

# The Basics of Assessment

Considerations for analyzing data such as:

Quality Assurance, Finding readily available data to supplement analysis,  
and Comparing data against criteria



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# Section 1: Learning Objectives

- To understand the potential data sources and formats that may be available from both the Tribe and other data partners for use in producing a water quality assessment
- To identify the factors that can affect the quality of data used for a water quality assessment

# Can we use any and all data we find?

- There are LOTS of data out there
  - Tribal data, university data, watershed group data, state data, federal data, etc.
- Before using the data:
  - How is your tribe generating quality data? Such as:
    - Do you calibrate your field sensors?
    - Do you have documented field and lab protocols?
    - QAPP in place?
      - Established Data Quality Objectives?
      - Do you perform QA of results?
  - How can you assess the quality of outside data? Such as:
    - Who collected it?
    - Where was it collected?
    - How was it collected/analyzed?
    - How old is it?
    - How was it managed?



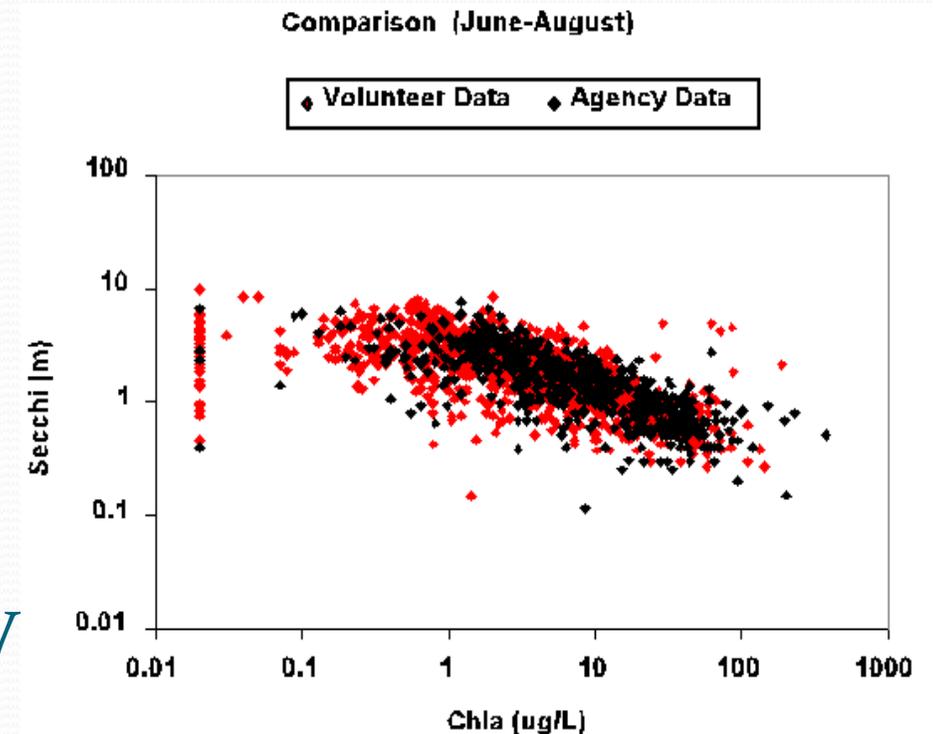
# Considerations for Assessing Data

- How are water quality data managed?
  - Hard copy v. electronic management
  - Consistency among parameters over time for analysis
- Does each data set have supporting metadata?
  - Documents when, where, why, how of sampling
  - Allows comparability of data over time
  - Enhances validity
  - Explains irregularities
  - Ability to combine data/comparable

Activity ID	Medium	Activity Type	Activity Category	Activity Start Date	Activity Status	Activity Depth	Activity Characteristic	Activity Result Value	Activity Result Unit	Activity Field/Lab	Activity Date	Activity Quantification
1	Water	Sample	Routine S4	5/7/2003	EST	0.1 m	Chlorophyll a, cc0.0006	mg/L	10200-H	APHA	mg/l	0.0005
3	Water	Sample	Routine S4	5/7/2003	EST	0.1 m	Conductivity	266	umhos	2510-B	APHA	umhos
4	Water	Sample	Routine S4	5/7/2003	EST	2 m	Conductivity	265	umhos	2510-B	APHA	umhos
5	Water	Sample	Routine S4	5/7/2003	EST	4 m	Conductivity	265	umhos	2510-B	APHA	umhos
6	Water	Sample	Routine S4	5/7/2003	EST	6.9 m	Conductivity	265	umhos	2510-B	APHA	umhos
7	Water	Sample	Routine S4	5/7/2003	EST	8.1 m	Conductivity	265	umhos	2510-B	APHA	umhos
8	Water	Sample	Routine S4	5/7/2003	EST	10 m	Conductivity	265	umhos	2510-B	APHA	umhos
9	Water	Sample	Routine S4	5/7/2003	EST	12 m	Conductivity	265	umhos	2510-B	APHA	umhos
10	Water	Sample	Routine S4	5/7/2003	EST	14 m	Conductivity	265	umhos	2510-B	APHA	umhos
11	Water	Sample	Routine S4	5/7/2003	EST	16 m	Conductivity	265	umhos	2510-B	APHA	umhos
12	Water	Sample	Routine S4	5/7/2003	EST	18 m	Conductivity	265	umhos	2510-B	APHA	umhos
13	Water	Sample	Routine S4	5/7/2003	EST	19.9 m	Conductivity	265	umhos	2510-B	APHA	umhos
14	Water	Sample	Routine S4	5/7/2003	EST	21.9 m	Conductivity	265	umhos	2510-B	APHA	umhos
15	Water	Sample	Routine S4	5/7/2003	EST	0.1 m	Dissolved oxygen	13.61	mg/l	4500	APHA	mg/l
16	Water	Sample	Routine S4	5/7/2003	EST	2 m	Dissolved oxygen	13.52	mg/l	4500	APHA	mg/l
17	Water	Sample	Routine S4	5/7/2003	EST	4 m	Dissolved oxygen	13.51	mg/l	4500	APHA	mg/l
18	Water	Sample	Routine S4	5/7/2003	EST	6.9 m	Dissolved oxygen	13.49	mg/l	4500	APHA	mg/l
19	Water	Sample	Routine S4	5/7/2003	EST	8.1 m	Dissolved oxygen	13.47	mg/l	4500	APHA	mg/l
20	Water	Sample	Routine S4	5/7/2003	EST	10 m	Dissolved oxygen	13.46	mg/l	4500	APHA	mg/l
21	Water	Sample	Routine S4	5/7/2003	EST	12 m	Dissolved oxygen	13.42	mg/l	4500	APHA	mg/l
22	Water	Sample	Routine S4	5/7/2003	EST	14 m	Dissolved oxygen	13.41	mg/l	4500	APHA	mg/l

# Considerations for Assessing Data

- Are there procedures for validating data?
  - Decision points to accept, reject, or qualify data
  - Procedures could include:
    - Examining results for high/low results
    - Checking calculations
    - Calculating precision & accuracy of instruments
- Are data adequate for a water quality assessment?



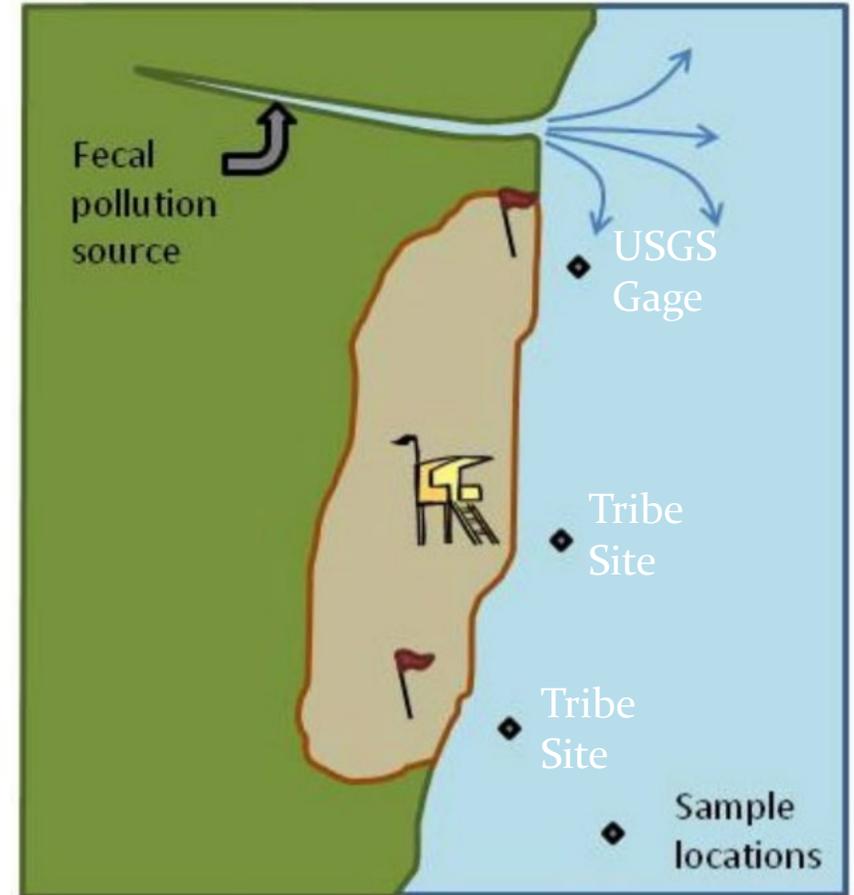
# A Note...

- Tribes need established procedures for:
  - Providing data stewardship – who will oversee the collection, management and storage of data, and how will it be done?
  - Protecting their data – storage of paper files, transferring results to electronic databases, maintaining backup databases
  - Encompasses data collection, analysis, evaluation, assessment and data management
- Also:
  - Tribal data collected with 106 funding must be shared with EPA at the end of each grant cycle.
  - Tribal data collected using other resources does not have to be shared



# Why Consider Other Data?

- Might help to create a more comprehensive water quality assessment
- To fill data gaps
- Important for tribes interested in TAS for Section 303(d)



# Types of Data to Consider

- Volunteer monitoring data
- Beach closure notices
- Fish kills
- Land use/cover data
- Waste site inventories



- Source water assessments
- Fish consumption advisories
- Hydrology, climate, geological studies/reports
- And more!

# Possible Sources: Tribal Agencies

- Bureau of Indian Affairs
- Indian Health Services
- Tribal commissions and ceded territory agencies
- Nearby Tribes



## Sanitation Tracking and Reporting System (STARS)

Welcome to STARS, a system of the Indian Health Service (IHS).



**SELECT AN AREA**  
Click an area on the map or the list below.



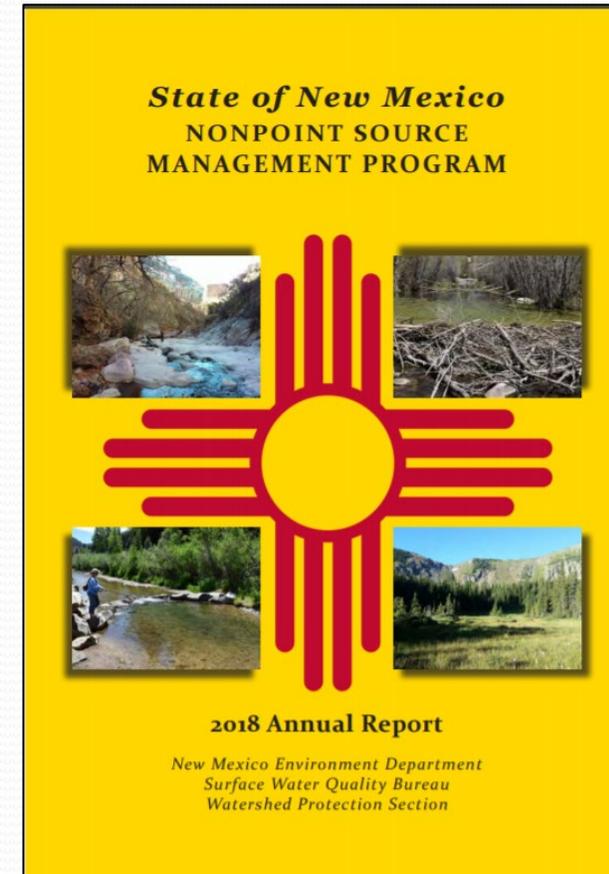
The mission of the Indian Health Service (IHS) is to raise the health status of the American Indian and Alaska Native people to the highest possible level by providing comprehensive health care and preventive health services. To support the IHS mission, the Division of Sanitation Facilities Construction (DSFC) provides technical assistance and sanitation facilities services to American Indian tribes and Alaska Native villages for cooperative development and continued operation of safe water, wastewater, and solid waste systems and related support facilities. STARS is a web-based database used to track sanitation facilities projects. It also contains information on existing Operation and Maintenance (O&M) organizations serving American Indians and Alaskan Natives (AI/AN).

STARS includes six major data systems:

▶ Aberdeen Area	▶ Nashville Area
▶ Alaska Area	▶ Navajo Area
▶ Albuquerque Area	▶ Oklahoma Area
▶ Bemidji Area	▶ Phoenix Area
▶ Billings Area	▶ Portland Area
▶ California Area	▶ Tucson Area

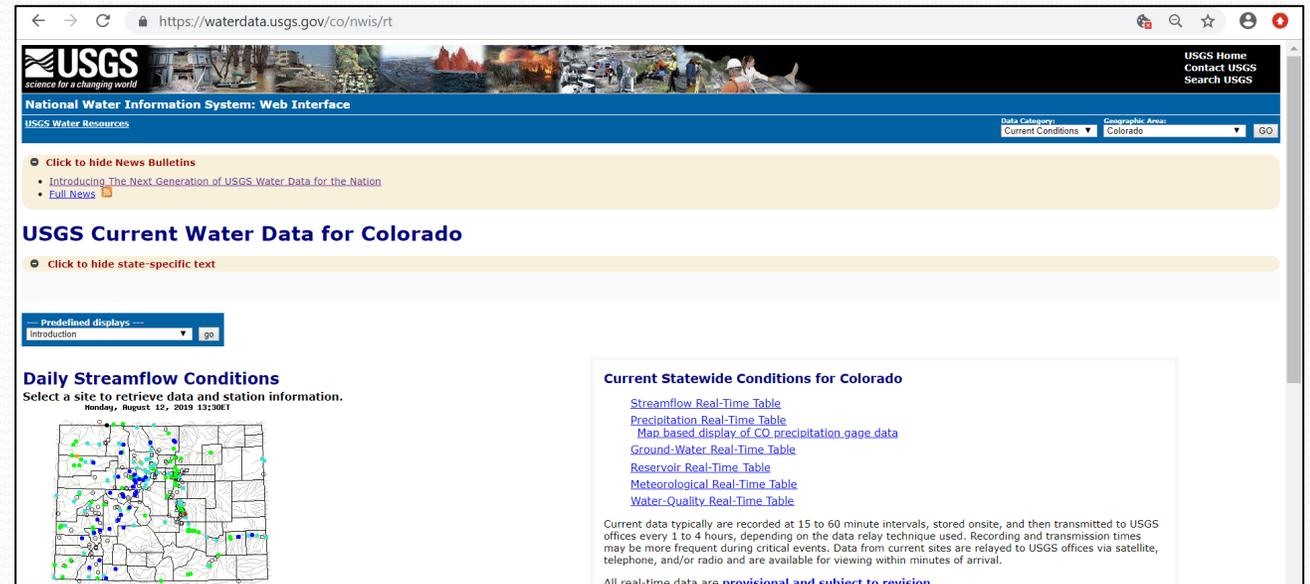
# Possible Sources: State and Local Agencies

- Water Utilities
- Soil and Water Conservation Districts
- Universities
- Watershed Groups
- State Departments of Environmental Protection/Management/Quality
- Departments of Natural Resources
- Departments of Health



# Possible Sources: Federal Agencies

- U.S. Environmental Protection Agency (ATTAINS, NARS)
- EPA & USGS Water Quality Portal (WQX/WQP)
- U.S. Department of Agriculture Forest Service
- National Oceanic Atmospheric Administration (coastal and estuarine data for both oceans and Great Lakes)
- U.S. Geological Survey
- U.S. Fish and Wildlife Service



The screenshot shows the USGS National Water Information System (NWIS) web interface. The browser address bar displays the URL <https://waterdata.usgs.gov/co/nwis/rt>. The page header includes the USGS logo and the text "science for a changing world". The main content area is titled "National Water Information System: Web Interface" and "USGS Water Resources". It features a navigation menu with "Data Category" set to "Current Conditions" and "Geographic Area" set to "Colorado". Below the navigation, there are sections for "Click to hide News Bulletins" and "USGS Current Water Data for Colorado". A "Predefined displays" dropdown menu is set to "Introduction". The "Daily Streamflow Conditions" section includes a map of Colorado with various data points and a link to "Select a site to retrieve data and station information." The "Current Statewide Conditions for Colorado" section lists several data tables: Streamflow Real-Time Table, Precipitation Real-Time Table, Map based display of CO precipitation gage data, Groundwater Real-Time Table, Reservoir Real-Time Table, Meteorological Real-Time Table, and Water Quality Real-Time Table. A disclaimer at the bottom states: "Current data typically are recorded at 15 to 60 minute intervals, stored onsite, and then transmitted to USGS offices every 1 to 4 hours, depending on the data relay technique used. Recording and transmission times may be more frequent during critical events. Data from current sites are relayed to USGS offices via satellite, telephone, and/or radio and are available for viewing within minutes of arrival. All real-time data are provisional and subject to revision."



# Data Quality

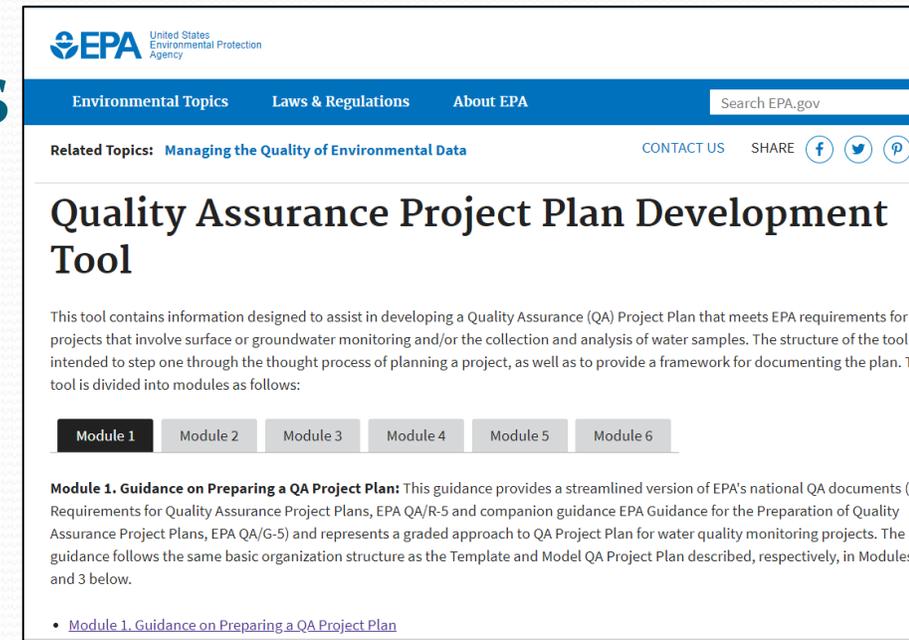
# Aspects of Data Quality

- Quality assurance elements
- Quality control data
- Quality assessment procedures



# Quality Assurance Project Plan (QAPP)

- Documents the procedures to ensure the data collected for a particular purpose meet data quality objectives
- Can address data that:
  - Include direct measurements (data collected by the tribe writing the QAPP)
  - Non-direct measurements (secondary data collected from other sources)



The screenshot shows the EPA website's navigation bar with links for Environmental Topics, Laws & Regulations, and About EPA. Below the navigation bar, the page title is "Quality Assurance Project Plan Development Tool". The main content area includes a description of the tool and a list of modules. The first module, "Module 1. Guidance on Preparing a QA Project Plan", is highlighted.

**Quality Assurance Project Plan Development Tool**

This tool contains information designed to assist in developing a Quality Assurance (QA) Project Plan that meets EPA requirements for projects that involve surface or groundwater monitoring and/or the collection and analysis of water samples. The structure of the tool is intended to step one through the thought process of planning a project, as well as to provide a framework for documenting the plan. The tool is divided into modules as follows:

**Module 1**   Module 2   Module 3   Module 4   Module 5   Module 6

**Module 1. Guidance on Preparing a QA Project Plan:** This guidance provides a streamlined version of EPA's national QA documents (EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5 and companion guidance EPA Guidance for the Preparation of Quality Assurance Project Plans, EPA QA/G-5) and represents a graded approach to QA Project Plan for water quality monitoring projects. The guidance follows the same basic organization structure as the Template and Model QA Project Plan described, respectively, in Modules 2 and 3 below.

- [Module 1. Guidance on Preparing a QA Project Plan](#)

# Data Quality Objectives (DQOs) and Water Quality Assessments

- Establishes the quality and quantity of data needed to support decisions
  - Clarify study objectives
  - Define the appropriate type of data
- Specifies data performance and acceptance criteria
  - Quantitative
  - Qualitative
- EPA's DQO Guidance:  
<https://www.epa.gov/sites/default/files/2015-06/documents/g4-final.pdf>



# Data Quality Indicators (DQIs) for Water Quality Assessments

- DQIs are quantitative and qualitative measures of the quality of the data
- DQIs to meet DQOs will vary, but often include:
  - Precision
  - Bias
  - Accuracy
  - Representativeness
  - Comparability
  - Completeness





# Bias

- Systematic error or persistent distortion in data
- Causes constant errors in a particular direction
- Coupled with precision to determine accuracy
- Site selection can introduce bias

# Precision

- Assessment of the degree to which two or more measurements agree with each other
- Amount of random error in a data set
- Measure of the “scatter” of the results
  - Data with high precision = less scatter (results are clumped together)
  - Data with less precision = more scatter (results are dispersed over a wider area)
- Coupled with bias to determine accuracy
- Can be measured as Relative Percent Difference (RPD)

$$RPD = \frac{(x_1 - x_2)}{(x_1 + x_2)/2} * 100$$

Where: RPD = Relative Percentage Difference  
 $x_1$  = largest sample value  
 $x_2$  = smallest sample value

# Accuracy

- Degree of agreement of an analytical result with the true value
  - Results closer to the true value = higher data accuracy
  - Results farther from the true value = less accurate data
- Affected by both systematic errors (bias) and random errors (imprecision)
- Can be measured with spiked samples and calculated as Percent Recovery

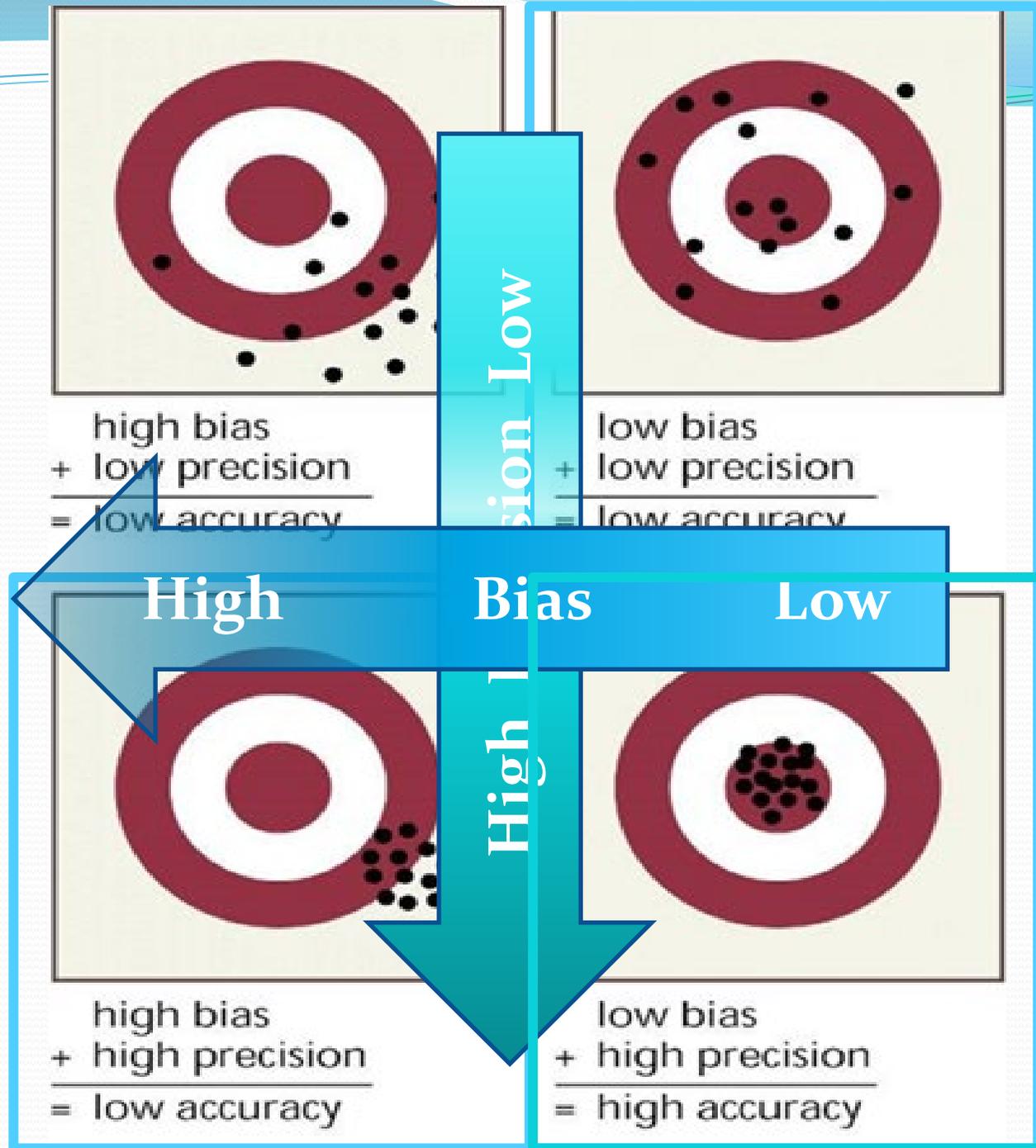
$$\%R = \left( \frac{R_1}{R_2} \right) * 100$$

Where: %R = percent recovery of a parameter

$R_1$  = the observed value for a parameter, obtained via testing/analysis

$R_2$  = the actual value of the parameter in the sample

# How Bias and Precision Impact Accuracy

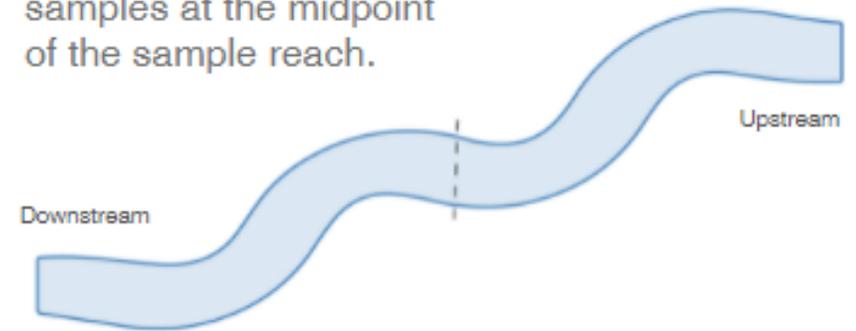


# Representativeness

- The extent to which measurements characterize the true environmental condition or population at the time a sample was collected.
- Two Types of Representativeness should be considered:
  - Spatial Representativeness
    - Site Selection Considerations
    - Field Method Considerations
  - Temporal Representativeness

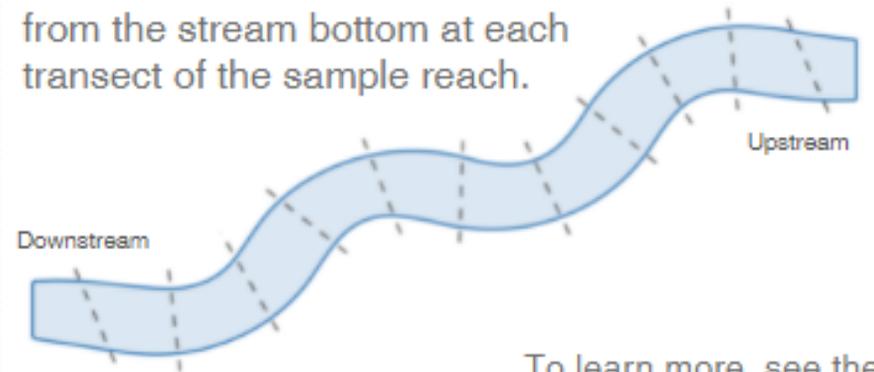
## Where are phosphorus samples collected?

Crews collect phosphorus samples at the midpoint of the sample reach.



## Where are macroinvertebrates collected?

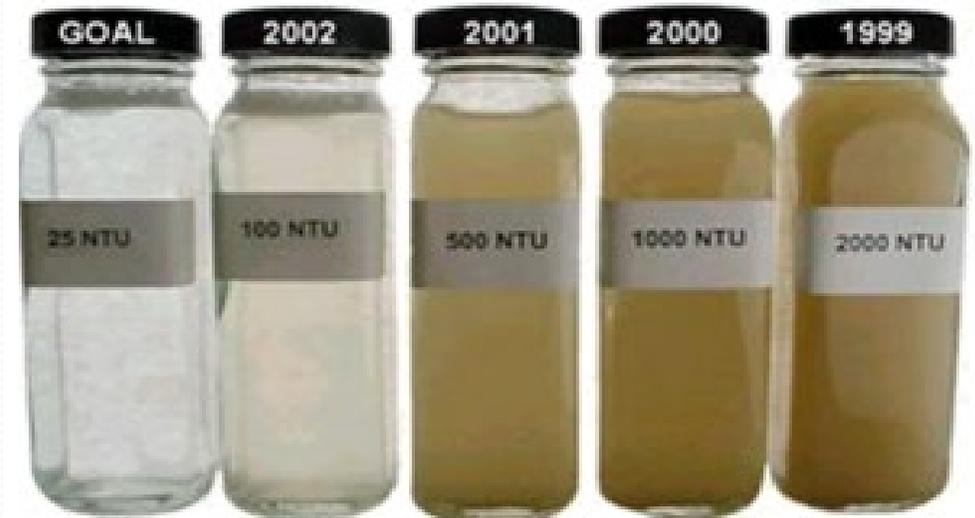
Crews collect macroinvertebrates from the stream bottom at each transect of the sample reach.



To learn more, see the [NRSA Field Operations Manual](#).

# Comparability

- Degree to which data can be compared directly to similar studies
- Repeated use of standardized sampling protocols and analytical methods = more comparable
- Different sampling protocols and analytical methods = less comparable
  - E.g.: Arsenic – one method Detection level is 1 mg/l and another is 0.25 mg/l (yield very different results)
- Important to document data procedures to verify/evaluate comparability



# Completeness

- Amount of usable data collected versus the amount of data called for in the sampling plan
- Measured as target percentage of valid results obtained compared to the total number of samples taken for a parameter
- Target percentage will vary from program to program





# Assessing Data



# Section 2: Learning Objectives

- Introduce basic approaches of assessing data for specific water quality parameters
- Acute and chronic water quality criteria
- Sample size when evaluating water quality data
- How parameters are evaluated against water quality criteria

# Numeric Water Quality Criteria

- EPA develops recommended human health and aquatic life water quality criteria as guidance for use in developing criteria. Levels adopted are applied to monitoring data to assess water quality
- Numeric criteria are expressed as
  - Less than, such as nitrate is *not to exceed* 10 mg/L
  - Greater than, such as the 7-day average of the daily mean dissolved oxygen should be *at least* 8.5 mg/L
  - A range, such as pH shall be *within the range* of 6.5 to 8.5 S.U.
  - No more than one exceedance of the calculated criteria in three years:  $WQC = (e^{(x[\ln(\text{hardness})]+y)})^z$

# Parts of a Numeric Water Quality Criterion

**Explicit Value = actual  
number/magnitude**

**Duration =  
period of time**

Example: Should not exceed 10 mg/L as an annual average,  
and cannot be exceeded more than 10% of the time.

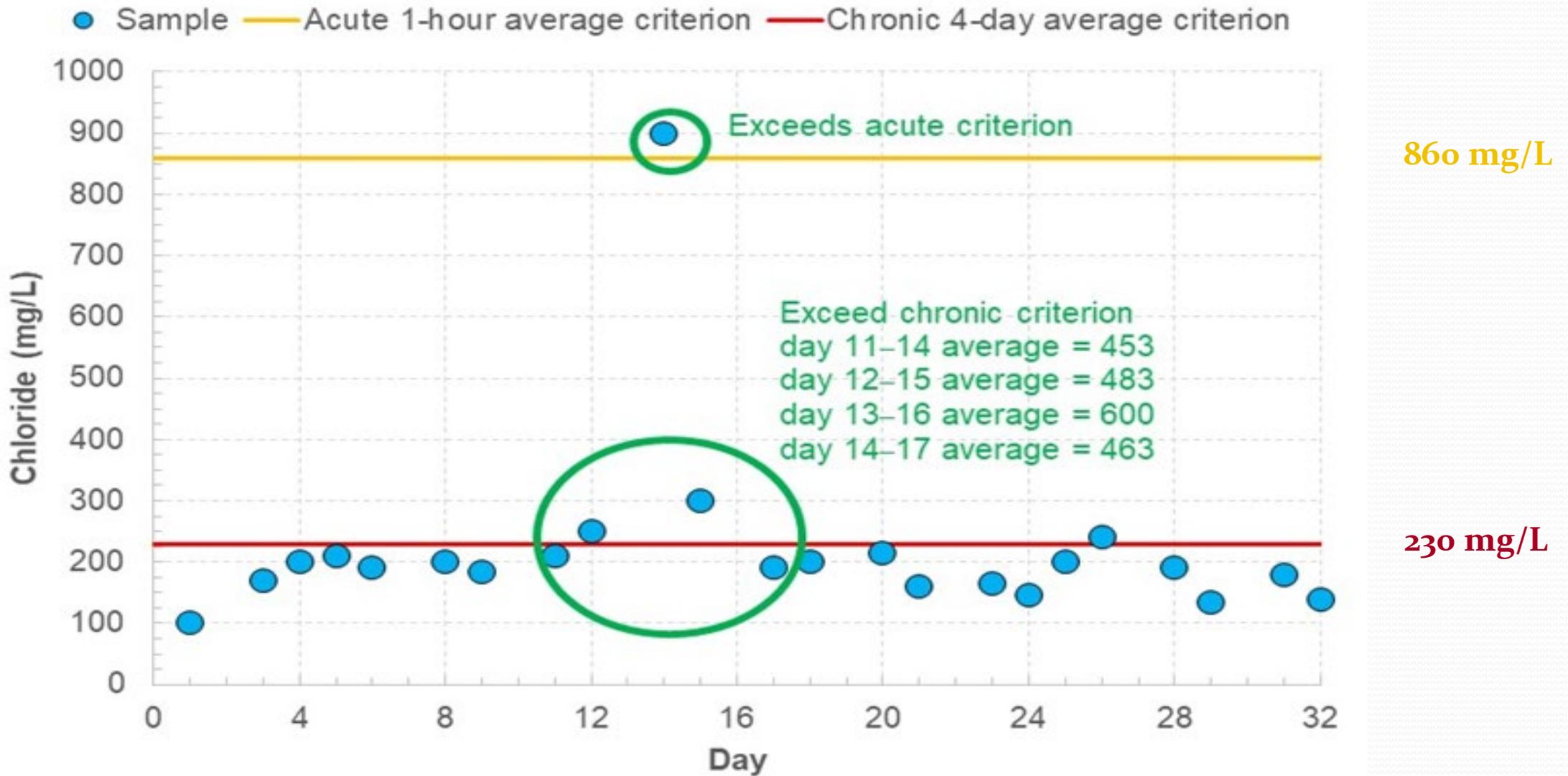
**Frequency =  
recurrence interval**

# Considerations for Acute and Chronic Water Quality Criteria – Aquatic Life

- *Acute*: Toxicity at higher concentrations over short time periods
- *Chronic*: Lower concentrations, longer term exposures
- Example: chloride criteria for aquatic life
  - Acute 860 mg/L
  - Chronic 230 mg/L



# Lummi Nation Chloride Example



# Considerations for Sample Size

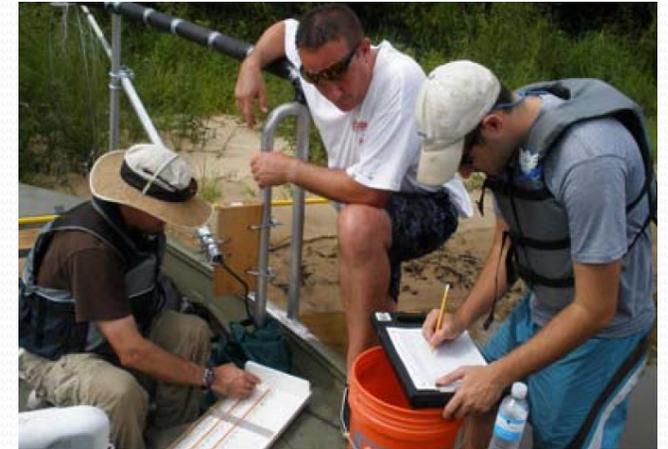
- **Sample size should target research questions:**

- Types of waterbodies to be assessed
- High/low flow conditions to be considered
- Parameters of interest & seasonality

- **Number of samples to be taken**

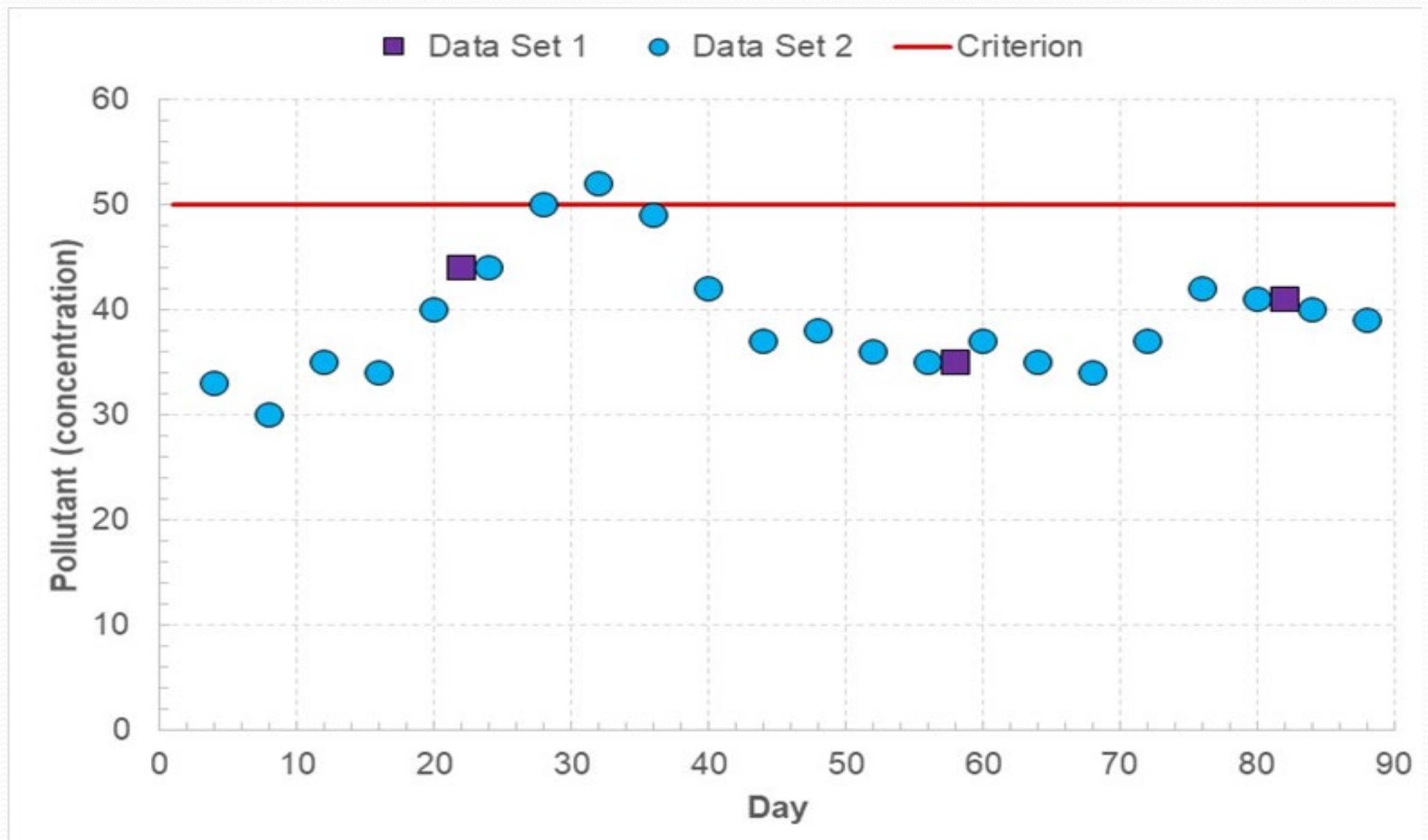
- Balance cost and completeness of dataset (seasonality coverage, etc)

- Note: Not meeting minimum sample size does not always mean you cannot make a decision





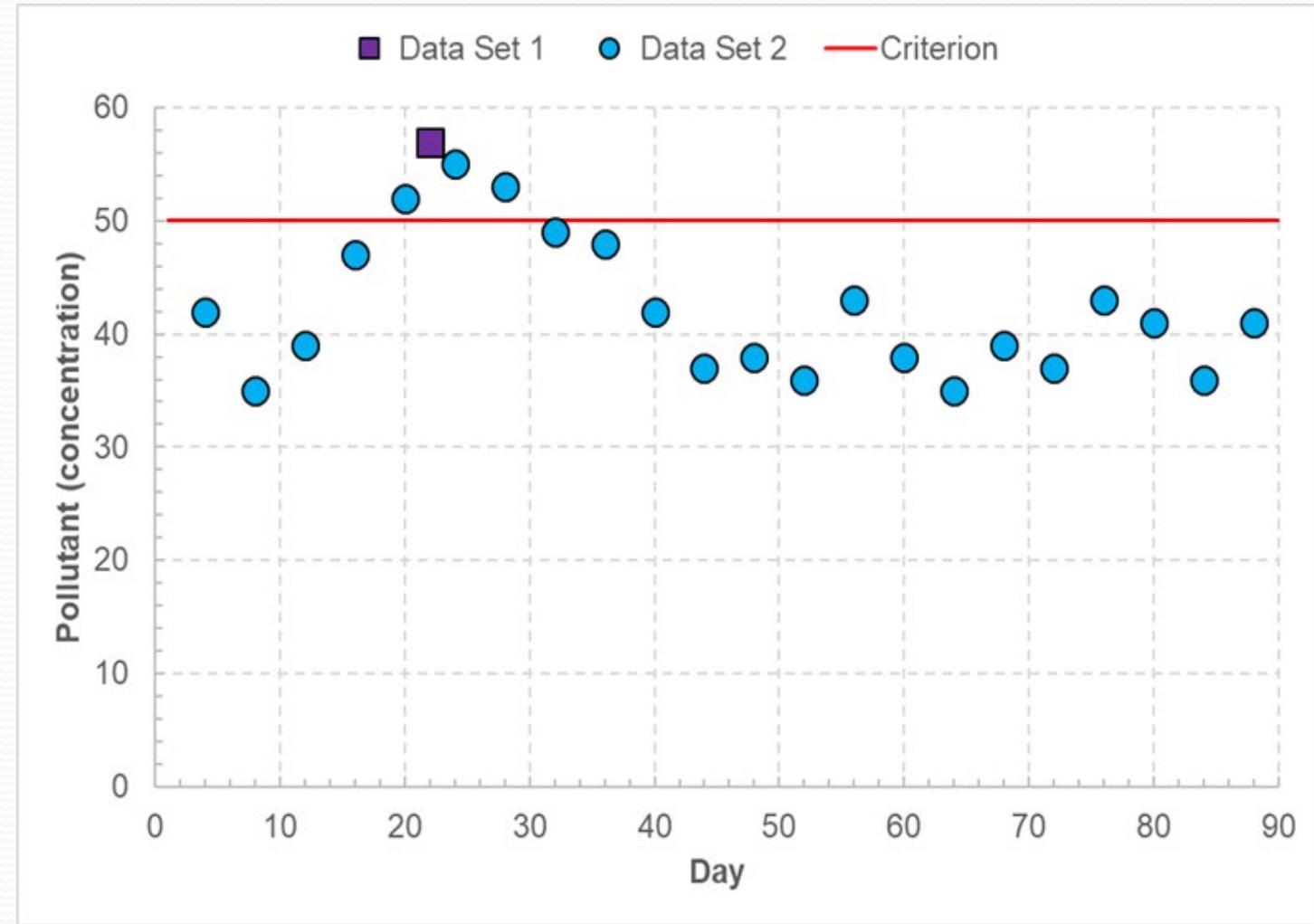
# Sample Size Example





# Considerations for Sample Size

- Aim to collect enough data to interpret the numeric criterion
- You may need to make decisions with a small dataset
- Numerous factors are considered when developing a sampling frequency, but that is for another module



# WQS: Designated Uses

Examples of beneficial use designations:

- Drinking water source
- Swimming (primary contact)
- Boating (secondary contact)
- Aquatic life support (fish, etc.)
- Cultural and traditional uses
- Agricultural, industrial, other uses



*Mississippi River Headwaters*

# Overview of Water Quality Standards

- Conventional: DO, pH, Temperature, Turbidity
- Nutrients





# Examples of Dissolved Oxygen Criteria:

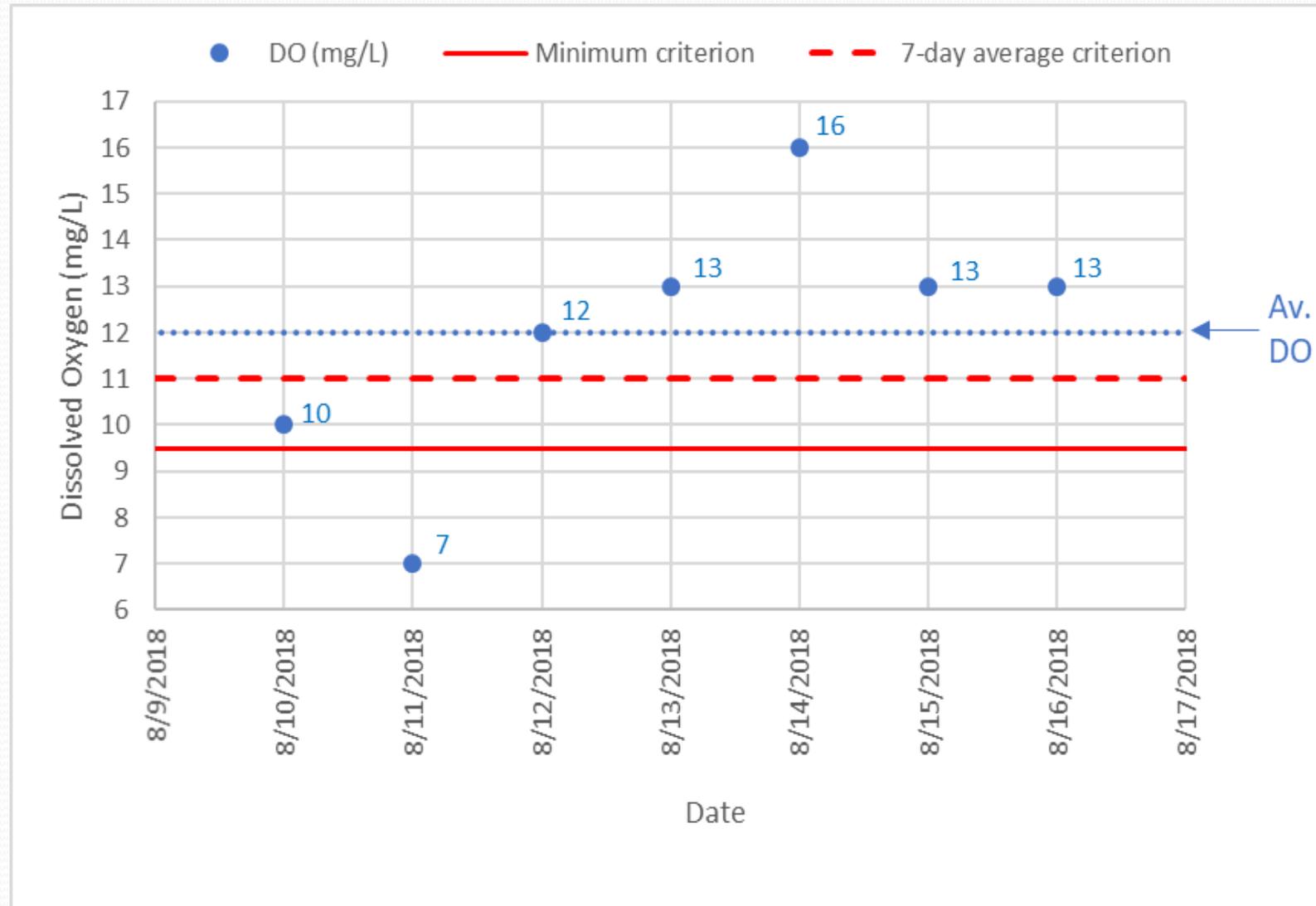
## Makah Tribe

- Salmon and trout spawning
  - 7-day average of the daily mean dissolved oxygen: 11 mg/L
  - Minimum: 9.5 mg/L
- Salmon and trout rearing and migration
  - 7-day average of the daily mean dissolved oxygen: 8.5 mg/L
  - Minimum: 6.5 mg/L



# Dissolved Oxygen Assessment

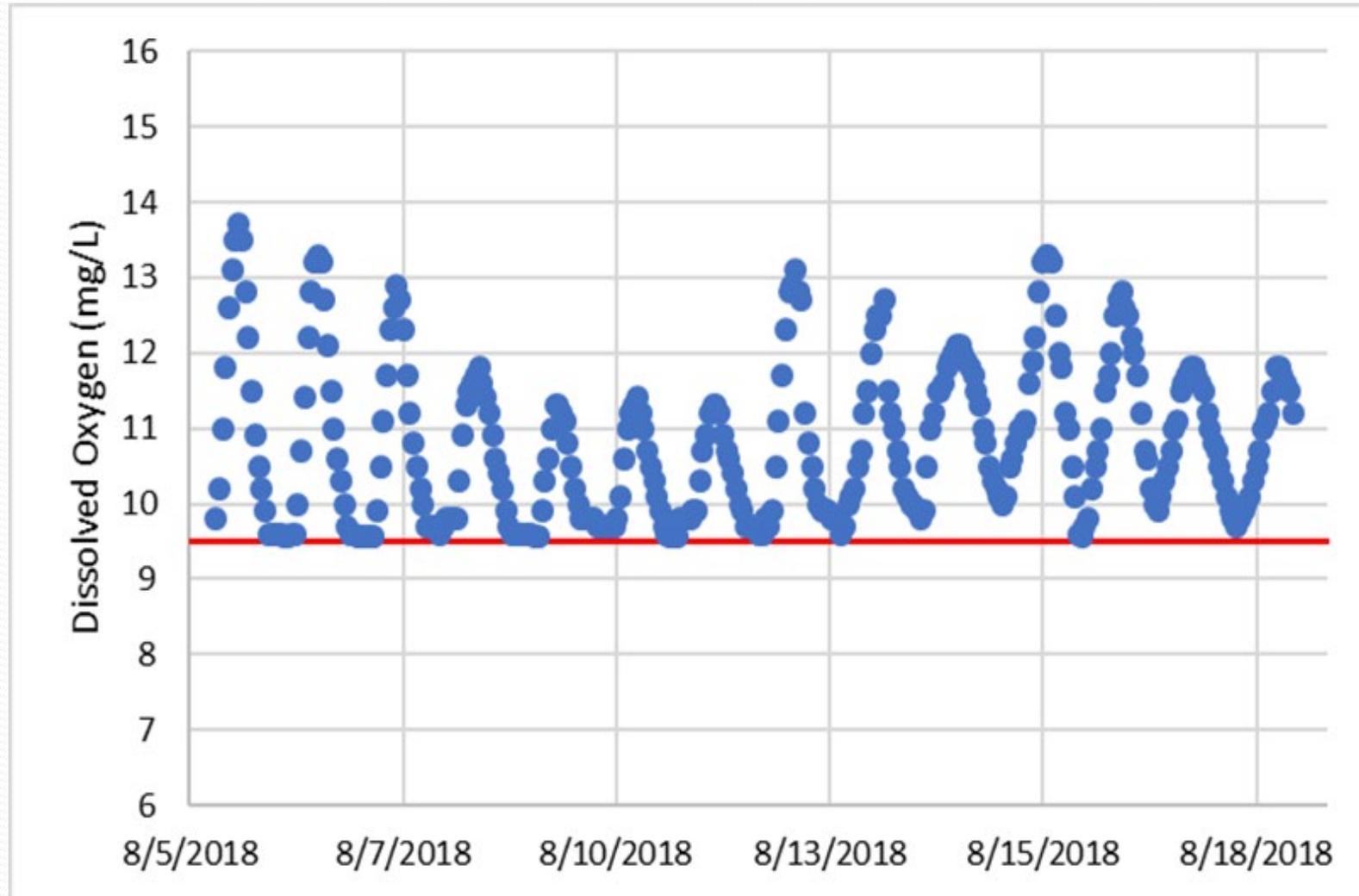
- Salmon and trout spawning water
  - 7-day average of the daily mean dissolved oxygen: 11 mg/L
  - Minimum: 9.5 mg/L
- 7-day average: 12 mg/L
- Range: 7–16 mg/L



# Dissolved Oxygen Assessment

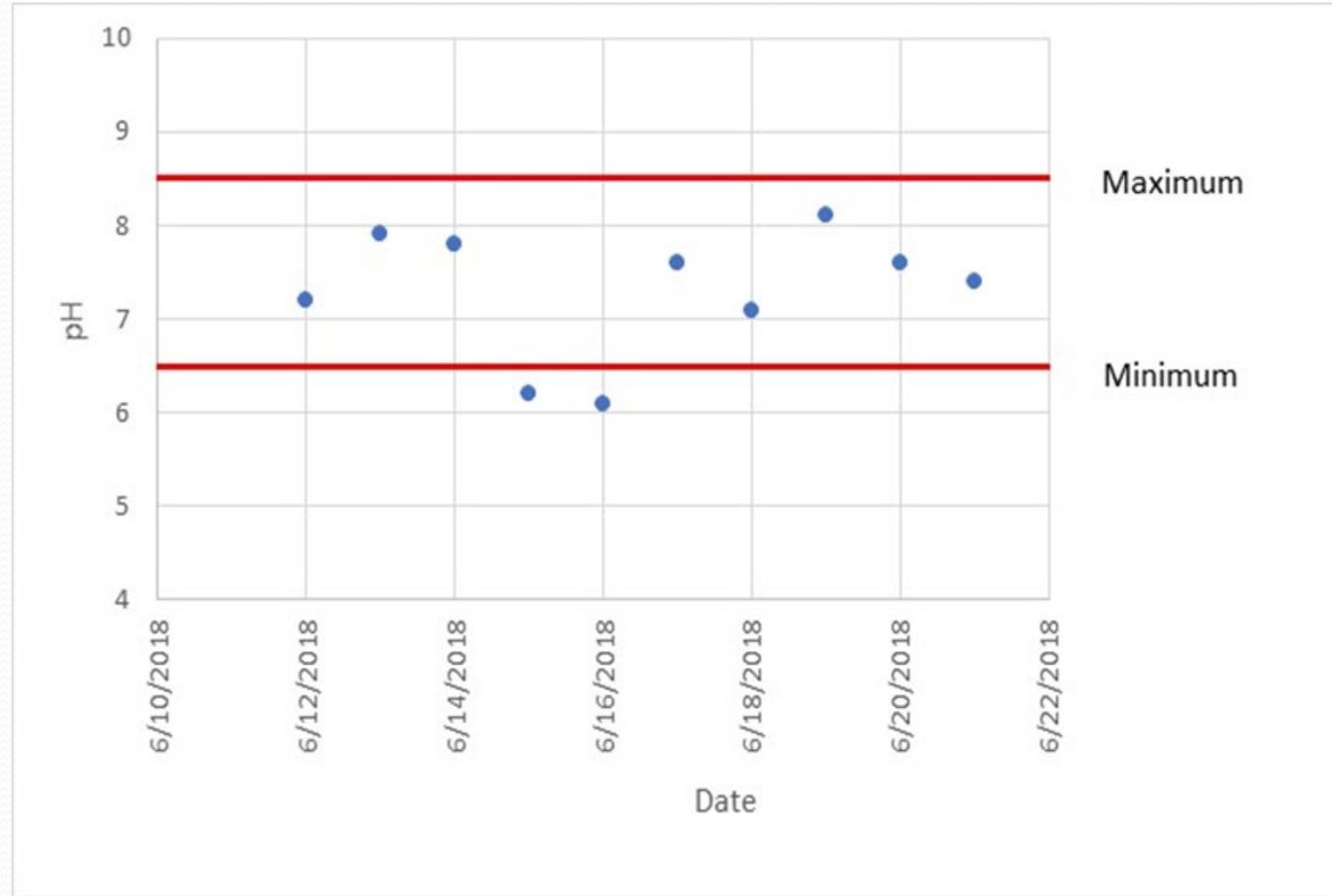
Salmon and trout spawning water criteria:

- 7-day average of the daily mean dissolved oxygen: 11 mg/L
- Minimum: 9.5 mg/L



# pH Criteria

- A measure of acidity and alkalinity of the water
- Criteria require keeping pH within a specific range
  - To protect human health, the pH must be within the range of 5 to 9
  - To protect aquatic life, the pH must be within the range of 6.5 to 9.0 for freshwater and 6.5 to 8.5 for saltwater



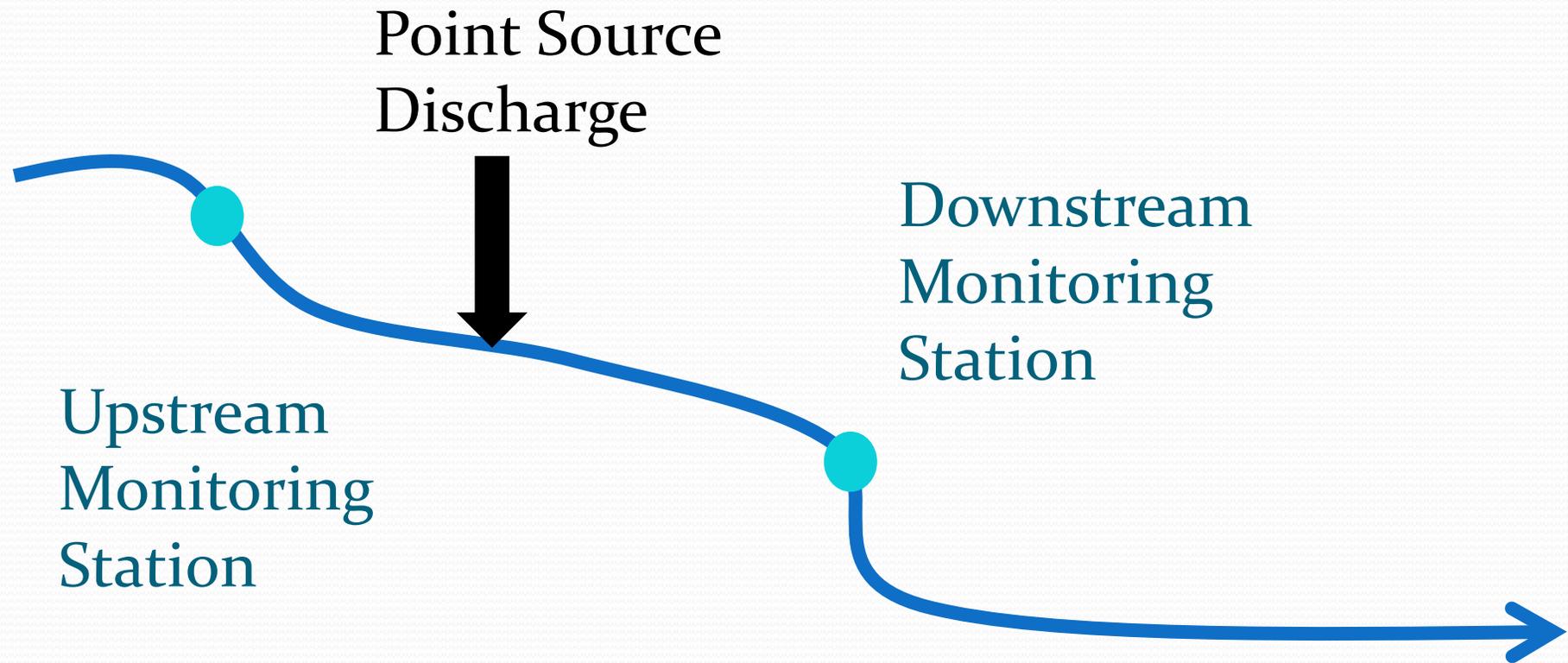
# Temperature

- Criteria focused on aquatic life support—warmwater and coldwater
- “In a stream, the introduction of heat by other than natural causes shall not increase the temperature, as measured upstream from the point of introduction, by more than  $2.7^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ), based on the weekly average of the maximum daily temperatures measured at mid-depth or three feet, whichever is less.”





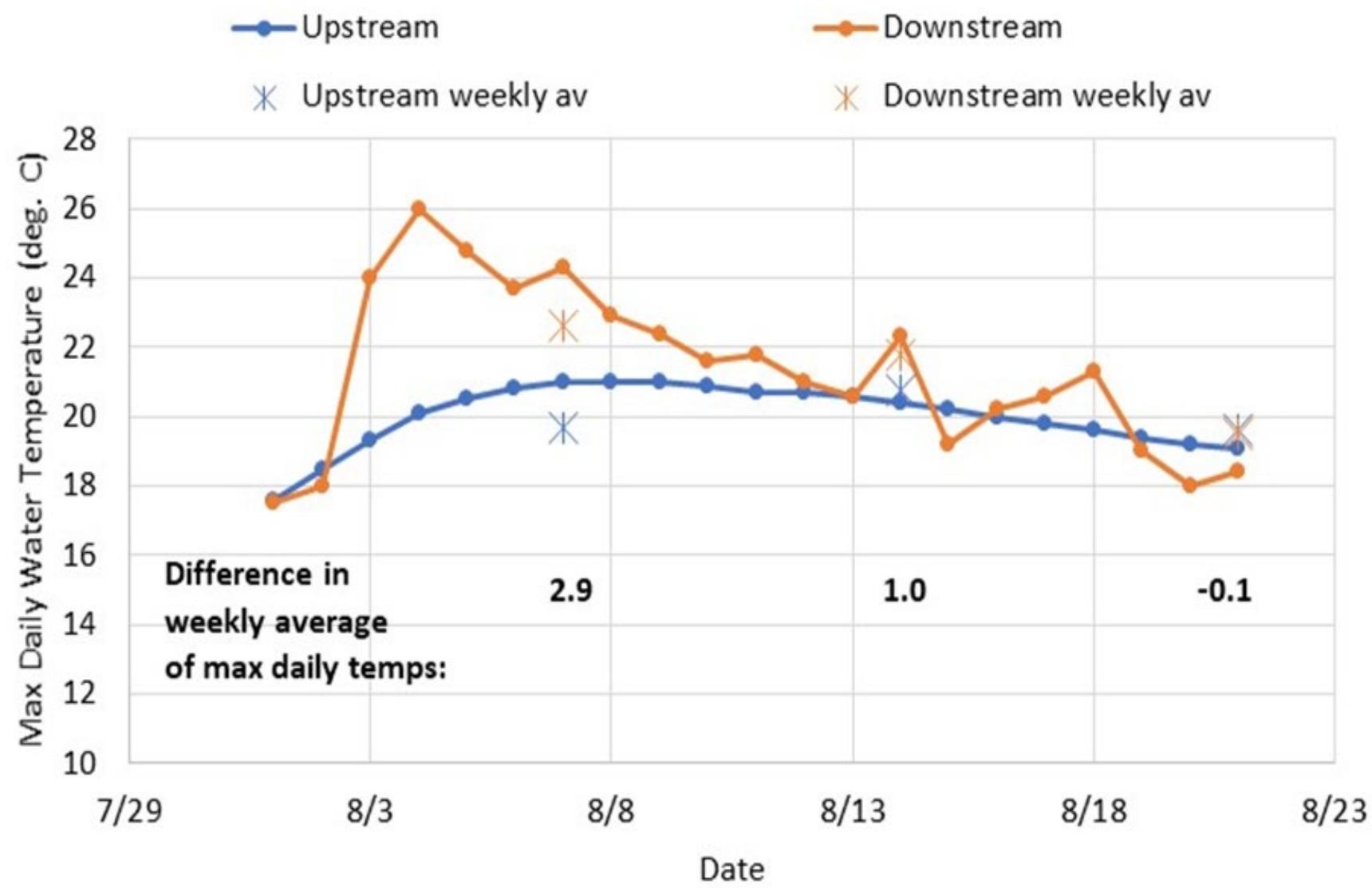
# Temperature





# Temperature

“No increase in the weekly average of the maximum daily temperature between upstream/downstream locations that is greater than 2.7° C”



# Turbidity

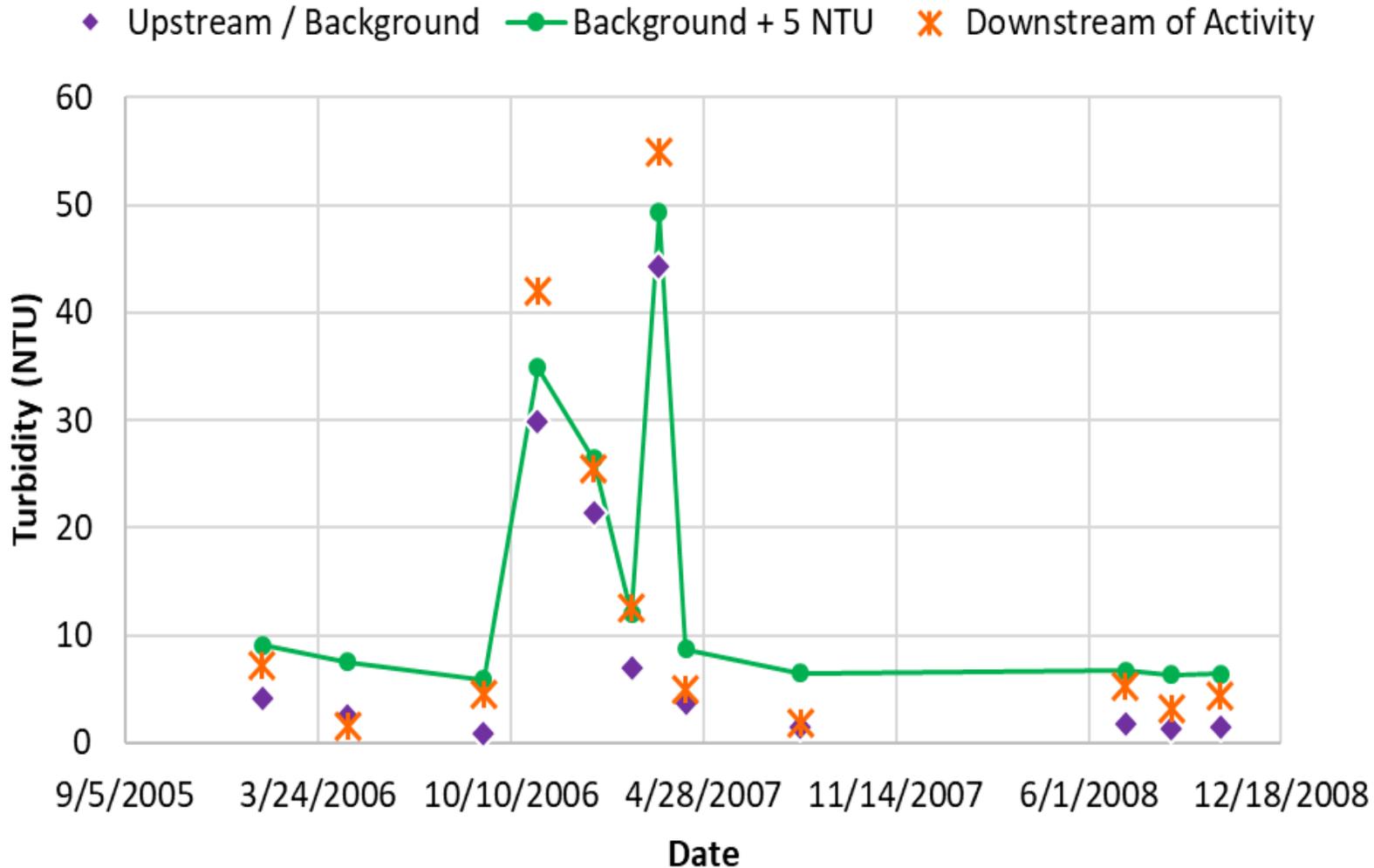
- Measure of cloudiness of water
- Turbidity shall not exceed 5 NTU over background when background turbidity is 50 NTU or less, with no more than a 10 percent increase when background turbidity is more than 50 NTU. Background turbidity shall be measured at a point immediately upstream of the turbidity-causing activity.” (Pueblo of Sandia Tribe 2010)
- “Turbidity shall not exceed 25 NTU.” (Pueblo of Tesuque 2015)



# Turbidity: Increase over Background Turbidity

## Example

- Pueblo of Sandia: “Turbidity shall not exceed 5 NTU over background when background turbidity is 50 NTU or less, with no more than a 10 percent increase when background turbidity is more than 50 NTU. Background turbidity shall be measured at a point immediately upstream of the turbidity-causing activity.”
- Note conditions when criteria is exceeded



# Copper

- Aquatic Life Use
- Relationship with hardness
- Toxic
- Criteria often expressed as an equation:

$$WQC = (e^{(0.8545[\ln(\text{hardness})] - 1.3862)}) * 0.960$$

Where:

WQC = water quality criteria

$e$  = Euler's number (~2.71828)

$\ln$  = natural log

hardness = hardness collected concurrent with your sample

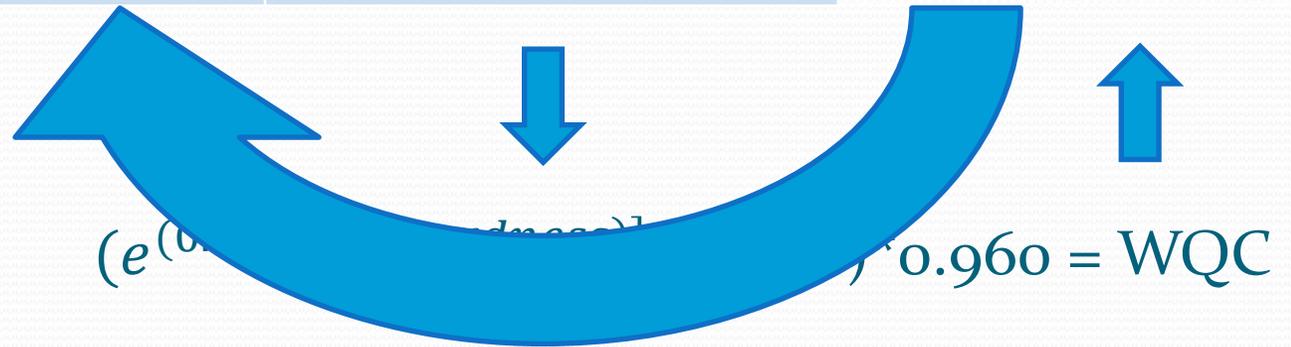
# Copper – Example

The Aquatic Life beneficial use designated for a waterbody shall be deemed to be fully supported with respect to any individual toxicant parameter if no more than one of the sample concentrations from the waterbody exceeds the acute or chronic criterion for that toxicant listed in the table within a three year period:

Parameter	Acute (µg/L)	Chronic (µg/L)	Conversion Factor
Copper	$e^{(0.9422[\ln(\text{hardness})] - 1.3844)}$	$e^{(0.8545[\ln(\text{hardness})] - 1.3862)}$	0.960
Lead	$e^{(1.273[\ln(\text{hardness})] - 1.460)}$	$e^{(1.273[\ln(\text{hardness})] - 4.705)}$	$1.46203 - 0.145712$ $*[\ln(\text{hardness})]$
Zinc	$e^{(0.8473[\ln(\text{hardness})] + 0.884)}$	--	0.978

# Copper - Assessment

Date	Copper ( $\mu\text{g/l}$ )	Hardness, Ca, Mg (mg/L)
11/12/2021	0.895	27.3
2/18/2022	4.582	25.9
8/25/2022	1.789	36.4
11/17/2022	6.465	44.4
3/9/2023	0.815	25.2



# Nutrient Parameters: Nitrogen and Phosphorus

- Essential for aquatic life—food for algae and plants
- Too much can lead to excessive algae and/or plants: eutrophication, harmful algae blooms and fish kills
- Other nutrients can be directly toxic: ammonia





# Example Nitrogen and Phosphorus Aquatic Life Criteria

To support fishing, frogging, recreation, and the propagation and maintenance of a healthy, well-balanced population of fish and other aquatic life and wildlife, the total phosphorus level shall not exceed 10 parts per billion (Miccosukee Tribe 2010, R4).

Aquatic life: References EPA's ecoregional criteria for TP, TN, and water clarity (Pueblo of Laguna 2014, R6 & <https://www.epa.gov/nutrient-policy-data/ecoregional-nutrient-criteria-rivers-and-streams> )

High quality coldwater fishery: total inorganic nitrogen shall not exceed 1.0 mg/L and total phosphorus shall not exceed 0.1 mg/L (Pueblo of Nambé 2017, R6).

EPA has issued final recommended ambient numeric nutrient water quality criteria recommendations for lakes and reservoirs. <https://www.epa.gov/nutrient-policy-data/ambient-water-quality-criteria-address-nutrient-pollution-lakes-and-reservoirs>

# Nutrients: Freshwater v. Saltwater

## Ecosystems

- Freshwater: typically more sensitive to phosphorus?
- Saltwater: typically more sensitive to nitrogen?
- Important to understand nutrient effects



# Nutrient Criteria for Other Uses

- Primary contact ceremonial use:  
Total inorganic nitrogen not to exceed 10.0 mg/L (Isleta Tribe, R6)
- Drinking water: Nitrate not to exceed 10 mg/L (Laguna Tribe, R6)



# Questions

## Region 6 Water Quality Protection Tribal Team

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