The Basics of Assessment

Considerations for analyzing data such as:

Quality Assurance,

Finding readily available data to supplement analysis, and

Comparing data against criteria

Section 1: Learning Objectives

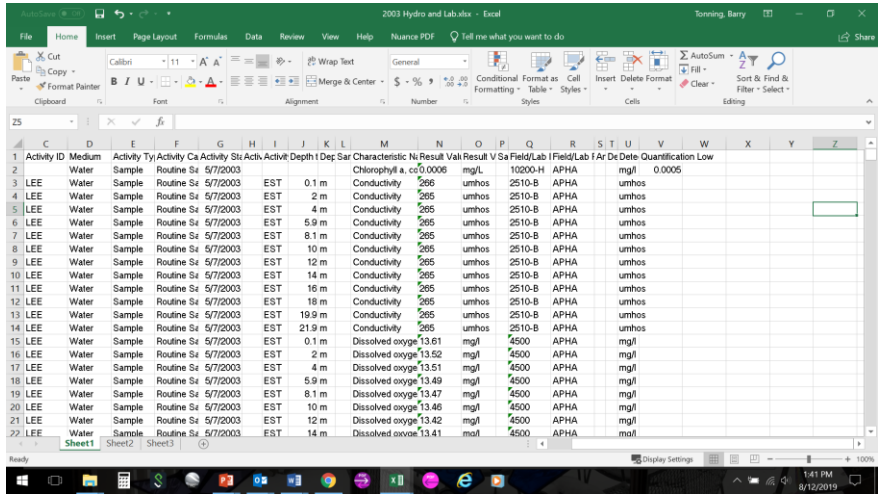
- To understand the potential data sources and formats that may be available from both the Tribe and other data partners for use in producing a water quality assessment
- To identify the factors that can affect the quality of data used for a water quality assessment
- To understand the limitations of data that do not meet a Tribe's data quality objectives, and how to document known data quality issues

So . . . 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 Objects?
      - 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?

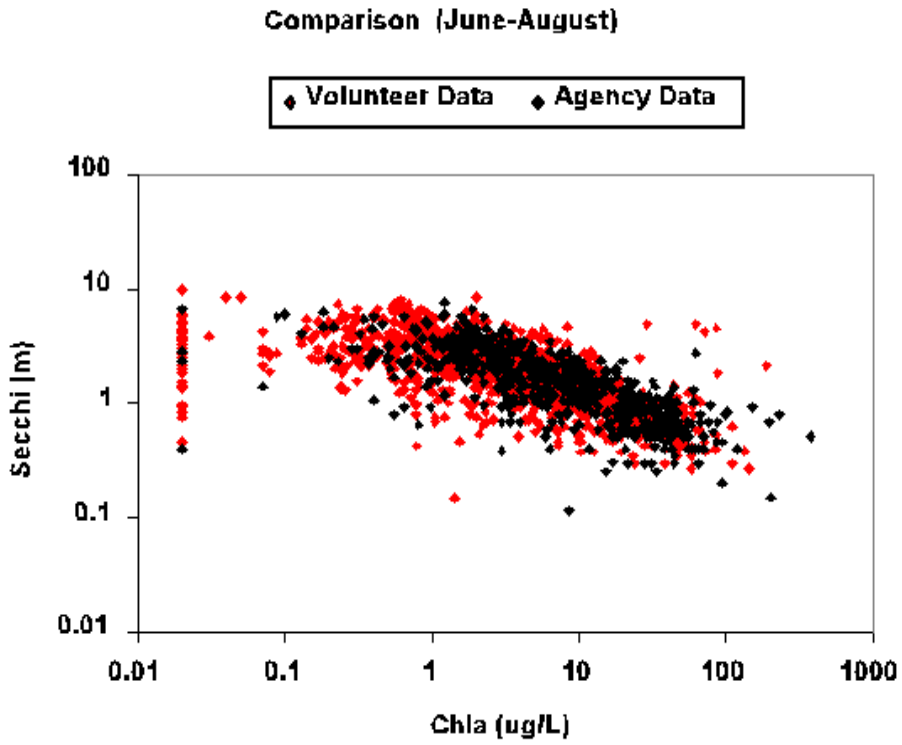
Considerations for Assessing Data

- 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



Considerations for Assessing Tribal 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?

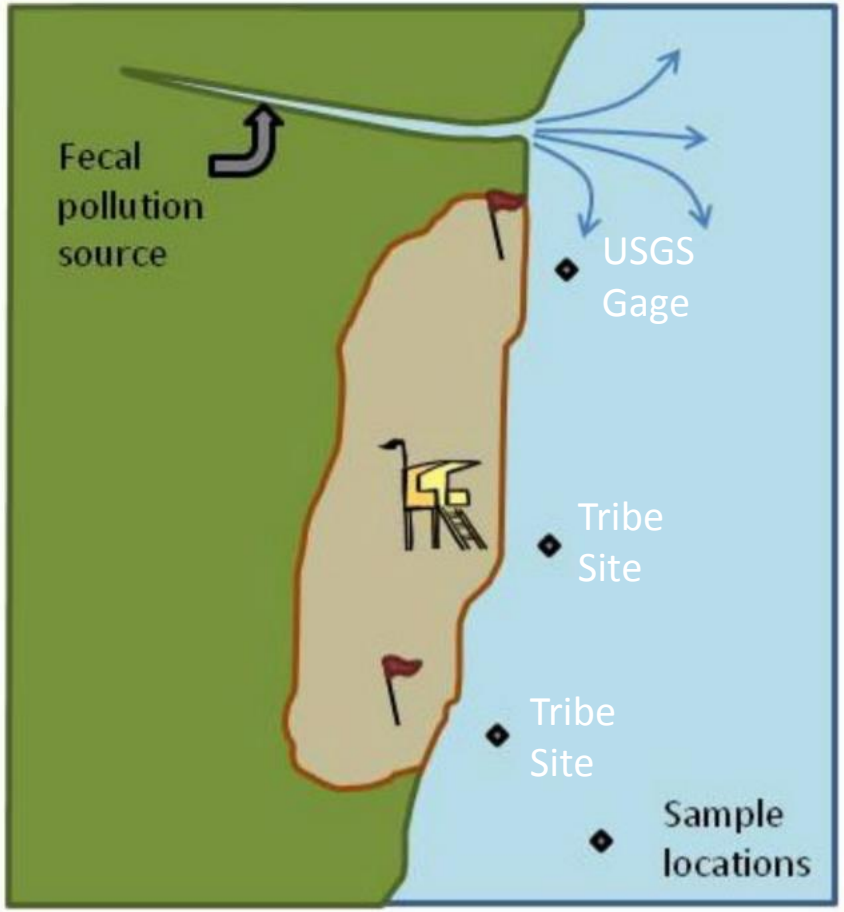


A note about tribal data

- 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
- To obtain other relevant information that supplements tribal data
- Important for tribes interested in TAS for Section 303(d)
- Supplement organizational monitoring for efficiency and cost savings

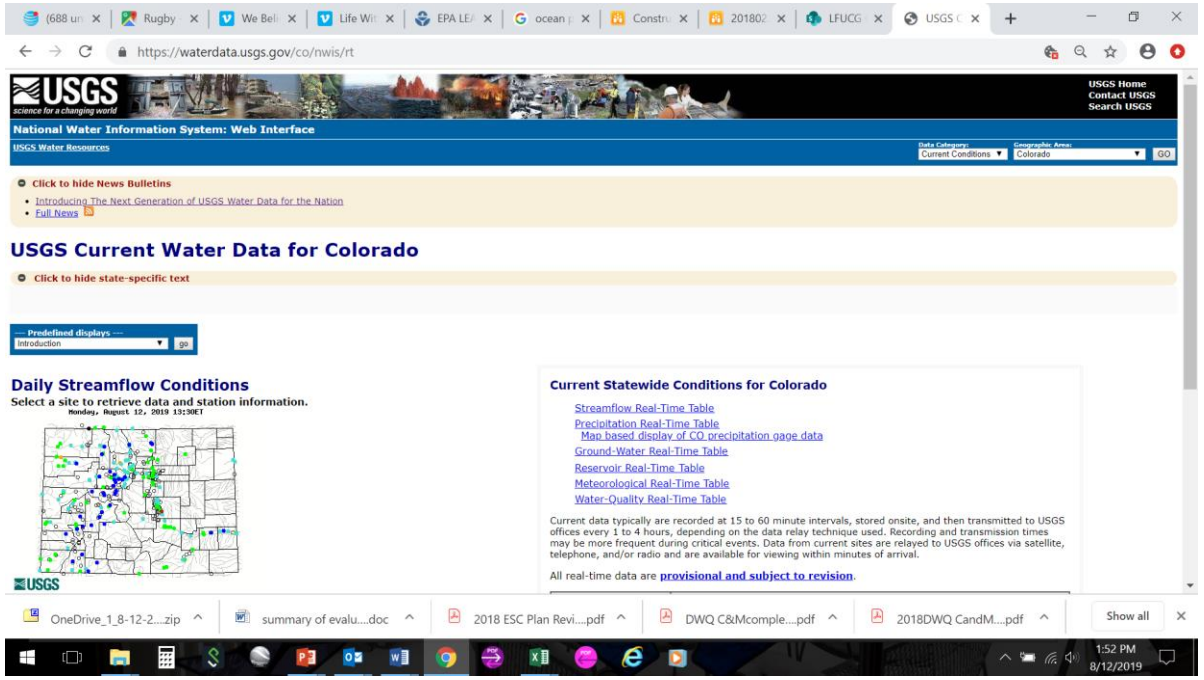


What Other Types of Data Can Tribes Consider?

- Volunteer monitoring data
- Beach closure notices
- Fish consumption advisories
- Fish kills
- Source water assessments
- Waste site inventories
- Land use/cover data
- Hydrology, climate, geological studies/reports
- And more!

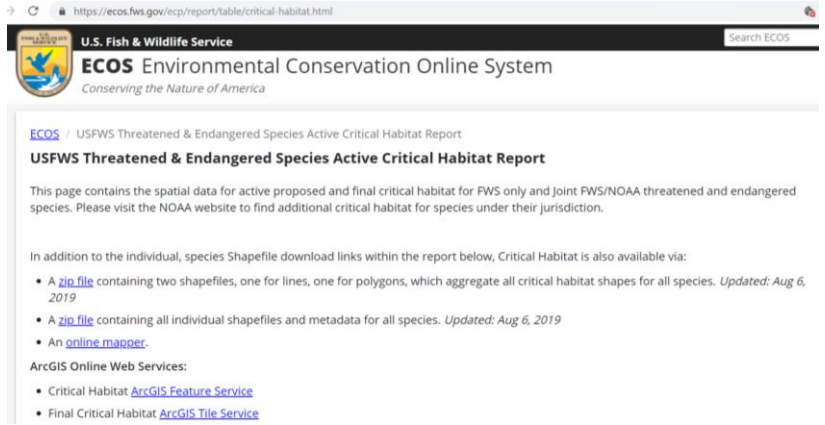
Possible Sources for Additional Water Quality Data: Federal Agencies

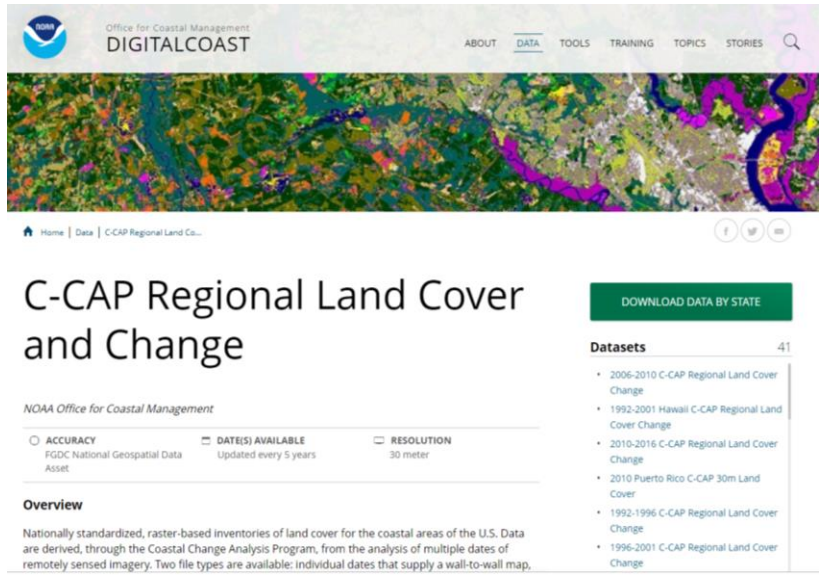
- U.S. Environmental Protection Agency (ATTAINS, NARS)
- EPA & USGS Water Quality Portal (WQX/WQP)
- U.S. Geological Survey



Possible Sources for Additional Water Quality Data: Federal Agencies, Other Groups

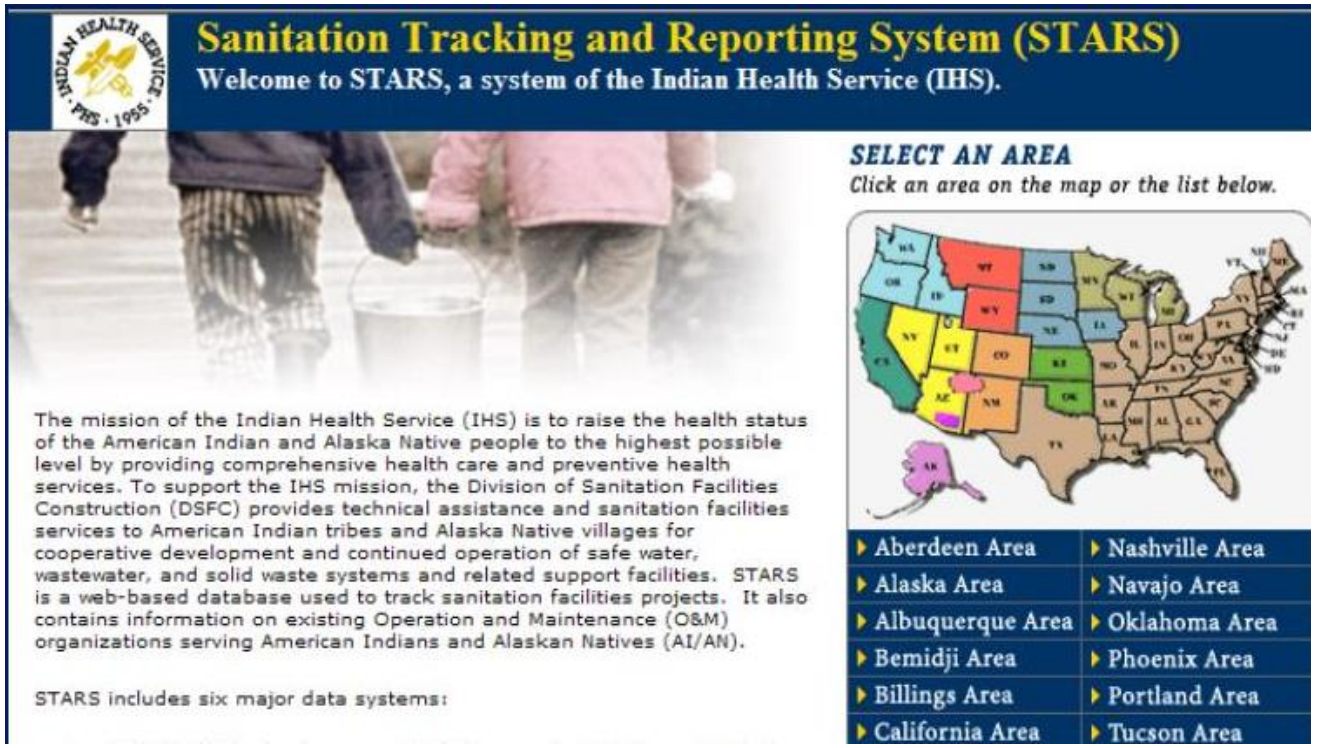
- U.S. Fish and Wildlife Service
  - Fish, habitat
- U.S. Department of Agriculture Forest Service
  - Forest management plans
- National Oceanic Atmospheric Administration (coastal and estuarine data for both oceans and Great Lakes)





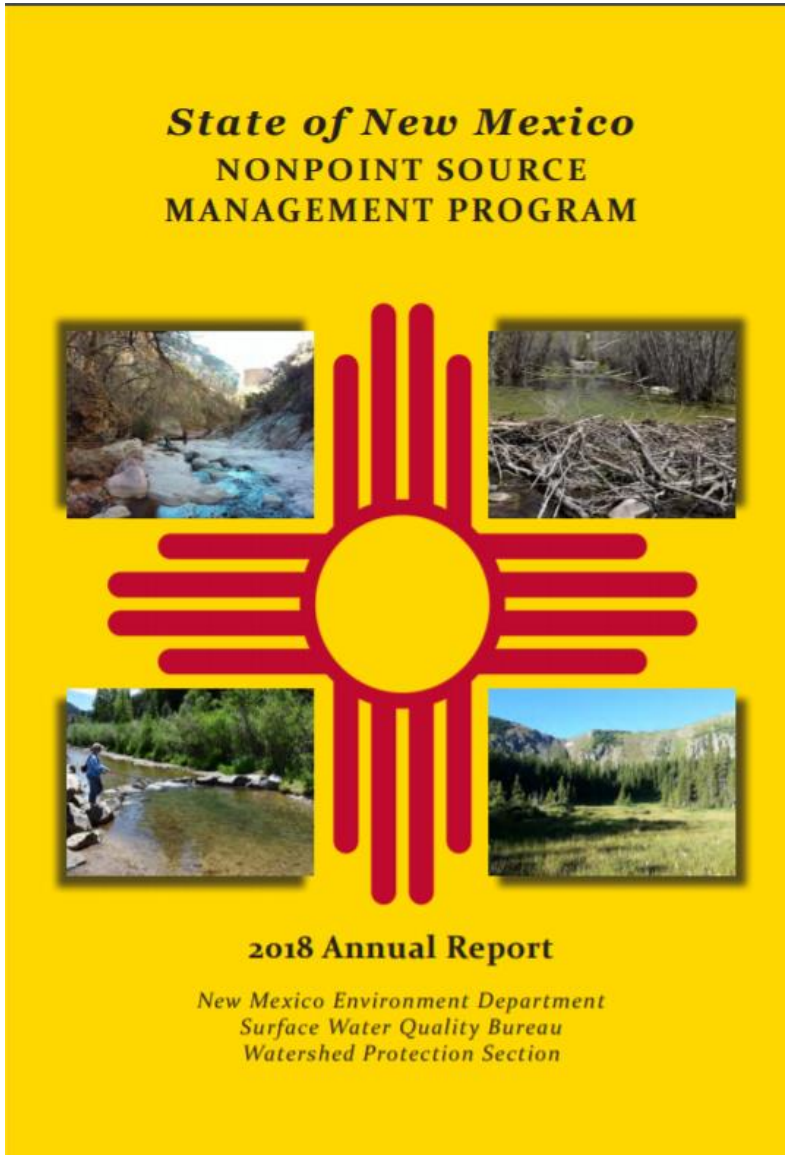
Possible Sources for Additional Tribal Water Quality Data

- Bureau of Indian Affairs
- Indian Health Services
- Tribal commissions and ceded territory agencies
- Range of possible data
  - Water quality
    - Monitoring data
    - Fisheries (census and contaminant data)
    - Natural resources
    - Drinking water intake results
  - Source information
    - Septic systems
    - Landfills/waste sites



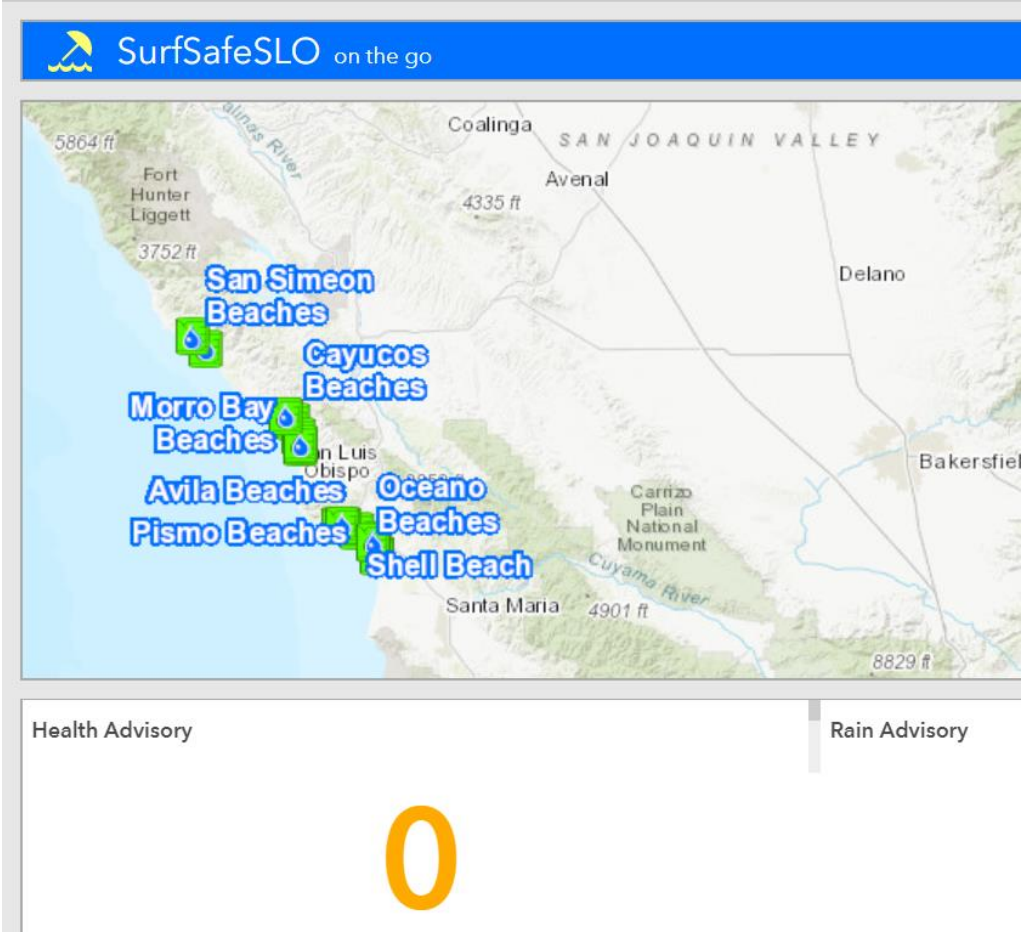
Possible Sources for Additional Water Quality Data: State Agencies

- State Departments of environmental protection (305(b)/303(d) water quality assessment data, modeling, NPS assessments, source water protection assessments, watershed plans)
- Departments of natural resources (scenic rivers monitoring)
- Departments of health (recreational waters bacteria sampling, septic systems)



Possible Sources for Additional Water Quality Data: Local Agencies

- Departments of Health
  - Septic system data
  - Beach monitoring data
- Water Utilities
  - Wastewater data
  - Drinking water monitoring data
- Soil and Water Conservation Districts
  - Water quality
  - Septic
  - Beach data



Water Quality Portal Demo

What is Accuracy?

- Degree of agreement of an analytical result with the true value (probe calibrations)
  - 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)

%R = (R1/R2)100

Where: %R = percent recovery of a parameter
R1 = the observed value for a parameter, obtained via testing/analysis
R2 = the actual value of the parameter in the sample

Discussion: Characteristics of High-Quality Data

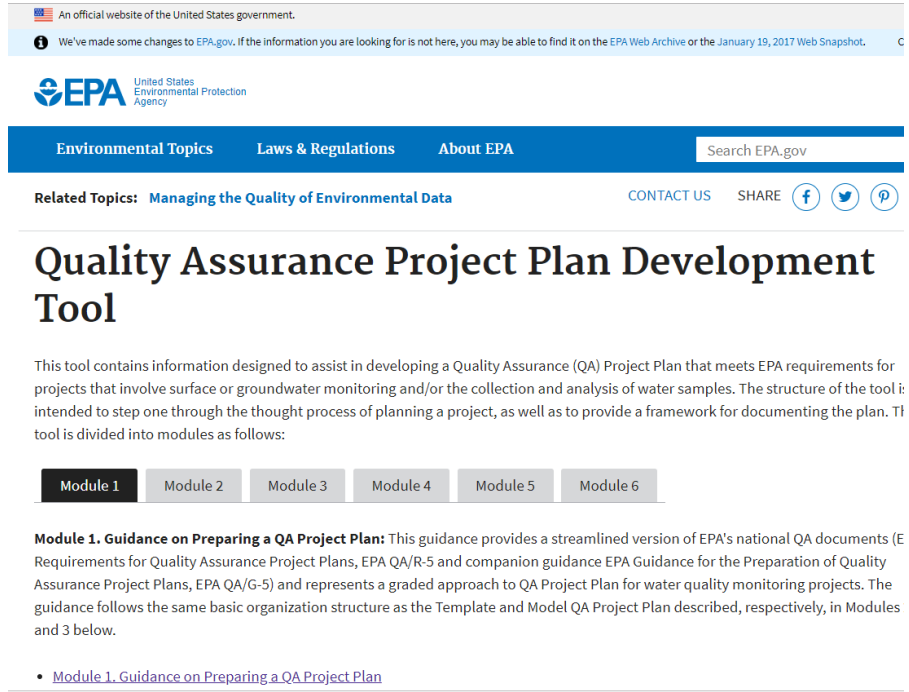
- What characteristics will you consider for tribal and non-tribal data to ensure data are high quality?
- Which characteristics are highest priority for your tribe?

Let’s Break Down Data Quality

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

Quality Assurance Project Plan (QAPP): Quick Review

- 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)



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
  - Specify tolerable levels of potential decision errors
- Specifies data performance and acceptance criteria
  - Quantitative
  - Qualitative
- EPAs DQO Guidance: https://www.epa.gov/sites/default/files/2015-06/documents/g4-final.pdf

Data Quality Indicators (DQIs) for Water Quality Assessments

- Data quality indicators (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

What Is Precision?

- Assessment of the degree to which two or more measurements are in agreement
- 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)

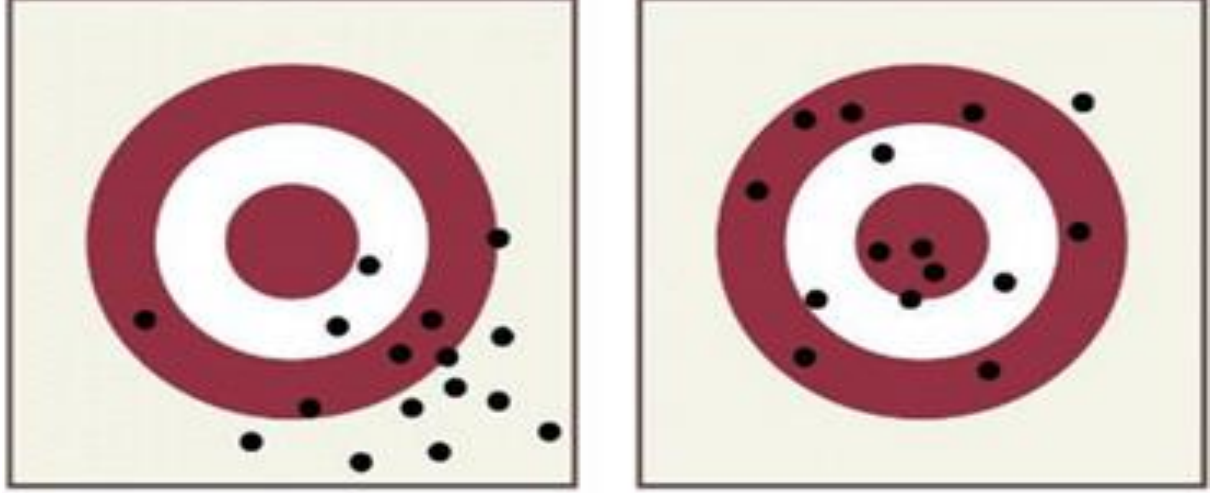
$$RPD = \frac{(X1 - X2)}{(X1 + X2)/2} * 100$$

Where: RPD = Relative Percentage Difference
X1 = largest replicate sample value
X2 = smallest replicate sample value

What is 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

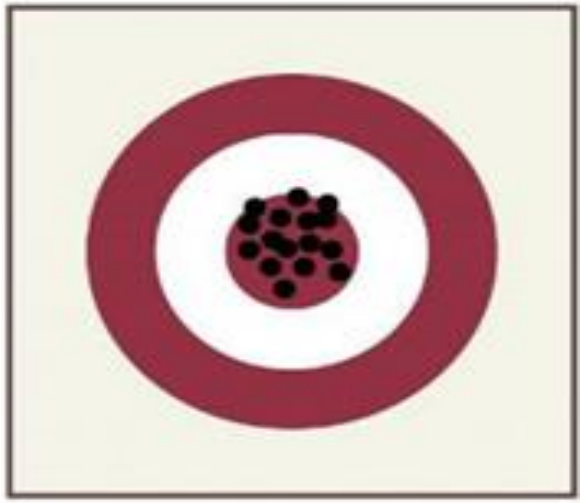
How Bias and Precision Affect Accuracy



high bias
+ low precision
= low accuracy

low bias
+ low precision
= low accuracy

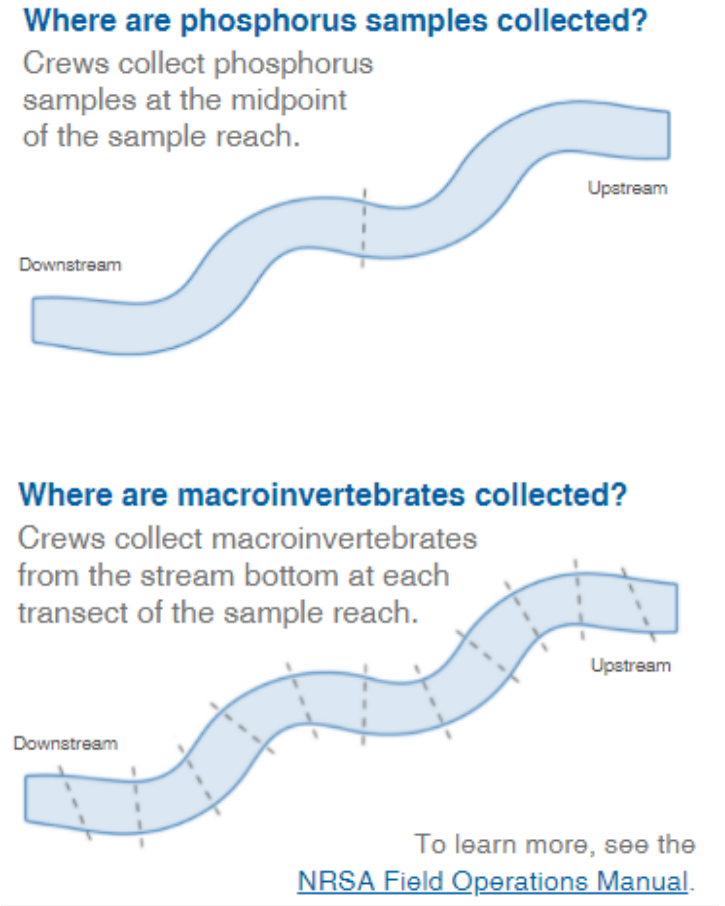
high bias
+ high precision
= low accuracy



low bias
+ high precision
= high accuracy

What is Representativeness?

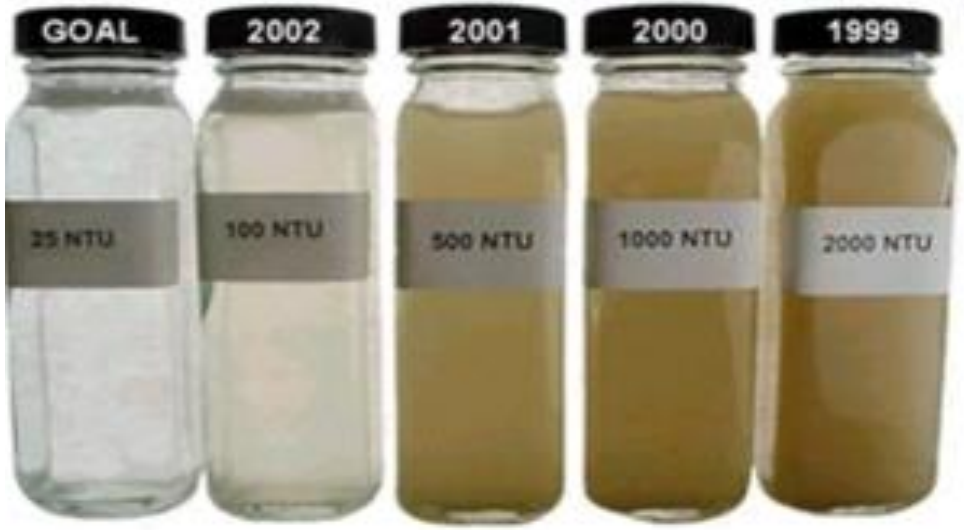
- The extent to which measurements characterize the true environmental condition or population at the time a sample was collected.
- Two Types of Representativeness should be considered:
  - Spatial Representativeness
    - Field Method Considerations
    - Site Selection Considerations
  - Temporal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



National Rivers and Streams Assessment Field Methods Application -- https://riverstreamassessment.epa.gov/fieldmethods/.

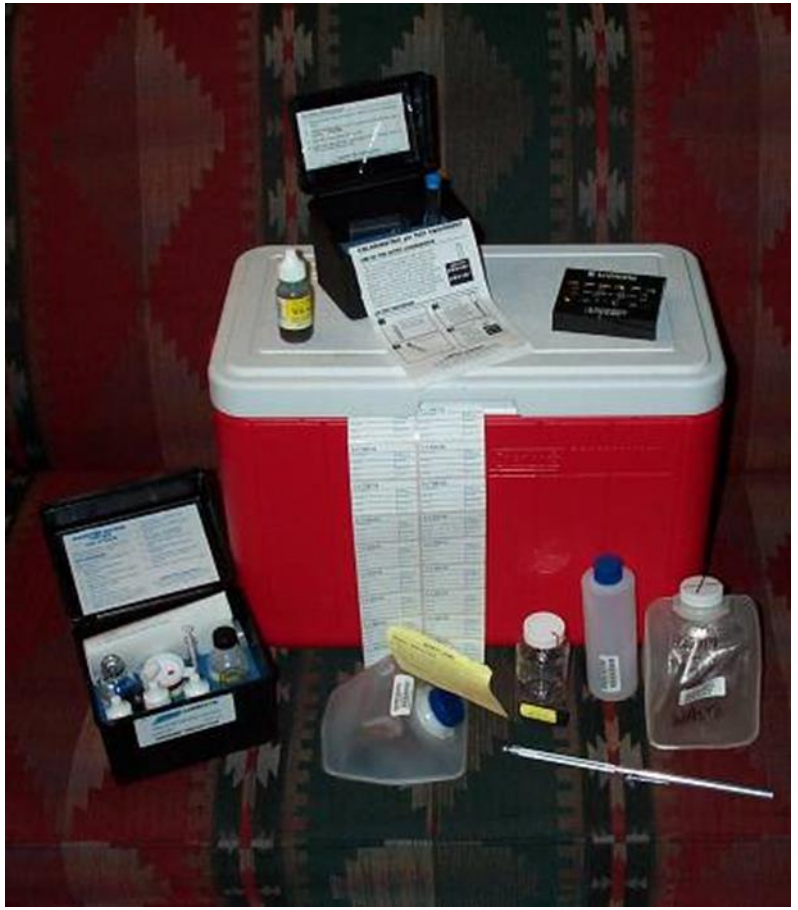
What is Comparability?

- 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 (ca yield very different results)
- Important to document data procedures to verify/evaluate comparability



What is 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



Section 2: Learning Objectives

- Introduce basic approaches of assessing data for specific water quality parameters
- Understand the distinction between acute and chronic water quality criteria
- Describe the importance of sample size when evaluating water quality data
- Understand how conventional parameters are evaluated against water quality criteria

Numeric Water Quality Criteria

- What is a numeric water quality criterion?
  - EPA develops recommended human health and aquatic life water quality criteria as guidance to tribes/states for use in developing their own criteria. Levels adopted in Tribal or state water quality standard or otherwise 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: pH shall be *within the range* of 6.5 to 8.5

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,

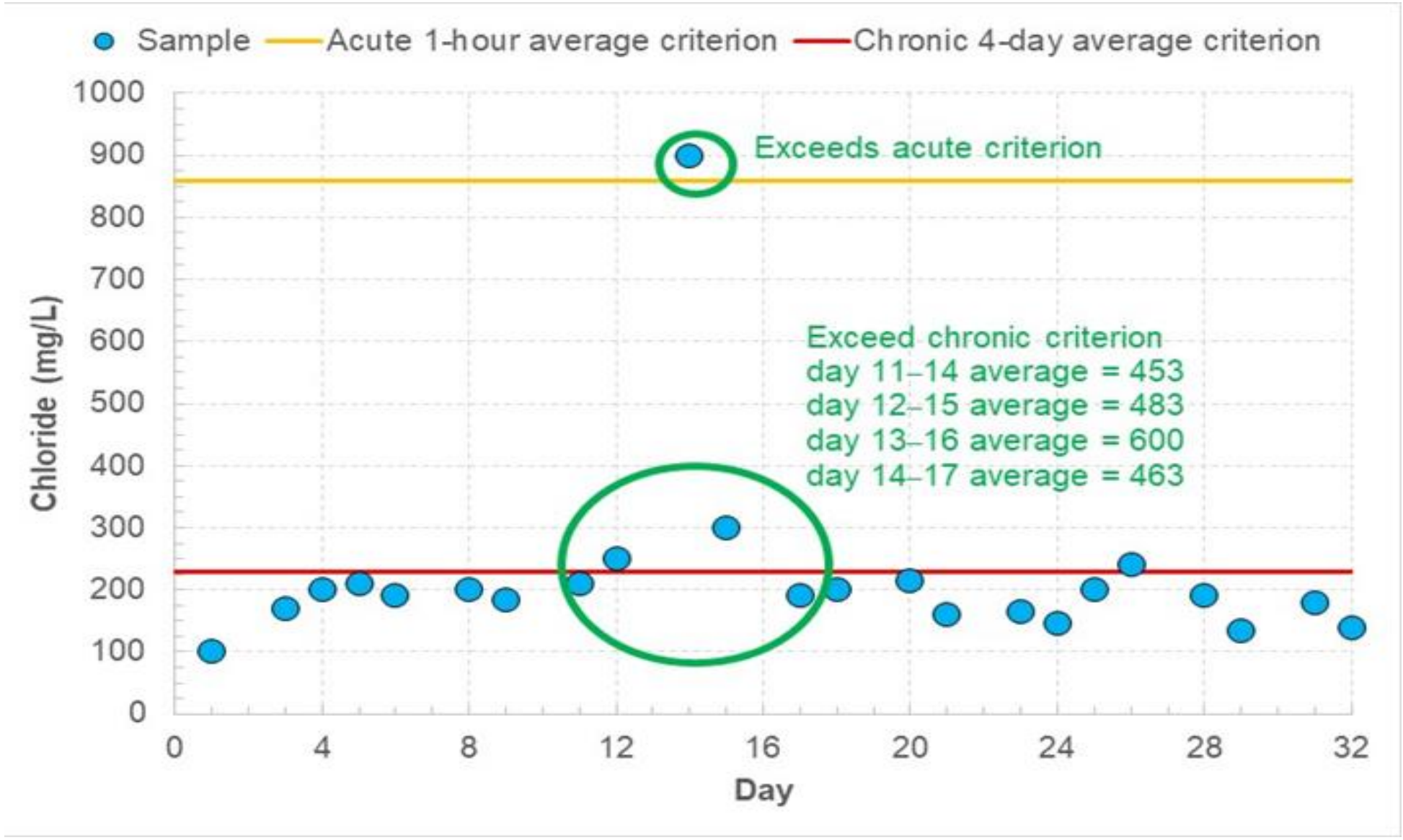
and cannot be exceeded more than 10% of the time.

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

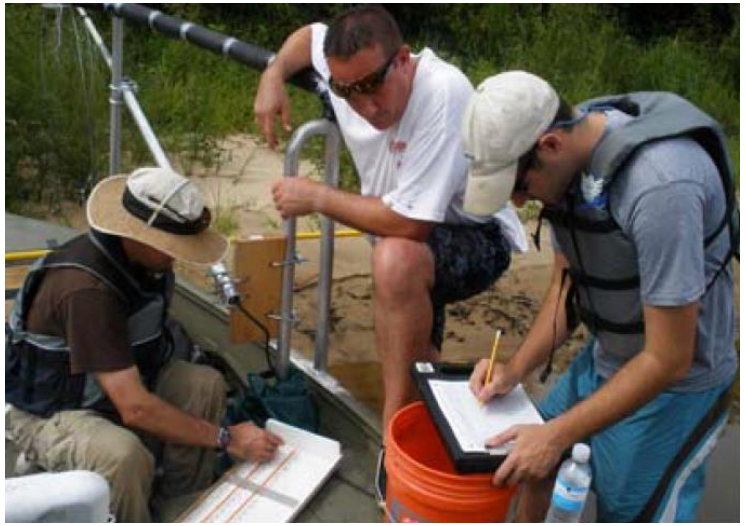
Acute and Chronic Water Quality Criteria: Lummi Nation Chloride Example



860 mg/L

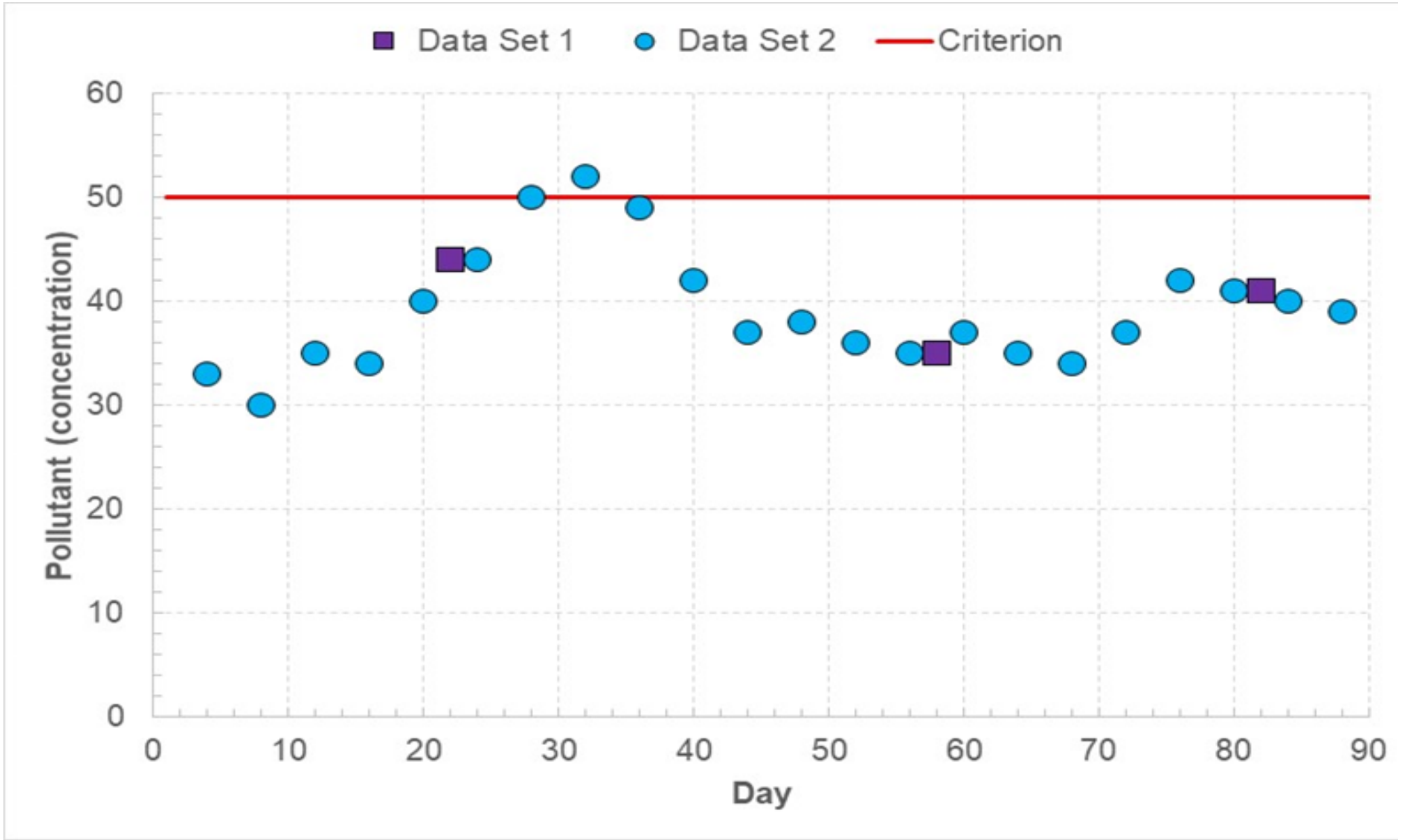
230 mg/L

Considerations for Sample Size



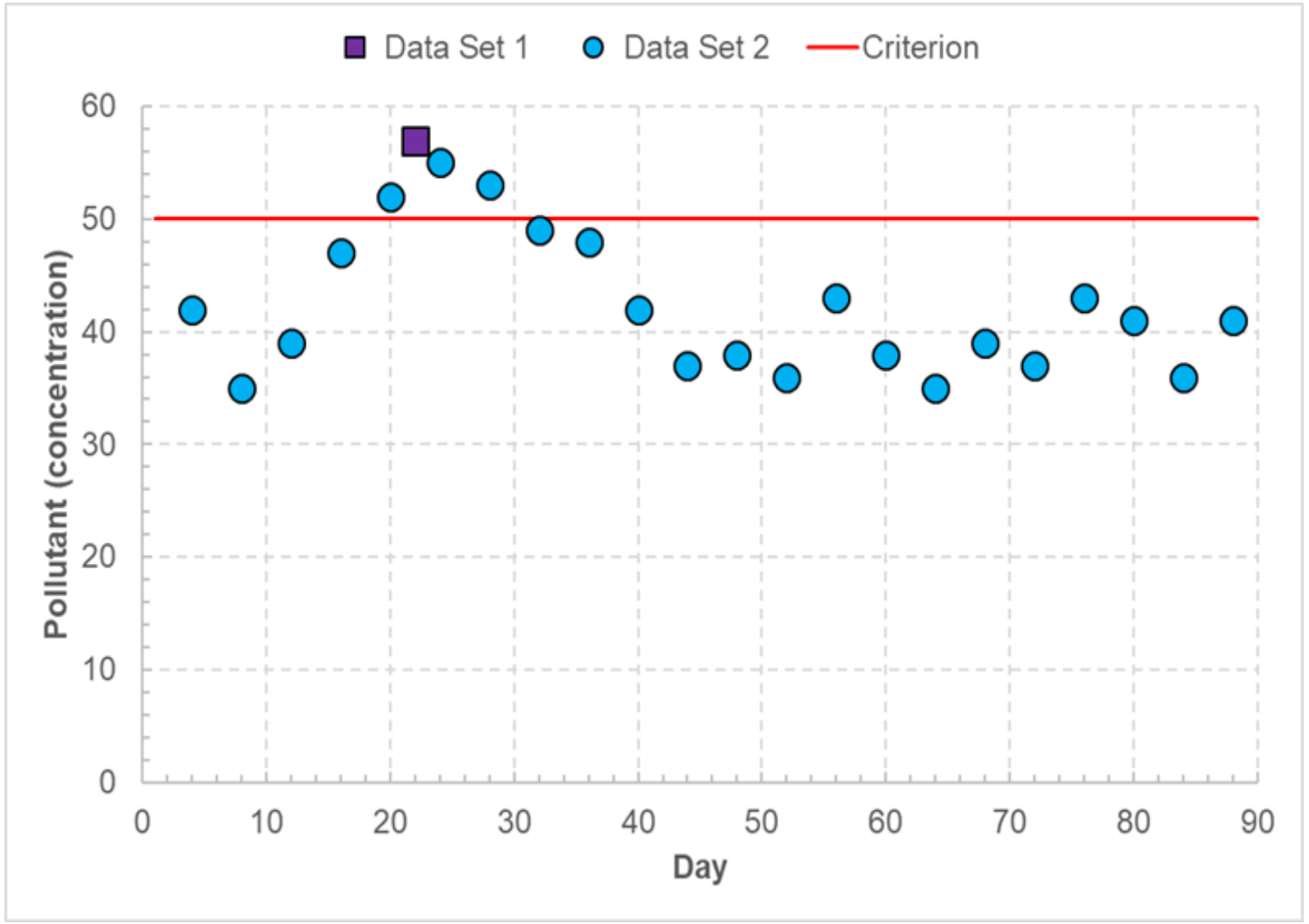
- **Sample size should target research questions**:
  - Types of waterbodies to be assessed
  - High/low flow conditions to be considered
  - Parameters of interest & seasonality
- **Number of samples to be taken**
  - Balance cost and completeness of dataset (seasonality coverage, etc)
  - Note: Not meeting minimum sample size does not always mean you can't 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

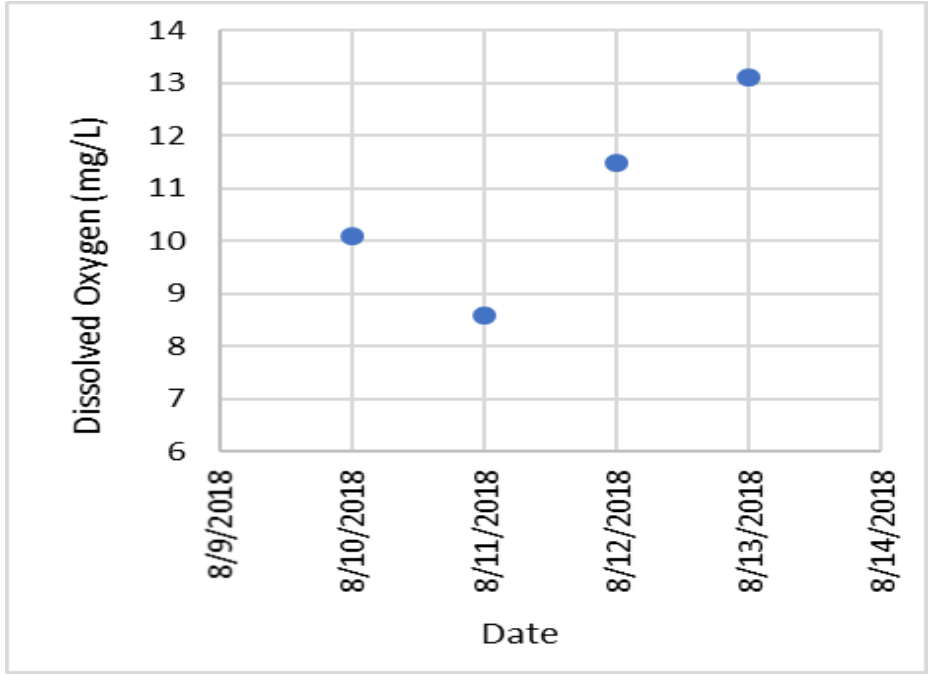
Analysis of Conventional Pollutants

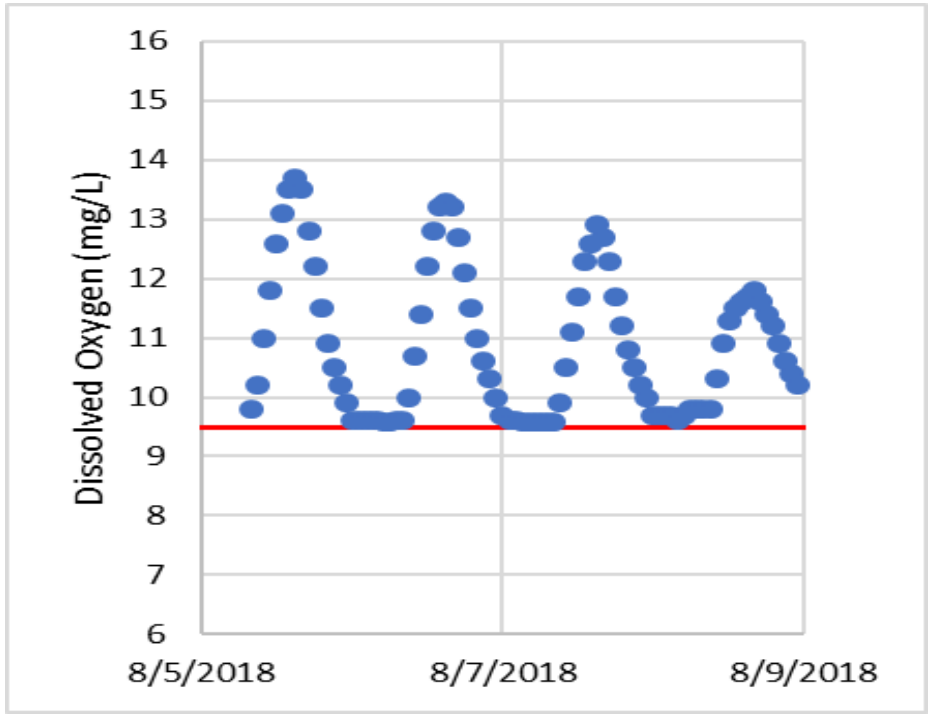
- DO, pH, temperature, turbidity, conductivity
- Relatively easily to measure

https://www.fondriest.com/environmental-measurements/measurements/measuring-water-quality/dissolved-oxygen-sensors-and-methods/

Dissolved Oxygen

- Critical for life!
- Causes of low dissolved oxygen
- Relationship with temperature
- Discrete and continuous measurements
- How can you be confident of your DO readings?





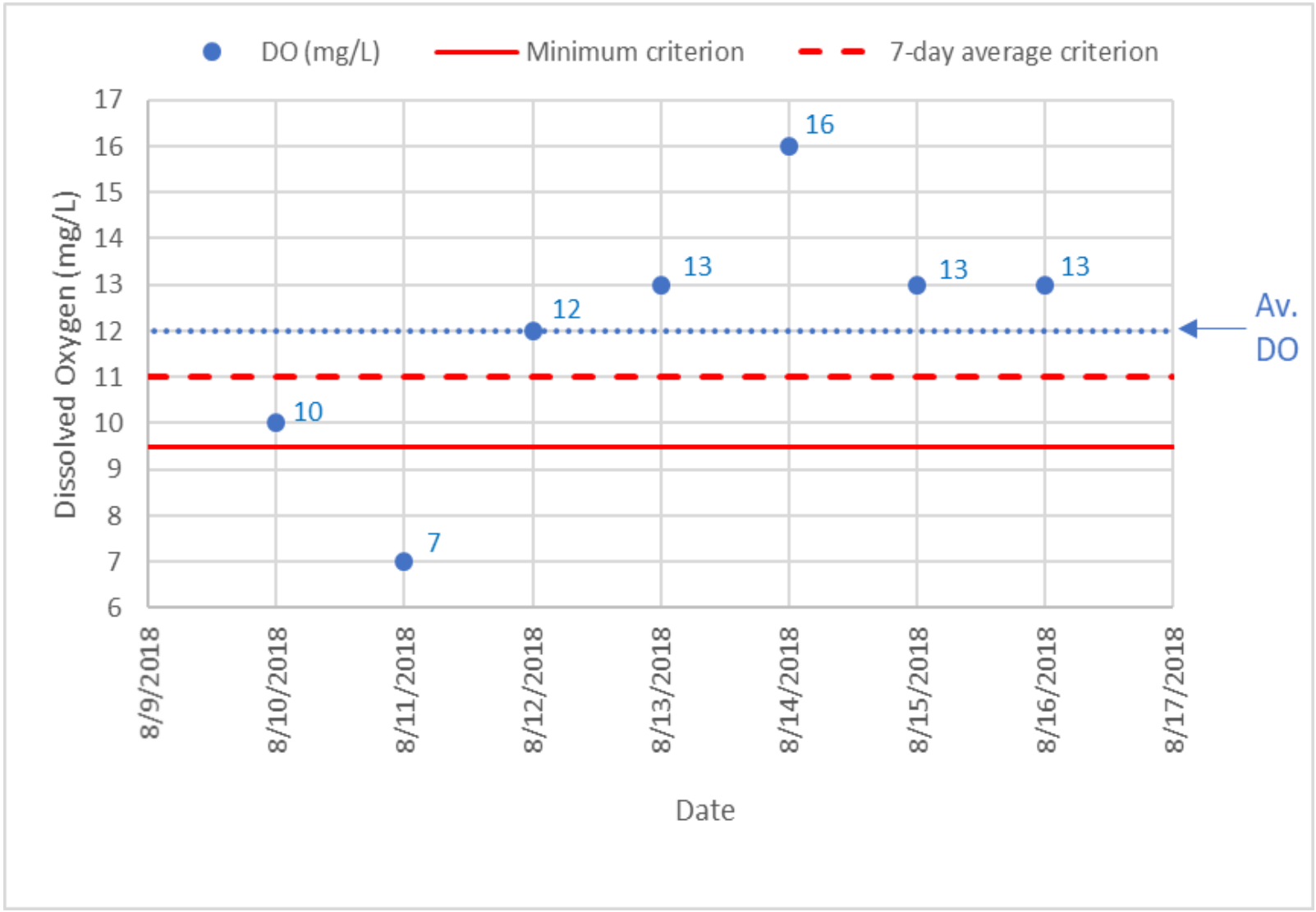
Examples of Dissolved Oxygen Criteria: Makah Tribe

- 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

https://nwtreatytribes.org/loomis-great-day-salmon-tribal-treaty-rights-everyone-lives/

Dissolved Oxygen Assessment

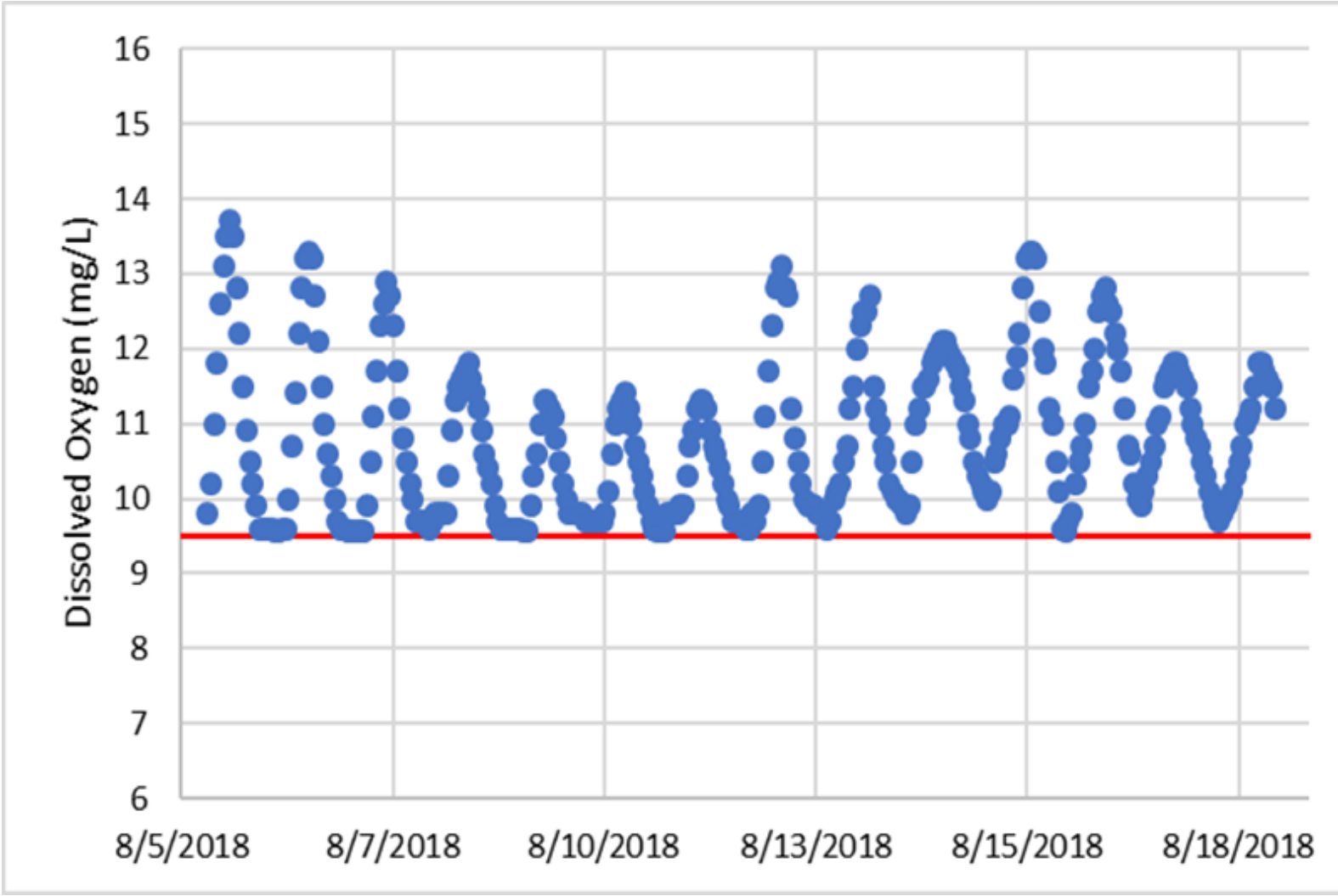
- Salmon and trout spawning water
  - 7-day average of the daily mean dissolved oxygen: 11 mg/L
  - Minimum: 9.5 mg/L
- 7-day average: 12 mg/L
- Range: 7–16 mg/L



Dissolved Oxygen Assessment

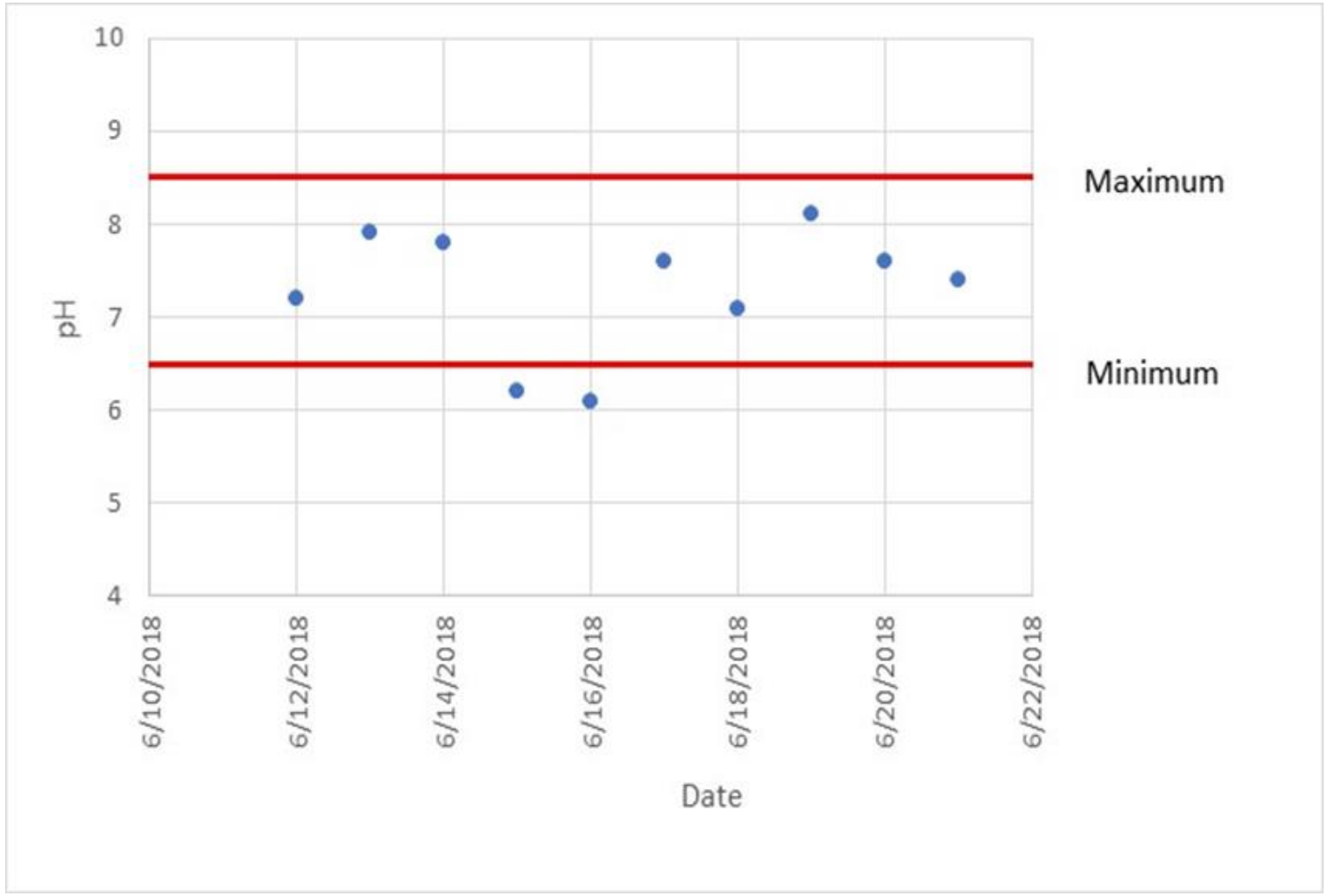
Salmon and trout spawning water criteria:

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



pH Criteria

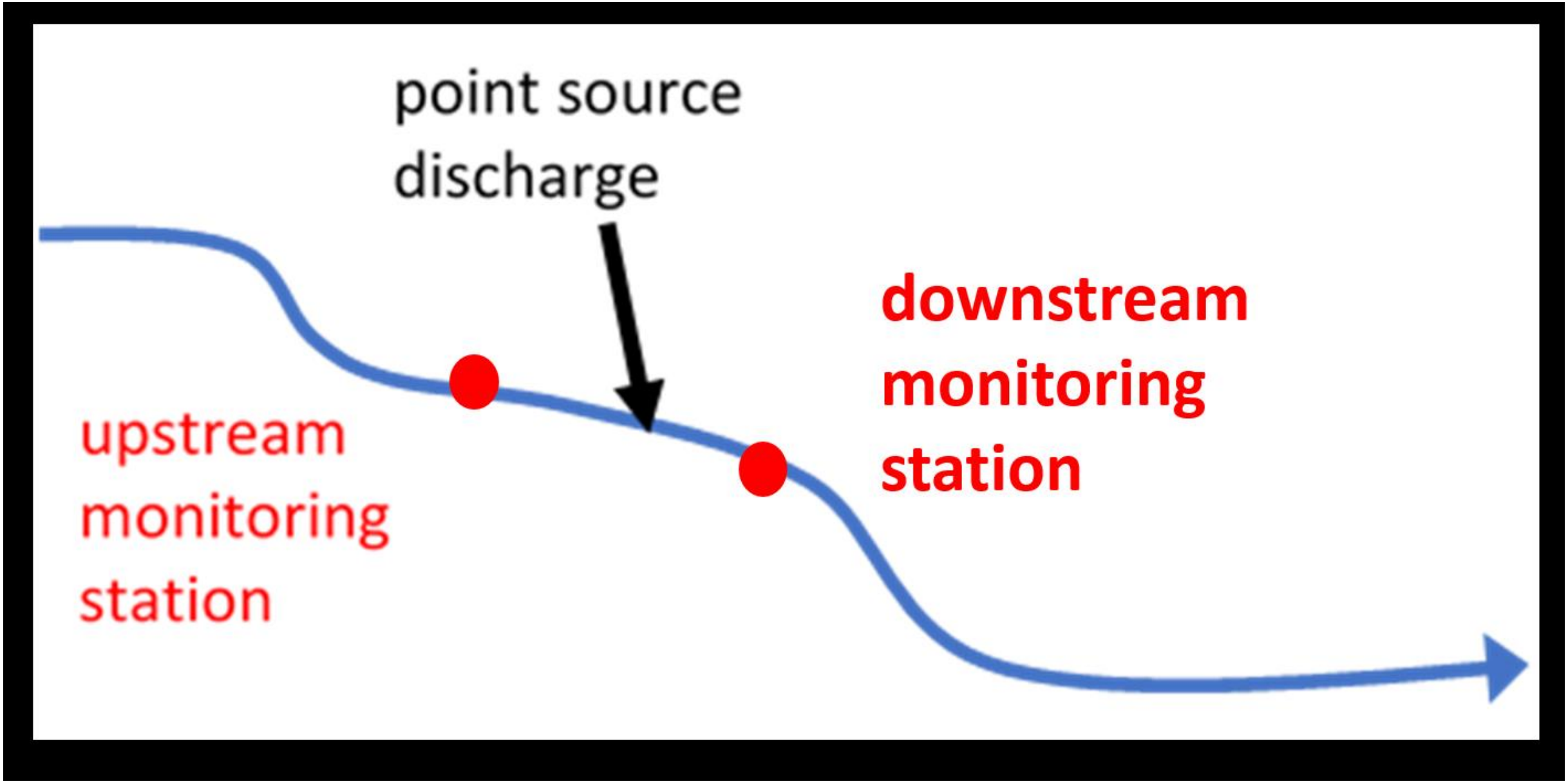
- A measure of acidity and alkalinity of the water
- Criteria require keeping pH within a specific range
  - To protect human health, the pH must be within the range of 5 to 9
  - To protect aquatic life, the pH must be within the range of 6.5 to 9.0 for freshwater and 6.5 to 8.5 for saltwater



Temperature

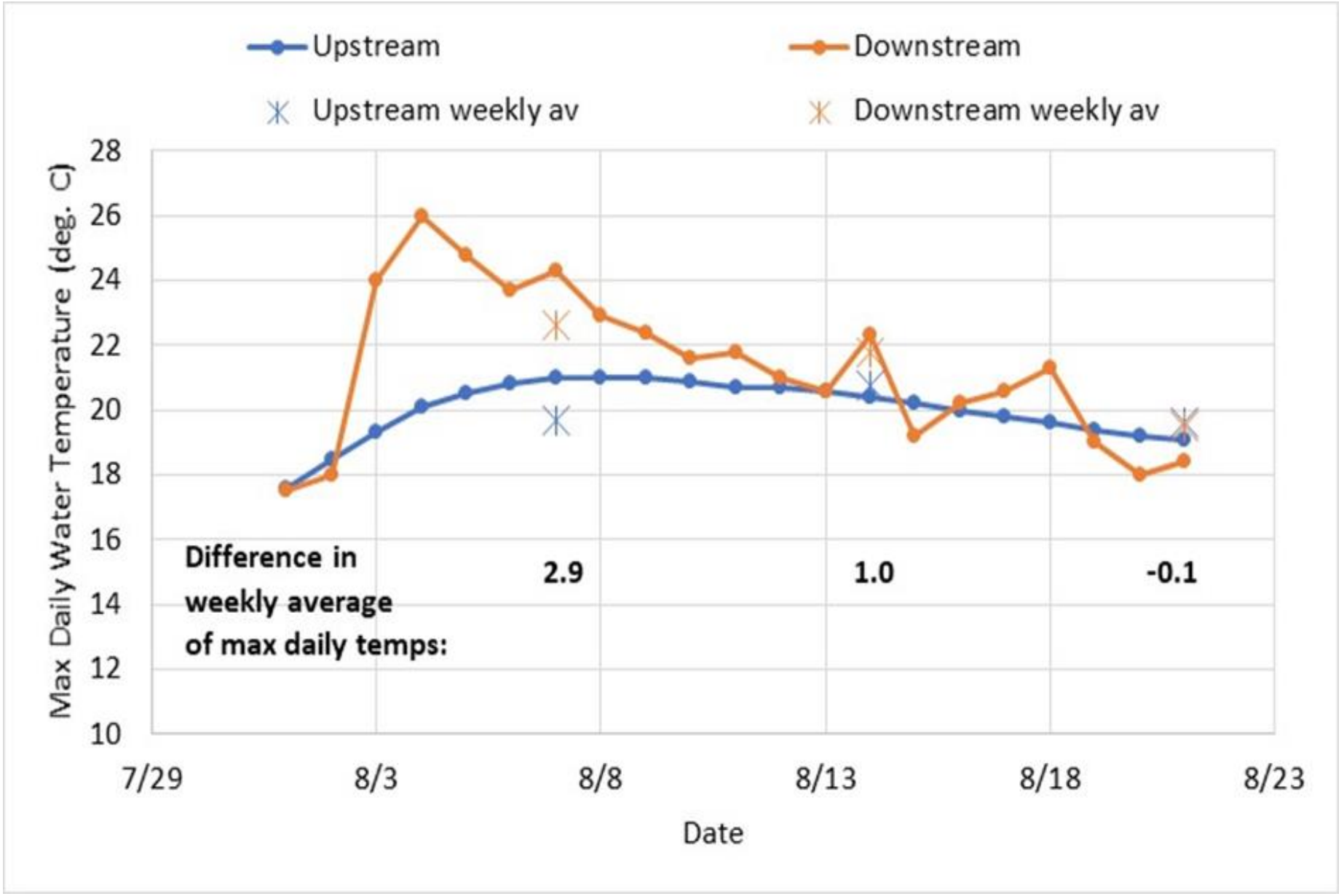
- Criteria focused on aquatic life support—warmwater and coldwater
- “In a stream, the introduction of heat by other than natural causes shall not increase the temperature, as measured upstream from the point of introduction, by more than 2.7° C (5° F), based on the weekly average of the maximum daily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

Temperature Criteria Example



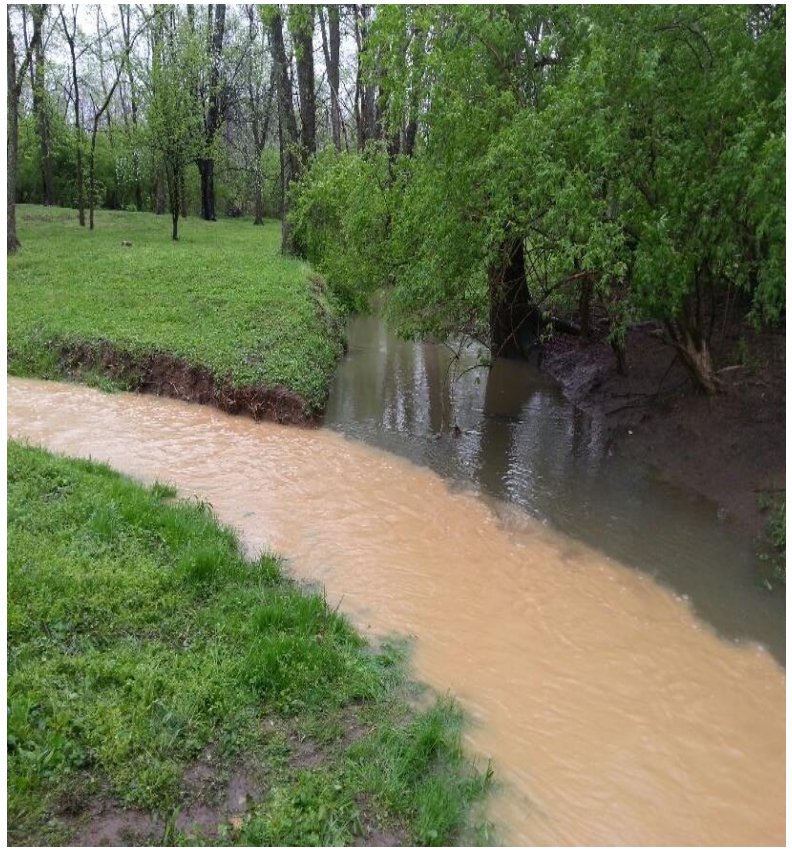
Temperature Example

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



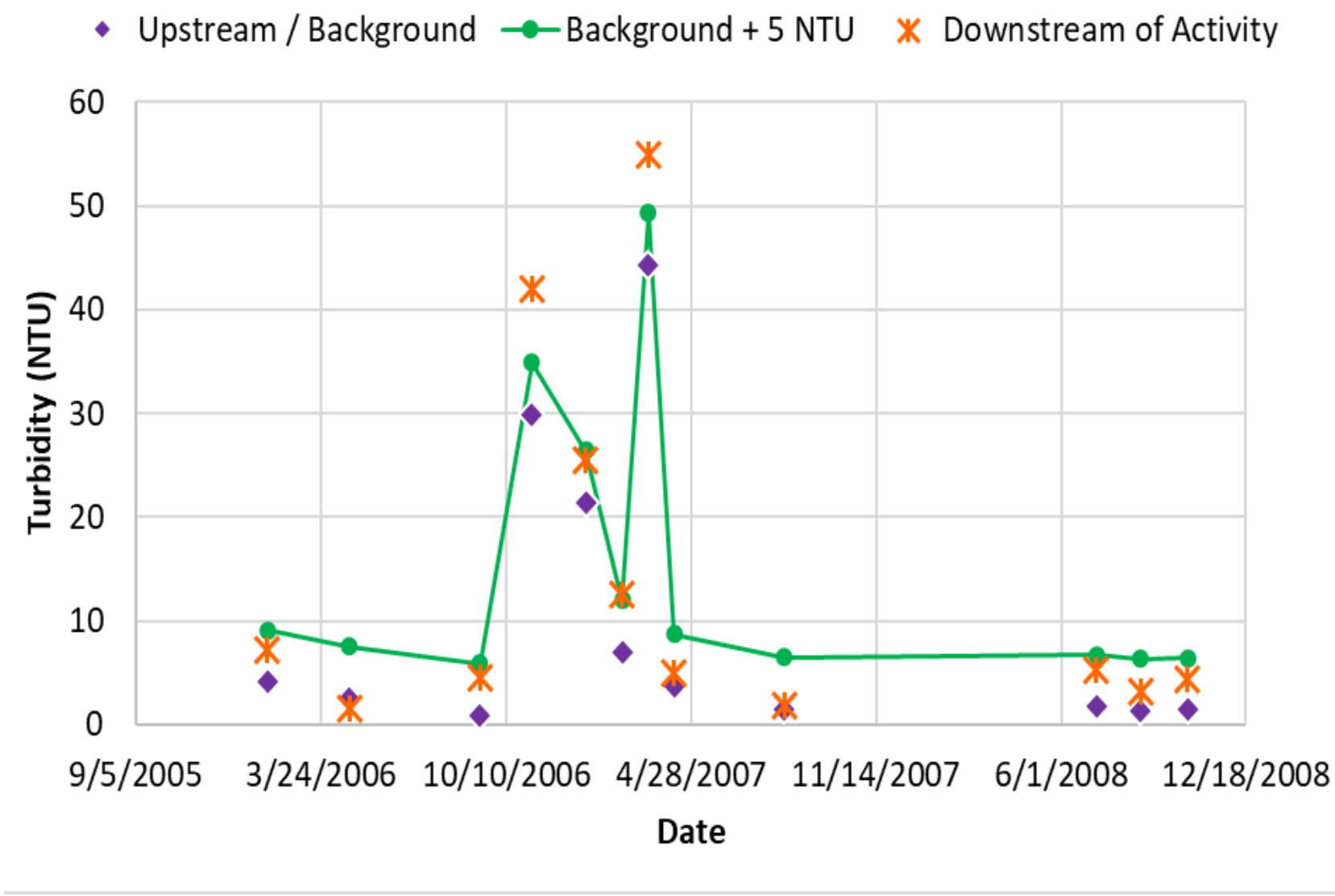
Turbidity

- 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



Analysis of 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

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