Monitoring and Assessment

Virtual WQS Academy

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

June 2024

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  - Impose any binding requirements
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  - Change or substitute for any statutory provision or regulation requirement
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What Does This Session Cover?

- Brief intro to monitoring and assessment
  - Who monitors water quality?
  - How are monitoring data used?
  - What are different types of monitoring designs?
- What are critical components of a monitoring program needed to generate data of documented quality?
- 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 lakes, streams, rivers and other types of water bodies to assist them in managing water quality.
- Water resource managers use data to determine: where pollution problems exist, where to focus pollution control energies or 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

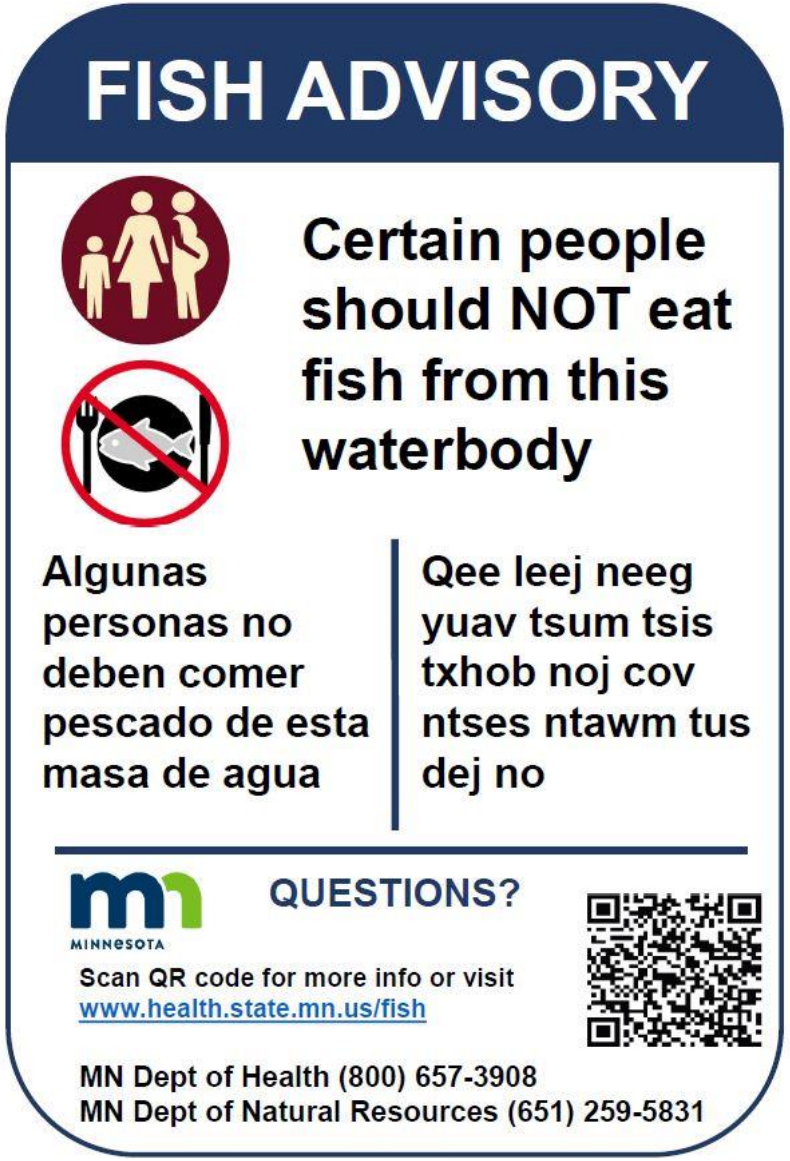
- Downtown Atlanta, GA waterway polluted by stormwater flooding and CSOs.
- Runs through economically depressed portion of city (4 Superfund sites in area).
- Neighborhood Water Watch Program expanded by Urban Waters Federal Partnership grant.
- Residents near Creek trained to monitor streams and collect 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

- Monitoring Data is a part of the story that we can tell about water and aquatic life.
- It feeds into assessment decisions and can inform on-the-ground actions for water quality restoration and protection.

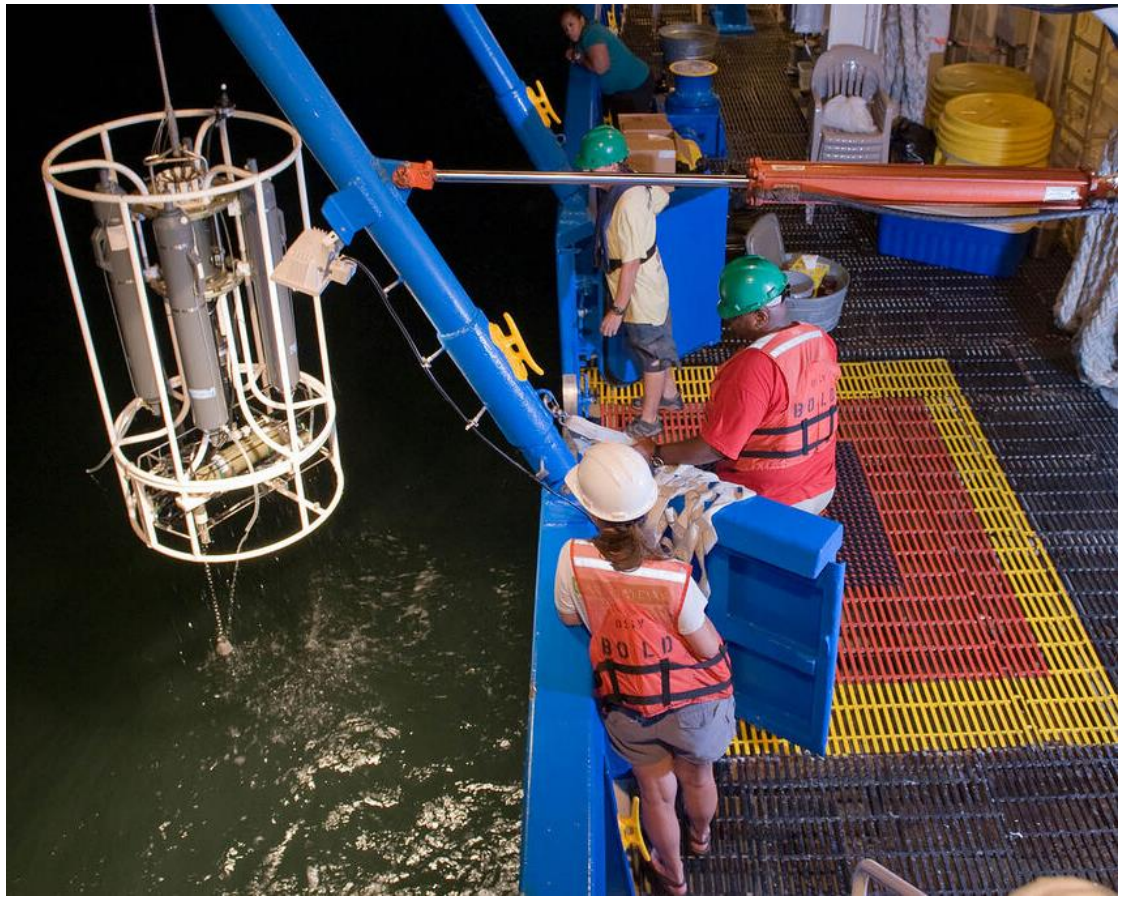
How Are Monitoring Data Used?

- 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
- Determine change in water quality conditions over time



Project Design

- Approach for answering the questions:
  - The why, who, what, how, and where of monitoring
- Sampling locations based on spatial and temporal representativeness
- Core indicators
- Data quality objectives and methods
- Quality assurance
- Data management and interpretation.
- Are existing data suitable?
- Costs are a major consideration



Quality Assurance Plans and Laboratory and Field Protocols

- To ensure quality data are generated:
  - Use existing protocols to the extent possible
  - Develop Quality Assurance Project Plans (QAPPs) and other quality-related references
  - Document that laboratory methods meet data quality objectives
  - Document sample collection procedures for water, biology, tissue and habitat data indicators
  - Train and assess performance of all field crew personnel
  - Evaluate lab competency

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

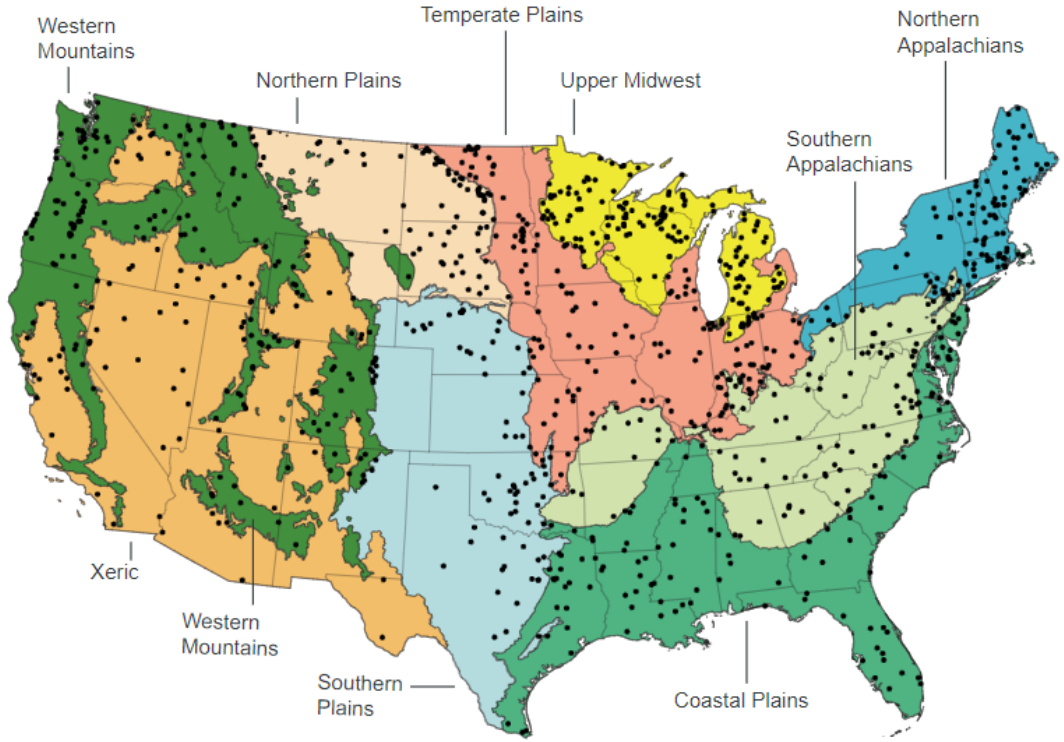
Types of Monitoring Designs

- We can't monitor everywhere, so we must monitor "smart."
- Types of monitoring designs include:
  - Statistically-valid surveys
  - Targeted monitoring
  - Fixed Site Network
  - Rotating basin
- EPA recommends that States/Tribes integrate a variety of designs to best meet the range of monitoring objectives and multiple decision needs.

Statistically-Valid Surveys

- Site selection and data analysis are based on well developed and documented 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?

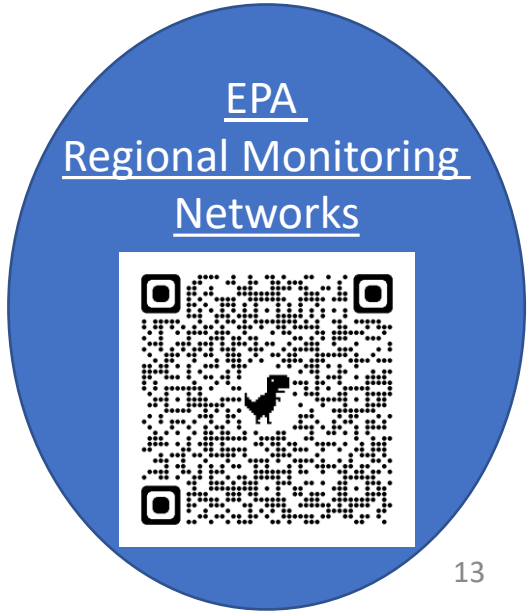
Exhibit 1: Map of NLA 2017 Sampling Sites in Each Ecoregion



From: [EPA's National Lakes Assessment: The Third Collaborative Survey of Lakes in the United States]

Targeted Sampling

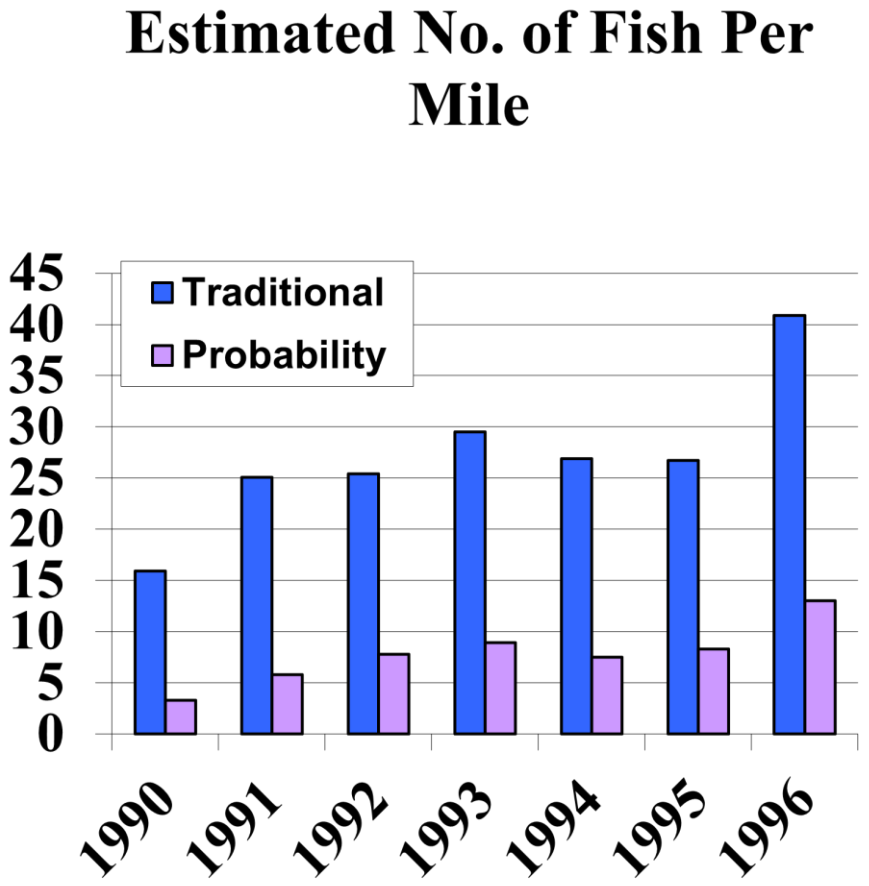
- Intentional selection of locations and parameters to inform a particular issue or question
- Allows for detailed analysis of cause and effect, fate and transport, seasonal variation
- Often targeted towards areas of concern. For example, targeted designs might:
  - Confirm 303(d) listing needed
  - Confirm and supplement information on pollutants/sources
  - Establish baseline - address climate change
  - 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.



Rotating Basin

- More an Implementation Approach than a 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, targeted designs.
- Typically informed by discussion across programs to address range of program decision needs, like TMDL development, permit renewal.
- Five year return cycle supports tracking changes and trends over time.

Example:

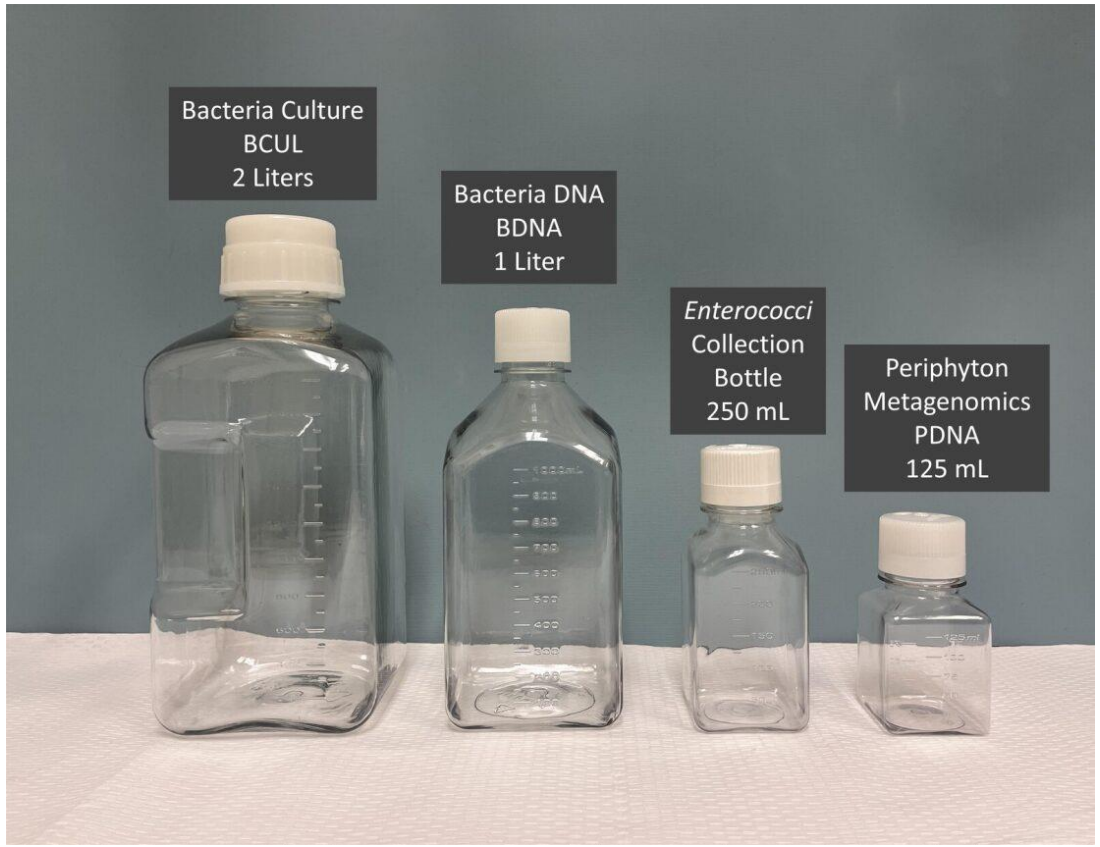
OKLAHOMA CONSERVATION COMMISSION

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

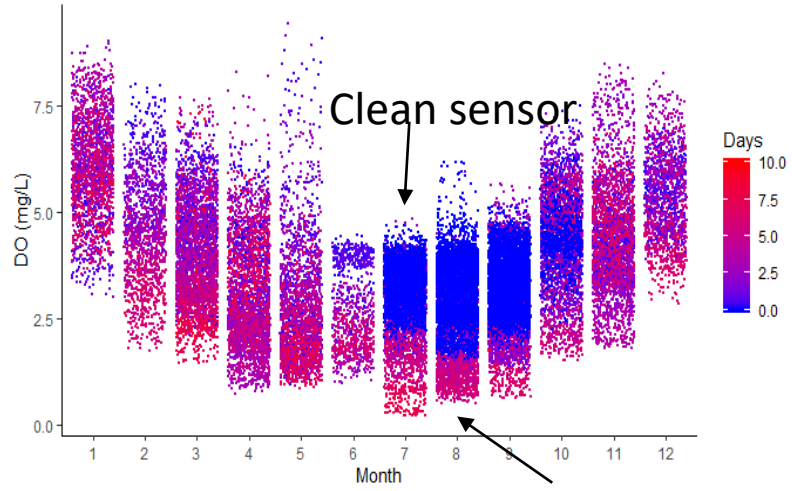
Sample Frequency and Techniques

- Discrete, composite or grab, samples – collection frequency varies by indicator and data quality objectives
  - 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 15 minute or greater intervals in water column for parameters including DO, temp, pH



Continuous Monitoring

- Technology and science is growing
  - Widely used for basic parameters, DO, pH, temp
  - Growing use for nutrients and other measures
- 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

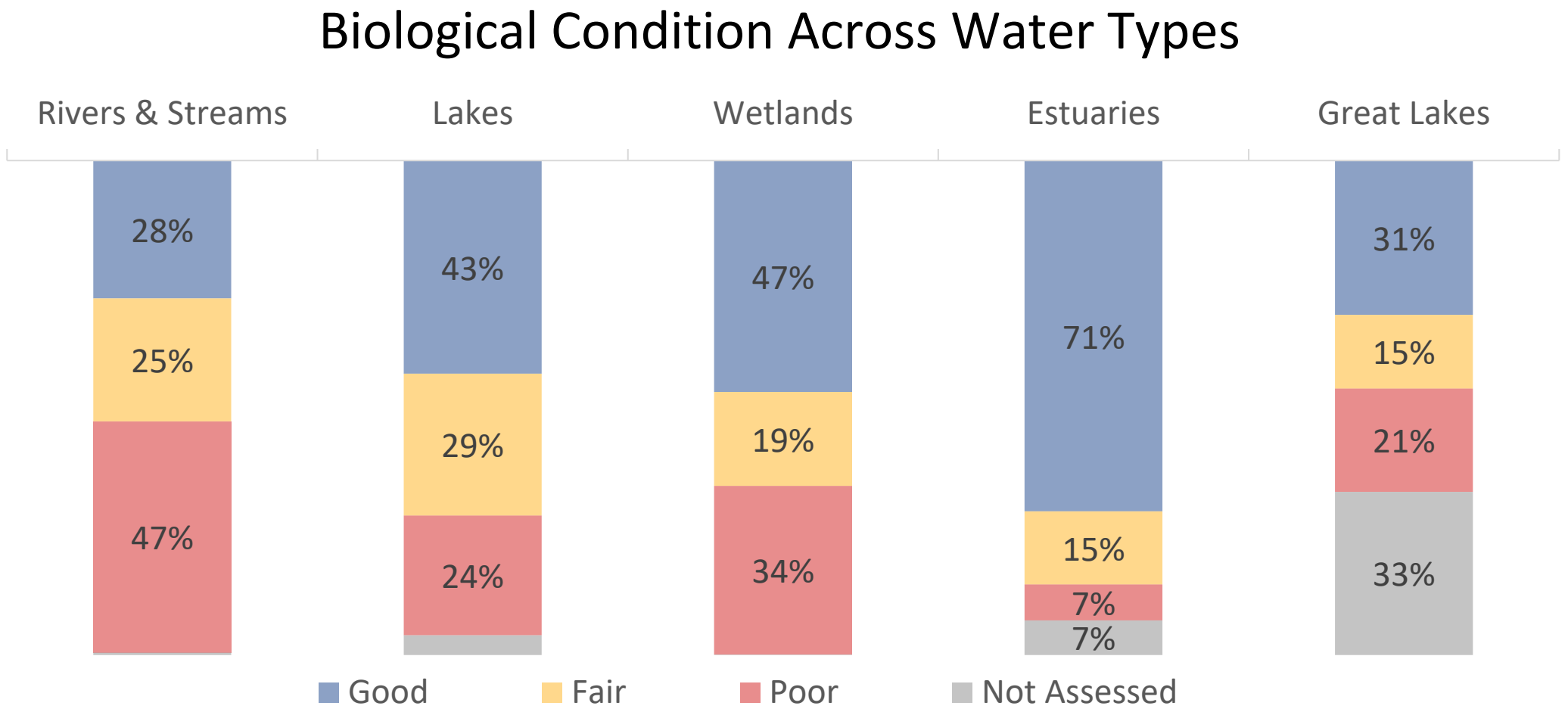
National Aquatic Resource Surveys:
A Partnership among EPA, States and Tribes

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?



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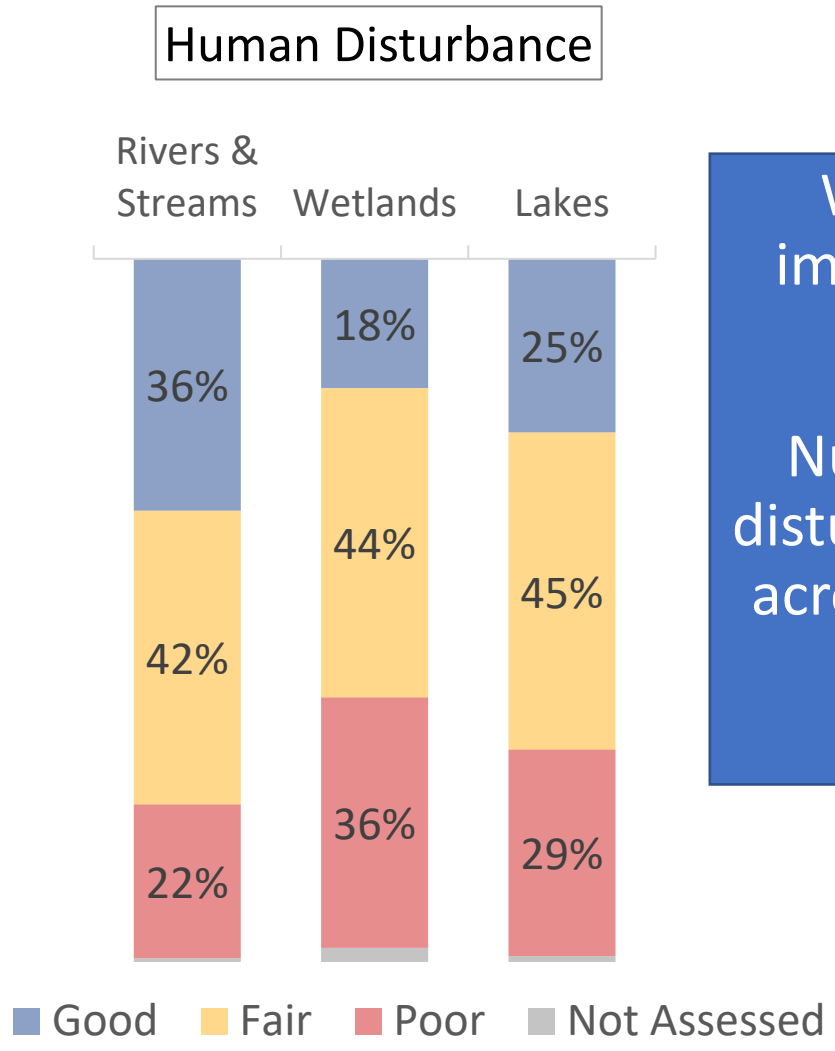
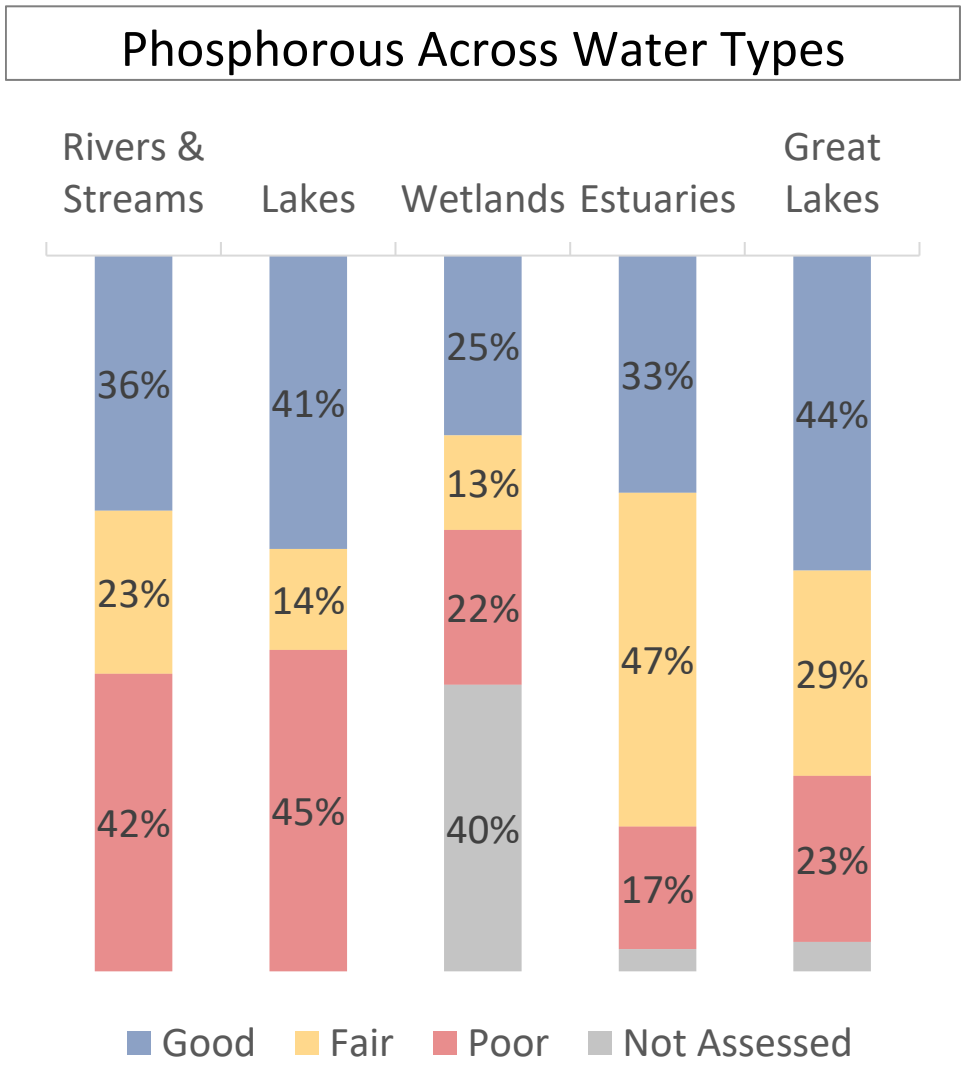


What Stressors are impacting our waters?

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

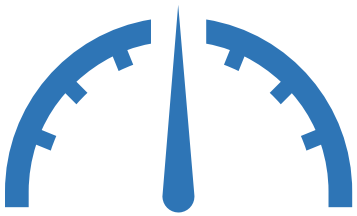
Site Cost $1,000	Site Cost $6,000
Seasonal employees	Permanent Staff
2-person field crews	3-to-4-person field crews
Consumables	Consumables + equipment
Sites close-by, easy access	Remote sites, difficult access
Simple reporting	Glossy reporting

Water Quality Assessments and Tools

Water Quality Assessments

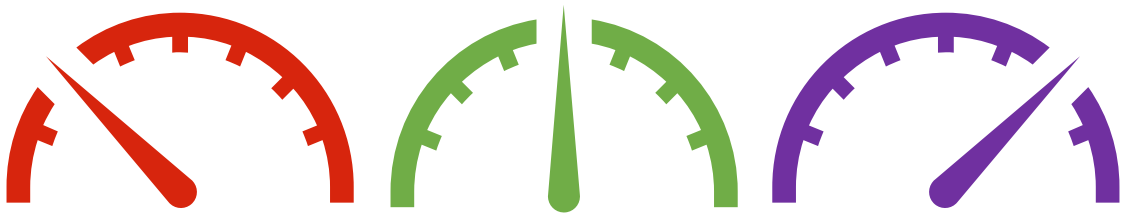
Program

*Program specific



Water Quality Standards, Designated Uses, Criteria, Assessment Units (Waterbodies)

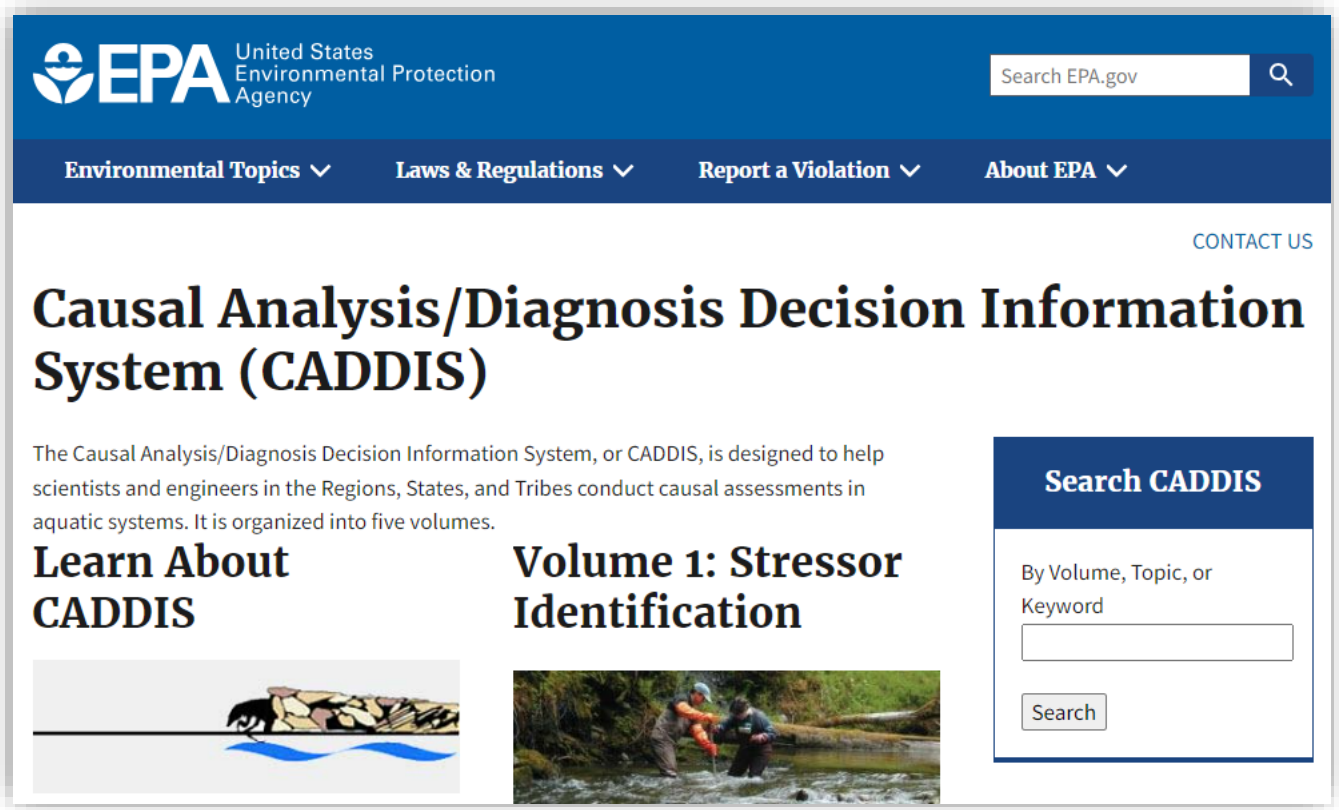
Data



Observed monitoring data, ecological indicators, other applicable information, etc.

Assessment Resources

A library of guidance documents for developing Water Quality Standards and Assessment Methods, and Criteria

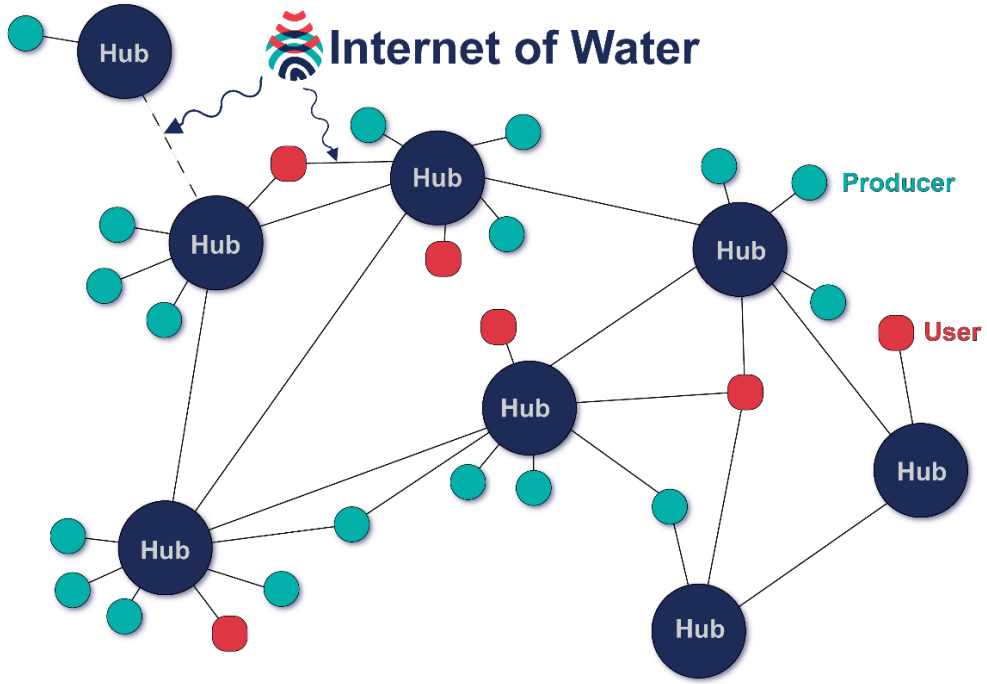


Additional resources and tools for criteria development, stressor identification, and modeling

What data and tools are available to assist with assessments?

Data Management - Internet of Water

The IoW concept envisions a world engaged in sustainable water resource management and stewardship enabled by open, shared, and integrated water data and information.



- **Data Producers**: Generators of data
- **Data Hubs**: Collections of data sets in standard formats
- **Data Users**: Create value by using data

What is the Water Quality Exchange (WQX)?

It is a standardized data format and submission database

WQX is a ‘standardized’ approach for sharing water quality monitoring sample data

WQX defines a common data model for sharing water quality data of different types (chem, phys, bio, etc.)

Tools available to automate submissions from your existing dataset

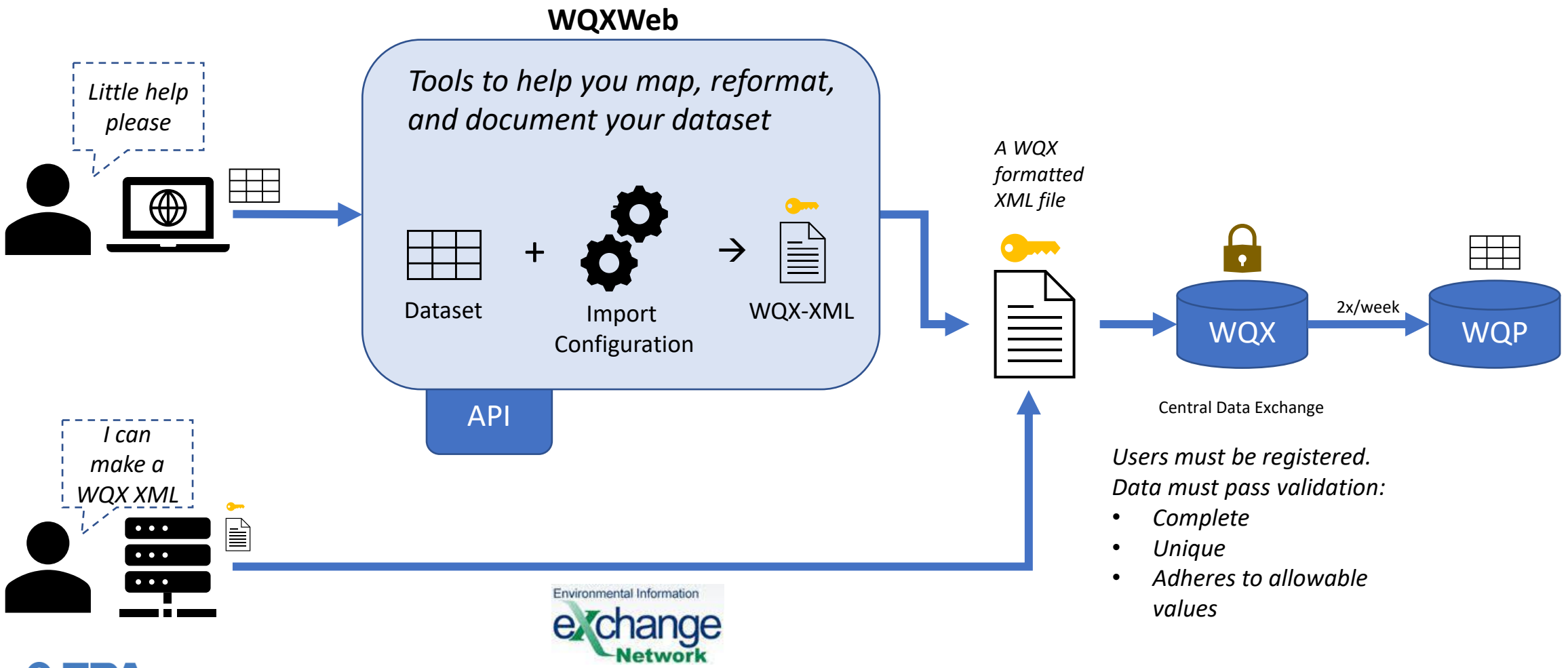
The structure of datasets and data systems don’t matter, as long as they can map data to WQX standards

Many ways to prepare and submit data to WQX: including direct submissions, WQXWeb, and 3rd party apps

EPA

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

Ways to share your data to WQX



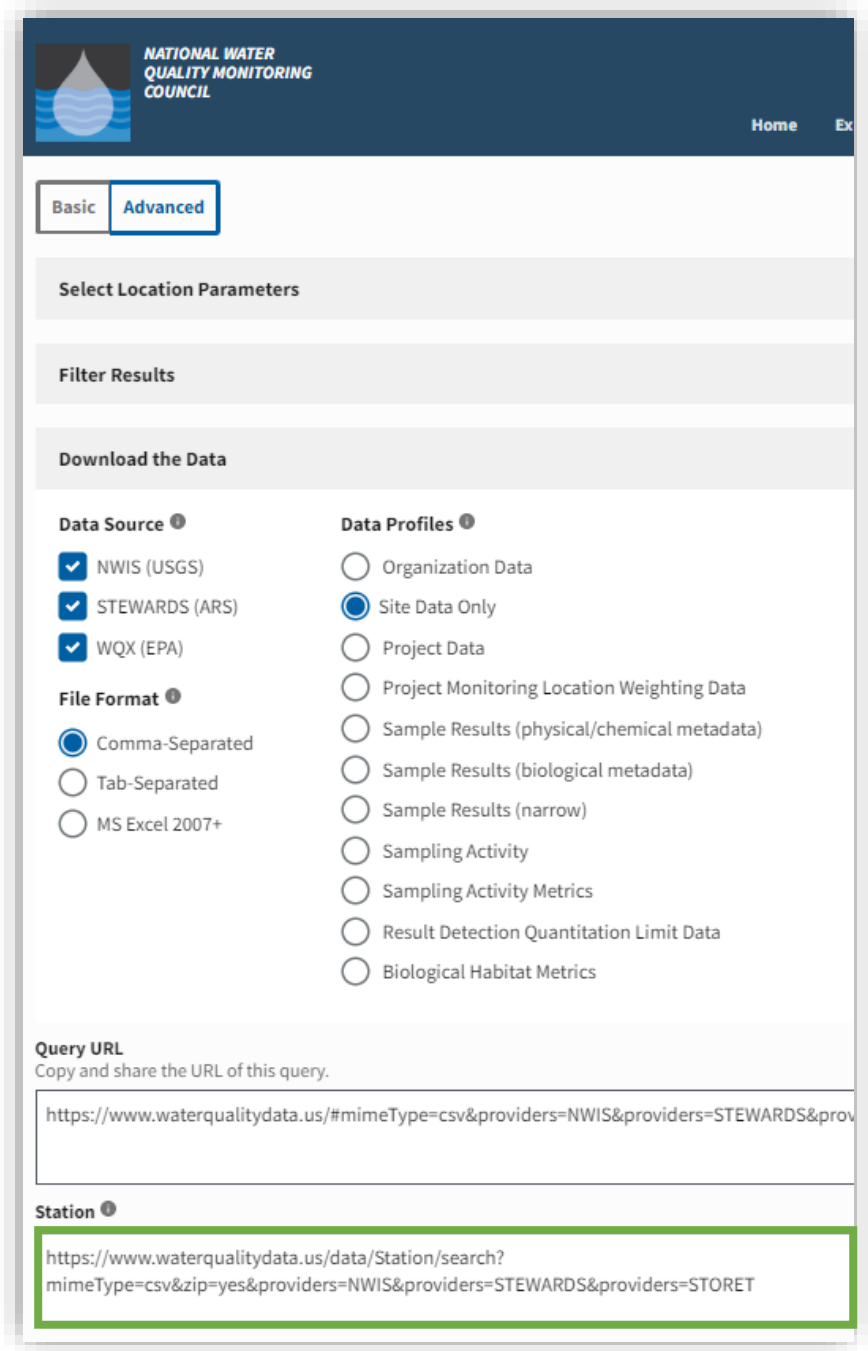
Accessing Water Quality Data

The Water Quality Portal

Integrates publicly available water quality data from the USGS National Water Information System (NWIS) the data submitted to the EPA's Water Quality Exchange (WQX).

Serves >415 million records collected from >1 million sites by >1,000 organizations.

Data available as downloads or via web services.



Supporting the CWA Through Development of R Tools for Automated Data Analysis (TADA)

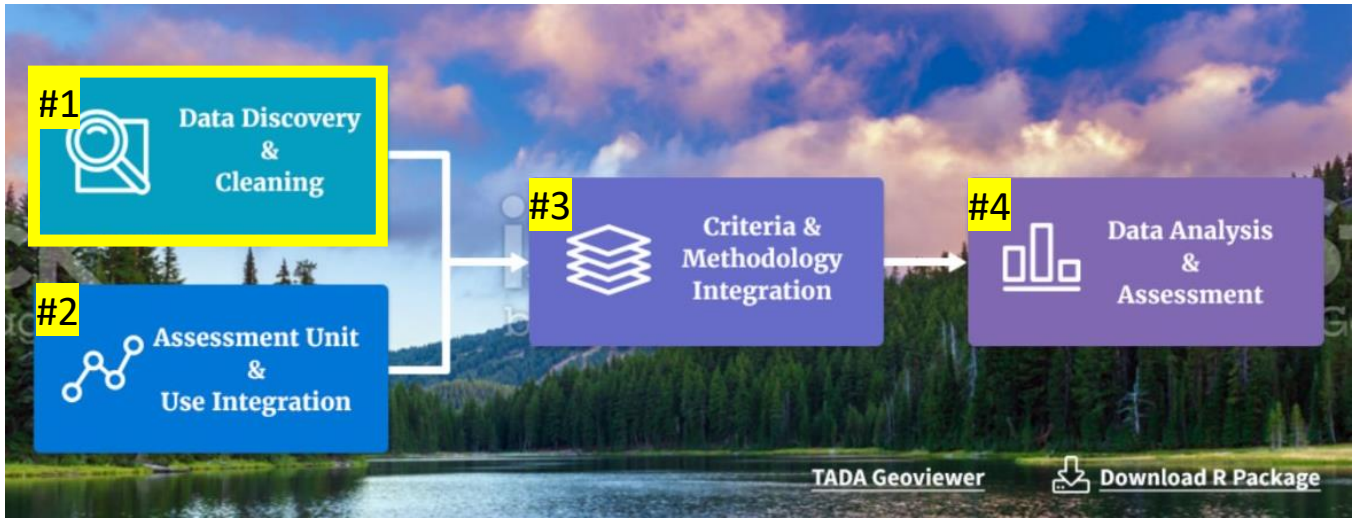
- EPA TADA Website
- R Package

(for programmers)

- R Shiny Application

(for non-programmers)

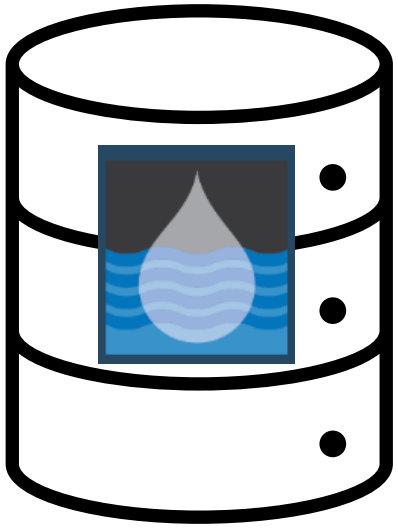
- User Guide
- R and R Shiny Learning Resources

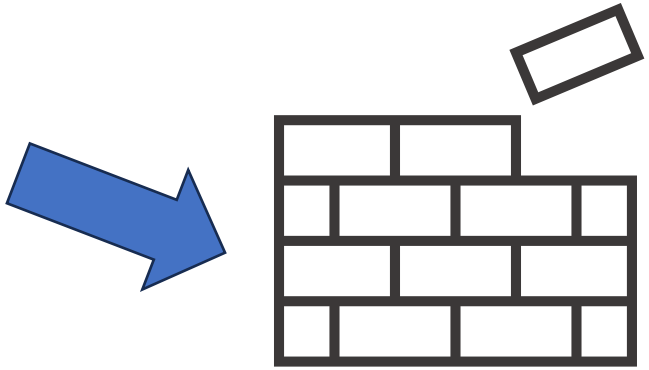


Working Group Mission Statement: To share and develop **R code** for evaluating and visualizing **WQP** data more efficiently though collaboration and open-source programming. This includes working together to find commonalities in assessment processes across the nation, creating flexible tools that can be easily customized to work within existing workflows, supporting each other in learning R, and ensuring products will be accessible to organizations most in need.

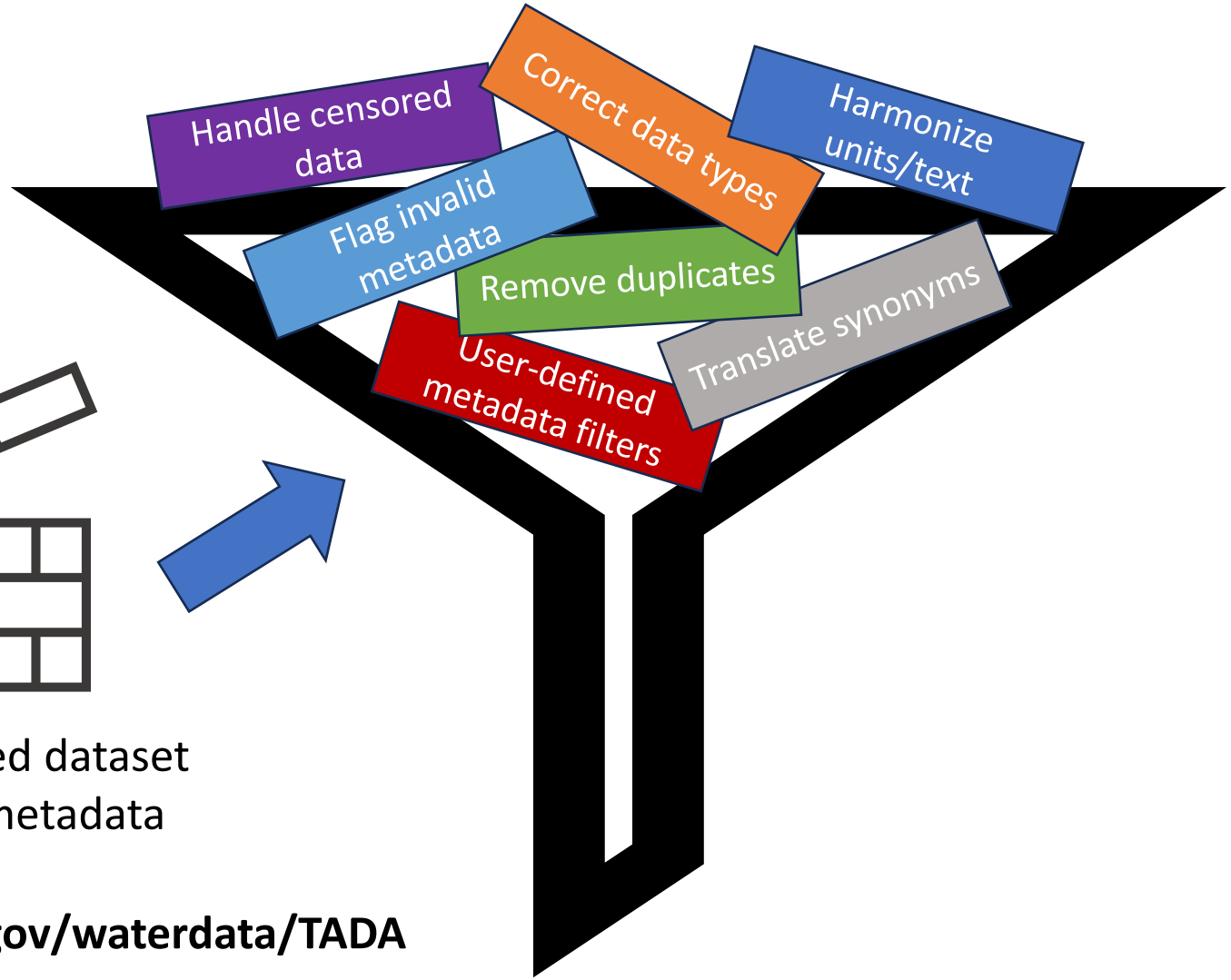
R Tools for Automated Data Analysis (TADA)

Retrieve Water Quality Portal Data





Construct a unified dataset containing key metadata



Find out more at: www.epa.gov/waterdata/TADA

EPA

Where to Find ATTAINS Information

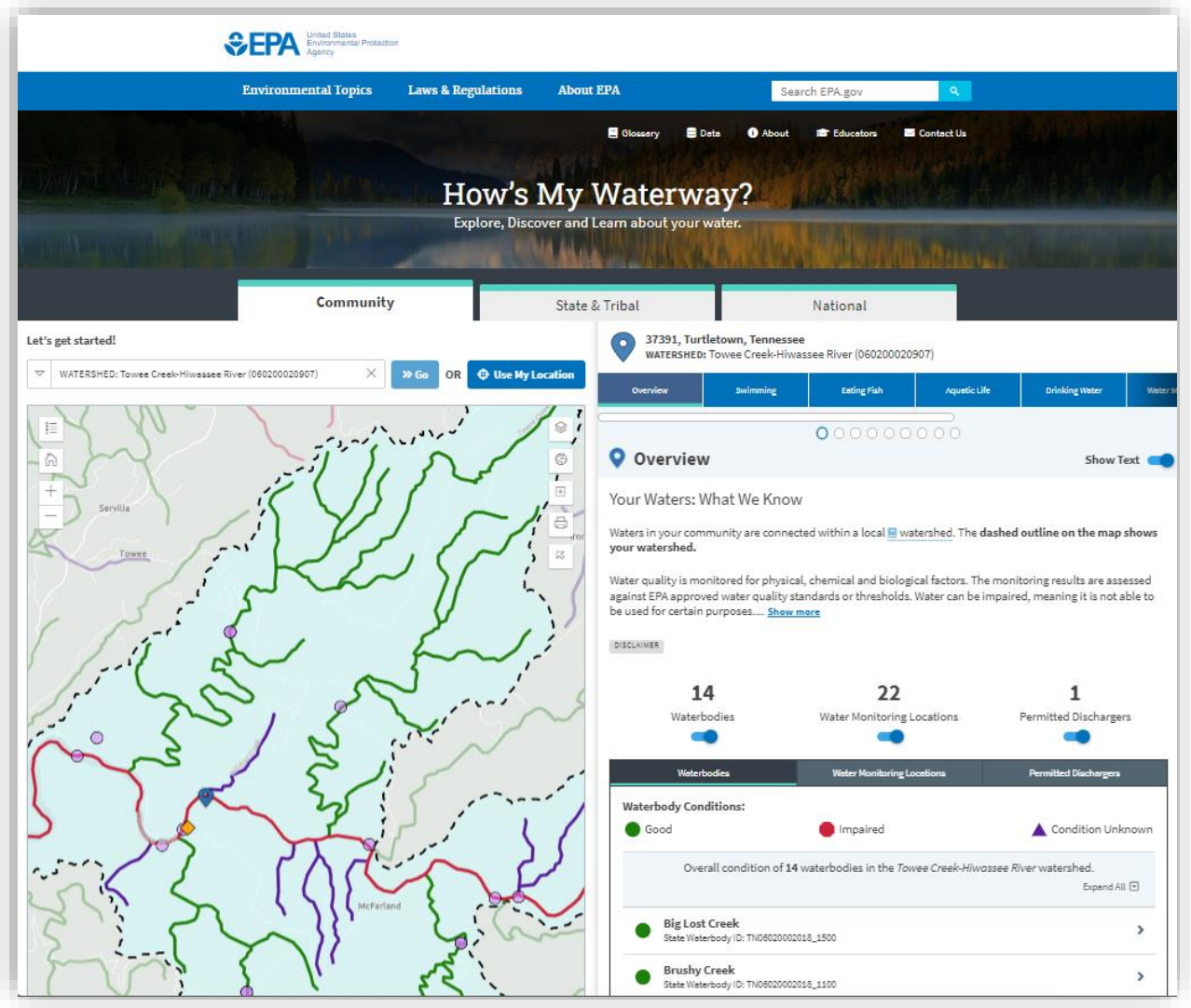
- Inside ATTAINS
  - Query Draft or Final Data
  - Query within an Organization
  - Answer Common Questions
  - Compare Data Between Cycles

- 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

Reporting Results: How's My Waterway

- The EPA's one-stop water information application:
  - Mobile-friendly website.
  - Not a database, refreshes data and information from original sources in real-time.
  - Delivers information from WQP, ATTAINS, ECHO, EJ Screen etc.
  - 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 Monitoring and Assessing Water Quality Website
- EPA's Monitoring and Assessing Water Quality - Volunteer Monitoring Website
- EPA's Test Method Collections
- EPA's Clean Water Act Analytical Methods
- EPA's Biological Criteria and Data
- Integrated Reporting Guidance
- EPA's Water Quality eXchange (WQX)
- EPA's WATERS (Watershed Assessment, Tracking, and Environmental Results System)
- EPA's WATERS Geoviewer
- EPA's Envirofacts
- EPA's My Environment – Environmental Information for My Area
- EPA's EnviroMapper