Monitoring and Assessment

Virtual WQS Academy

U.S. EPA Office of Wetlands, Oceans, and Watersheds

February 2026

Disclaimer

- This Presentation does not:
  - Impose any binding requirements
  - Determine the obligation of the regulated community
  - Change or substitute for any statutory provision or regulation requirement
  - Represent, change or substitute for any Agency policy or guidance
  - Control in any case of conflict between this discussion and statute, regulation, policy, or guidance

  The views expressed in this presentation are those of the author[s] and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

What Does This Session Cover?

- Brief intro to monitoring and assessment
  - Who monitors water quality?
  - How are monitoring data used?
- What are critical components of a monitoring program?
  - What are the different types of monitoring designs?
  - Quality assurance and quality control
- What tools are available to assist with assessments?

Introduction to Monitoring and Assessment

- Water quality monitoring is a crucial aspect to protecting water resources.
- State, Tribal and Federal agencies have primary responsibility to monitor water bodies (lakes, rivers, streams).
- Water resource managers use data to understand:
  - where pollution problems exist,
  - where to focus pollution control energies, and
  - where progress is being made to improve water quality.

Who Monitors Water Quality?

- **States, Tribes, Territories, and interstate organizations** implement monitoring programs under CWA 106.
- **EPA and partners** monitor to assess the physical, chemical, and biological integrity of the nation's waters tracking progress toward achieving the CWA goals for healthy aquatic life and safe recreation.
- **Federal agencies** monitor to support their management and research needs.
- **Volunteer and citizen groups** monitor to understand local conditions.
- **Other organizations** include local government and academic organizations.

Case Study: Proctor Creek

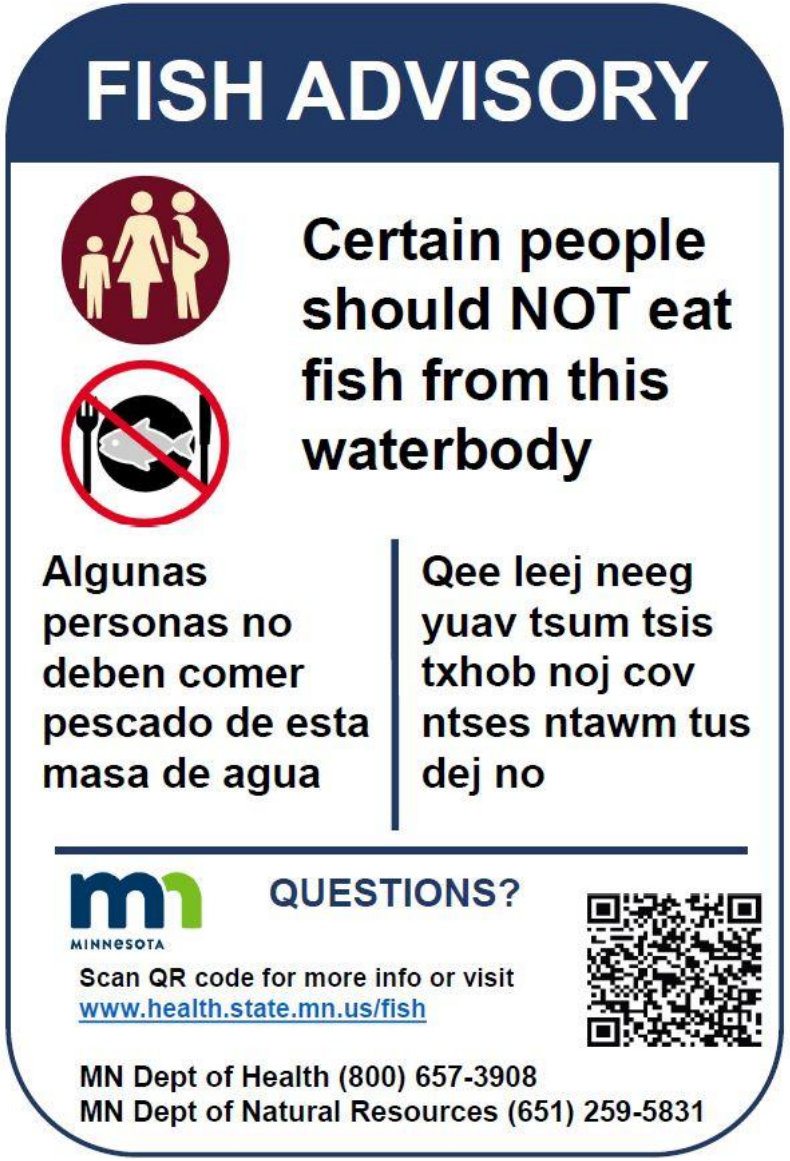
- Downtown Atlanta, GA waterway polluted by stormwater flooding and CSOs.
- Runs through economically depressed portion of city (4 Superfund sites in area).
- Neighborhood Water Watch Program expanded by Urban Waters Federal Partnership grant.
- Residents near Creek trained to monitor streams and collect samples.
- 288 samples in 2010 & 6,000+ in 2015.
- Data reviewed by an approved Quality Assurance Project Plan developed by EPA under the grant.
- Used to clean up Creek and remove it from impaired waters list.

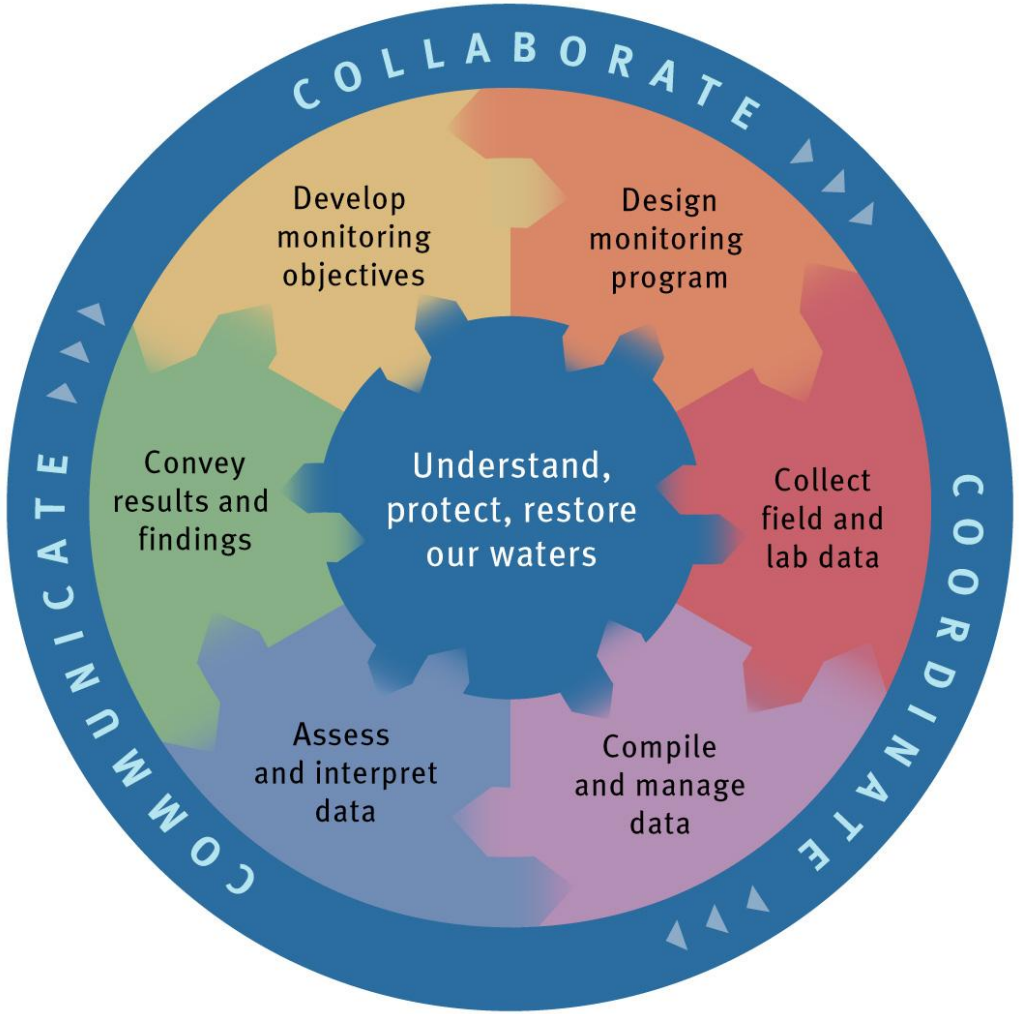
Monitoring Data To Tell the Water Story

- Chemical, physical, and biological data are a part of the story that we can tell about water and aquatic life.
- It informs assessment decisions and on-the-ground actions for water quality restoration and protection.

How Are Monitoring Data Used?

- Assess extent of our Nation's waters meeting CWA goals: 305(b)
- Identify impaired waters: 303(d)
- Set protection and restoration priorities
- Inform fish consumption advisories and swimming advisories
- Identify emerging problems
- Support Reasonable Potential Analysis for NPDES permits
- Develop and implement TMDLs and watershed plans
- Develop models to understand ecosystem processes and predict problems and solutions
- Identify high quality waters for protection and as reference
- Determine the effectiveness of water pollution controls and actions
- Measure change in water quality conditions over time



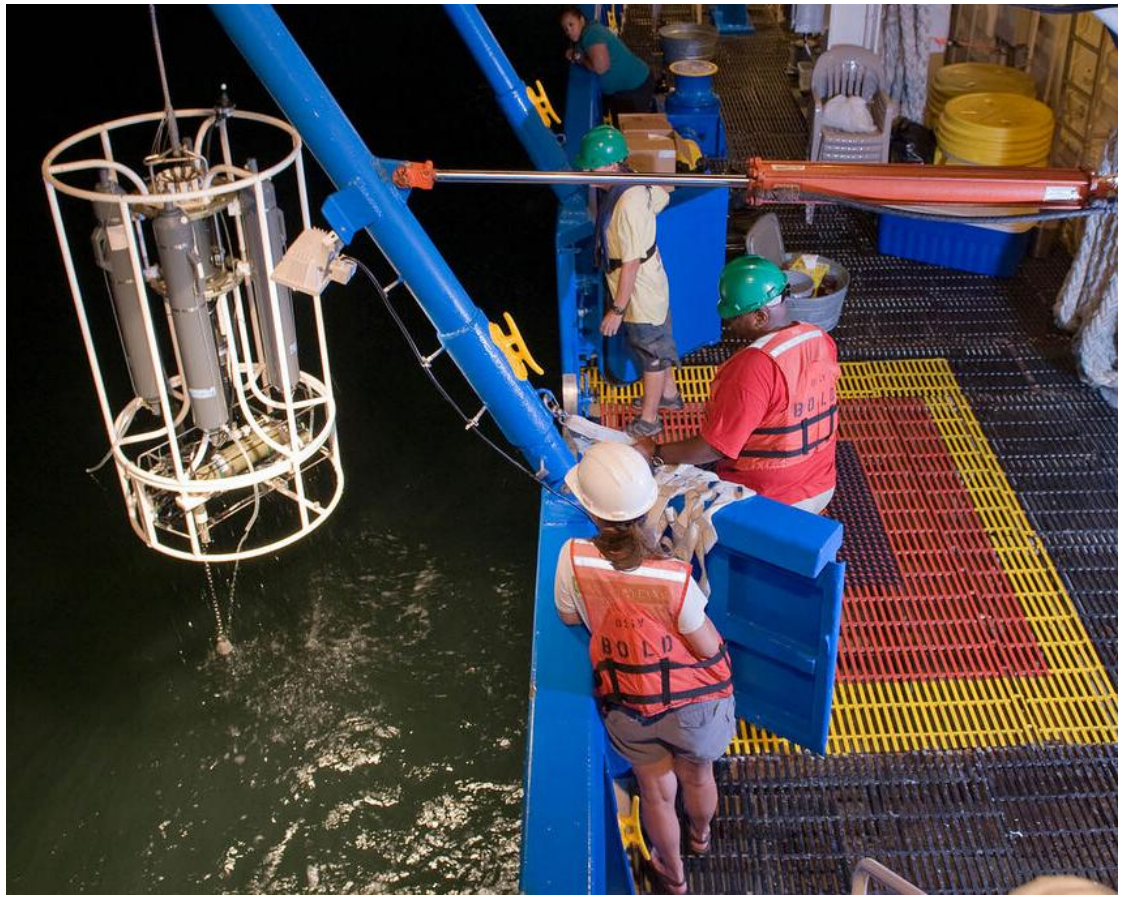


Water Quality Monitoring Program Key Components

Program Design:
The Who, What, Why, When, & Where of monitoring

The design should include…

- Sampling locations based on spatial and temporal representativeness
- Core indicators
- Data quality objectives and methods
- Quality assurance and control measures
- Data management and interpretation
- Are existing data suitable?
- Costs



Quality Assurance and Quality Control (QA/QC)

- To ensure quality data are generated:
  - Develop Quality Assurance Project Plans (QAPPs) and other quality-related references
  - Identify study objectives
  - Use existing lab and field protocols to the extent possible
  - Document that laboratory methods meet data quality objectives
  - Document collection procedures for all environmental information (samples and observations)
  - Train and assess performance of field crew and lab personnel
  - Evaluate lab competency

For more information: https://www.epa.gov/quality

Types of Monitoring Designs

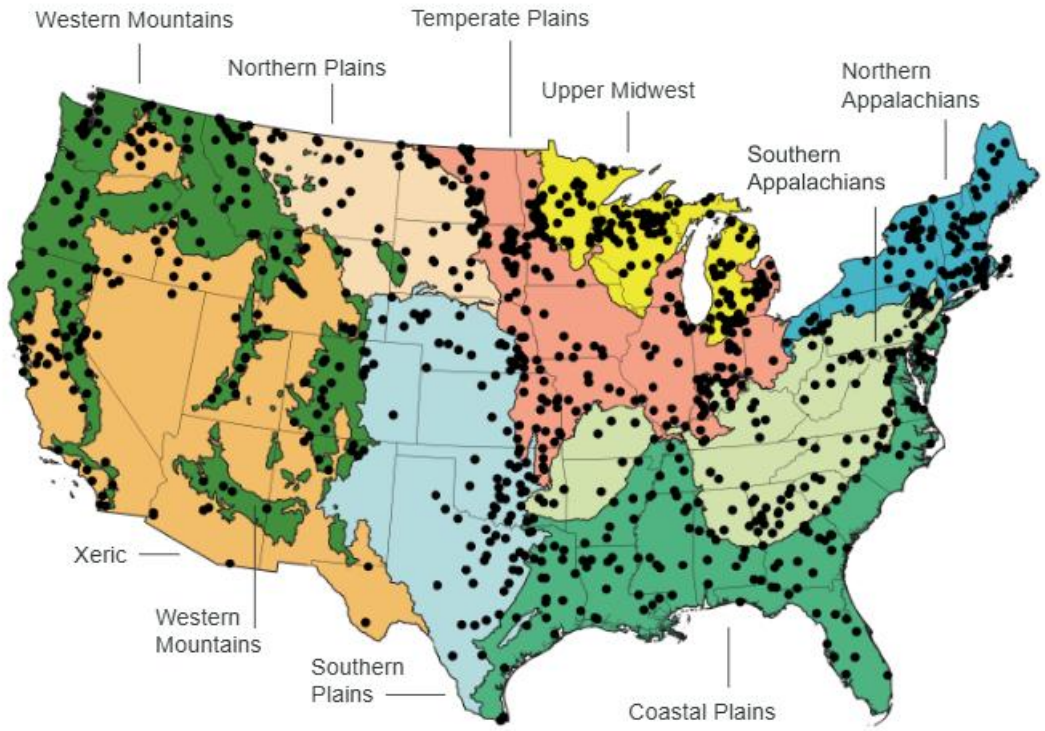
- Statistically-valid surveys
- Targeted monitoring
- Fixed site network
- Rotating basin

EPA recommends that States/Tribes integrate a variety of designs to best meet monitoring objectives and multiple decision needs.

Statistically-Valid Surveys

- Site selection and data analysis are based on statistical methods.
  - Generate unbiased, representative assessment of target population.
  - Balanced spatially across area of interest (e.g., U.S.).
  - Balanced across sub-classes of target population (e.g., lake size, ecoregion).
  - Data are used to produce scientifically-valid reports on the condition of all waters of the U.S., state, watershed, or region.
- Focus is usually on key, broad, questions:
  - What extent of our Nation's waters support healthy ecosystems, recreation, fish consumption?
  - What key stressors are associated with poor conditions?
  - Is water quality changing?

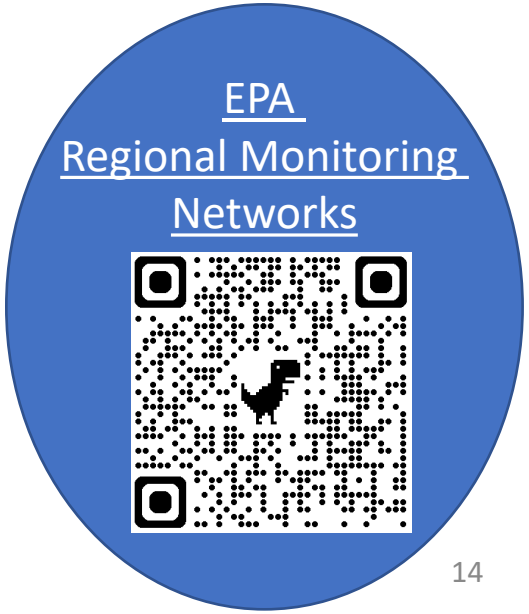
Exhibit 1: Map of NLA 2022 Sampling Sites in Each Ecoregion



From: National Lakes Assessment: The Fourth Collaborative Survey of Lakes in the United States

Monitoring Designs: Targeted Sampling

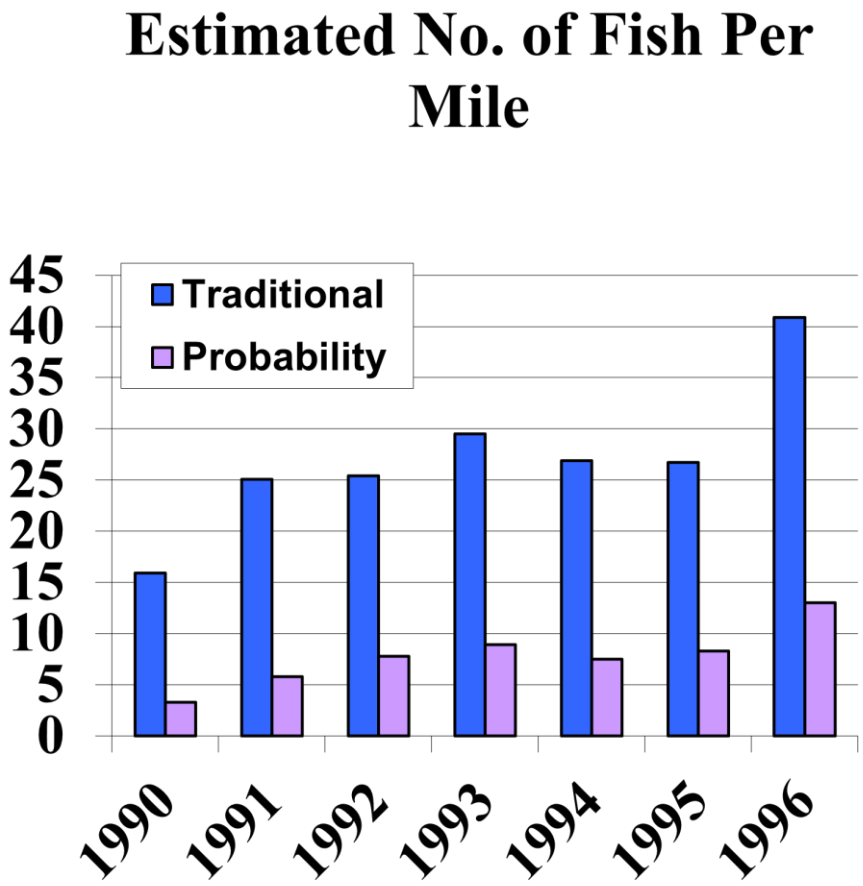
- Intentional selection of locations and parameters to inform a particular issue or question
- Allows for detailed analysis of cause and effect, fate and transport, seasonal variation
- Often targeted towards areas of concern. For example, targeted designs might:
  - Confirm 303(d) listing needed
  - Confirm and supplement information on pollutants/sources
  - Establish baseline water quality and biological condition
  - Monitor recreational waterbodies (e.g., pathogens, HABS)
- Used to develop site-specific controls
  - TMDL
  - NPS management measures
  - WQ-based NPDES permits



Case Study on Sampling Design

Improved Estimates of Population Size Oregon Coastal Coho Salmon

- Historic long term, targeted monitoring of spawning suggests minimal problem.
- Targeted sample locations were biased toward productive areas.
- Statistical (probability) survey results more accurately reflect populations.
- Survey sites selected using randomized design were more representative of conditions.
- State program modified based on statistical design.



Monitoring Designs: Rotating Basin

- More implementation rather than design.
- State or region is divided into several geographic or hydrologic areas that are assessed on a rotating basis (commonly 5-year rotation).
- Sampling design within basins may include statistical surveys, fixed station, or targeted designs.
- Typically informed by discussion across programs to address needs, like TMDL development, permit renewal.
- Five-year return cycle supports tracking changes and trends over time.

Example:

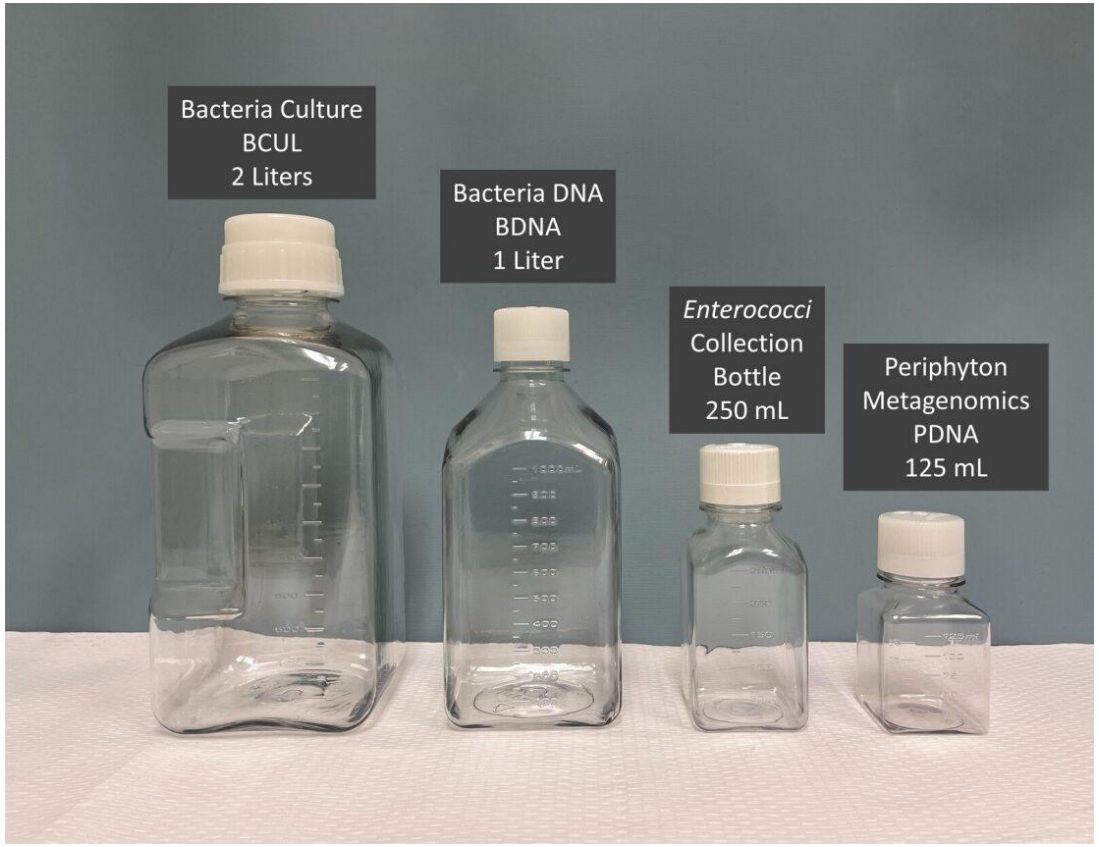
OKLAHOMA CONSERVATION COMMISSION

Common Indicators

	Aquatic Life	Recreation	Drinking Water	Fish/Shellfish
CORE	• Biological communities (fish, benthic macroinvertebrates, plants, plankton) • Basic chemistry (e.g., DO, pH) • Nutrients • Flow • Habitat assessment • Landscape condition	• Cyanobacteria toxins • Pathogen indicators (*E. coli,* enterococci) • Nuisance plant growth • Nutrients • Chlorophyll • Flow • Landscape condition	• Cyanobacteria toxins • Trace metals • Pathogens • Nitrates • Salinity • Sediments/TDS • Flow • Landscape condition	• Pathogens • Mercury • Chlordane • DDT • PCBs • Landscape condition
OTHER	• Ambient toxicity • Environmental DNA • Sediment toxicity • Health of organisms • Other chemicals of concern in water or sediment	• Hazardous chemicals • Aesthetics • Other chemicals of concern in water or sediment	• VOCs • Hydrophylic pesticides • Algae • Other chemicals of concern in water or sediment	• Other chemicals of concern in water or sediment

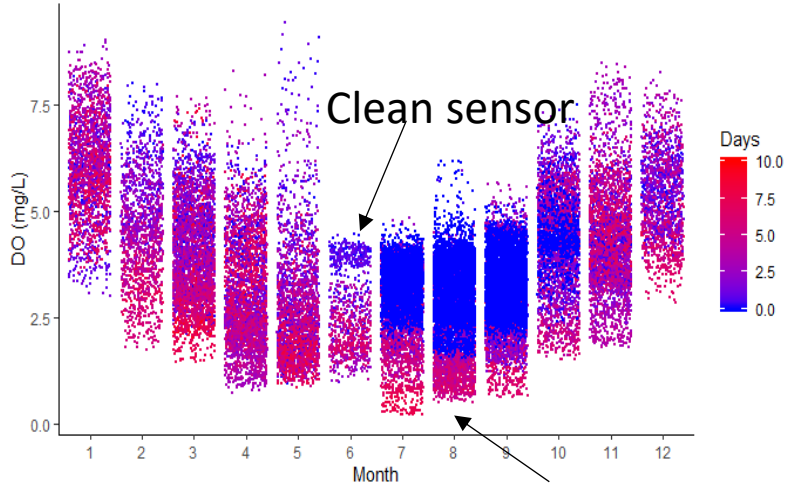
Sample Frequency and Techniques

- Sample type and collection frequency varies by indicator and data quality objectives
- Grab samples - discrete or composite
  - Pollutants in water column
  - Pathogens in water column
  - DNA in water column
  - Sediment core for pollutants or diatoms
  - Fish tissue contaminants
  - Biological communities (e.g., fish, benthic macroinvertebrates, vegetation)
- Continuous monitoring - data sondes/probes collect measurements at a defined interval (e.g., 1, 5, 15 min)
  - Dissolved Oxygen
  - Temperature
  - pH
  - Conductivity



Continuous Monitoring

- Technology and science is growing
  - Widely used for basic parameters: DO, pH, temp
  - Growing use for nutrients and other parameters
- Many advances driven by information technology
  - Microprocessor cost
  - Cloud computing capabilities
  - Ubiquitous communications
  - Novel techniques for handling “big data”
- Deployment, operation, maintenance critical to data quality
  - Infrastructure needs – secure location, power source
  - Staffing needs – routine visits to address fouling, calibration
  - Equipment loss due to currents, extreme weather, vandalism



Fouled sensor

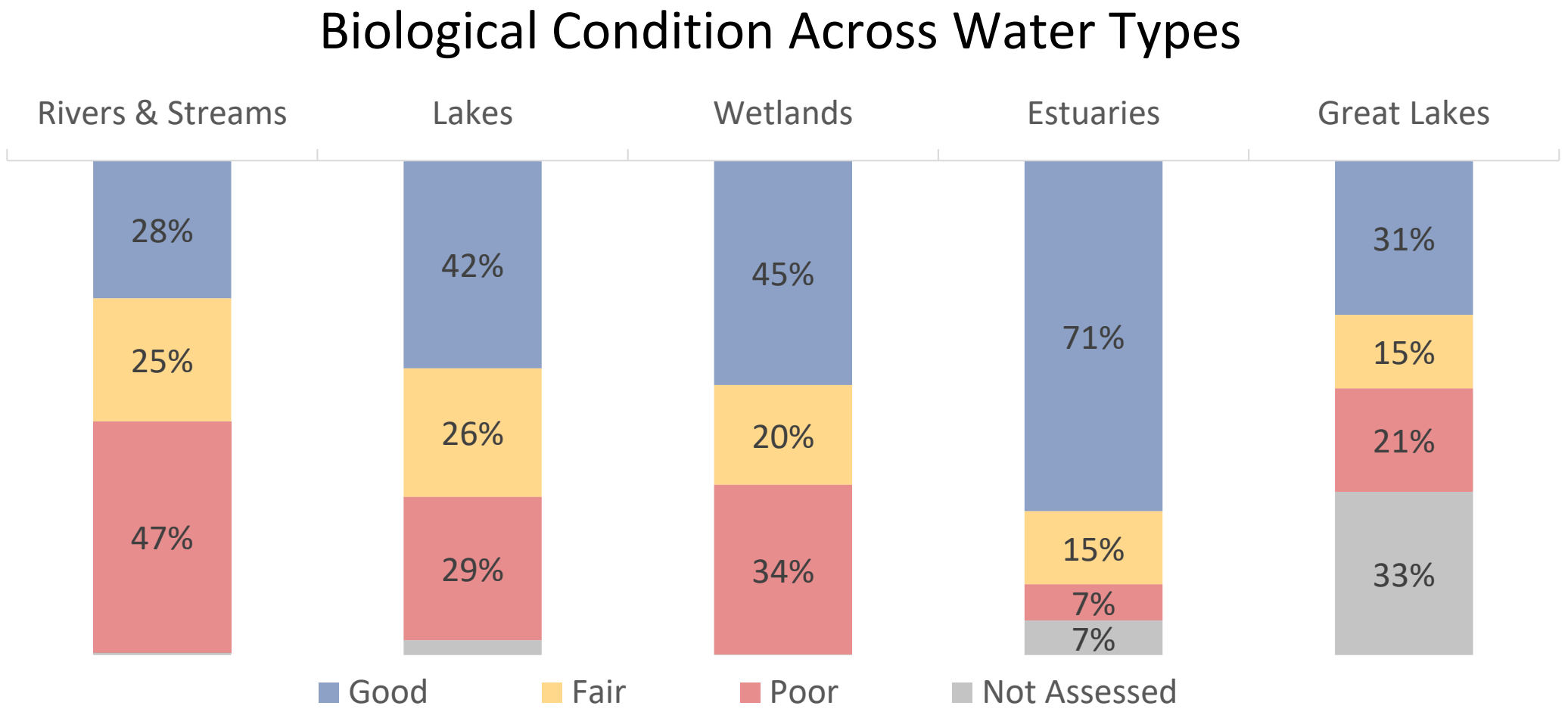
National Aquatic Resource Surveys:
A Partnership among EPA, States and Tribes

Coastal *Streams and Rivers* *Wetlands* *Lakes*

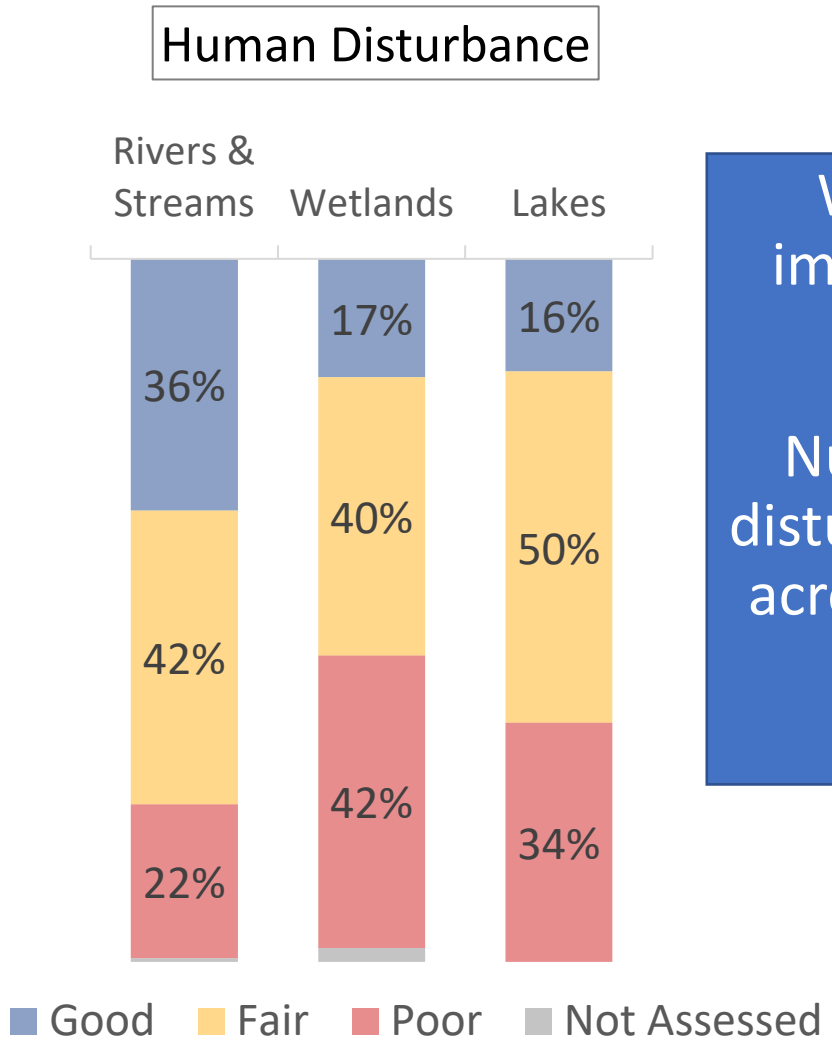
1. Assess biological and recreational condition and changes over time of the nation's waters using indicators of condition and stress.
2. Rank stressors based on the relative associations between indicators of condition and indicators of stress.
3. Build/enhance state and Tribal monitoring and assessment capacity.

For more information: https://www.epa.gov/national-aquatic-resource-surveys

What is NARS Telling Us?

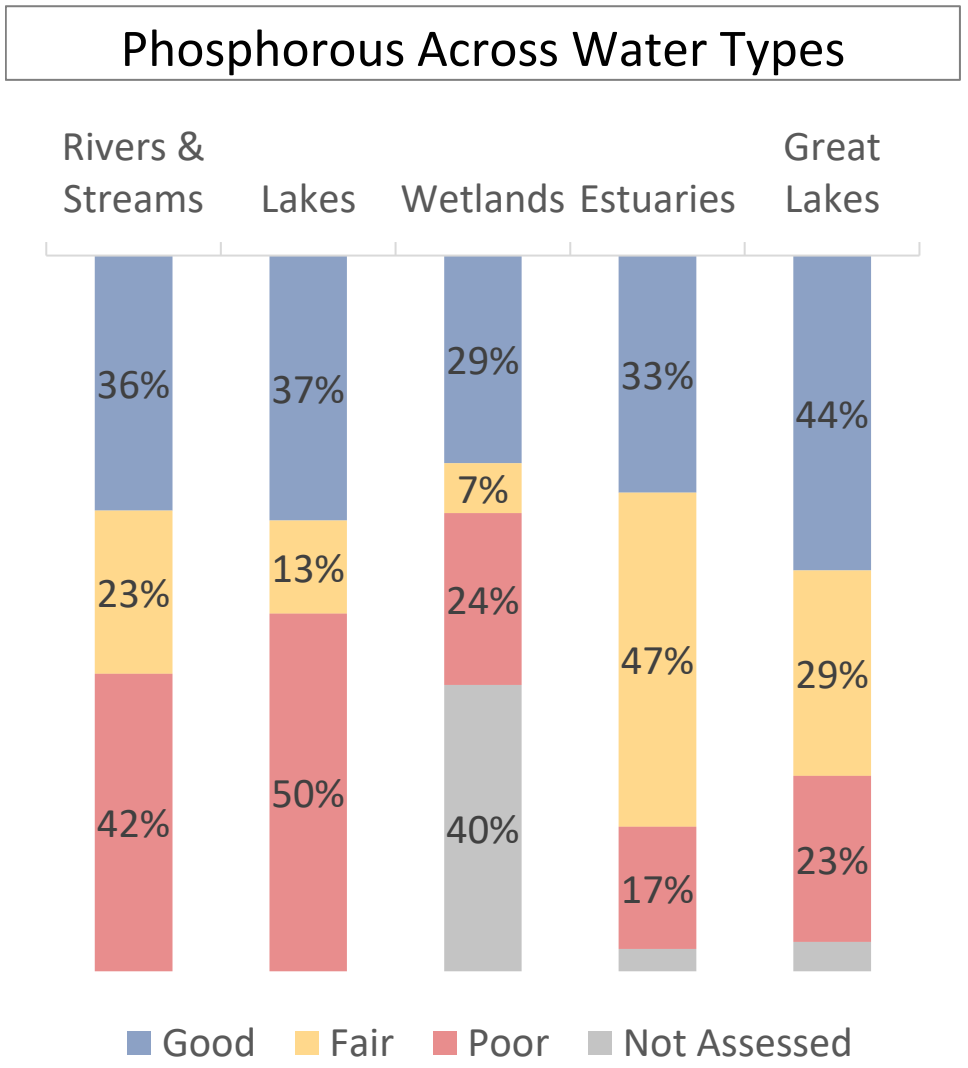


What is NARS Telling Us?



What Stressors are impacting our waters?

Nutrients and habitat disturbance are problems across water body types



What is NARS Telling Us?

What is the recreational condition of our nation's waters?

- Cyanobacteria Toxins
  - In lakes, microcystins were detected in 20% of lakes and were at levels of concern in 2%
  - In wetlands, <1% had levels of concern
- Fecal Contamination
  - Enterococci were found at levels exceeding a human health threshold in 20% of rivers and streams
- Fish Tissue
  - Mercury levels in fish were above the criterion in 5% of river and stream miles and 2% of coastal estuaries

Approximate Costs

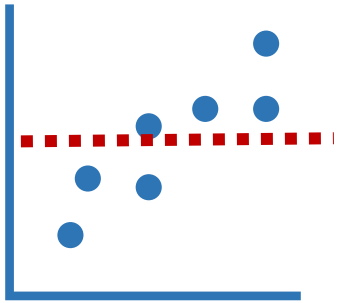
Many factors influence field sampling costs per site

- **<u>Lab costs (per sample):</u>**
- Water (basic, e.g., nutrients): $70 to $160
- Water (Metals): $25 to $115
- Water (Priority pollutants): $100 to $200
- Water (Indicator bacteria): $20 to $50
- Fish Tissue Contaminants: $60 to $1200
- Macroinvertebrates (identification & counting): $350 to $500

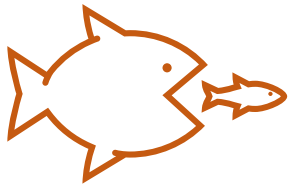
Site Cost $1,000	Site Cost $6,000
Seasonal employees	Permanent Staff
2-person field crews	3-to-4-person field crews
Consumables	Consumables + equipment
Sites close-by, easy access	Remote sites, difficult access
Simple reporting	Glossy reporting

Water Quality Assessments and Tools

Basics of Water Quality Assessment



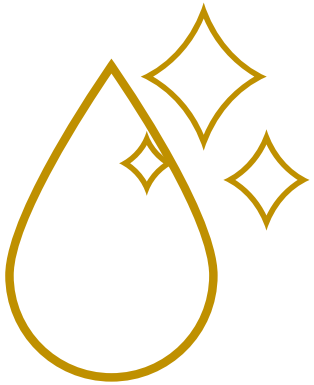
Designated uses drive numeric and narrative water quality criteria



Assessment unit overlay with monitoring locations and WQC

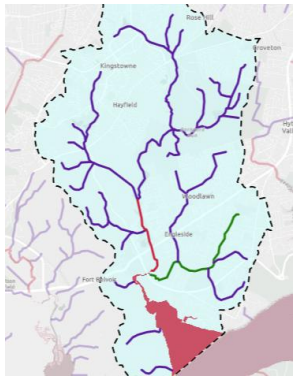
Data analysis guides impairment decisions based on:

- Criteria components
  - Frequency
  - Duration
  - Magnitude
- Additional complexities
  - Seasonality
  - Site-specific
  - Acute vs. chronic exposure
  - Spatial & temporal aggregation
  - Sampling depth
  - And more!



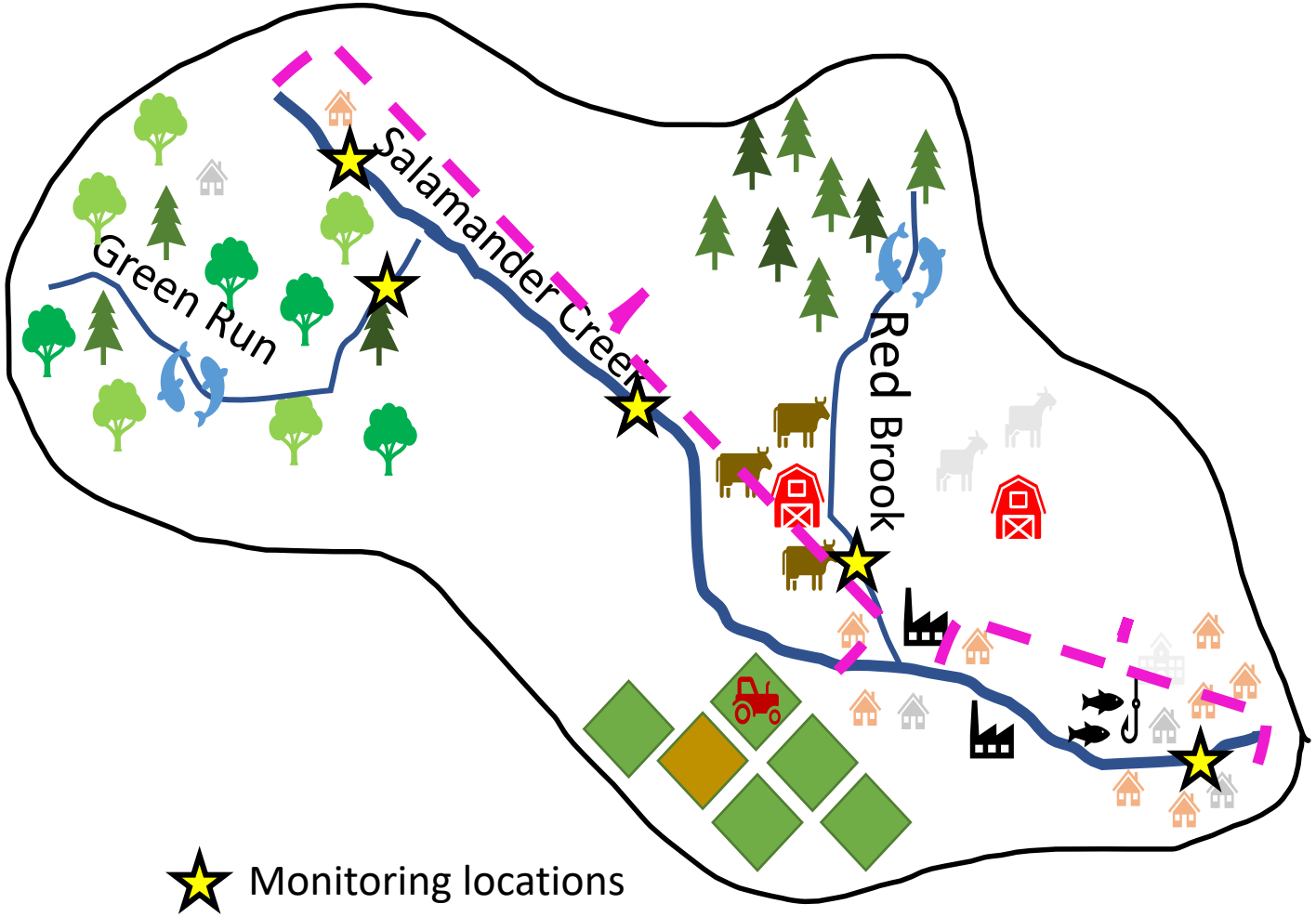
Discover, assemble, and QC available data

Assign assessment units



Example: Salamander Creek Watershed

Type	Designated Use	Salamander Creek	Red Brook	Green Run
Aquatic Life Support	Aquatic Life Other Than Fish	X	X	X
	Coldwater Fisheries		X	X
	Warmwater Fisheries	X		
Recreation	Primary Contact		X	X
Water Supply	Irrigation	X		
	Livestock		X	
	Drinking	X		



Salamander Creek: Numeric Criteria

Salamander Creek is designated for four uses that have the following numeric criteria:

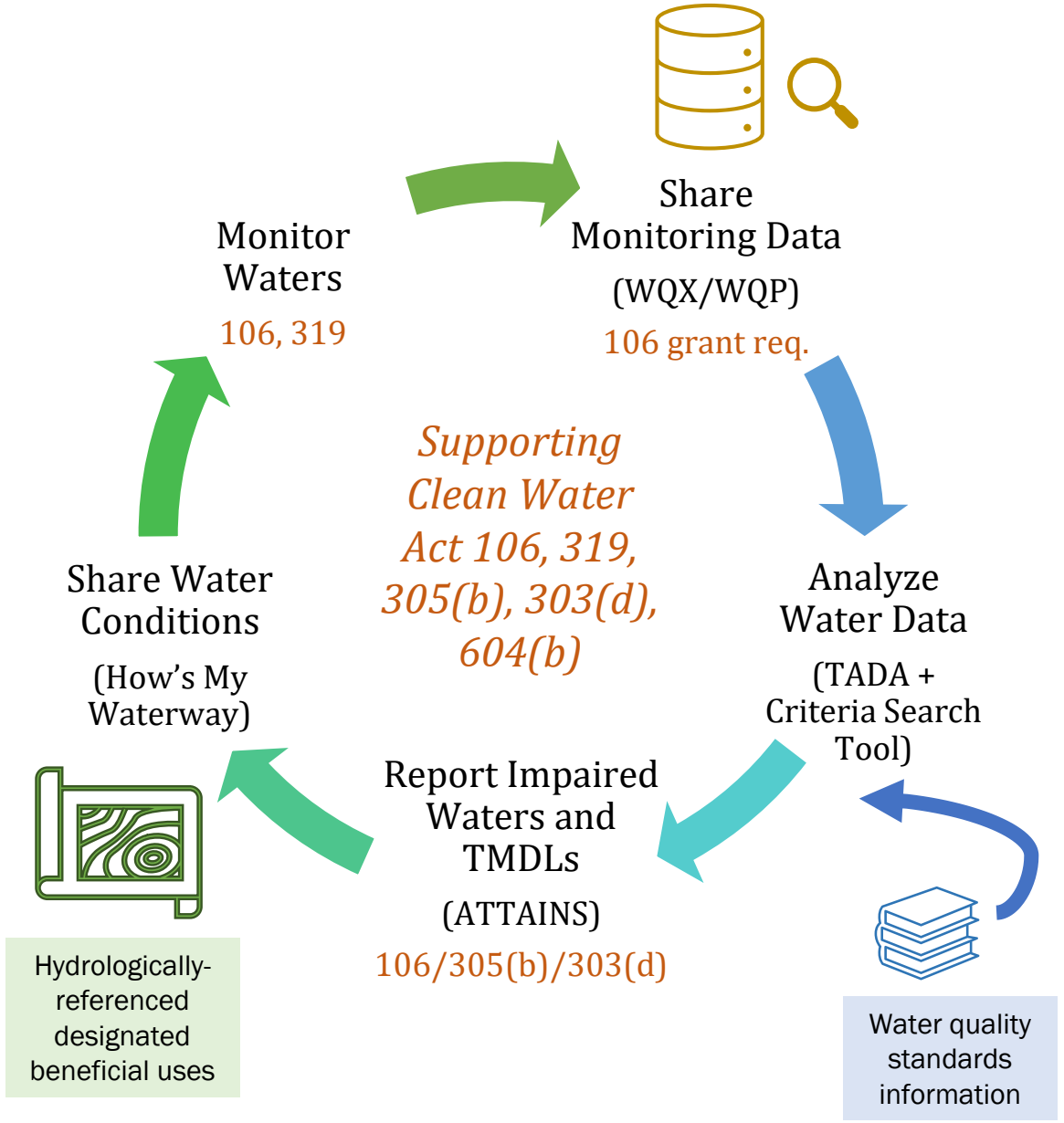
Parameter	Unit	Type	Statistic	Exceedance	Aquatic Life Other Than Fish	Irrigation Water Supply	Public Drinking Water Source	Warmwater Habitat
Conductivity	uS/cm	Maximum	Instantaneous	10%	750	2,500	1,000	1,500
Dissolved oxygen	mg/L	Minimum	Instantaneous	None	5.0	--	--	5.0
Nitrate	mg/L	Maximum	Average*	None	1.5	100	10*	1.0
pH	SU	Range	Instantaneous	None	6.5<pH<9	--	--	6.5<pH<9
Total phosphorus	mg/L	Maximum	Average	None	0.1	--	--	0.3

** The nitrate criterion is instantaneous for the public drinking water source.*

What data and tools are available to assist with assessments?

Data and Tools Supporting the CWA

- Water Quality eXchange (WQX)
- Water Quality Portal (WQP)
- Tools for Automated Data Analysis (TADA)
- Criteria Search Tool (CST)
- Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS)
- How's My Waterway? (HMW)



What is the Water Quality Exchange (WQX)?

A data system managed by the EPA that standardizes and centralizes the submission and sharing of water quality data, making it accessible for analysis and monitoring by researchers, policymakers, and the public.

A standardized format and database for submitting water monitoring data.

Provides a common data model for sharing various types of water quality data, including chemical, physical, and biological.

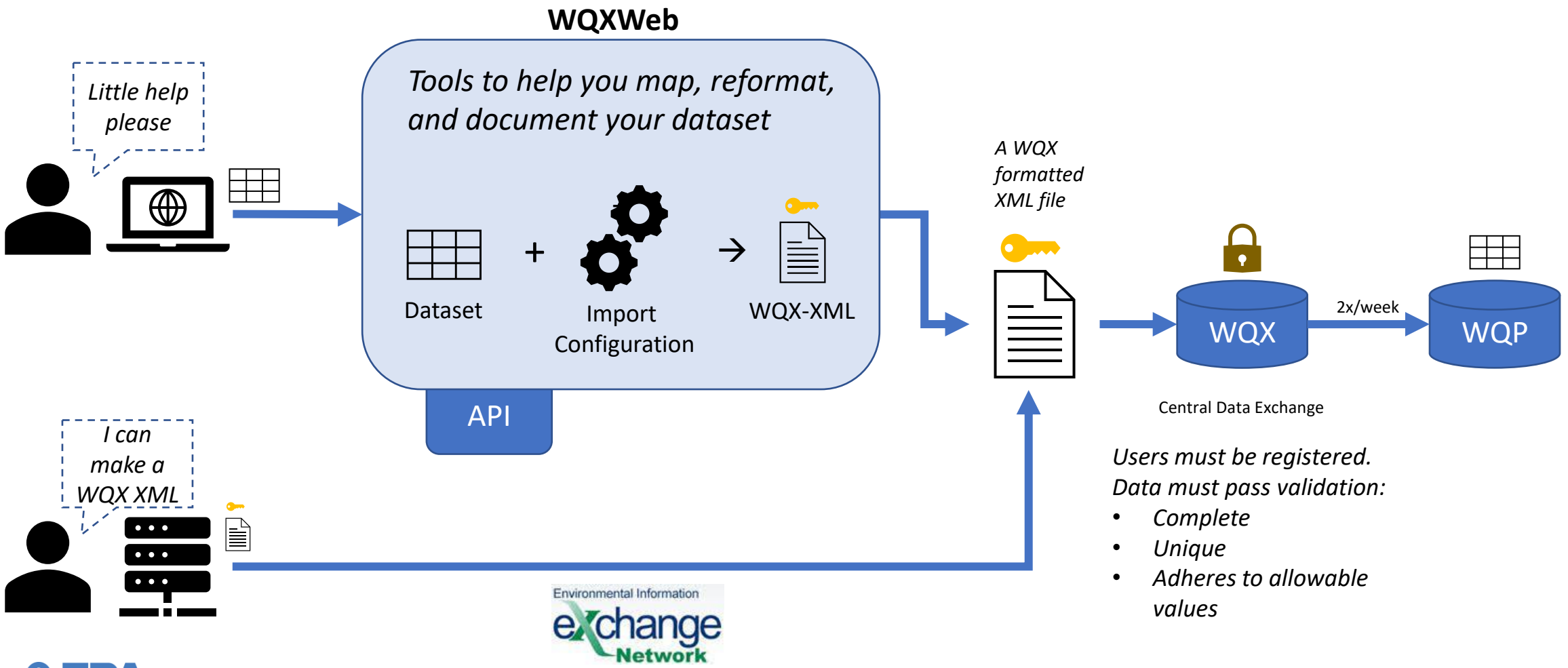
Your datasets can be adapted to WQX standards with our custom configurations, and tools are available to automate submissions.

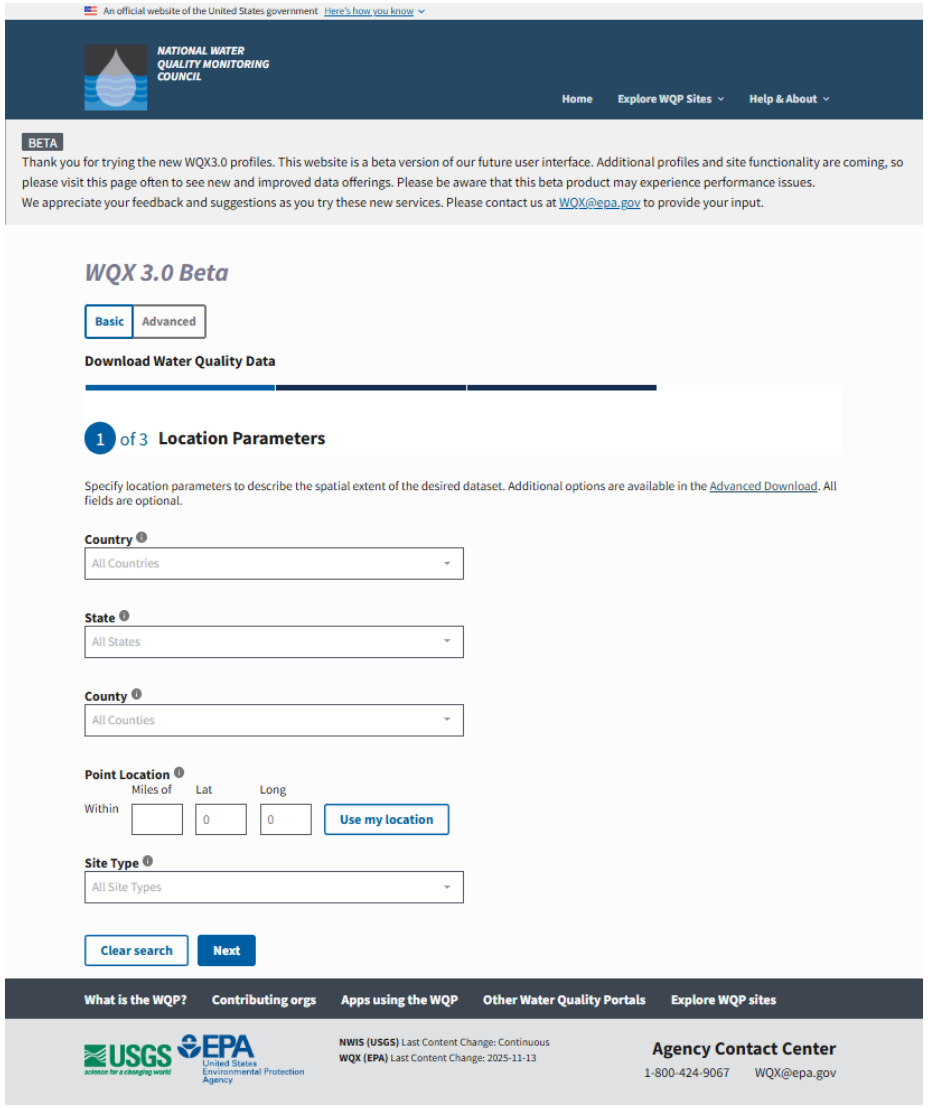
You can submit data to WQX via direct submissions, WQXWeb, or third-party apps.

Part of the Water Quality Portal, a collaboration between the EPA and USGS, offering centralized access to water quality data.

https://www.epa.gov/waterdata/water-quality-data-upload-wqx

Ways to share your data to WQX





Access Water Quality Data Through the Water Quality Portal

- **Data Sources:** Combines USGS and EPA WQX data.
- **Records:** 430M+ records from 1M sites by 1,500+ organizations.
- **Formats:** Available for download or via web services.
- **Interface & Search:** Easy search, filter, and retrieval by location, date, and parameters.
- **R Packages:** dataRetrieval and EPATADA for direct R access.
- **WQX 3.0:** Enhances standardization and metadata, moving to production by 2026.

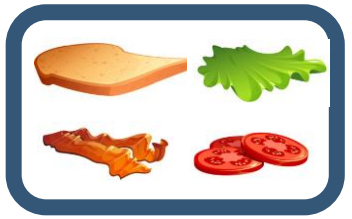
TADA: Tools for Automated Data Analysis

- A suite of open-source R tools (R package and R Shiny applications) designed to efficiently discover, compile, clean, analyze, and visualize data from the Water Quality Portal (WQP)
- A hub for the open-source water quality community collaborate!

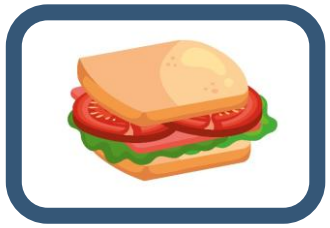
Contributors 24

+ 10 contributors

- Flexible Design

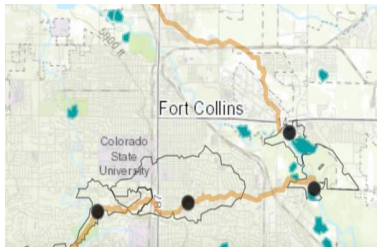


TADA Functions



Your Analysis

- Compatible with WQP/WQX and ATTAINS



Where to Find ATTAINS Information:

Assessment and TMDL Tracking System (ATTAINS)

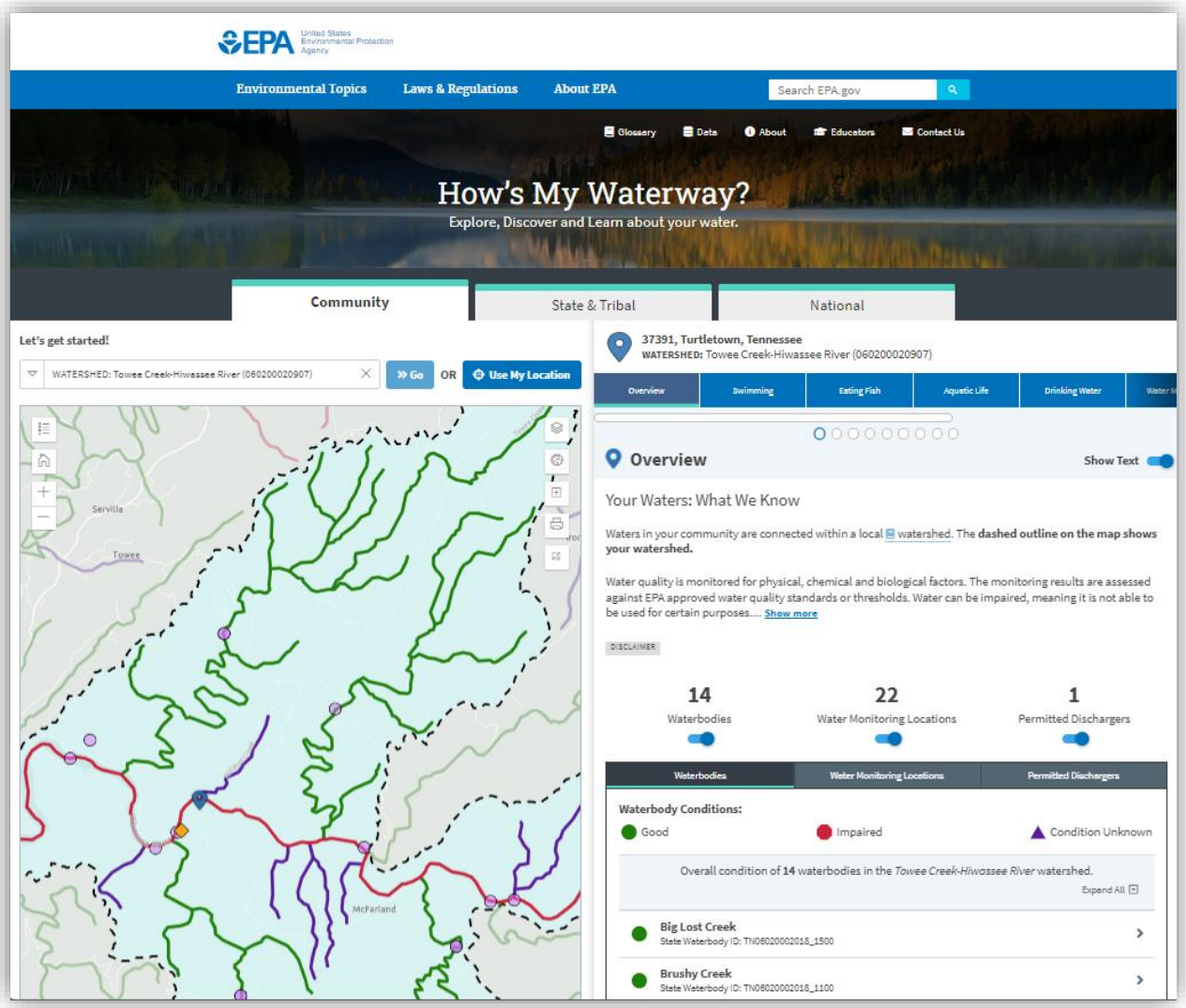
- **Inside ATTAINS**
  - Query Draft or Final Data
  - Query within an Organization
  - Answer Common Questions
  - Compare Data Between Cycles

- **Public**
  - Final Data Published Through Web Services
  - Can be configured by Apps like How's My Waterway
  - Geospatial Service (also consumed by HMW)
  - ATTAINS GIS Service is Most Used Geospatial Layer at EPA!
- **Coming Soon: Expert Query**
  - For Advanced Users

https://www.epa.gov/waterdata/attains

How's My Waterway?

- This mobile and public-friendly website integrates water data and information from many sources
- Covers the quality of local, state, and national waters, and whether they are suitable for:
  - swimming
  - eating fish
  - supporting aquatic life
  - drinking water
- Not a database, refreshes data from original sources including WQP/WQX, ATTAINS, and ECHO in real-time
- Users can customize with additional data streams



https://mywaterway.epa.gov/

Accessing Geospatial Data

Water geospatial data layers can be downloaded at EPA's WATERS website and linked to NHD

- Permitted Dischargers
- Fish Consumption Advisories
- Fish Tissue Data
- Impaired Waters with TMDLs
- Sewage No Discharge Zones
- Nonpoint Source Projects
- Water Quality Standards
- Listed Impaired Waters
- Assessed Waters
- Beaches
- Clean Watershed Needs
- Combined Sewer Overflows
- CWSRF Benefits Reporting

Summary on Water Monitoring

Summary

Monitoring and Assessment

CWA Product	Objective
Criteria/ Standards	Set measures and levels which allow desired uses
305(b) Reporting	Describe extent of waters supporting CWA goals and contribution of point and Nonpoint sources
303(d) List	List all impaired waters that need a TMDL to meet WQS
TMDLs	Determine loadings which allow desired use
Permit/ Remediation	Take appropriate actions to limit loadings to achieve desired uses

Integrate Monitoring for these Programs

Additional Resources

- EPA's Biological Criteria and Data
- EPA's Clean Water Act Analytical Methods
- EPA's Envirofacts
- EPA's EnviroMapper
- EPA's Monitoring and Assessing Water Quality - Volunteer Monitoring Website
- EPA's My Environment – Environmental Information for My Area
- EPA's Test Method Collections
- EPA's Water Topics
- EPA's Water Quality eXchange (WQX)
- EPA's WATERS (Watershed Assessment, Tracking, and Environmental Results System)
- EPA's WATERS Geoviewer
- Ecological Risk Models and Tools
- Integrated Reporting Guidance