

USGS Water Quality Monitoring

*Briefing to
ACWI Workgroup
How to Sustain and Enhance High Quality
Water Monitoring under Constrained Budgets
February 11, 2013*



Monitoring Networks Outline

- Background: Relevant Water Quality Concepts
- Supporting Infrastructure
- Quality Assurance
- Existing and Proposed Networks
- Q & A



Why do we need to monitor Water Quality?

- *“Without measurement, there is no basis on which to evaluate whether policies are effective, no foundation on which to build water management decisions, and no vantage point from which to foresee and forestall water resource challenges”*
(National Research Council, 2012)

Water quality remains a concern for human use and ecosystem health



- * Contaminants in streams and groundwater
- * Degraded stream health
- * Changing Stream and groundwater quality
- * Deteriorating estuary conditions

Concerns expressed by GAO in 1981, 2000, 2004, 2005

BY THE COMPTROLLER GENERAL
Report To The Congress
OF THE UNITED STATES

Better Monitoring Techniques Are Needed To Assess The Quality Of Rivers And Streams Volume I

The Environmental Protection Agency and the Geological Survey use sampling networks to assess the quality of the Nation's rivers and streams. The Council on Environmental Quality strongly endorses this approach and uses the water quality data from the networks in its annual environmental reports.

Water quality is far too complex to be monitored by these networks. Small samples, generally taken monthly, cannot account for water quality at individual sites and cannot accurately represent other locations on the same river. Nationwide reports based on data from the networks are not reliable.

Special studies of individual rivers or river segments would yield more scientifically sound and useful information on water quality. The Environmental Protection Agency and the Geological Survey should stop using their networks and shift their resources and attention to a program of well-managed special studies.

United States General Accounting Office
Report to the Chairman, Subcommittee
on Water Resources and Environment,
Committee on Transportation and
Infrastructure, House of Representatives

GAO

March 2000

WATER QUALITY

Key EPA and State Decisions Limited by Inconsistent and Incomplete Data



GAO/RCED-00-54

United States General Accounting Office
Report to the Chairman, Subcommittee
on Water Resources and Environment,
Committee on Transportation and
Infrastructure, House of Representatives

GAO

June 2004

WATERSHED MANAGEMENT

Better Coordination of Data Collection Efforts Needed to Support Key Decisions



GAO-04-382

GAO Highlights

Highlights of GAO-05-516, a report to congressional requesters

Why GAO Did This Study

The federal government supports numerous data programs that assemble and analyze quantitative measures of the nation's environmental conditions and trends (known as indicators). A substantial number of these data programs are housed in several federal agencies, and provide various types of data used routinely by decision makers from the private sector and all levels of government. As federal agencies take actions to improve the coverage and usefulness of these programs, it is equally important that the quality and availability of existing data generated by these programs do not erode overtime. In this regard, periodic, uninterrupted monitoring to determine conditions and trends is important to accurately describe the extent or seriousness of environmental problems, or conversely, improvements in environmental conditions.

GAO reviewed 20 data programs to determine whether federal agencies responsible for the programs anticipate that changes during fiscal years 2005 and 2006 related to funding, shifting priorities, or other factors will affect the ability of the programs to (1) continue to generate data comparable with data from past years, and (2) continue providing data used in a nationwide ecological indicator study by the H. John Heinz III Center for Science, Economics and the Environment, *The State of the Nation's Ecosystems*.

www.gao.gov/cgi-bin/getattr?GAO-05-516
To view the full product, including the scope and methodology, click on the link above. For more information, contact John B. Stephenson at (302) 512-3941 or jstephens@gao.gov.

September 2005 ENVIRONMENTAL INFORMATION

Status of Federal Data Programs That Support Ecological Indicators

What GAO Found

The federal officials responsible for 14 of the 20 data programs that GAO reviewed are confident that the 14 programs will continue to provide all of the types of data that they provided in 2002 at a comparable or higher level of availability and quality. Agency officials do not expect 2 of the programs to provide such data and are uncertain about the ability of 4 programs to do so. However, several of these programs are likely to benefit from enhancements, including new satellite observations and improved sampling and methodological techniques.

However, in the near term, regarding the specific data used to support 58 ecological indicators that were identified as suitable for national reporting in the Heinz Center's 2002 *State of the Nation's Ecosystems* report, agency officials are confident that 15 of the 20 data programs that produced these data will provide all of the types of data at a comparable or higher level of availability and quality as needed for the next edition of the report, which is planned for issuance in 2007. Even though agency officials informed us that they anticipate that the overall availability and quality of the data supporting the 58 indicators will be maintained, they also indicated that, in some cases, data weaknesses or uncertainties exist that could affect the usefulness of the data for the Heinz Center's 2007 report. For example, the information on the nation's forests will not be as current for some states as for others because of funding limitations. Furthermore, agency officials responsible for 2 of the 20 data programs stated that data will not be of an overall comparable level of quality and availability for 2007, and officials responsible for the remaining 3 data programs were uncertain as to the availability or quality of the data for 2007.

Examples of Ecological Attributes, Their Associated Descriptors, and Example Indicators

Essential ecological attribute	Description	Example indicator
Landscape condition	The extent, composition, and pattern of habitat in a landscape	Disturb and change in extent of ecosystems
Biotic condition	The number or variety of communities, populations, and individual plants	Trends in habitat and population trends in great lakes and streams
Ecological processes	Metabolic functions of ecosystems: energy flow, nutrient cycling, and the production, consumption, and decomposition of organic matter	Movement of nitrogen
Chemical and physical characteristics	Physical parameters (e.g., temperature) and concentrations of chemical substances (e.g., nitrogen) present in an ecosystem	Airfare, phosphate, and other chemical levels in streams
Hydrology and geomorphology	The results of water flow and land forms	Soil erosion
Natural disturbance regimes	The historical functions of fires and recurrent disturbances that shape ecosystems	Forest disturbances: fire, insects, and diseases

Source: GAO.

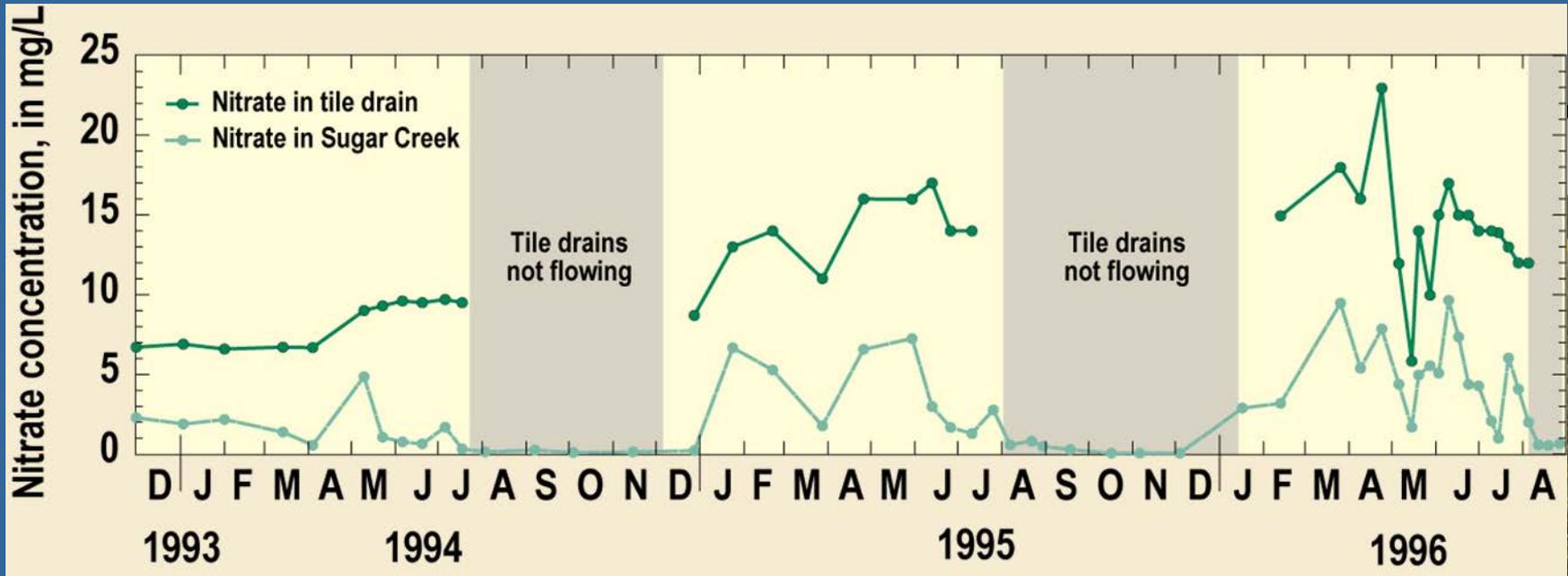
Water-quality monitoring efforts may vary a lot depending on the question being asked

- Mission, goals, objectives, and desired outcomes
- Spatial and temporal scales of interest
- Which component(s) of the hydrologic cycle are of interest?
- Which media?
- Which type of sample?
- Which measurements?
- What are the analytical requirements?
- What is the frequency?
- What is the length of Record?

What's different about USGS?

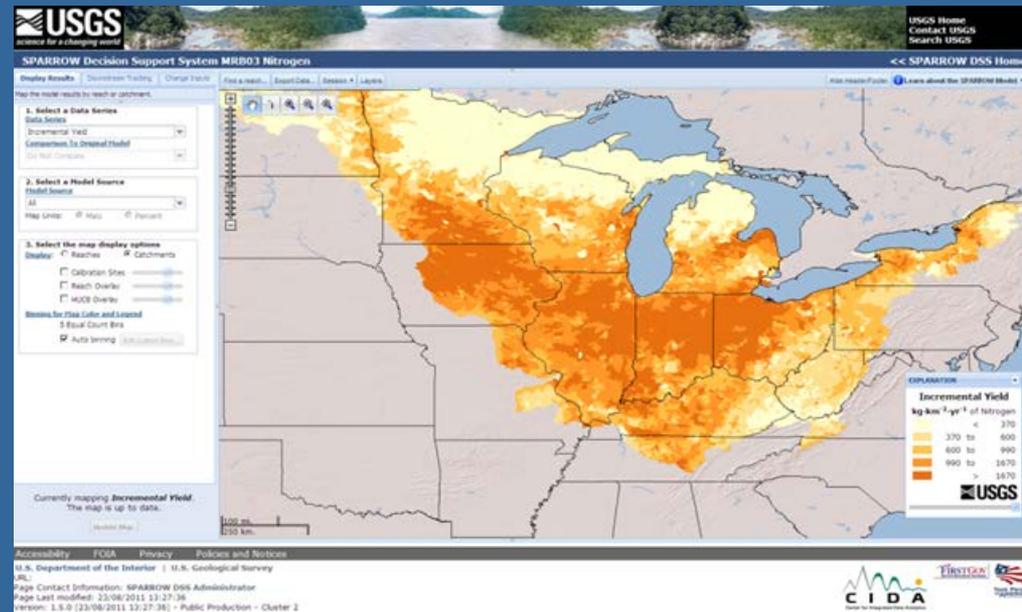
- Bureau mission and perspective
- National capabilities
- Regional & National and Long term
- Low-level analyses of pesticides and other potentially toxic chemicals that others typically can't afford
- Large Rivers (interstate) and Groundwater
- National Synthesis

Knowledge of hydrology and other natural and human factors are needed to interpret water-quality monitoring data



Outcomes from USGS Water-Quality Monitoring and Modeling

- Investments in USGS water-quality monitoring and modeling have resulted in outcomes that have evolved from providing data and trend analysis to those that include the potential to predict and forecast contaminant occurrence and trends under multiple scenarios at nationally significant scales



Supporting Infrastructure for water-quality monitoring is provided at several organizational levels

- **Bureau**
 - Fundamental Science Practices
- **Water Mission Area**
 - Water Science Field Team
 - Hydrologic Instrumentation Facility
 - Office of Water Quality
- **Water Science Centers**
 - Water-quality specialists (limited)

Supporting Infrastructure for Water Quality Monitoring—Office of Water Quality

- National Networks and NAWQA
- Hazard Response
- National Field Manual and other protocols
- Technical Memoranda
- Triennial Reviews
- Training
- Branch of Quality Systems
- National Water Quality Laboratory

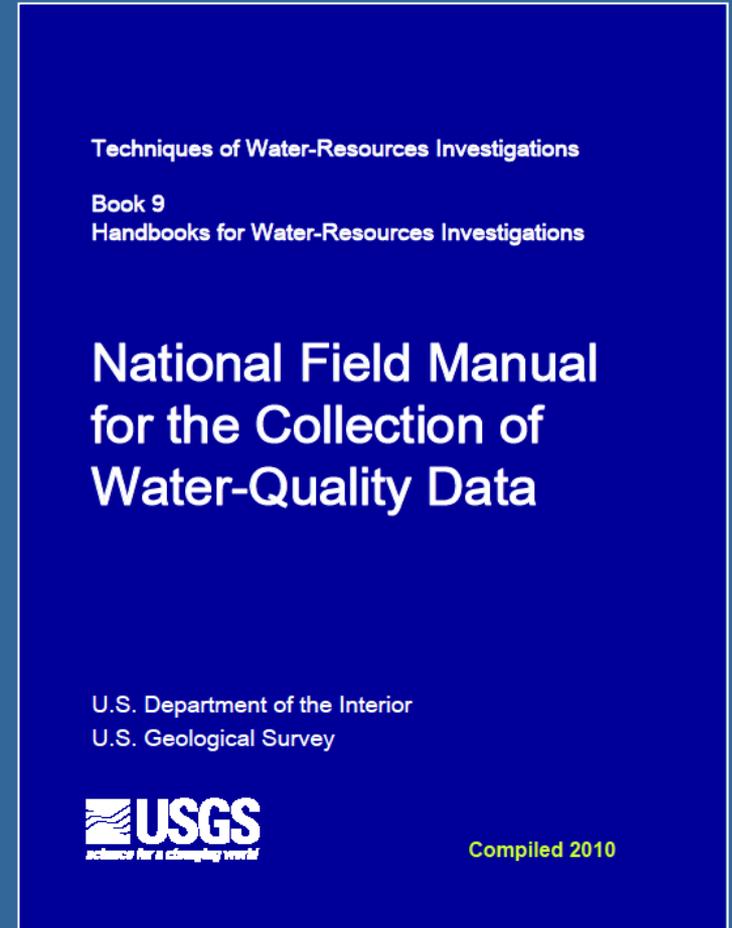


National Water Quality Laboratory
(NWQL) Denver Federal Center

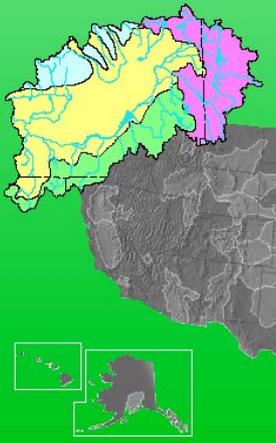
Supporting Infrastructure: Standardized Protocols for Collection of Water-Quality Data

USGS field protocols and procedures...

- Achieve consistency in the scientific methods and procedures used
- Document methods and procedures
- Facilitate sharing of data and resources
- National Environmental Methods Index (www.nemi.gov)



Supporting Infrastructure: Standardized Protocols for Assessing the Condition of Aquatic Communities

<p>Protocols for samples collected from U.S. Geological Survey Water-Quality Assessment Program</p>   <p>THE ACADEMY OF NATURAL SCIENCES PATRIOT</p>	<p>USGS science for a changing world</p> <p>Methods of Analysis National Water Quality Taxonomy, and Quality Macroinvertebrate Sampling</p> <p>U.S. Geological Survey Water-Resources Investigations</p> <p>Open-File Report 00-212</p>   <p>U.S. Department of the Interior U.S. Geological Survey</p>	<p>USGS science for a changing world</p> <p>Guidelines For Quality Assessment of Fish Taxonomic Data National Water-Quality Assessment Program</p> <p>U.S. Geological Survey Water-Resources Investigations</p>    <p>U.S. Department of the Interior U.S. Geological Survey</p>	<p>USGS science for a changing world</p> <p>Revised Methods of Sampling Aquatic Habitat in the National Water-Quality Assessment Program</p> <p>U.S. Geological Survey Water-Resources Investigations</p>  <p>U.S. Department of the Interior U.S. Geological Survey</p>	<p>USGS science for a changing world</p> <p>Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities as part of the National Water-Quality Assessment Program</p> <p>Open-File Report 02-150</p>        <p>U.S. Department of the Interior U.S. Geological Survey</p>
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Supporting Infrastructure to Disseminate Data and Information

New Aquatic Biological Data-base System - an authoritative source for USGS data

National Water Information System

Decision Support Systems

NAWQA Data Warehouse



BioData: A National Aquatic Bioassessment Database

By Dorene MacCoy

Introduction

BioData is a U.S. Geological Survey (USGS) web-enabled database that for the first time provides for the capture, curation, integration, and delivery of bioassessment data collected by local, regional, and national USGS projects. BioData offers field biologists advanced capabilities for entering, editing, and reviewing the macroinvertebrate, algae, fish, and supporting habitat data from rivers and streams. It offers data archival and curation capabilities that protect and maintain data for the long term. BioData provides the Federal, State, and local governments, as well as the scientific community, resource managers, the private sector, and the public with easy access to tens of thousands of samples collected nationwide from thousands of stream and river sites. BioData also provides the USGS with centralized data storage for delivering data to other systems and applications through automated web services.

BioData allows users to combine data sets of known quality from different projects in various locations over time. It provides a nationally aggregated database for users to leverage data from many independent projects that, until now, was not feasible at this scale. For example, from 1991 to 2011, the USGS Idaho Water Science Center collected more than 216 bioassessment samples from 63 sites for the National Water Quality Assessment (NAWQA) Program and more than 477 samples from 39 sites for a cooperative USGS and State of Idaho Statewide Water Quality Network (Fig. 1). Using BioData, 20 years of samples collected for both of these projects could be combined for analysis.

BioData delivers all of the data using current taxonomic nomenclature, thus relieving users of the difficult and time-consuming task of harmonizing taxonomy among samples collected during different time periods. Fish data are reported using the Integrated Taxonomic Information Service (ITIS) Taxonomic Serial Numbers (TSN's). A simple web-data input interface and self-guided, public data-retrieval web site provides access to bioassessment data. BioData currently accepts data collected using two national protocols: (1) NAWQA and (2) U.S. Environmental Protection Agency (USEPA) National Rivers and Streams Assessment (NRSA). Additional collection protocols are planned for future versions.

Highlights

Use the BioData Management System to:

- Capture, review, edit, finalize, approve, and archive bioassessment data collected for local, regional, and national aquatic bioassessment, monitoring, and research purposes.
- Store data collected using two nationally accepted protocols with the capability to add support for additional protocols in the future.

Use the BioData Retrieval System to:

- Retrieve bioassessment data through a single public web site (<https://aquatic.biodata.usgs.gov>).
- Retrieve data using a unified and consistent taxonomic identification system that accounts for changes in taxonomic nomenclature.



Figure 1. BioData users are able to retrieve data from multiple projects. An example in progress is the capability to retrieve sites in Idaho from the National Water-Quality Assessment Program (black circles) and the USGS-Idaho Statewide Cooperative Network (gray circles). Idaho rivers and streams are blue lines.

U.S. Department of the Interior
U.S. Geological Survey

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Fact Sheet 2011-2012
September 2011

Primary spatial and temporal scales of USGS water-quality monitoring programs and networks

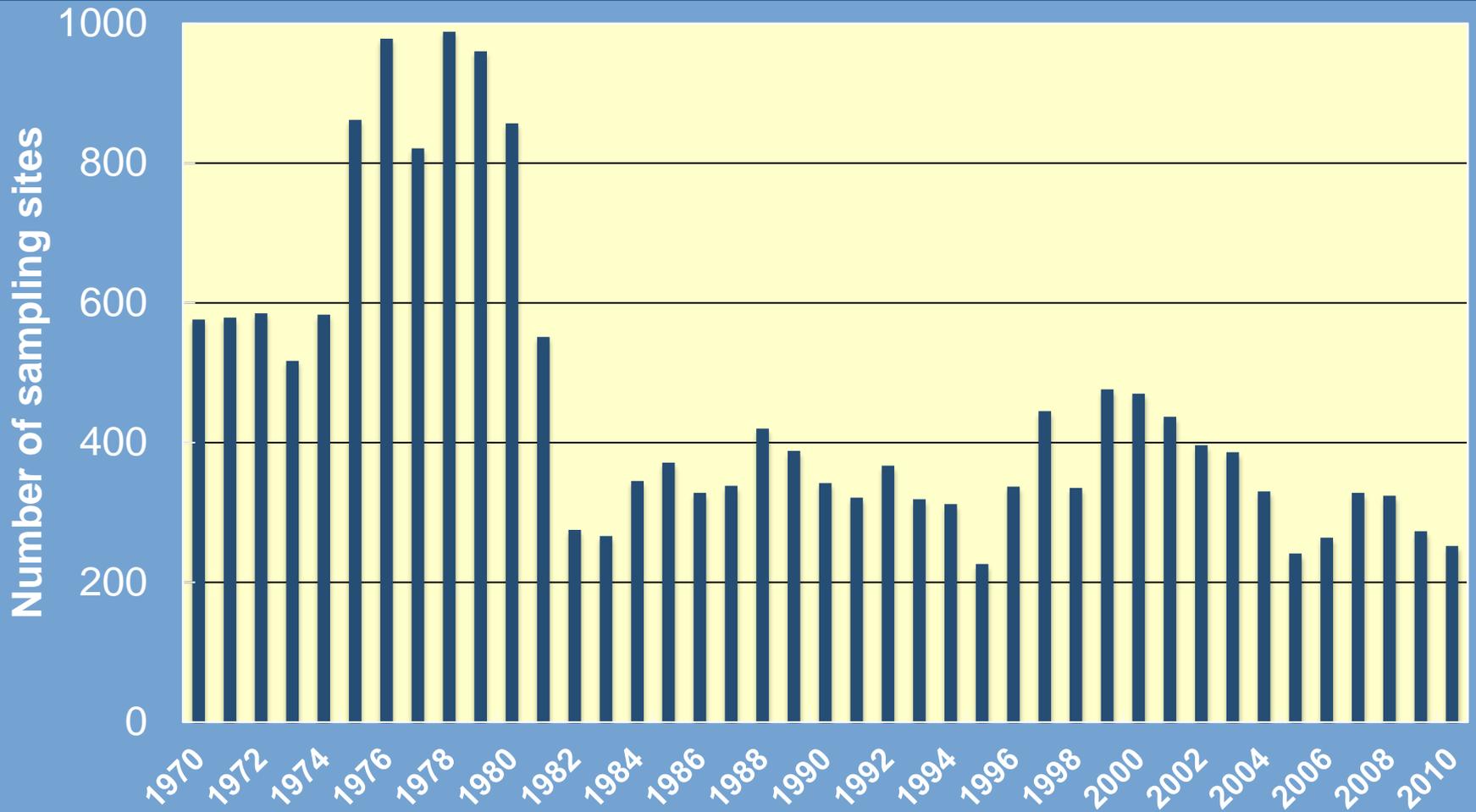
Temporal Scale	Spatial Scale		
	Local	Regional	National
Short Term (1 year)	CWP	NAWQA	NAWQA TOXICS
Multi Year (2-5 Years)	CWP NPS Partnership	CWP Toxics NAWQA	NAWQA
Decadal	WEBB	CWP UMRR	HBN NASQAN NAWQA NMN NADP

USGS Program or Network Name

HBN--Hydrologic Benchmark Network
 NASQAN--National Stream Quality Accounting Network
 NAWQA--National Water Quality Assessment Program
 NMN--National Monitoring Network
 NPS--National Park Service
 TOXICS--Toxic Substances Hydrology Program
 WEBB--Water, Environment and Biogeochemical Budgets
 UMRR--Upper Mississippi River Restoration
 CWP – USGS Cooperative Water Program

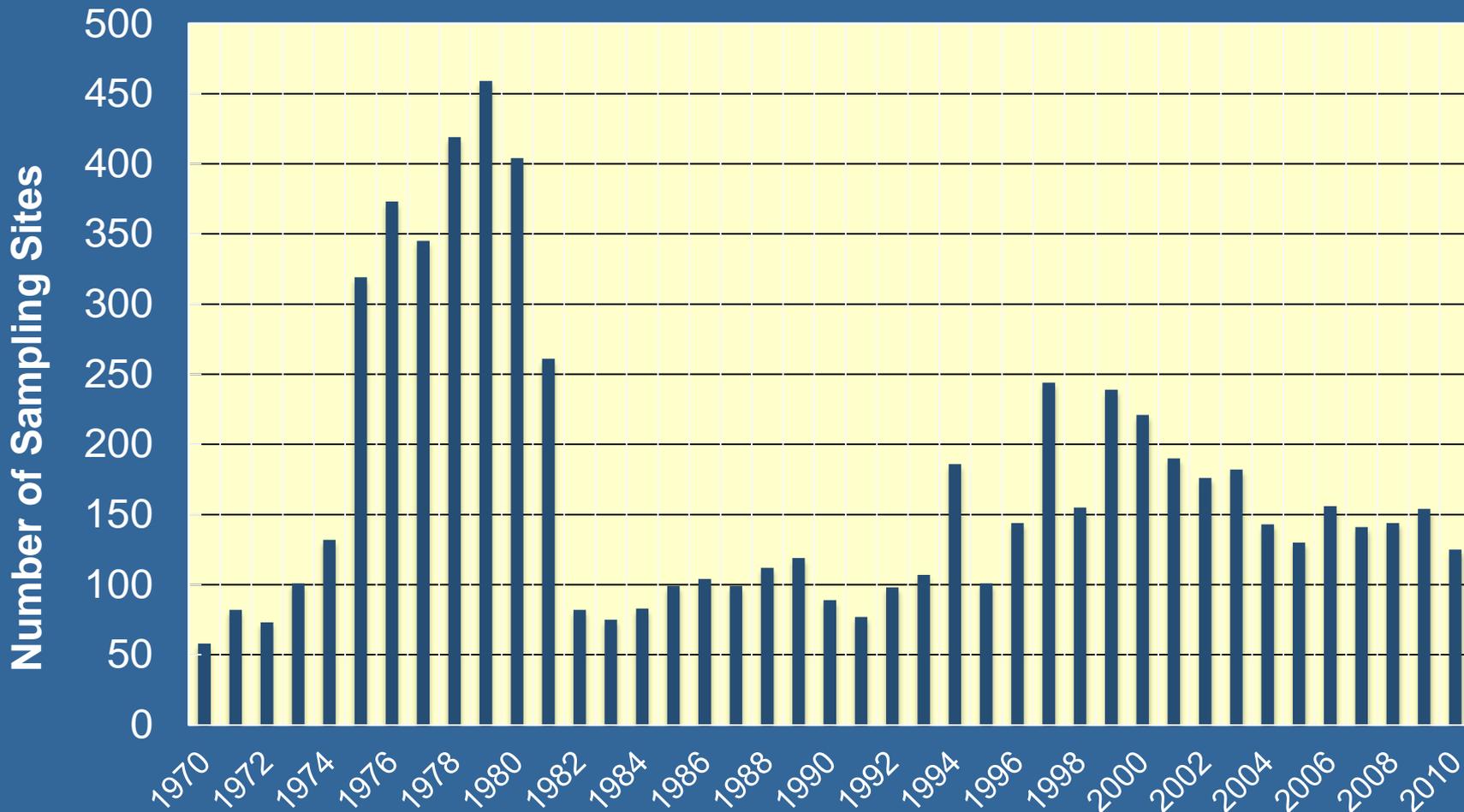
Number of stream sites sampled by USGS for nitrate

(Sites having at least 11 samples per year in 11 different months)



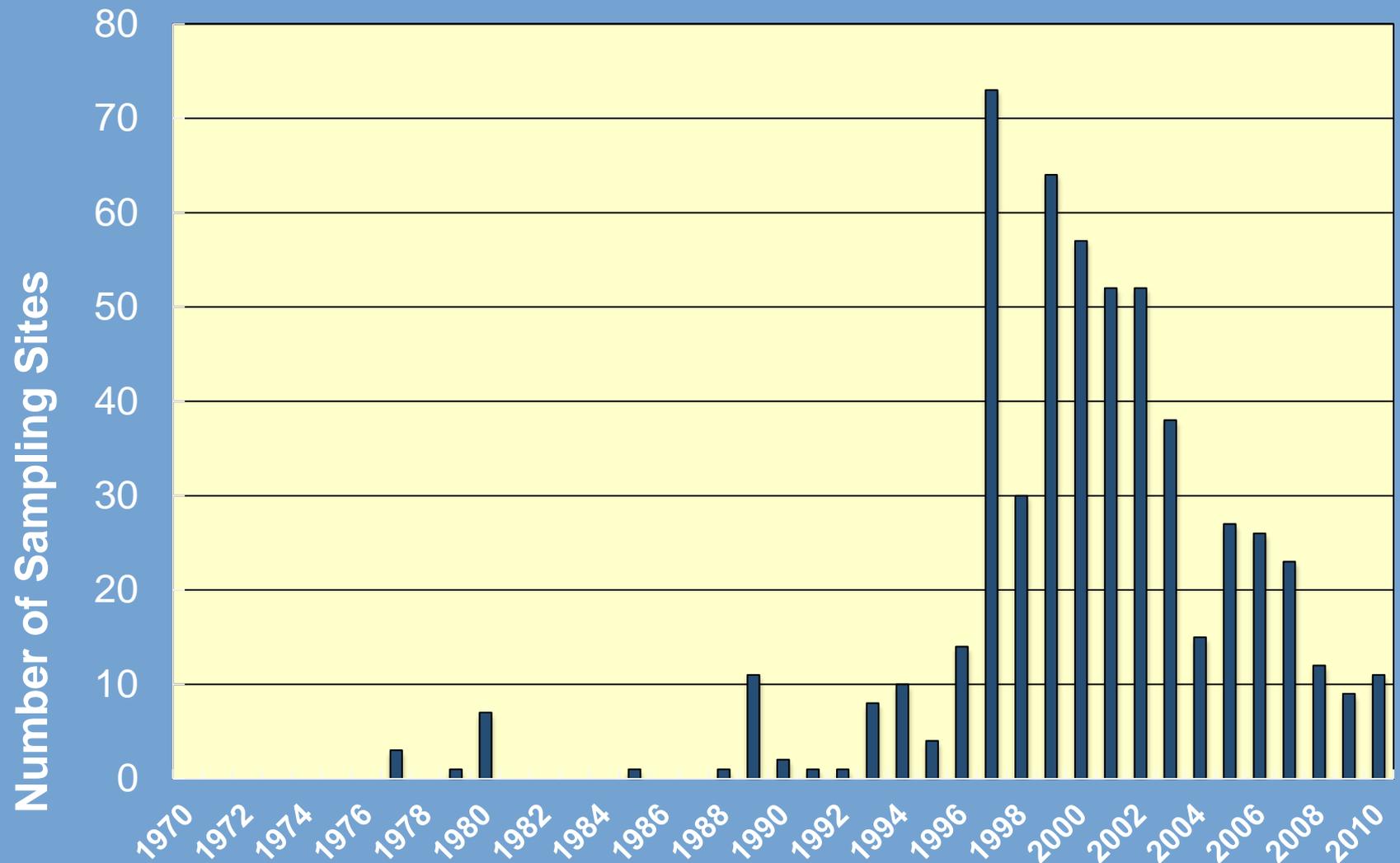
Number of stream sites sampled by USGS for Suspended Sediment

(Sites having at least 11 samples per year in 11 different months)

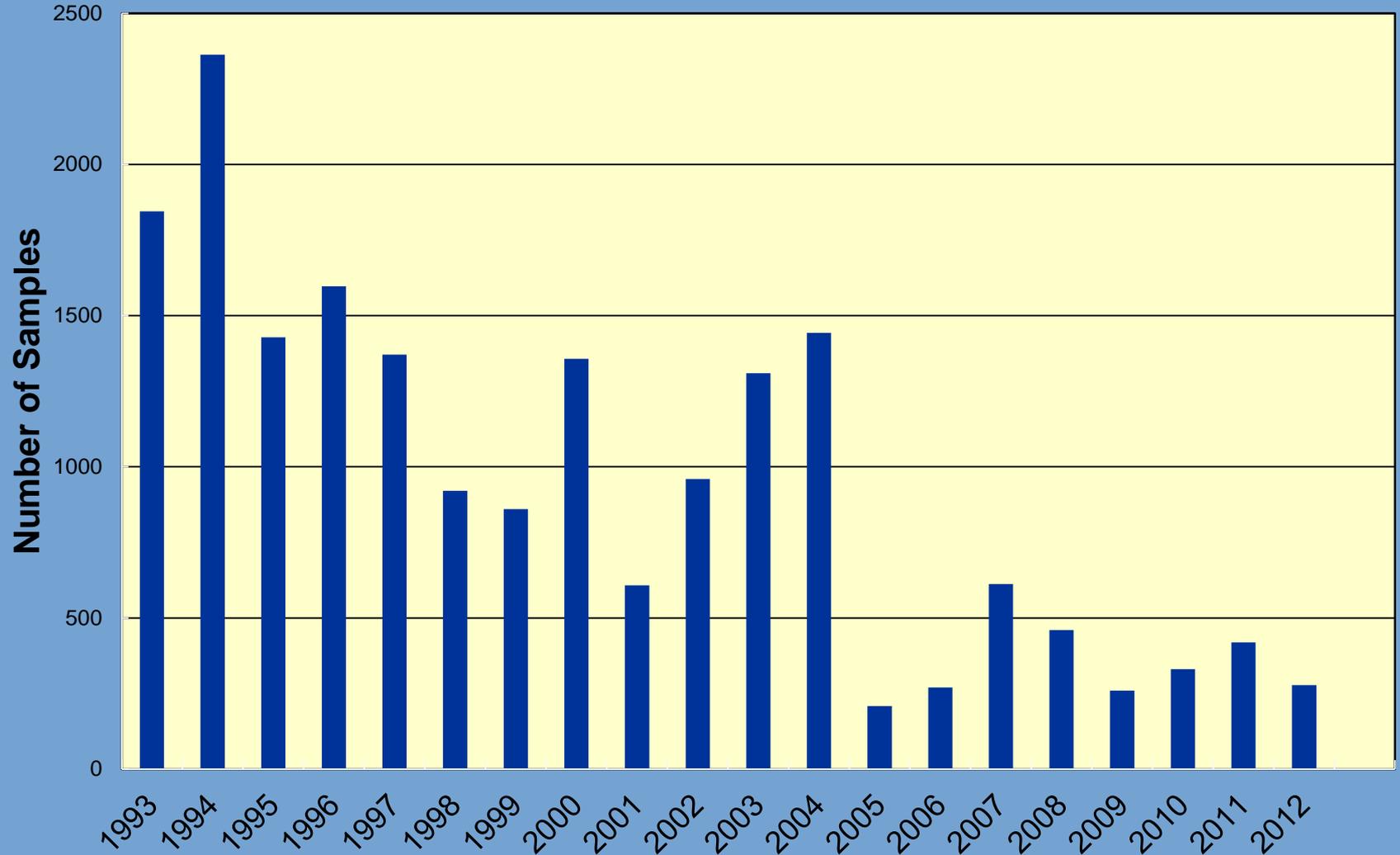


Number of stream sites sampled by USGS for atrazine

(Sites having at least 11 samples per year in 11 different months)

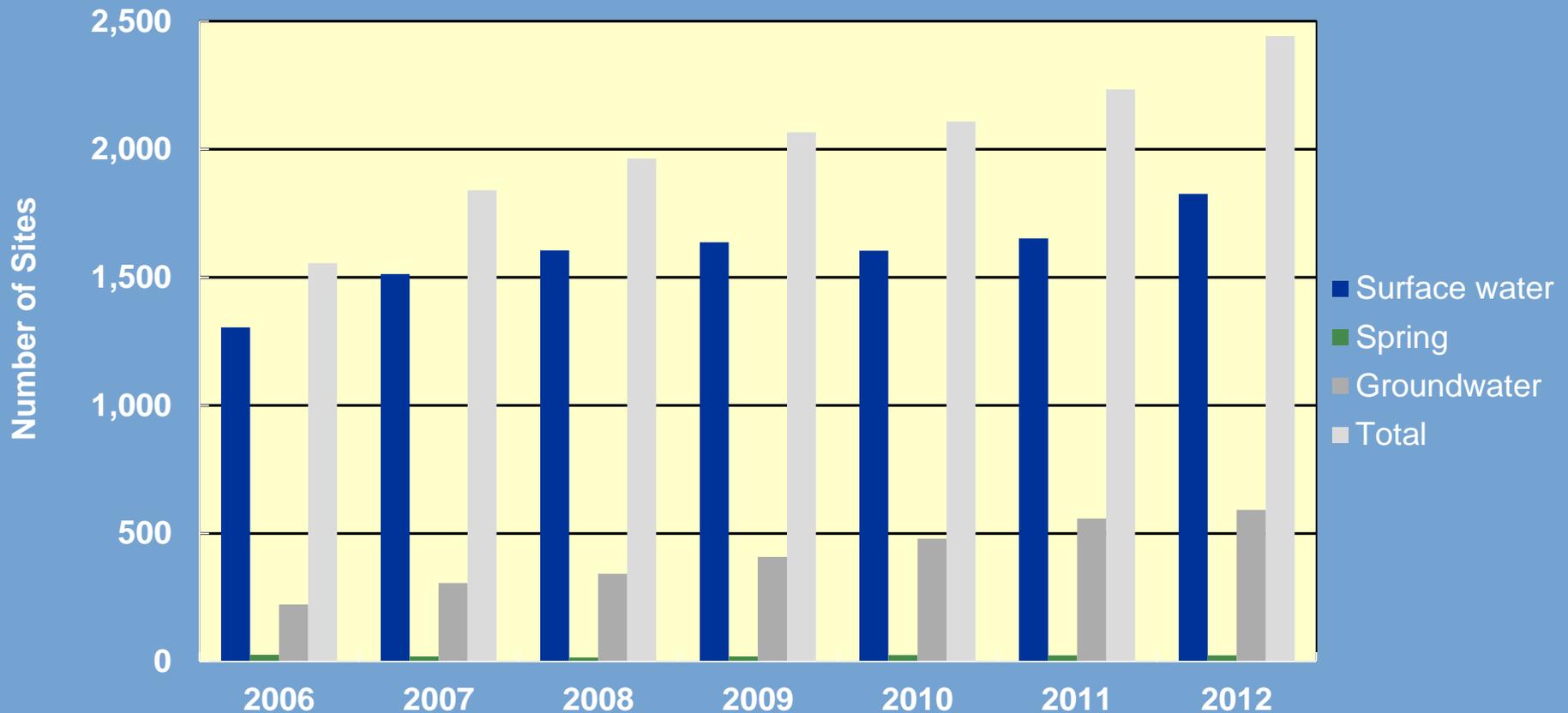


Number of Fish, Macroinvertebrate, and algae community samples

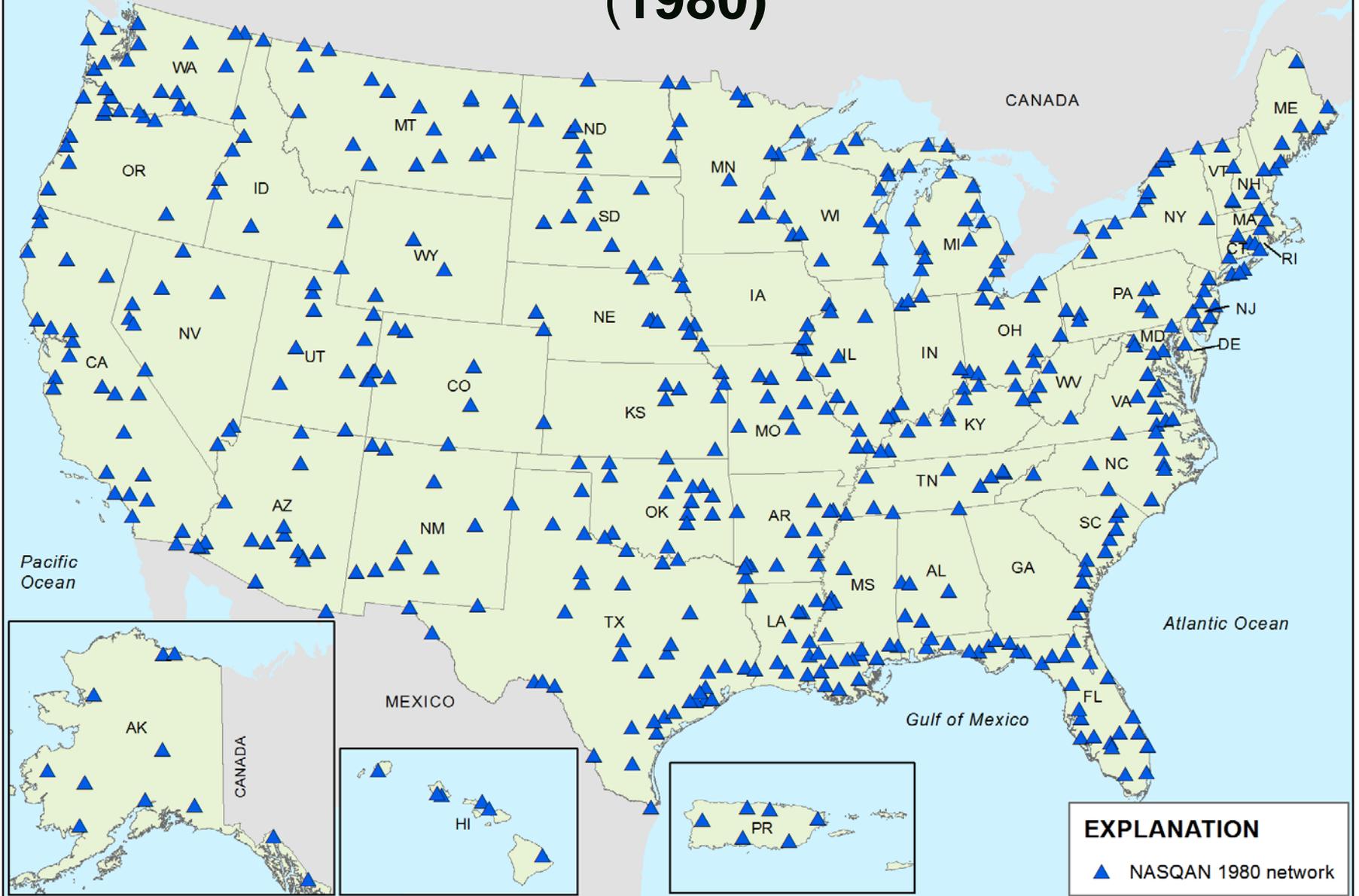


Monitoring water quality continuously and in real-time is increasing

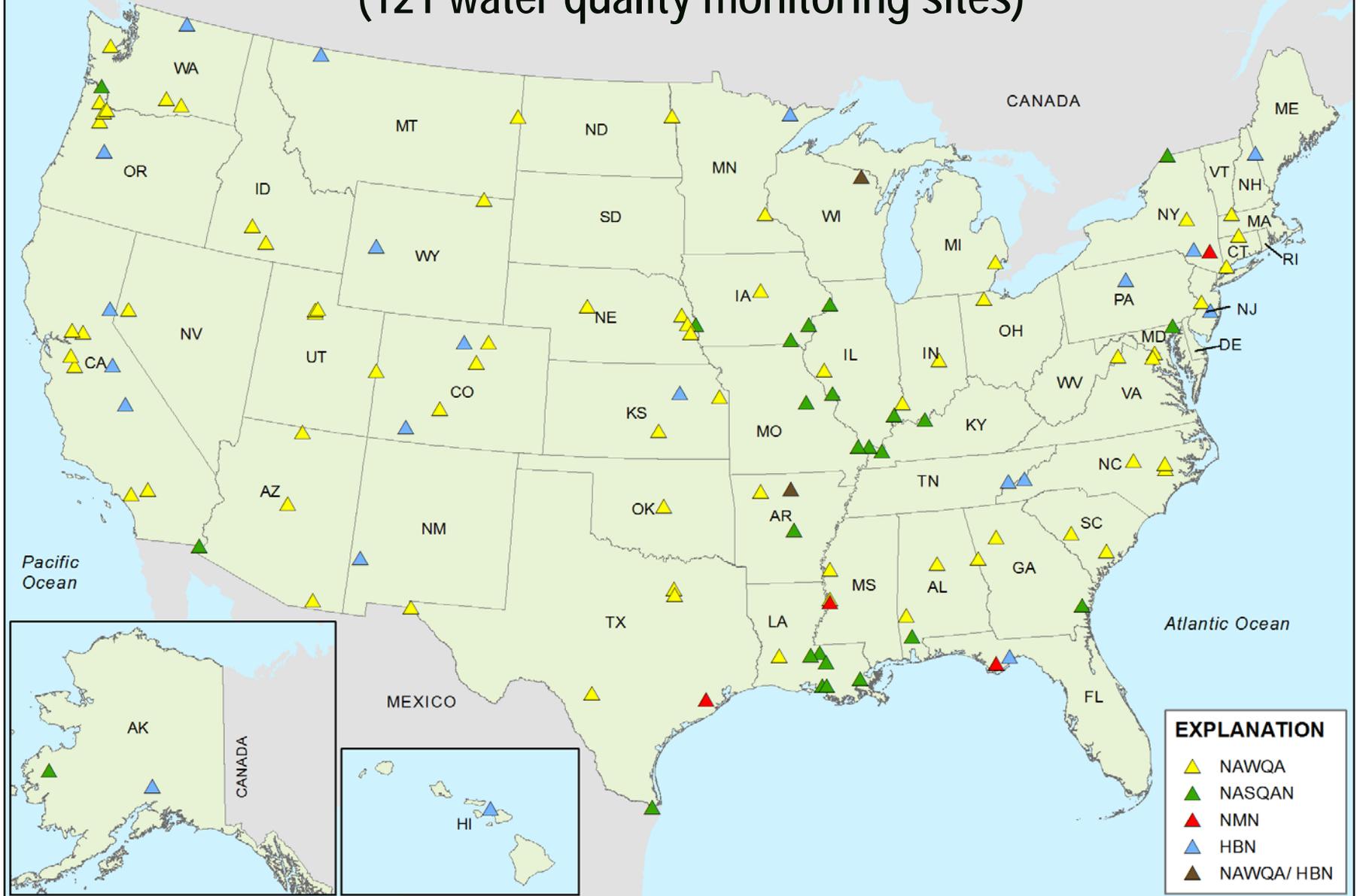
Number of Continuous Water Quality Sites 2006-12



National Stream Quality Accounting Network (1980)

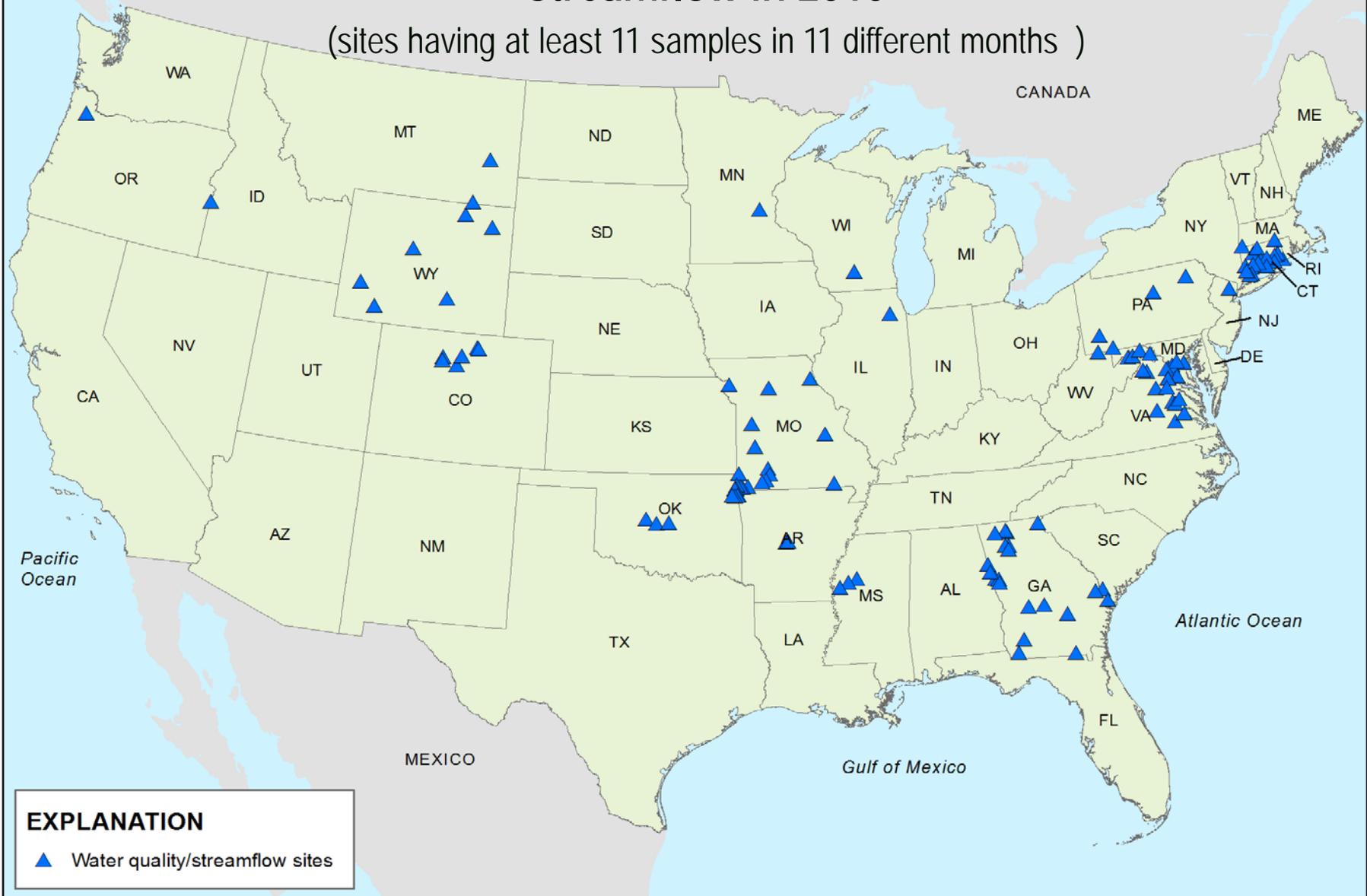


NAWQA, NASQAN, NMN, HBN in 2013 (121 water quality monitoring sites)



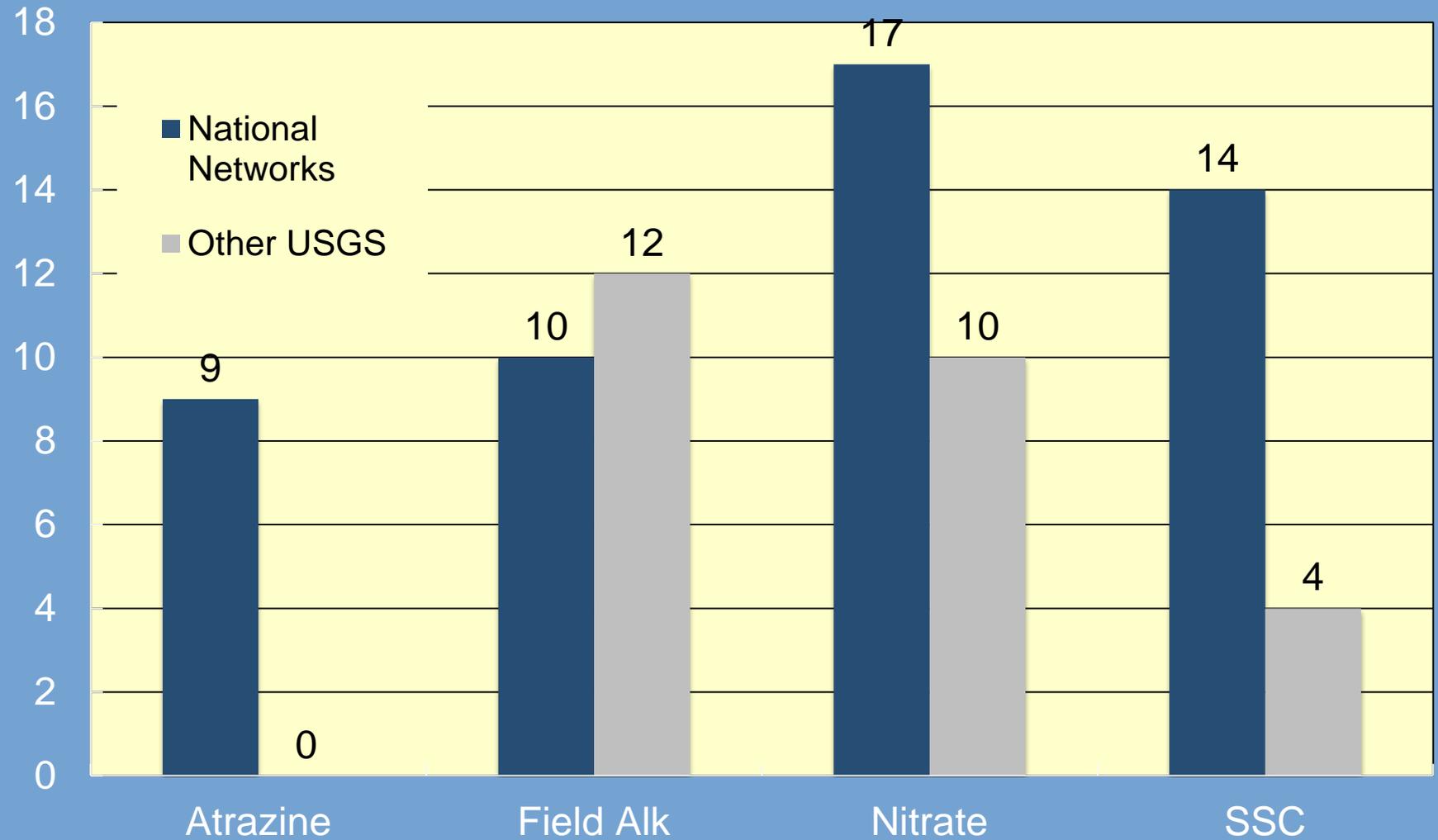
118 other USGS monitoring sites sampled for both nitrate and streamflow in 2010

(sites having at least 11 samples in 11 different months)



Median number of years for a sites period of record - 2010

(Sites having at least 11 samples in 11 different months)



Proposed: Restoration of Surface-Water-Quality Network

NAWQA Cycle 2

150 sites

Most only sampled every 2 or 4 yrs

No continuous monitors

58 ecological sampling sites

Single-year intake sampling

No lake or reservoir sites

Existing contaminant analyses

Minimal suspended sediment

NAWQA Cycle 3

⇒ ~330 sites

⇒ All sites sampled all years

⇒ Most with real-time monitoring

⇒ 88 ecological sites (add 30 reference)

⇒ 25 stream or river DW intake sites

⇒ 50 lake or reservoir DW intake sites

⇒ Expanded contaminant coverage

⇒ Expanded suspended sediment with turbidity monitoring

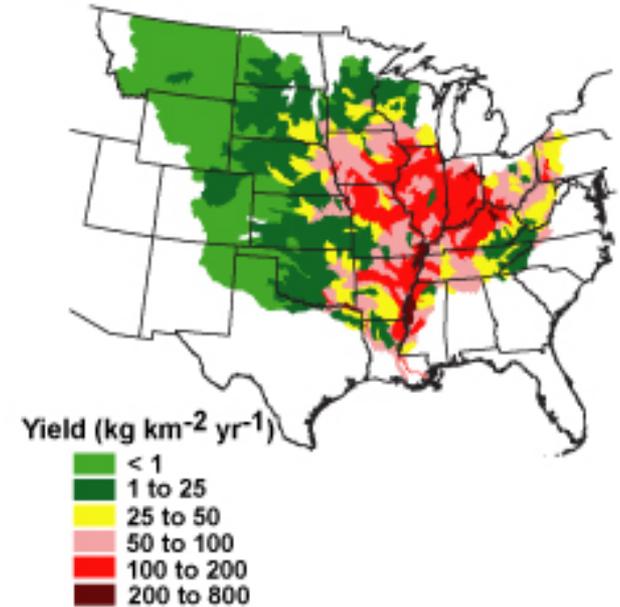
Proposed: Improved Models for Decision Making

From modeling average-annual conditions to “time varying”: monthly, seasonal, and annual

Requires:

- More frequent monitoring (e.g. real time, continuous)
- Improved ancillary data over time (e.g. satellite imagery)

Phosphorus yield delivered to the Gulf of Mexico



Discussion and Questions



NAWQA Funds Allocation FY 2010

