in EMAP

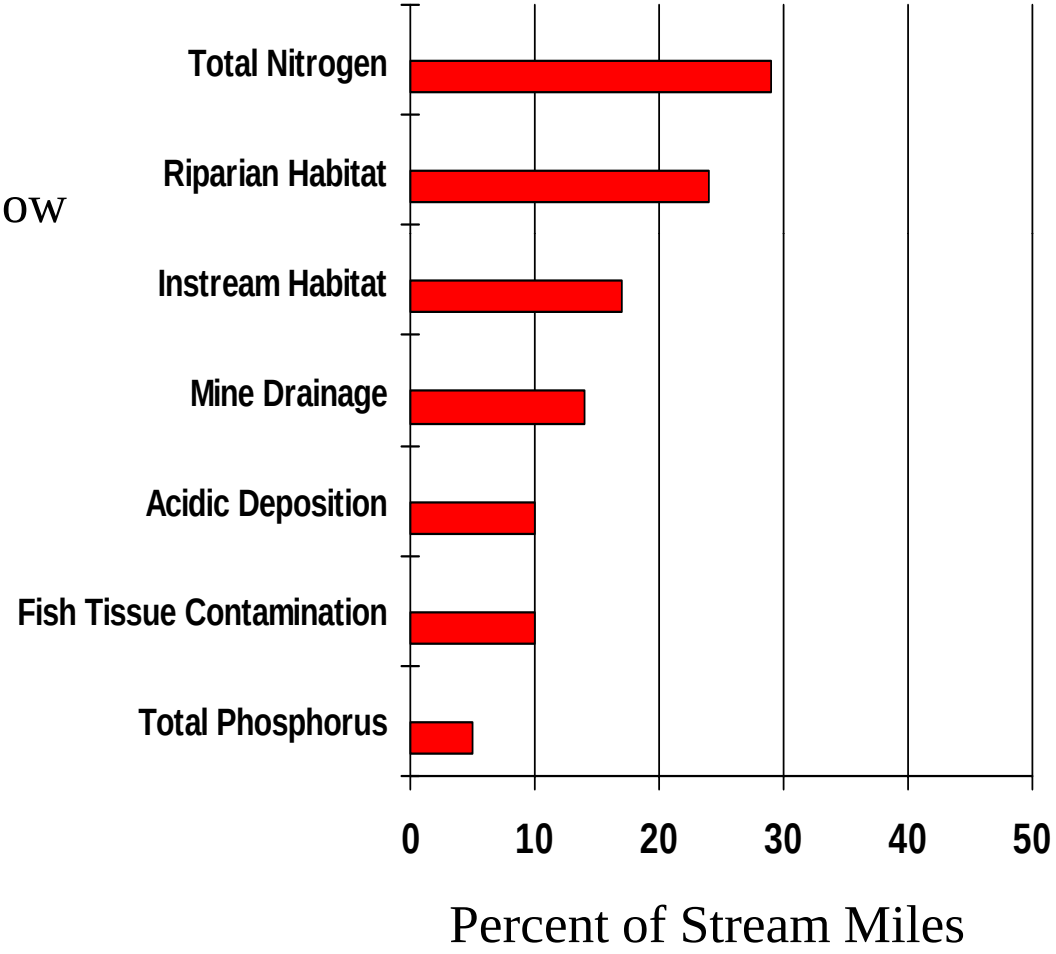
- Indicator Development - finding characteristics of the environment that can be measured and related to the biological condition of a resource
  - Streams, rivers, lakes, reservoirs, wetlands, estuaries, coral reefs
- Classification - meaningful groupings within resource types and/or ecosystem types to allow better statistical design and analysis
- Multi-Tier Monitoring Designs - scale defined statistical design that allows aggregation and interpretation of monitoring data

Stream Conditions in MAHA

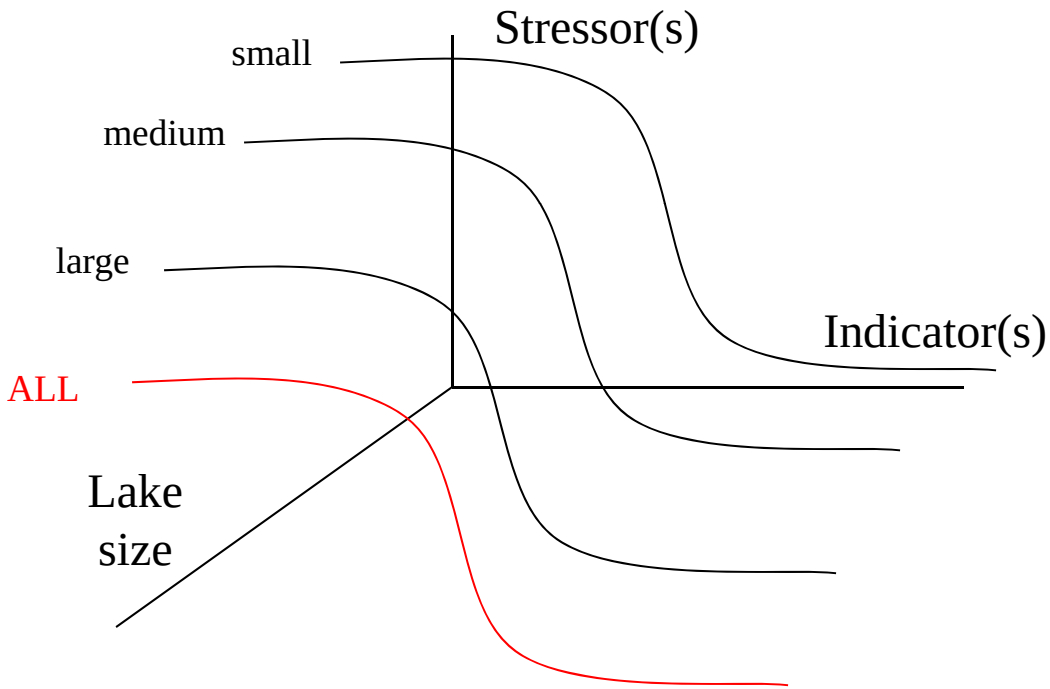
Watershed Disturbance



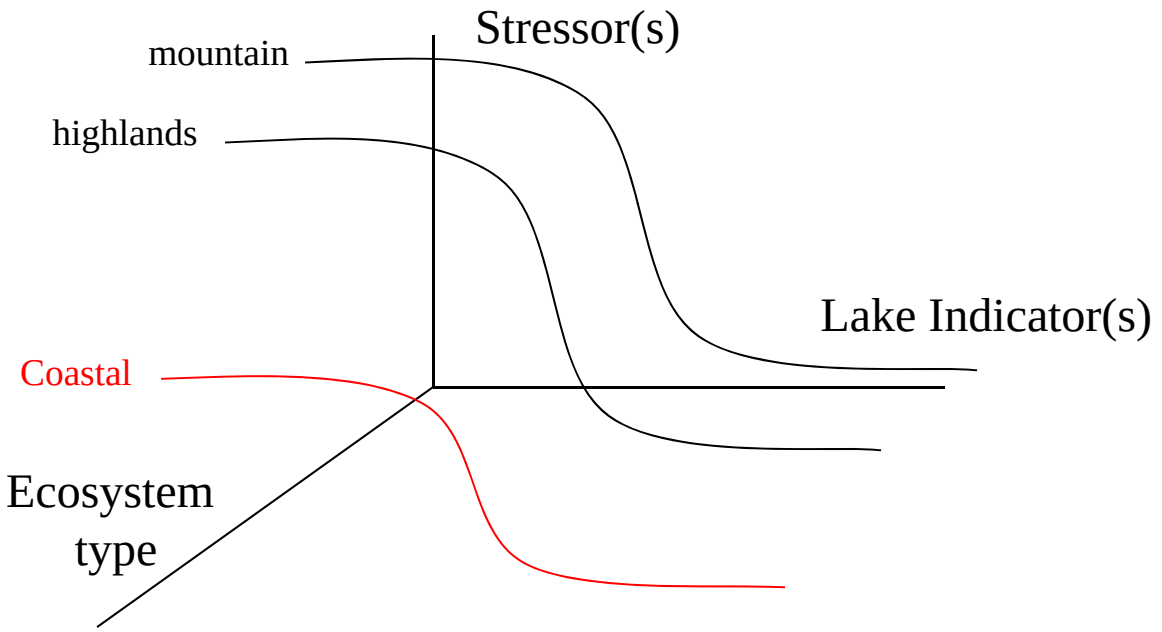
Ranking of Stressors



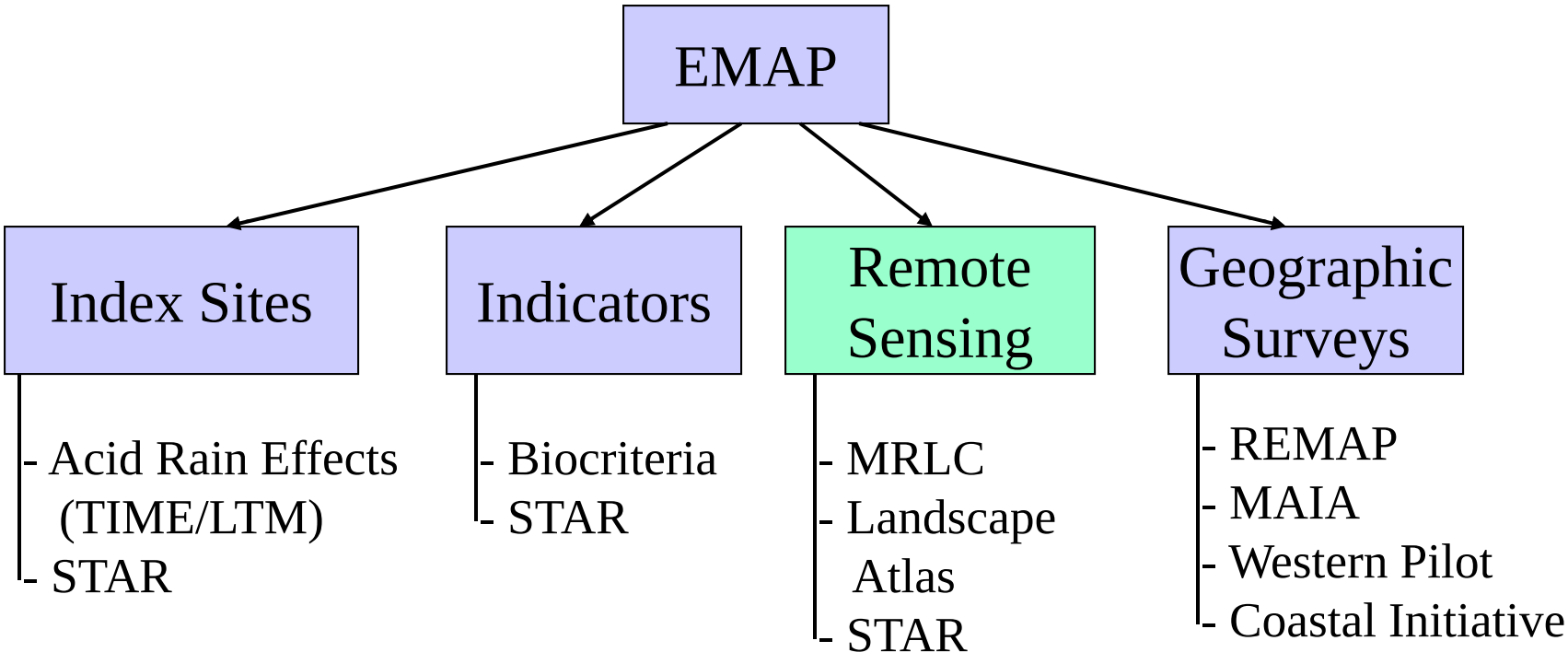
Resource Classification



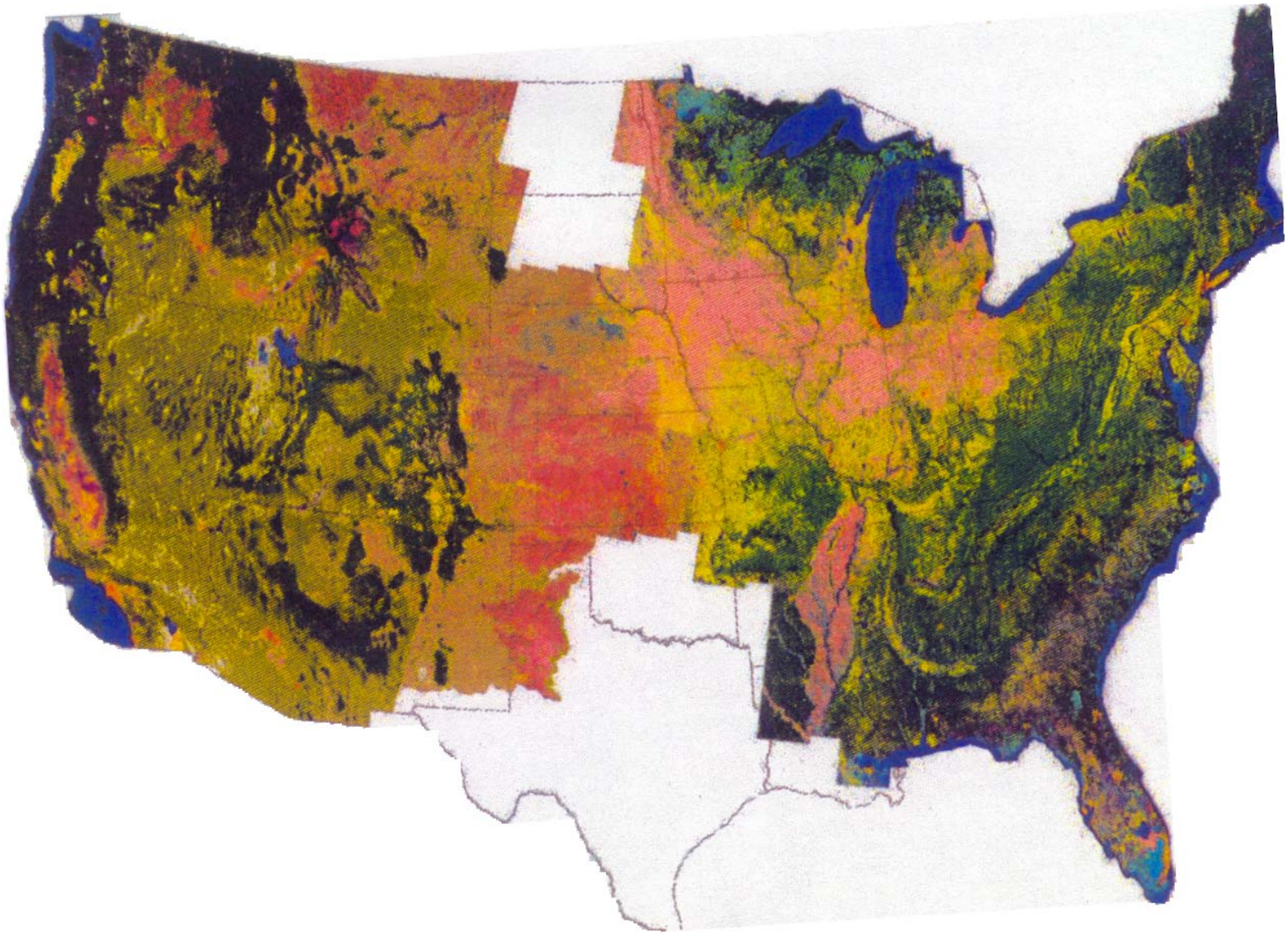
Ecosystem Classification



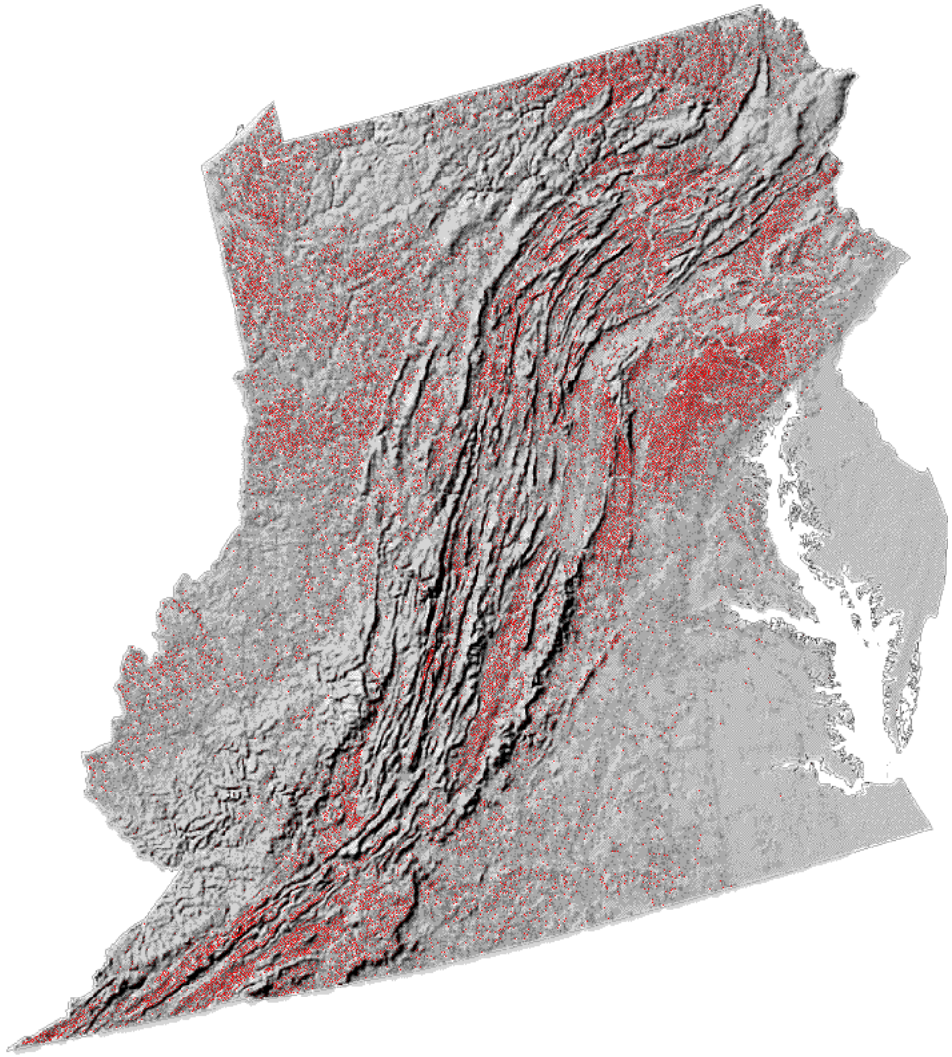
EMAP Research



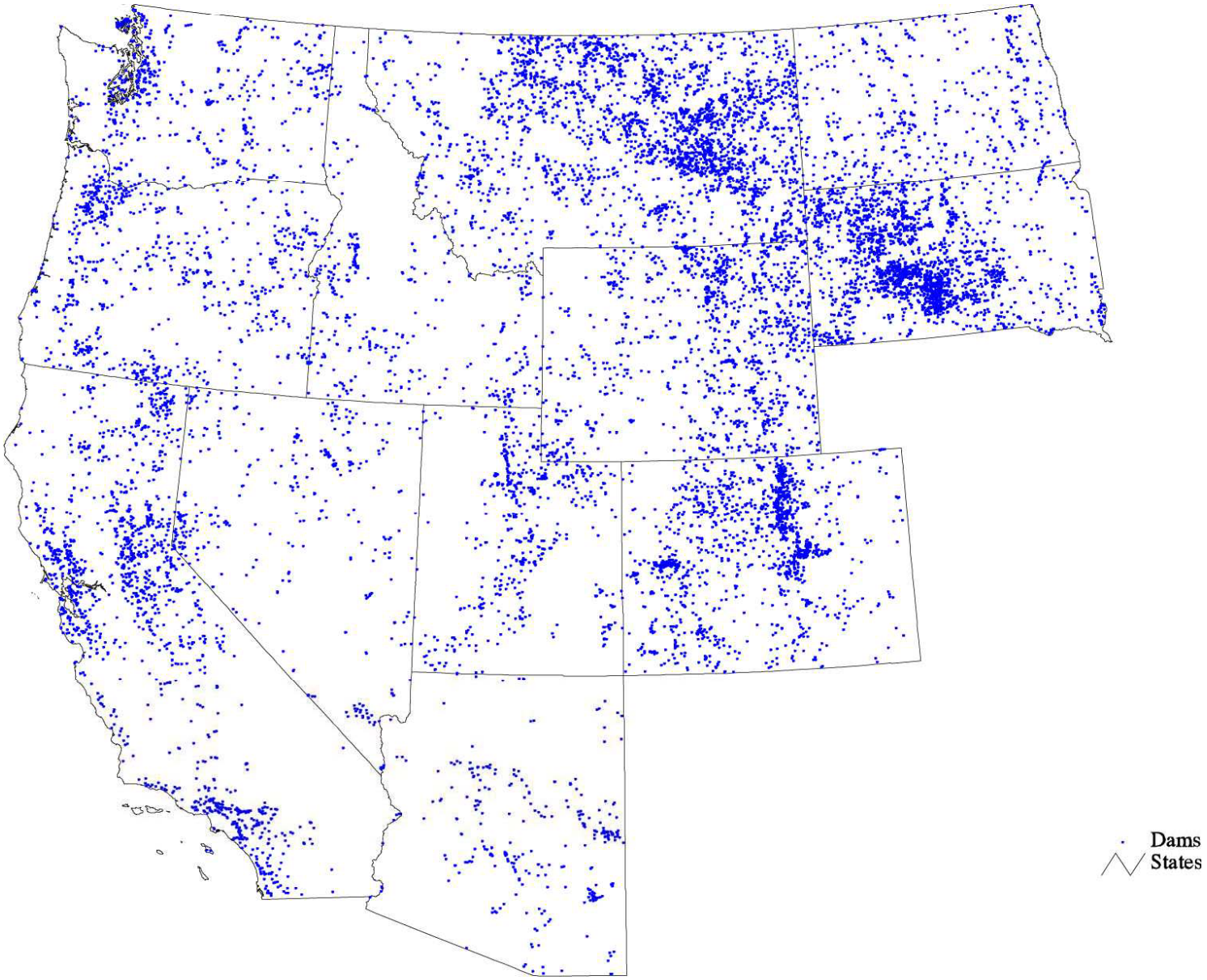
Multi-Resolution Land Characteristics



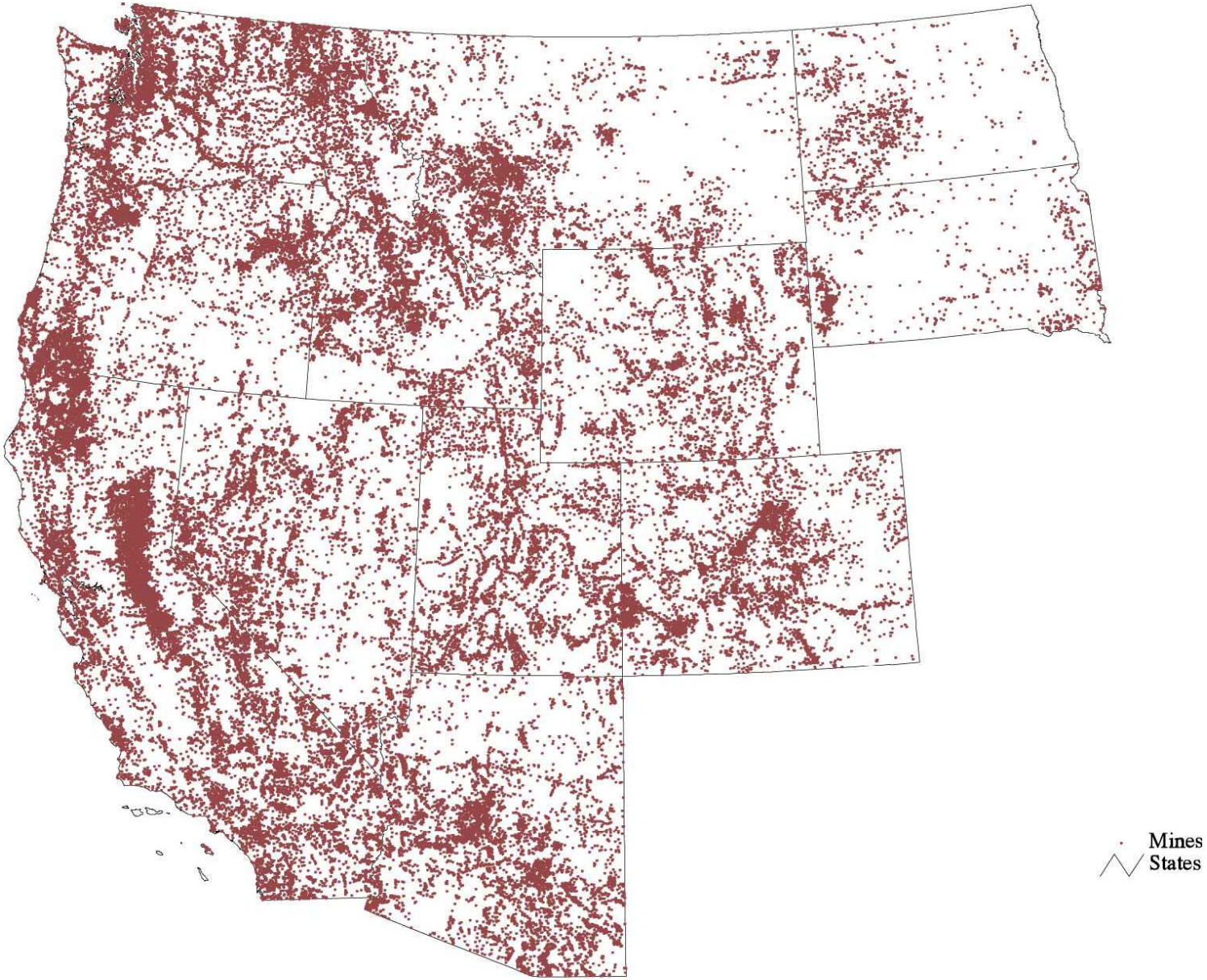
Agriculture on Slopes >3% in MAIA



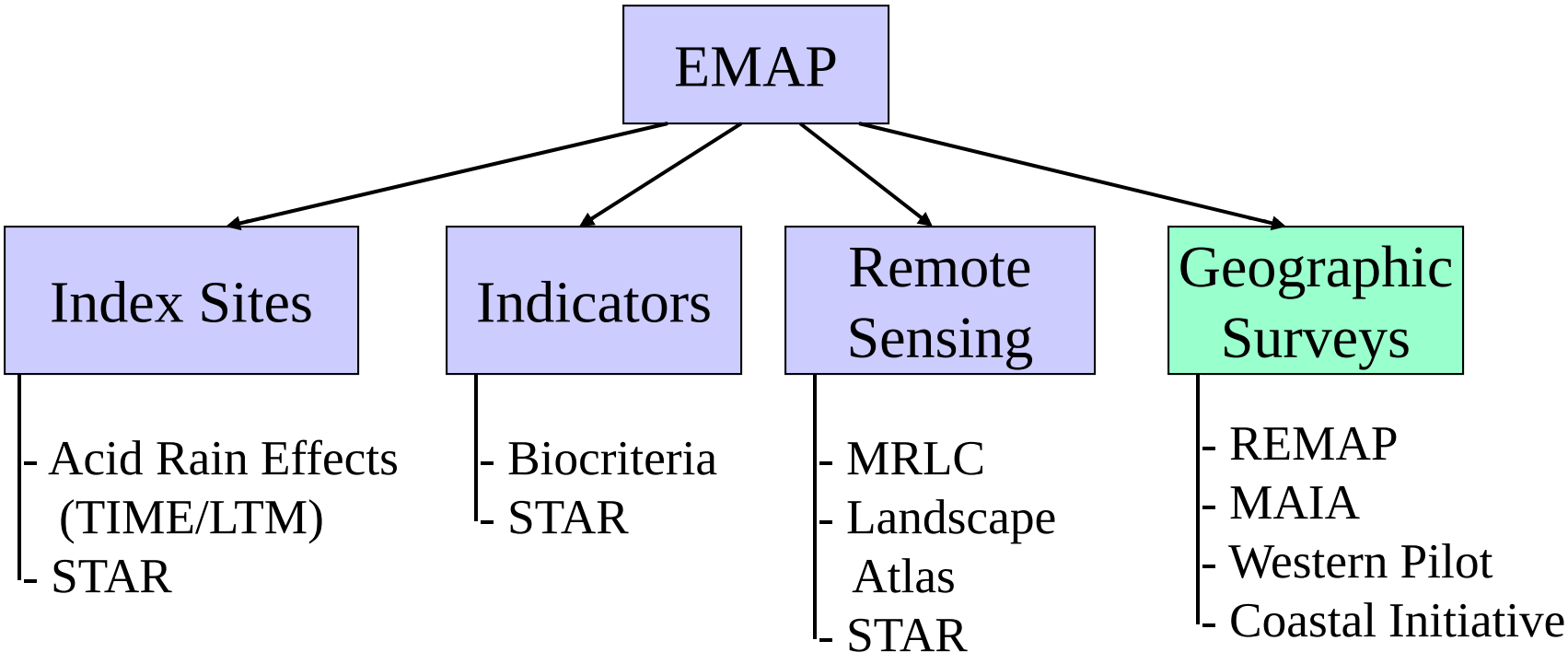
Dam Sites - Western Pilot

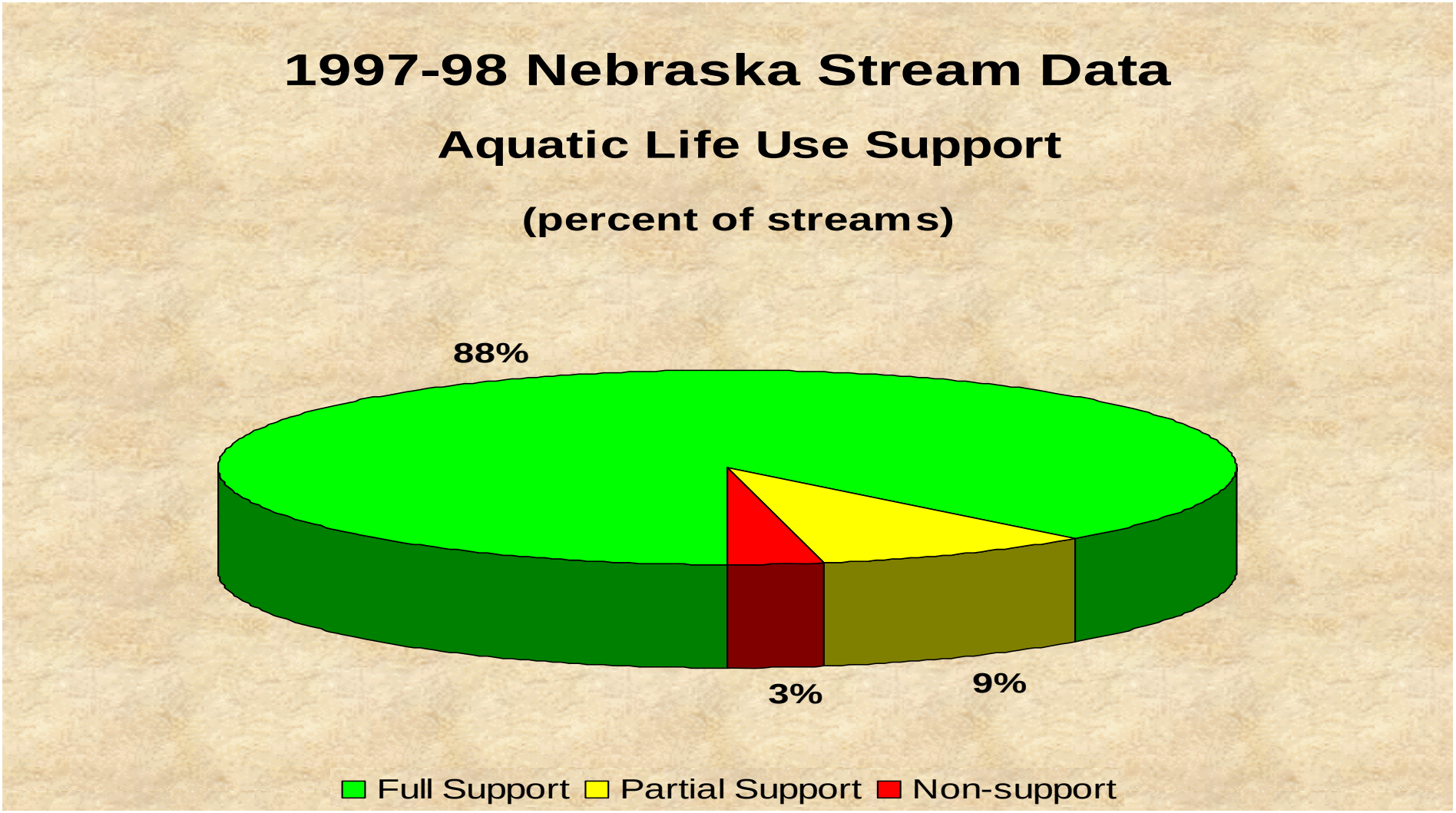


Mining Sites - Western Pilot

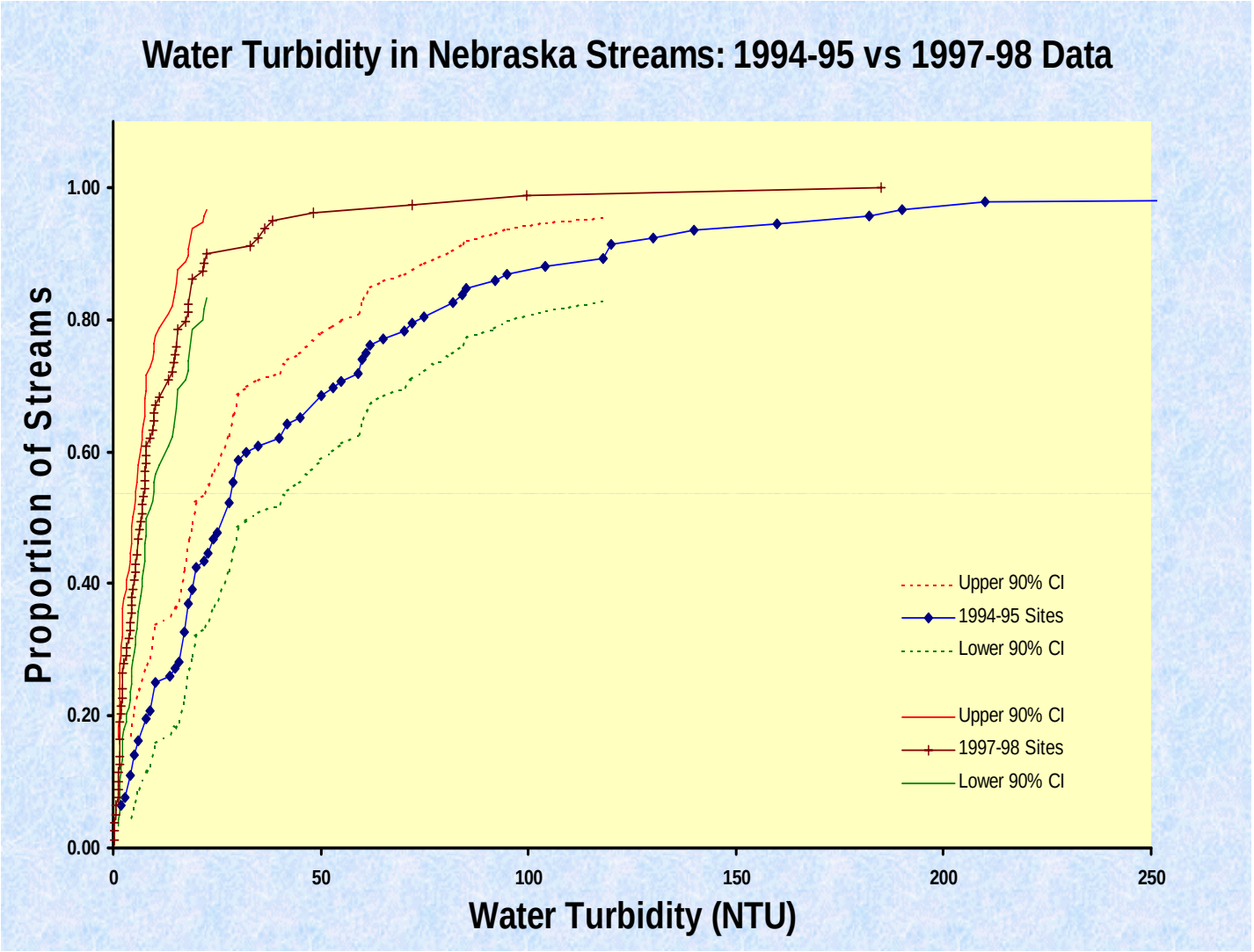


EMAP Research



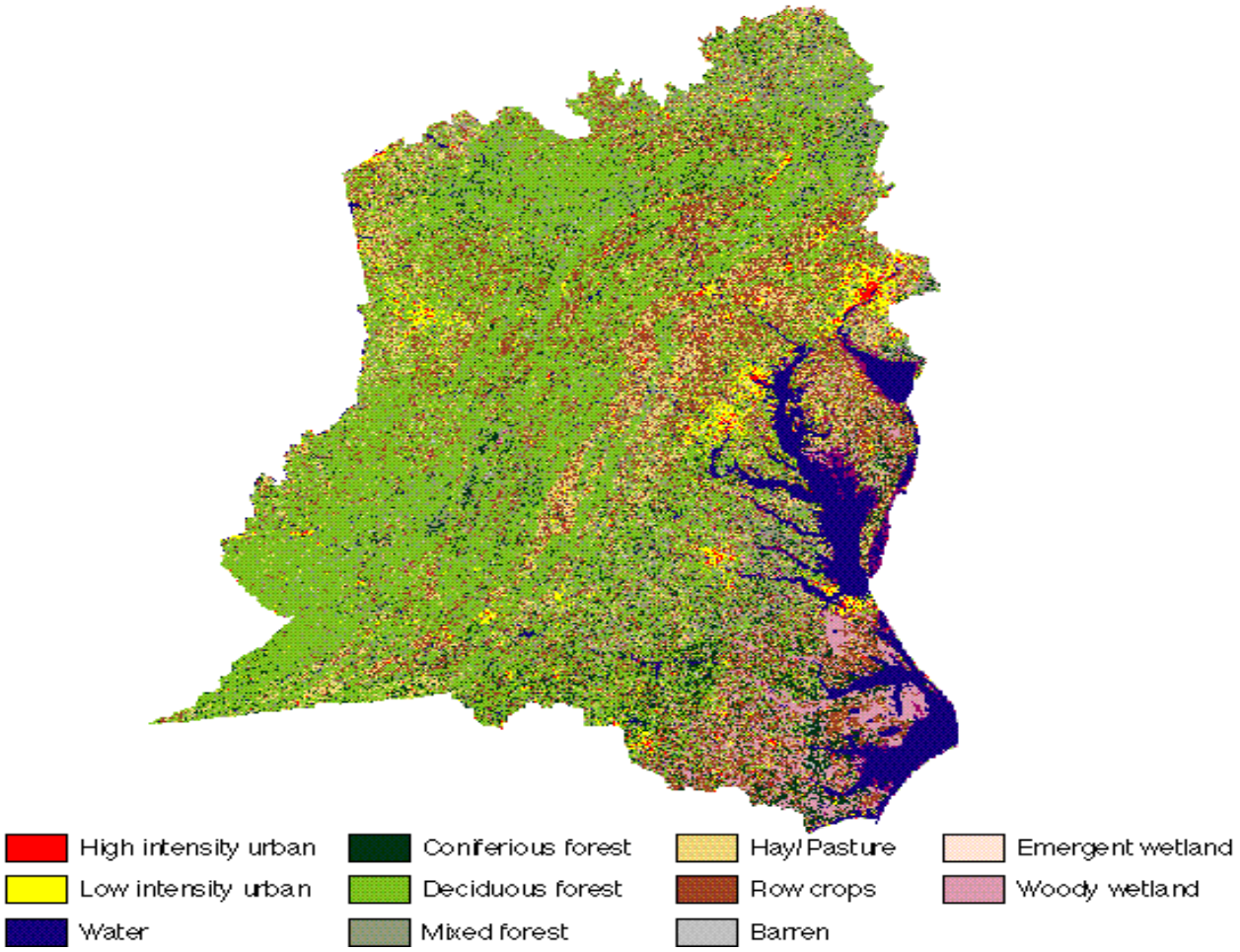


Aquatic Life Use Support percentages for Nebraska streams in the Big Blue, Loup, Niobrara, Republican and White river basins, based on Index of Biological Integrity (IBI). All estimates are at the 90% confidence level and are +/- 10%.



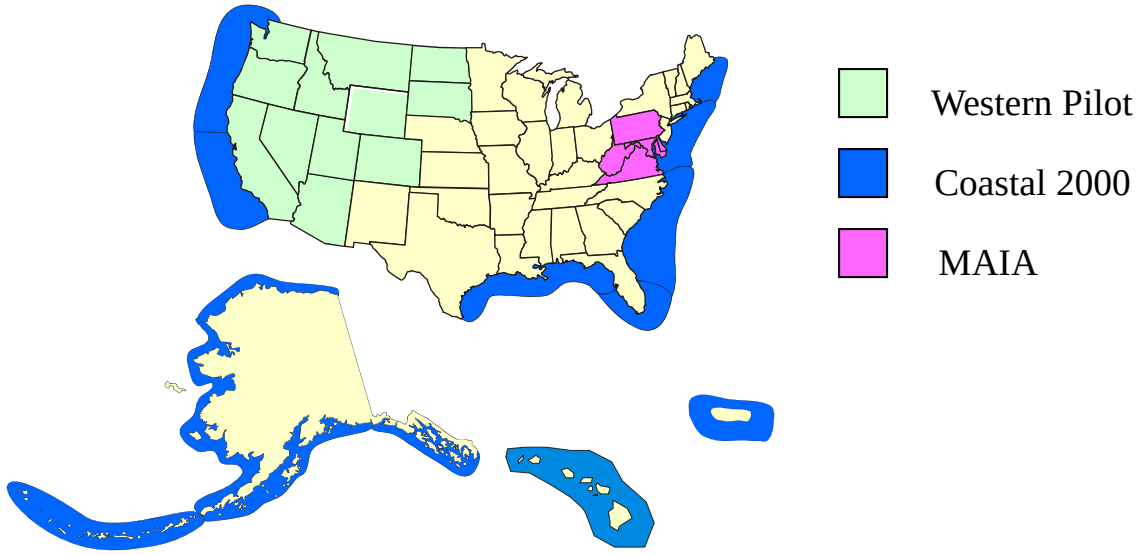
A statistically significant improvement in turbidity from the 1994-95 to 1997-98 sampling for the Big Blue, Republican, Loup, Niabrara and White river basins.

MAIA - Integrated Assessment



EMAP's New Geographic Research

- Western Pilot - ecosystems with greatest uncertainties
  - Develop baselines for environmental resources in western states (like MAIA)
  - Products: Landscape atlas, condition of western streams and estuaries, biological reference conditions (stream invertebrates, fishes, etc.)
- Coastal 2000 Initiative - national estuarine health
  - First attempt to assess health of a single aquatic resource nationwide
  - Demonstrate and transfer technology to improve states' coastal monitoring

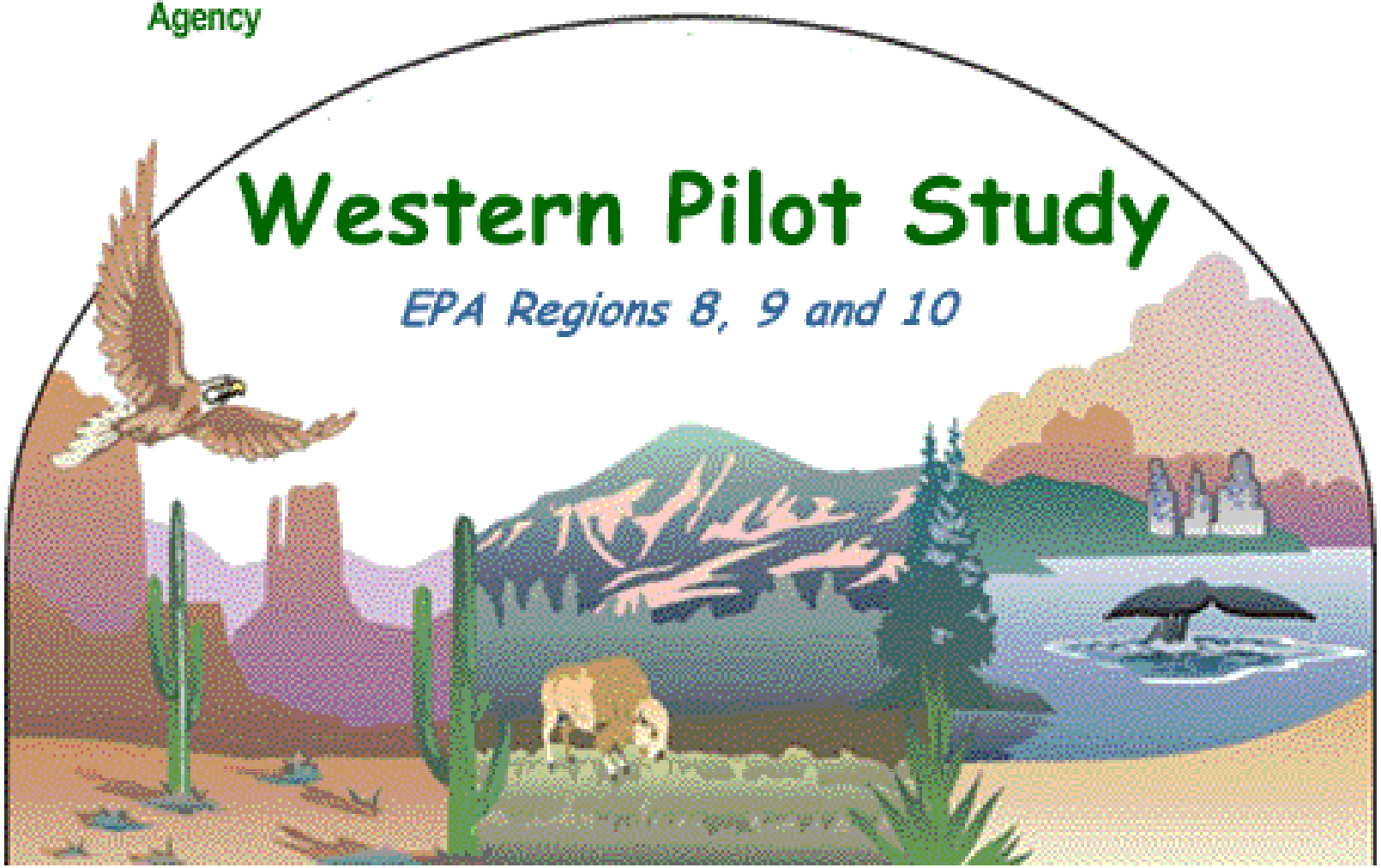


EPA
United States
Environmental Protection
Agency

EMAP

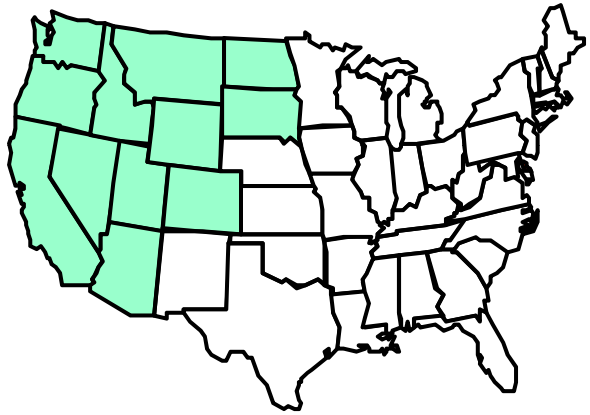
Western Pilot Study

EPA Regions 8, 9 and 10



Components for Western Pilot

- Core activities for the West
  - Information Management
  - Design/analysis
  - Landscape
- Major field components
  - Westwide streams study
  - Critical assessment areas in each Region
  - Western Estuaries

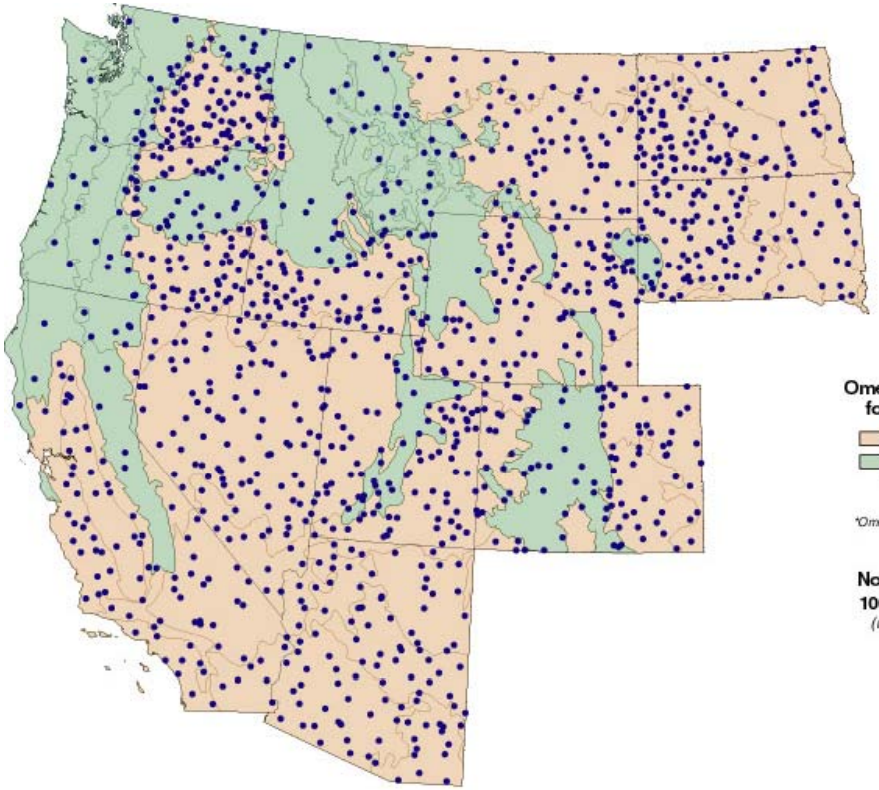


EMAP Information Management

- Support environmental assessments for Western Pilot and Coastal Initiative at the local, state, regional and national levels
- Establish long-term archival of EMAP data in STORET
- Make data publicly available and useable to others
- Help develop data systems that will be sustainable by groups in the region

EMAP Design - Western Pilot

- Sites selected for Western Pilot



EMAP West
Stream
and
River Survey
1999 - 2004

Omernik Level III Ecoregions* for Use in Survey Design

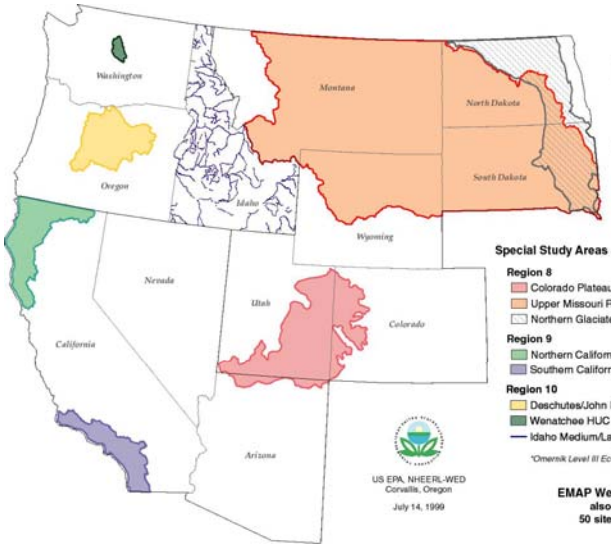
- Ecoregions Designated Arid
- Ecoregions Designated Humid or Mountainous

**Omernik Level III Ecoregions, January 1999*

Non-perennial Sample sites
100 sites selected per state
(not intended for field sampling)

US EPA, NHEERL-WED
Corvallis, Oregon

August 4, 1999



EMAP West
Stream
and
River Survey
1999 - 2004

Special Study Areas and Number of Field Sites

Region 8
- Colorado Plateaus Ecoregion* (60)
- Upper Missouri River Basin (160)
- Northern Glaciated Plains Ecoregion* (60)

Region 9
- Northern California Coastal Drainage (160)
- Southern California Coastal Drainage (160)

Region 10
- Deschutes/John Day River Basins (160)
- Wenatchee HUC (60)
- Idaho Medium/Large Rivers (60)

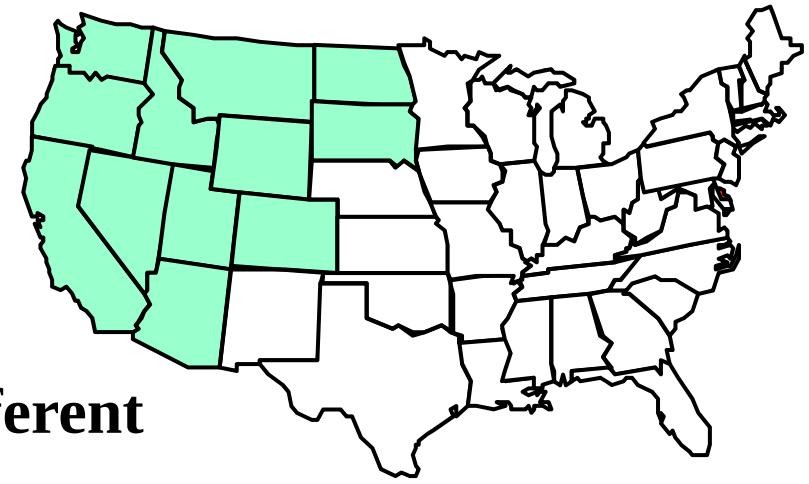
**Omernik Level III Ecoregions, January 1999*

US EPA, NHEERL-WED
Corvallis, Oregon
July 14, 1999

EMAP West Base Study also includes 50 sites per state.

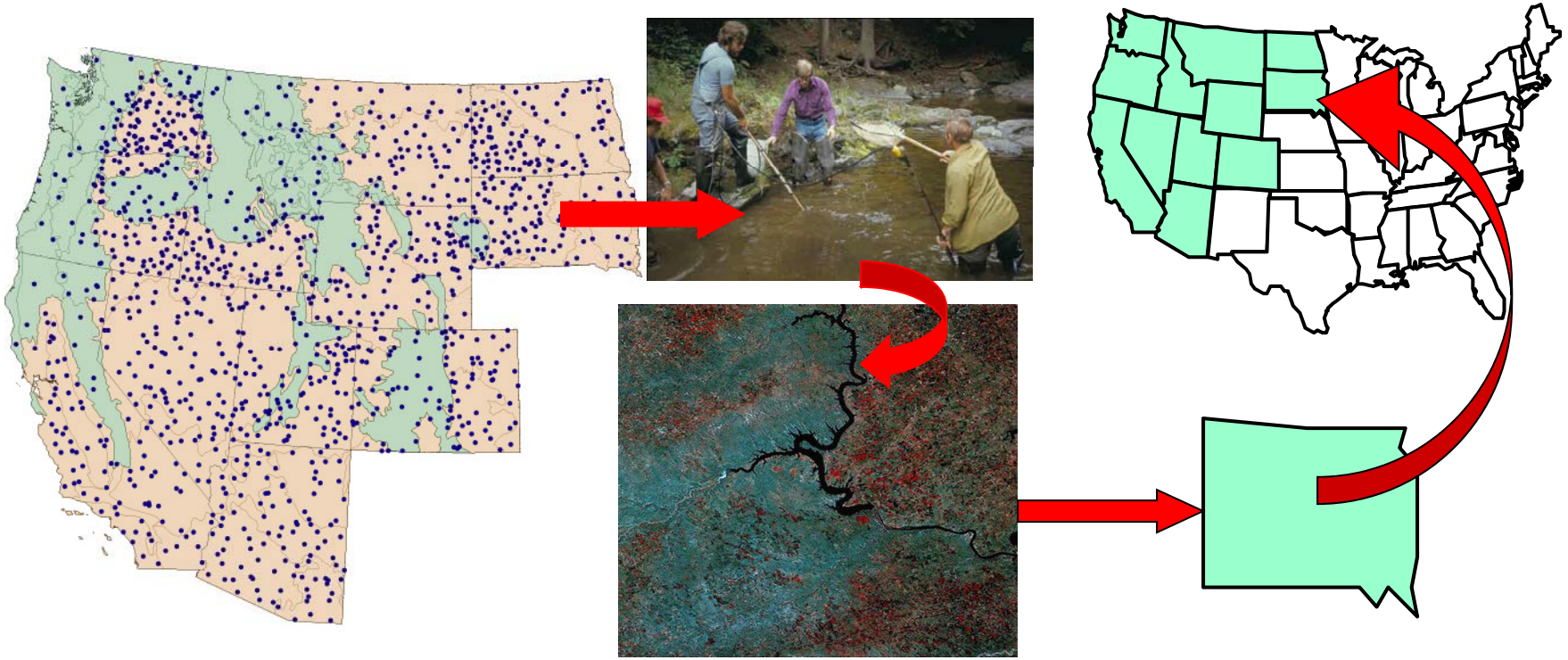
Western Pilot Landscape Indicators

- Watershed scale indicators
  - **Human use index (U)**
  - **Agriculture on steep slopes**
  - **Natural cover type index**
  - **Population density**
  - **Roads crossing streams**
- Riparian indicators
  - **% of stream miles w/ different types of land cover**
- Biophysical indicators
  - **Average slope of watershed**
  - **Palmer Drought Severity Index**



Western Pilot Streams

- Statistically-based sampling of Western streams and rivers
  - Unbiased and representative sampling
  - Uses aquatic biological systems as integrators of stresses
  - Data can be aggregated from local to state and national levels
  - Cost-effective and better information



Surface Water Indicators

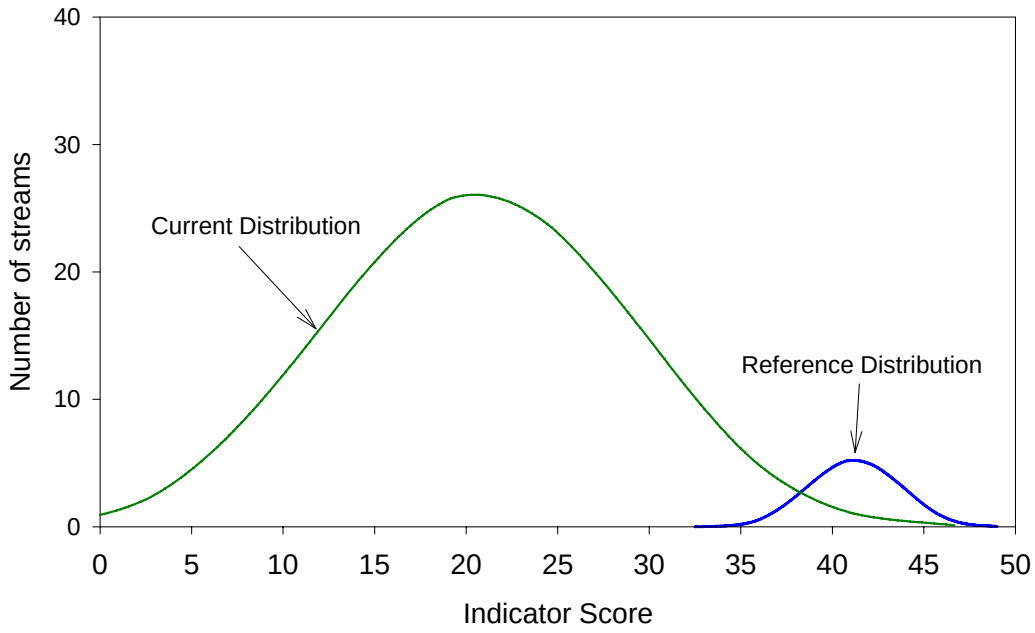
- Fish assemblage
- Fish tissue contamination
- Periphyton
- Macroinvertebrate assemblage
- Physical habitat (e.g. riparian characteristics, woody debris, canopy cover, gradient)
- Water physio-chemical (e.g. nutrients, temperature, alkalinity dissolved oxygen, heavy metals)

Westwide Stream Sampling

- Western states' stream samples
  - 900 total locations plus 15% revisits
    - 12 states
    - 18 ecologically-distinct western regions (ecoregions)
- Major western river systems
  - 150 locations plus 15% revisits
  - Integrated with USGS chemistry network
- Develop criteria for ecological reference sites to allow ecosystem health comparisons
  - 20 sites sampled per ecoregion
  - Improve Unified Watershed Assessments

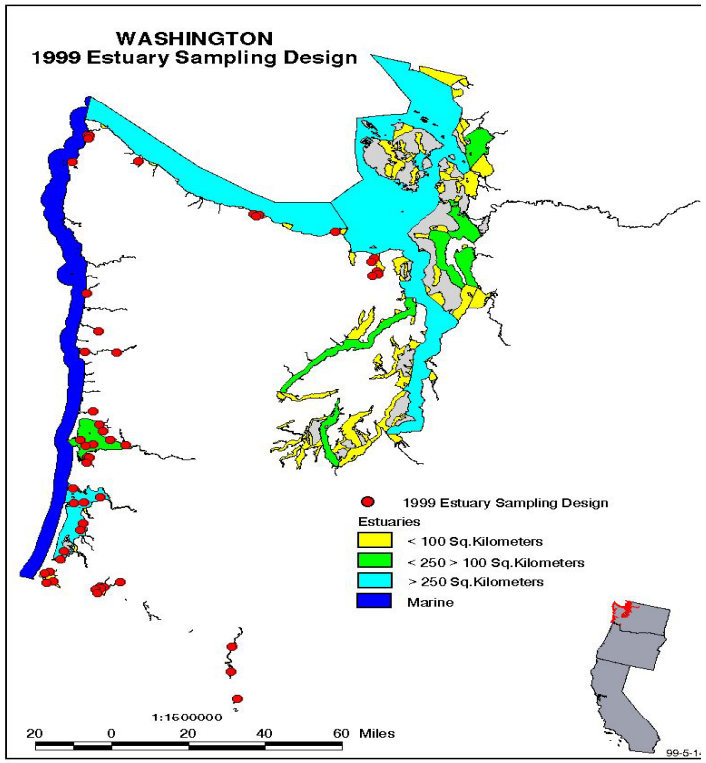
EMAP Biocriteria Goals

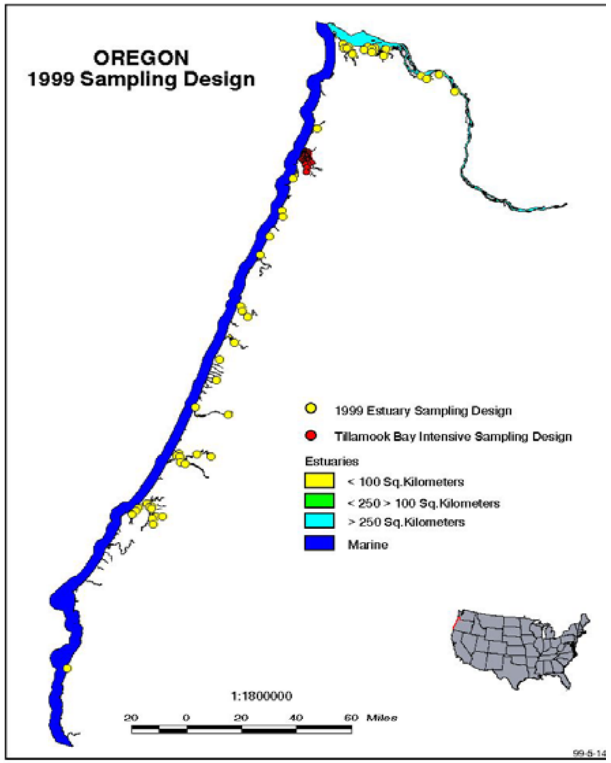
- Work with OW to standardize “process” for developing biological reference conditions
- Demonstrate “process” in the west

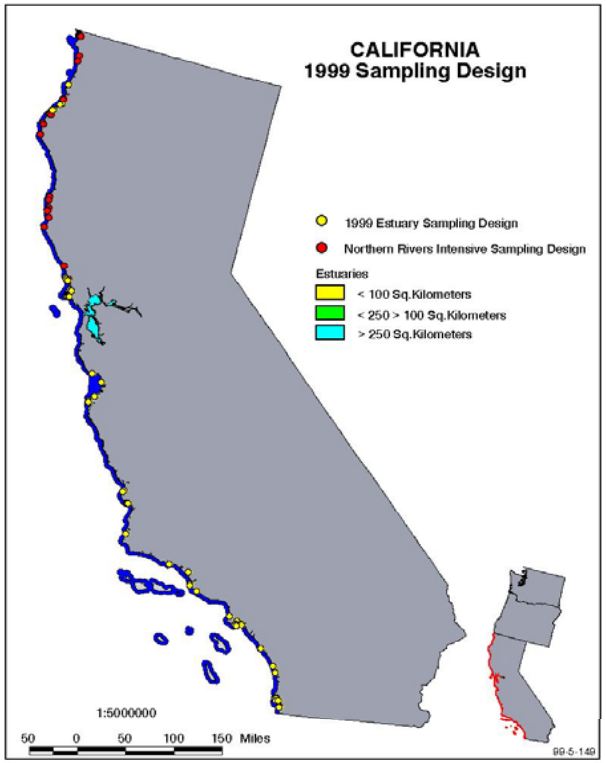


Western Pilot Estuaries

- Statistically-based sampling of Western Estuaries
  - Unbiased and representative sampling (>700 sites)

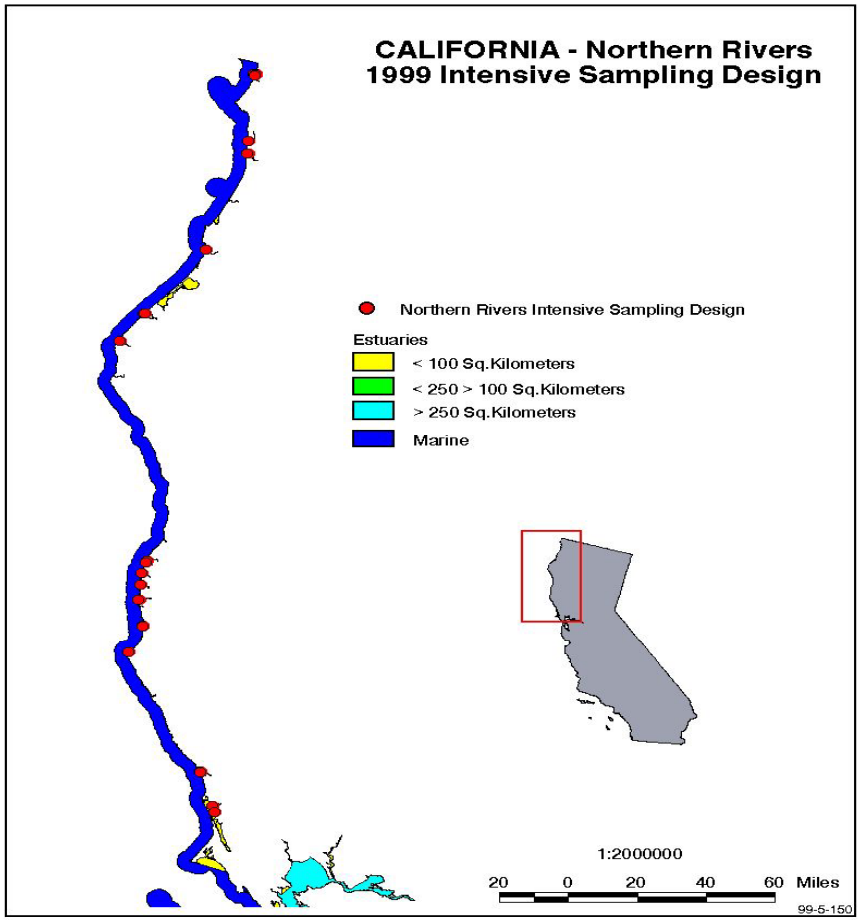


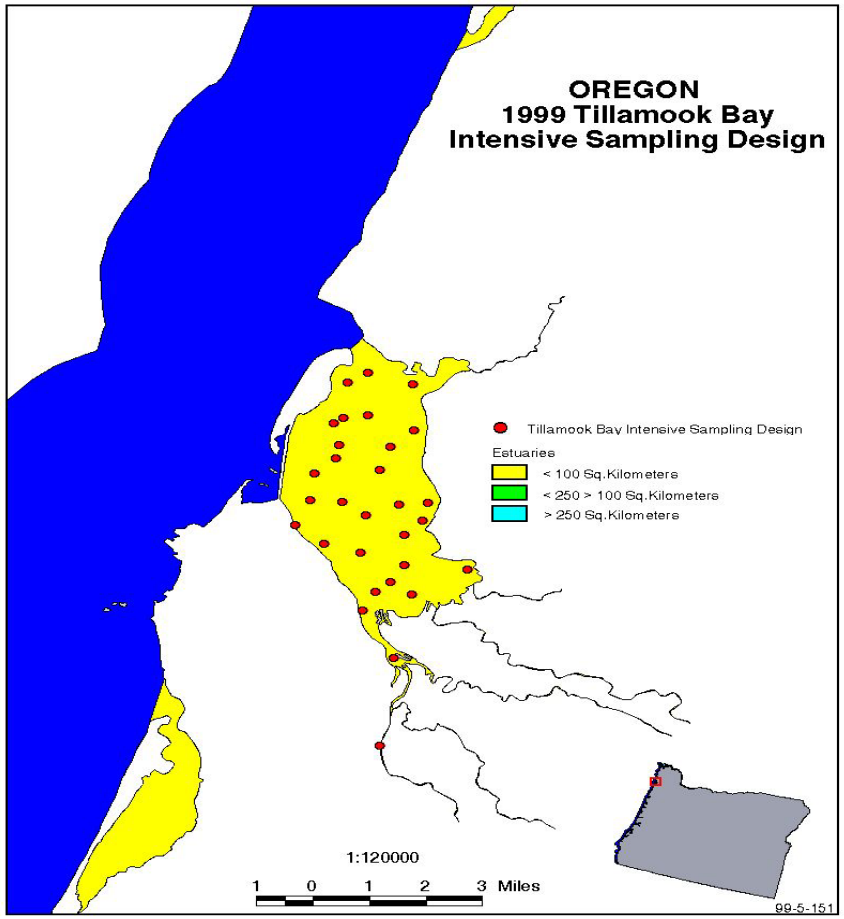




Western Estuaries

- Intensive sampling in focus areas





Estuarine Indicators

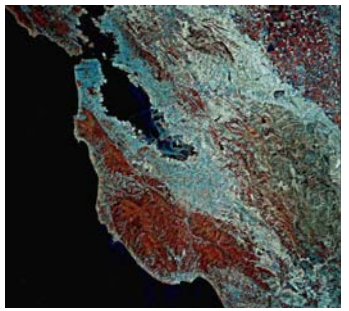
- Fish assemblage
- Fish pathologies
- Fish tissue contamination
- Submerged vegetation
- Benthic invertebrate assemblage
- Sediments (e.g. grain size, TOC, chemistry, toxicity)
- Water column (e.g. nutrients, temperature, salinity, depth, dissolved oxygen, pH, chlorophyll)

Western Estuaries

- Use aquatic biological systems as integrators of stresses
- Aggregate data from local to state and regional levels
- Cost-effective and better information

Products from Western Pilot

- Landscape Database for Western US
- Baseline Condition of Streams
  - 12 State Stream Reports
  - 3 EPA Regional State of Streams Reports
  - Western US State of Streams Report
- Baseline Condition of Estuaries
  - 3 State Estuaries Reports
  - 2 EPA Regional State of Estuaries Reports
  - State of Pacific Estuaries Report



EMAP Western Pilot Partnerships

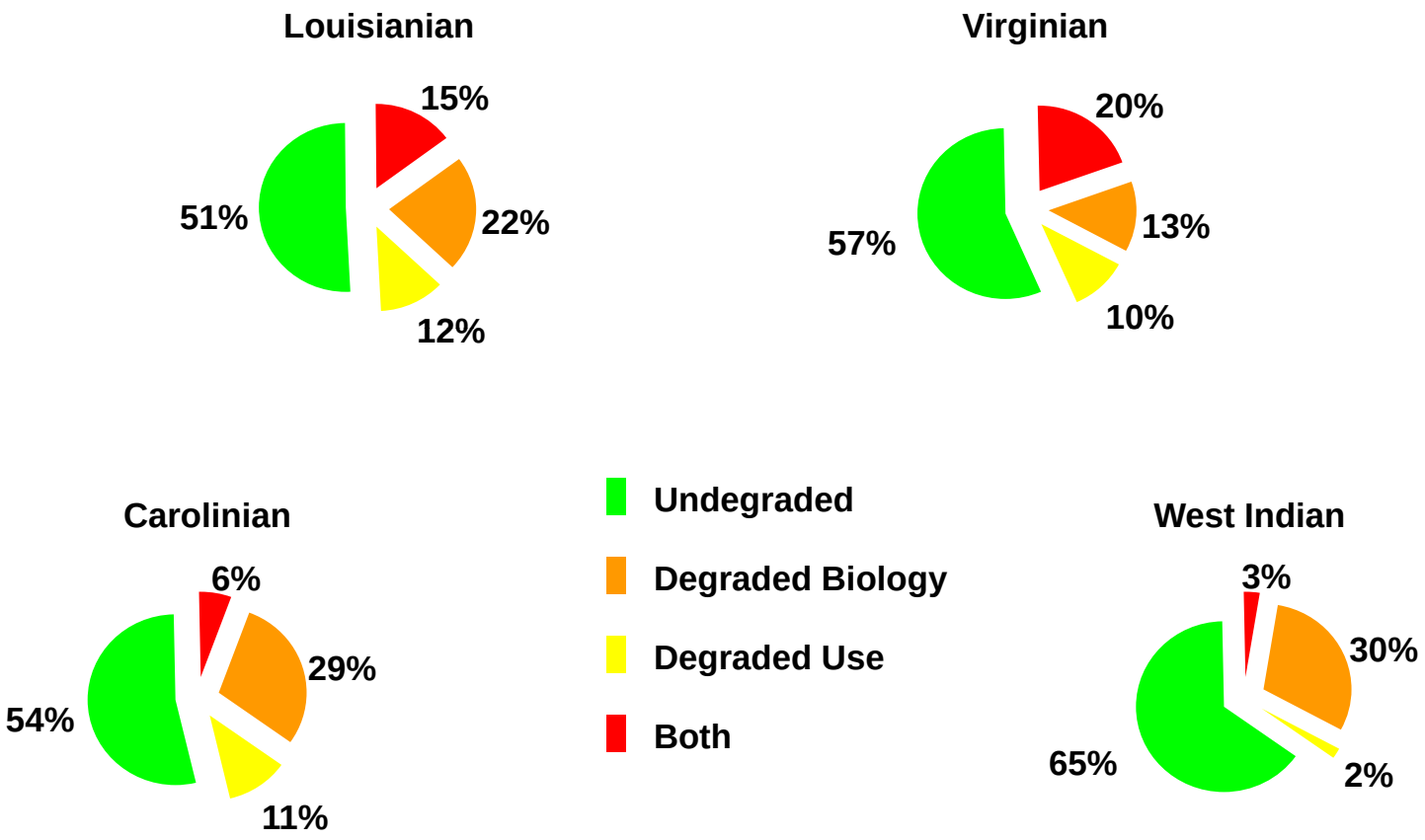
- Implemented through existing agencies and resource management groups
  - States: California, Oregon, Washington, Idaho, Nevada, Utah, Arizona, Montana, Wyoming, Colorado, North Dakota, South Dakota
  - Tribes: TBD
  - Federal Agencies: NOAA, USGS

Coastal Initiative

- National demonstration of a comprehensive, integrated estuarine monitoring program
- Approach similar to Western Pilot
  - Statistical sampling of coastal estuaries
  - Focus on biological indicators for baseline condition assessment
  - Data aggregated from local levels to state and national levels (>1750 samples across US)
    - 24 states and Puerto Rico
    - 13 ecological coastal provinces sampled

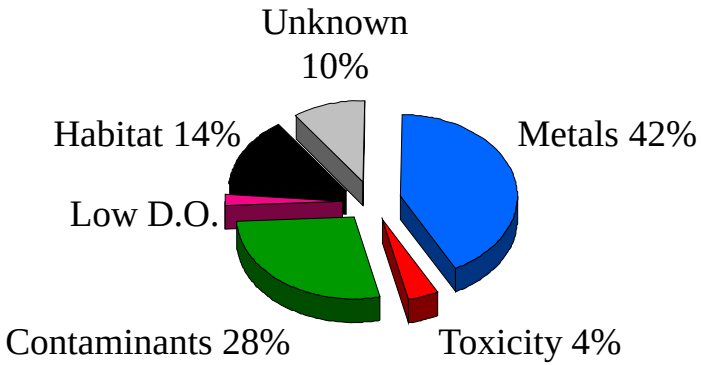
Coastal Provinces in Initiative

Condition of Estuarine Resources

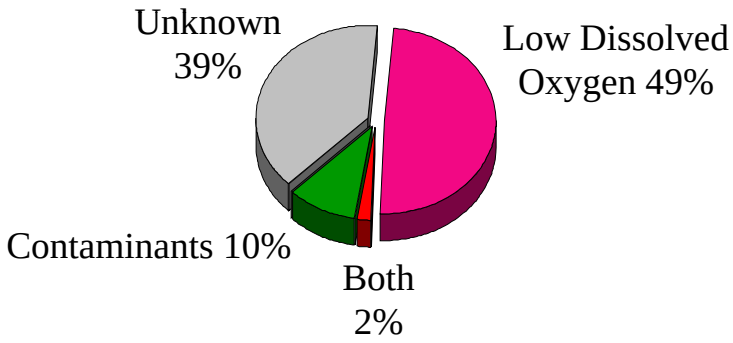


Stressors Associated with Degraded Biological Condition

Louisianian Province



Virginian Province

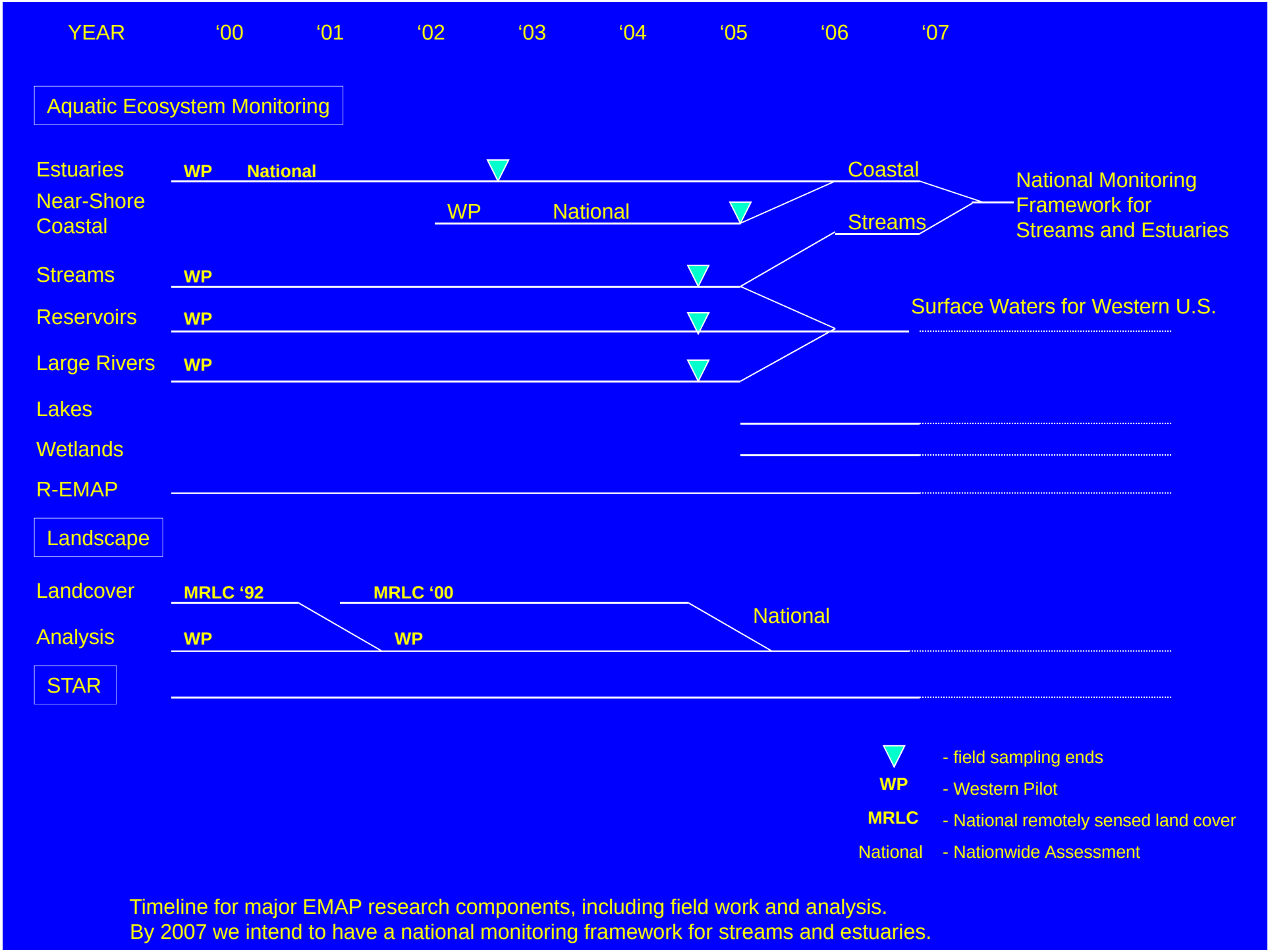


Products from Coastal Initiative

- Condition of Estuaries Reports for 24 states and Puerto Rico
- 7 EPA Regional State of Estuaries Reports
- Baseline Condition of all US Estuaries
- Change in Condition of Estuaries Report
  - Comparison of current data and historic EMAP estuarine data to demonstrate ability to detect subtle trends

EMAP Coastal 2000 Partnerships

- Implemented through existing monitoring programs of coastal agencies and resource management groups
  - States: California, Oregon, Washington, Maine, New Hampshire, Massachusetts, Rhode Island,Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Alaska, Hawaii, and Puerto Rico
  - Tribes: Seminole, Miccosukee, others
  - Federal Agencies: NOAA, USGS



Timeline for major EMAP research components, including field work and analysis.
By 2007 we intend to have a national monitoring framework for streams and estuaries.

EMAP Contribution

- Developing scientific basis and infrastructure for states and tribes to monitor the condition of their aquatic ecosystems
  - Cost effective monitoring designs for states, that can be summed nationally
  - Scientifically-defensible and representative
  - Trends in ecosystem condition quantified
  - Supports GPRA performance-based management
  - Basis for better public decisions at all levels

Next Steps

- Complete Western Pilot and Coastal Initiative in partnership with States and Regions
- Develop statistical monitoring designs for Great Lakes and Great Rivers
- Move design to watershed framework
- Improve designs and analyses (STAR)
- Develop new and better indicators (STAR)
  - productivity
  - wetlands
  - coral reefs