Integrating Probabilistic and Fixed-Site Monitoring for Robust Stream Water-Quality Assessments

Keith Robinson, US Geological Survey
and
Hal Walker, US Environmental Protection Agency

USGS science for a changing world

EPA United States Environmental Protection Agency

The Need for River Monitoring is as Great as Ever….

-Water- quality assessment reports (305b)

- TMDLs

-Nonpoint source controls

-Downstream impacts

-Efficient and effective management programs

But competition for resources devoted to monitoring continues to increase….

At the same time there are inconsistent approaches and techniques for river monitoring:

- biological vs chemical
- rotational vs continuous
- probabilistic vs targeted

Collectively, these inconsistencies inhibit water-quality assessments in larger river basins, across jurisdictional boundaries, and providing data needed for multiple water-quality management programs.

Objective of Today's Talk

Conceptualize how two different techniques of river water-quality monitoring can be integrated for improved assessments of conditions and pollution sources

Focus on:

- Probabilistic and fixed-site routine monitoring approaches
- Nutrients (nitrogen and phosphorus)
- New England region

Probabilistic Monitoring in New England

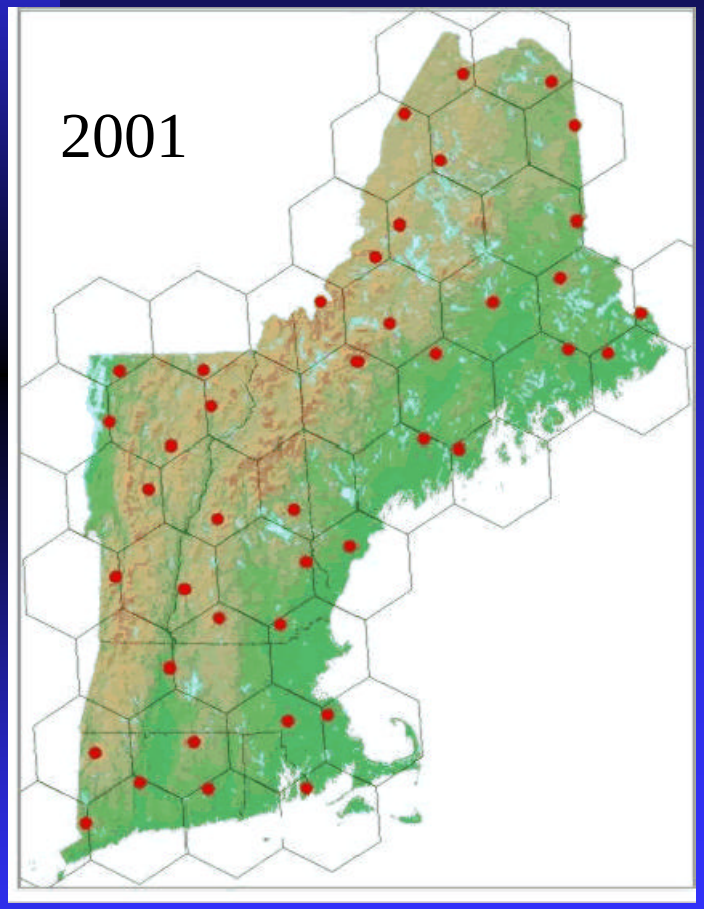
The New England Wadeable Streams (NEWS) Study – USEPA and States

Goal: Help states and region conduct comprehensive assessment of stream quality for 305(b) reporting.

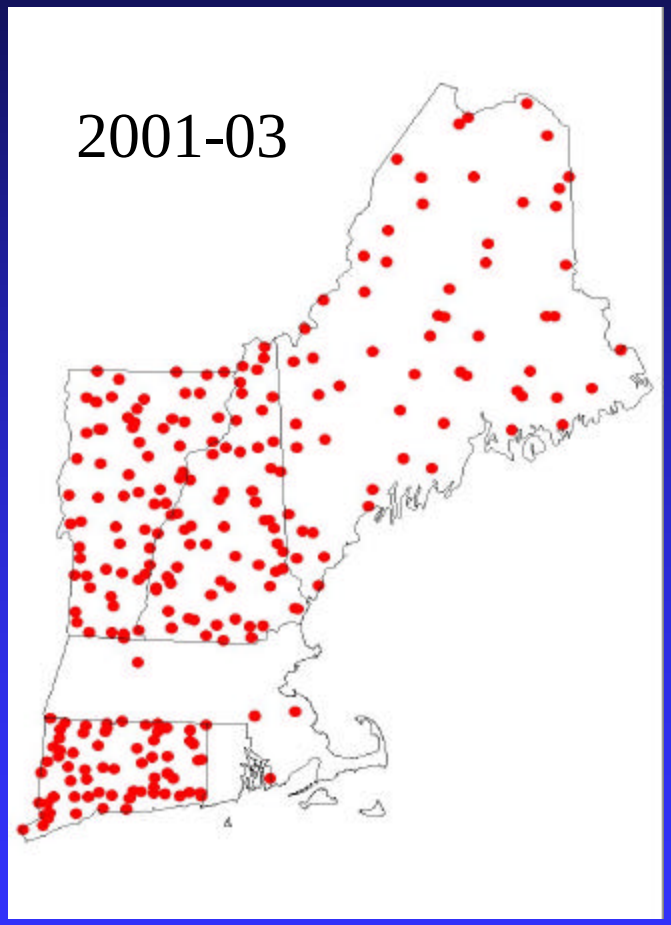
General Design:

- multi-year approach – region-wide to individual states
- random site selection based on EMAP/REMAP protocols
- smaller rivers that were wadeable
- comprehensive data collection (chemistry, flow, fish, invertebrates, fish community, habitat)
- Snap-shot of low flow conditions

Location of NEWS monitoring sites

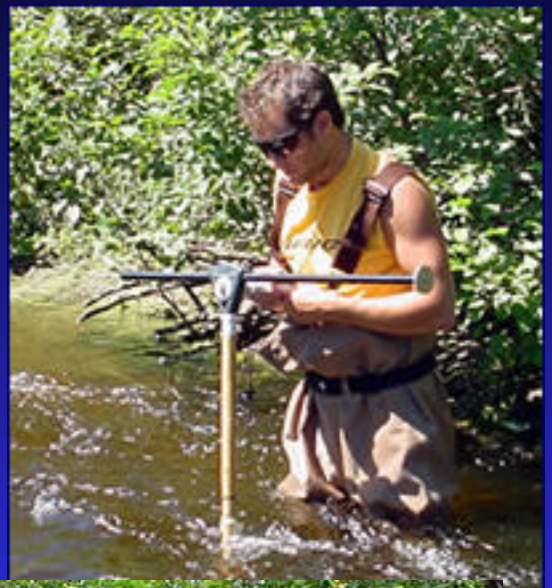


41 sites



260 sites

NEWS Monitoring



Costs:

- Range $<1,500-15,000 per site

- $300,000 (+ significant incidental costs) for all 260 sites from 2001-03

Data analysis
now underway

Photos from USEPA

Pros and Cons of NEWS Probabilistic Monitoring

Pros:

- Consistent methodologies over spatially diverse areas, multiple states /hydrologic units
- Statistically-valid assessments of water quality conditions in unmonitored water bodies
- Input for 305(b) reporting requirements
  - -conditions over a wide area
  - -where criteria is being exceeded
- Significant EPA support

Pros and Cons of NEWS Probabilistic Monitoring

Cons:

- Data represent a snap-shot in time that may or may not reflect what is frequently occurring or actual critical conditions – limited temporal analysis
- May be difficult to identify causes of water-quality degradation
- Load assessments are of limited utility (especially in New England where extreme fluctuations occur)
- Determining downstream effects may not be possible

Fixed-Site Routine Monitoring in New England

Multiple Agencies and Institutions

Goals: Variable, can include:

- general water-quality assessments/305(b) reporting
  (States of CT and RI, USGS-NAWQA)
- effect of pollutant source management/permits
  (State of CT and RI, Lake Champlain)
- long-term trends in concentrations
  (State of CT and RI, Lake Champlain, USGS-NAWQA, Hubbard Brook, Sleepers Watershed)
- scientific investigations
  (USGS-NAWQA, Hubbard Brook, Sleepers Watershed)

Fixed-Site Routine Monitoring in New England

General Design (variable by program):

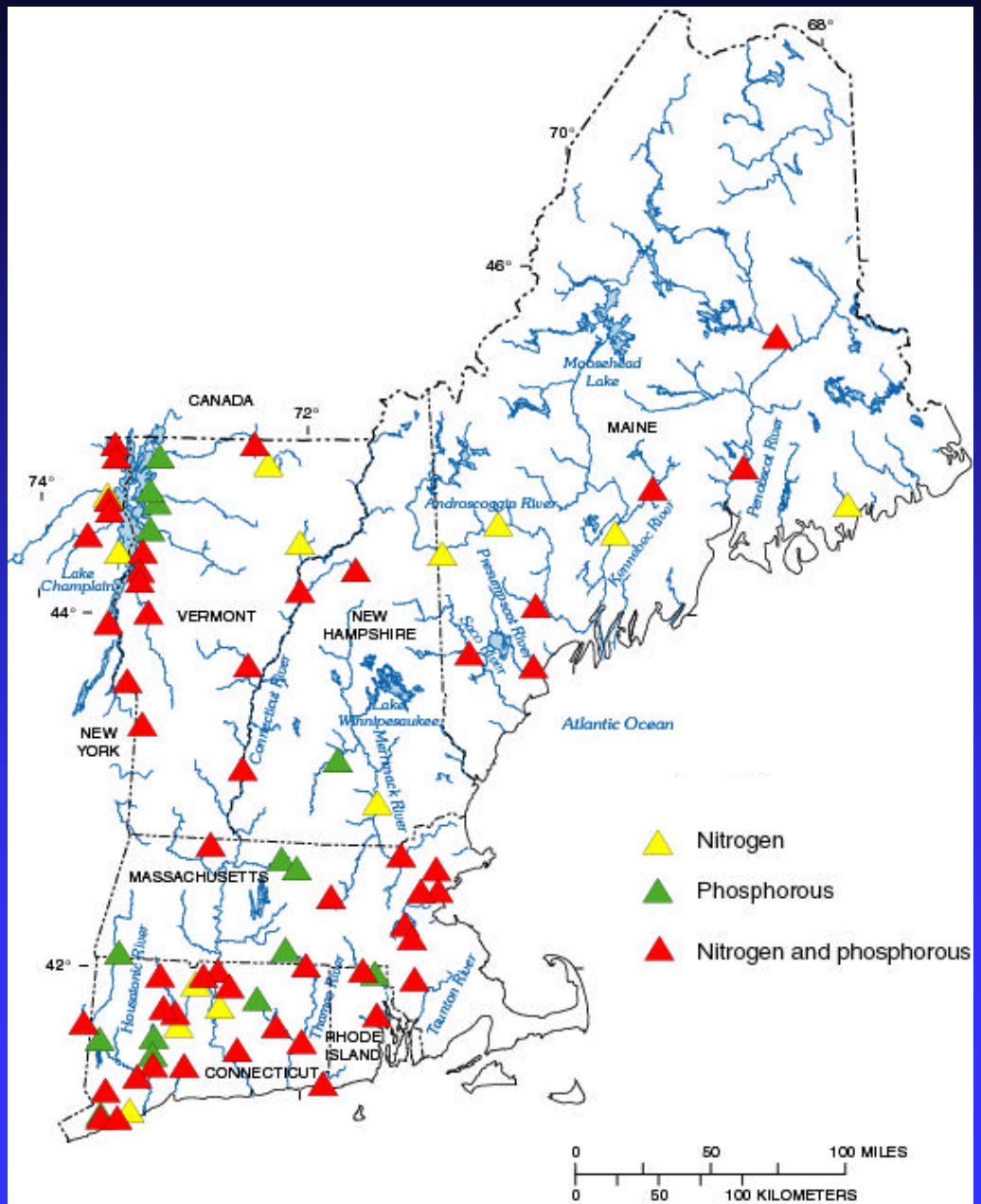
- Consistent temporal sampling (4-30+ times per year)
- Field parameters, nutrients, sediment, bacteria
- Small – large rivers
- Typically at or near streamflow gages
- Funding variable and often uncertain

Fixed-Site Routine Monitoring in New England

Routine fixed-sites in New England, 1985-2000

80-100 sites with decreasing numbers

Primarily:
- -State of CT
- -Lake Champlain
- -USGS NASQAN
- -USGS NAWQA



Fixed-Site Routine Monitoring in New England

Costs:

- $5000 – 20,000 per site
- ~$1 million spent yearly (plus incidentals and streamflow gaging)

Pros and Cons of Fixed-Site Monitoring

Pros:

- Track water-quality trends and relate to changes upstream
- Determine frequency of criteria exceedence
- Determine how water-quality varies by seasons/flow
- Identify loads
- Can define stream processes
- Assist in determining if regulatory actions are effective
- Consistent methodology at many sites

Pros and Cons of Fixed-Site Monitoring

Cons:

- Transferability of data to unmonitored rivers limited without new data assessments
- Difficult to maintain consistency/funding over time
- Aggregating data from multiple networks may not be possible
- Monitoring may not be able to provide sufficient information for intended purposes
- Limited suite of analysis/ no biological monitoring

Integrating Probabilistic and Fixed-Site Monitoring

Goal:

Utilize strengths of each design to enhance our understanding of stream water quality, factors influencing conditions, important processes, and changes. Enhance ability to provide regionally consistent reporting under Clean Water Act

General Design:

Create consistent New England-wide fixed site monitoring network from existing fixed-site networks and continue probabilistic monitoring to better define critical conditions and or specific issues/concerns

Integrating Probabilistic and Fixed-Site Monitoring Can be Successful

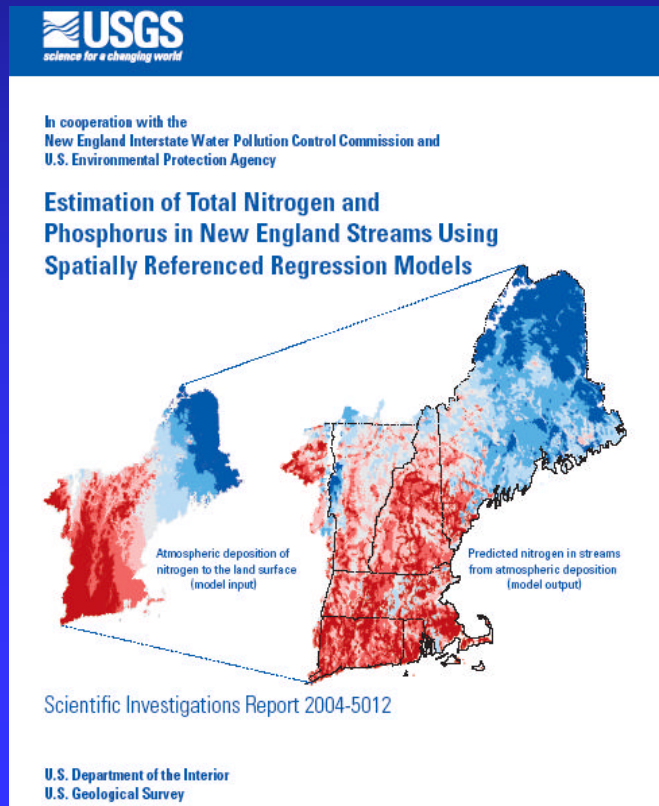
Why the Optimism?

New England SPARROW model results

Using fixed site data and available watershed data:

- -able to explain
  - 95% of variation in nitrogen loads,
  - 94% of phosphorus loads
- - significant predictors of nutrient loads

Establishes framework for regional water-quality analysis



Integrating Probabilistic and Fixed-Site Monitoring

Specifics on Probabilistic Monitoring in an Integrated Network

- Define short-term conditions or new water-quality concerns
  - -specific flow conditions
  - -emerging contaminants
- Enhanced spatial detail not provided by fixed sites
- Performed as needed
- Maintain consistency in field and analytical techniques

Integrating Probabilistic and Fixed-Site Monitoring

Specifics on Fixed-Site Monitoring in an Integrated Network

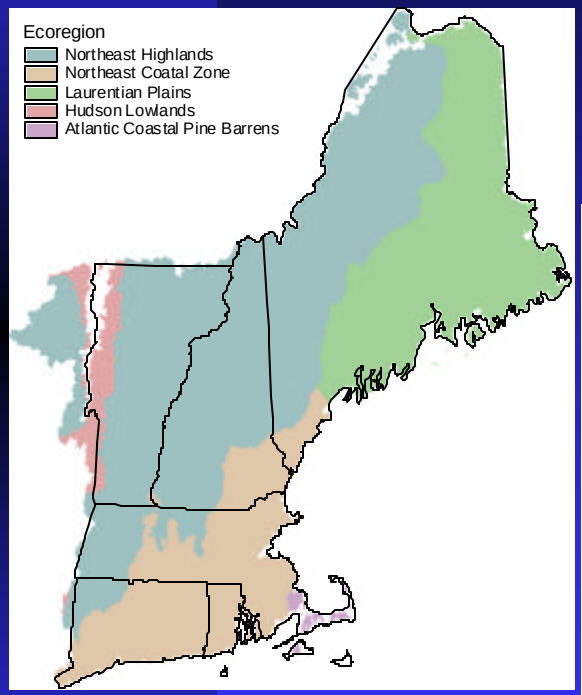
- Define variations in loads and concentrations throughout seasons/hydrologic characteristics
  - fixed sample collection frequency
  - co-locate at or near streamflow gages

- Stratified design
  select sites to represent specific environmental strata

- Maintain consistency in field and analytical techniques to extent possible

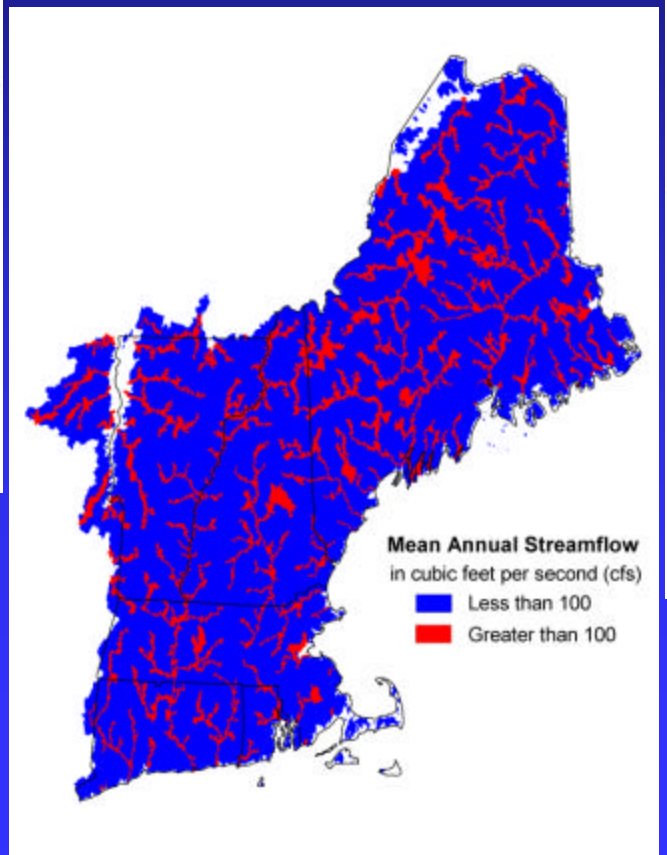
Integrating Probabilistic and Fixed-Site Monitoring

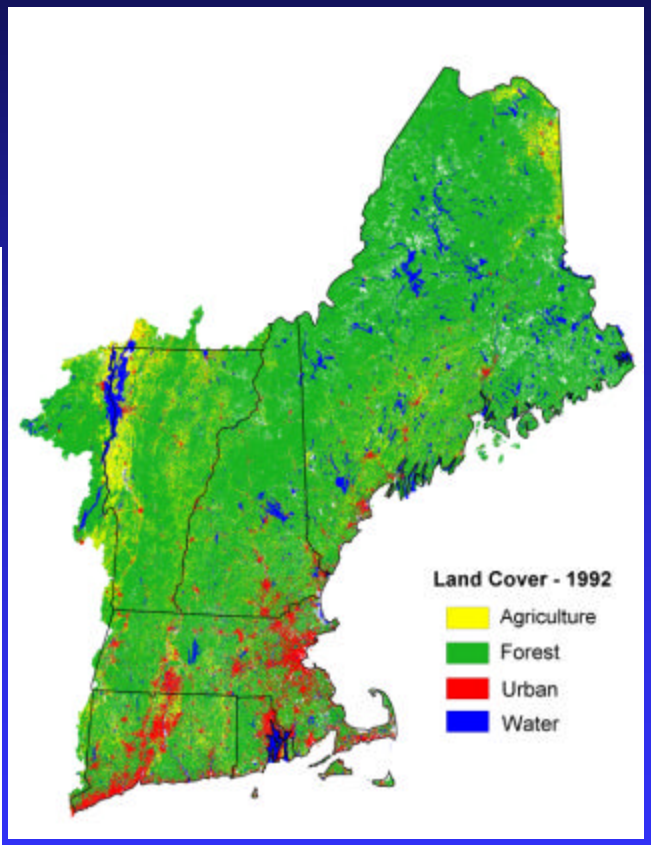
Potential stratifying variables



Ecoregions

Stream size



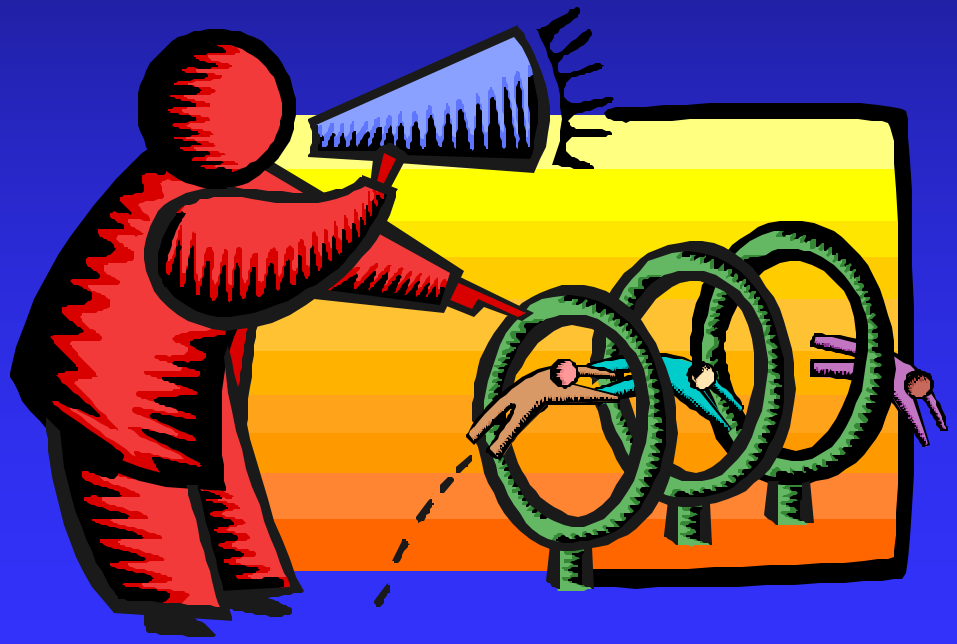


Land use

Integrating Probabilistic and Fixed-Site Monitoring

Institutional Issues

- Re-tool purpose of existing monitoring efforts to include regional focus
- Additional work/coordination
  New England Water Monitoring Council??
- Funding
- Long-term commitments



Integrating Probabilistic and Fixed-Site Monitoring

Now may be a good time!

- Comprehensive Monitoring Plans are required

- New assessment tools are available

- Future increases in monitoring funds

Acknowledgements:

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