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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USEPA Region 6

ATTAINS Tribal Training

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Section 1: Learning Objectives

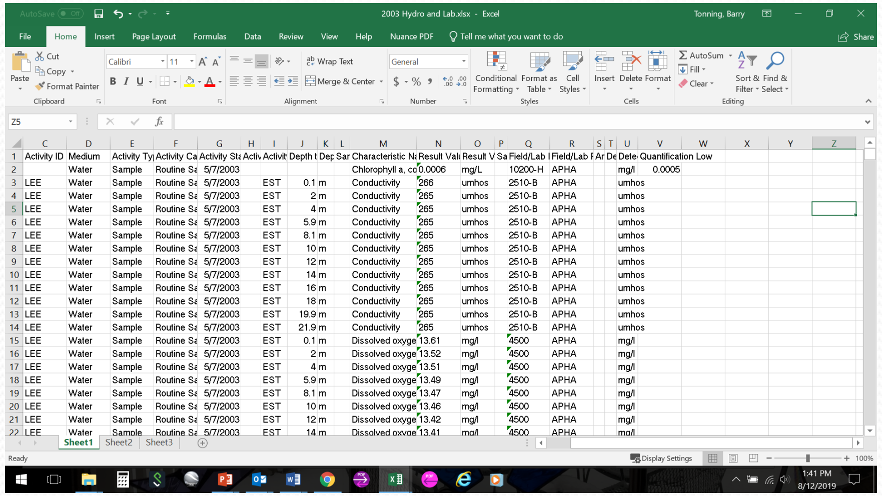
- To understand the potential data sources and formats that may be available from both the Tribe and other data partners for use in producing a water quality assessment
- To identify the factors that can affect the quality of data used for a water quality assessment

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



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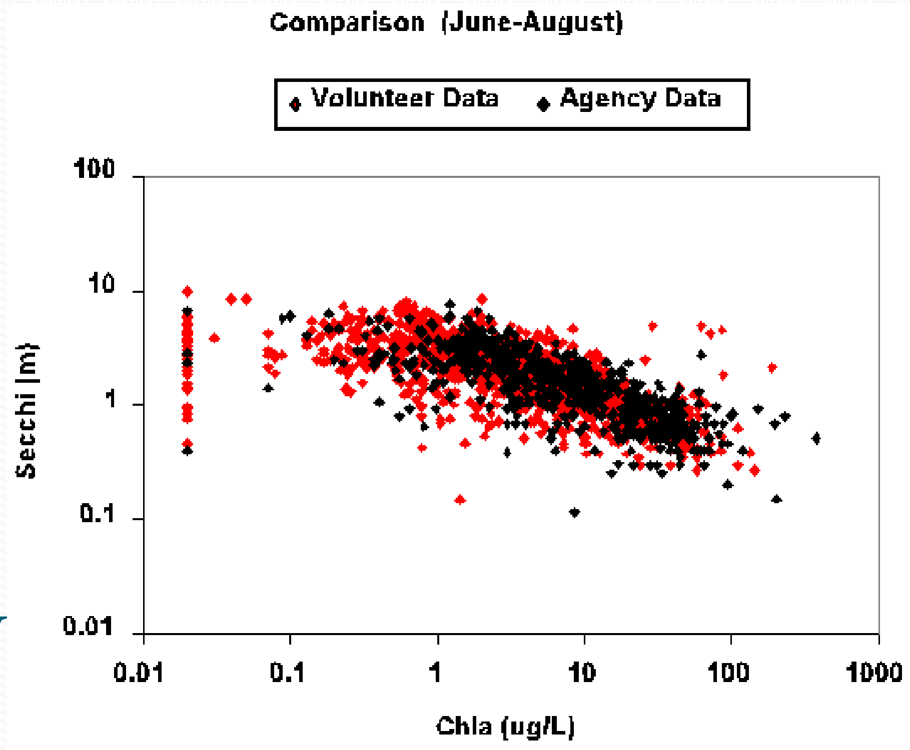
21	LEE	Water	Sample	Routine Sa	5/7/2003		EST	12	m		Dissolved oxyge	13.42	mg/l		4500	APHA			mg/l	
22	LEE	Water	Sample	Routine Sa	5/7/2003		EST	14	m		Dissolved oxyge	13.41	mg/l		4500	APHA			mg/l	

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?

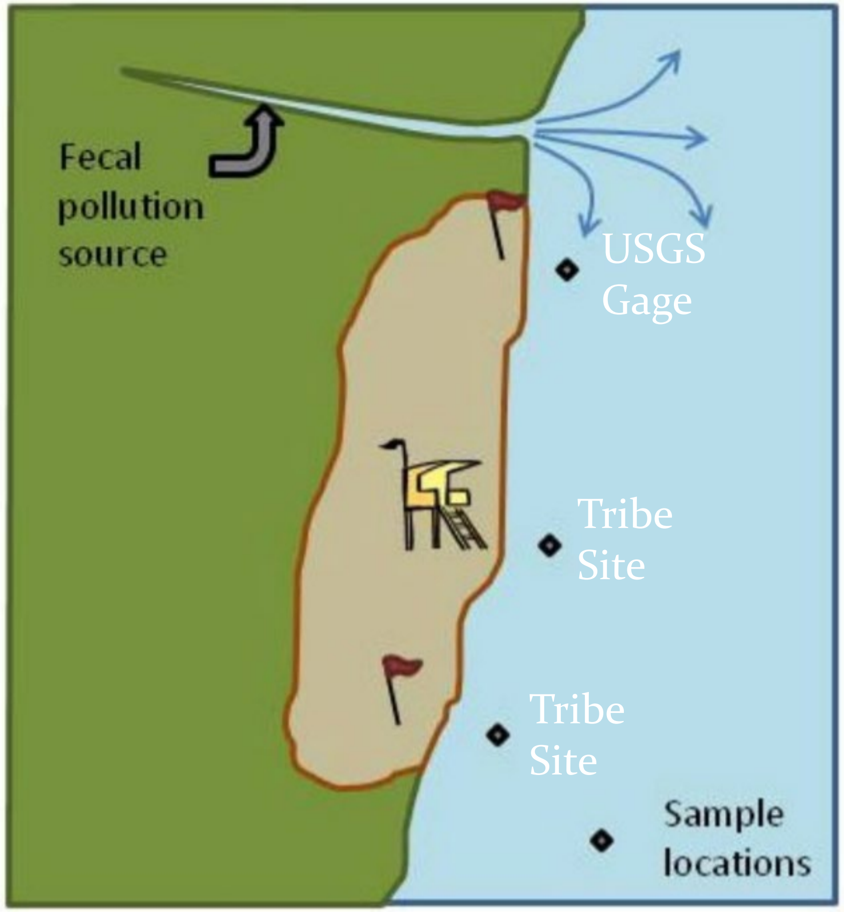


A Note…

- 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)



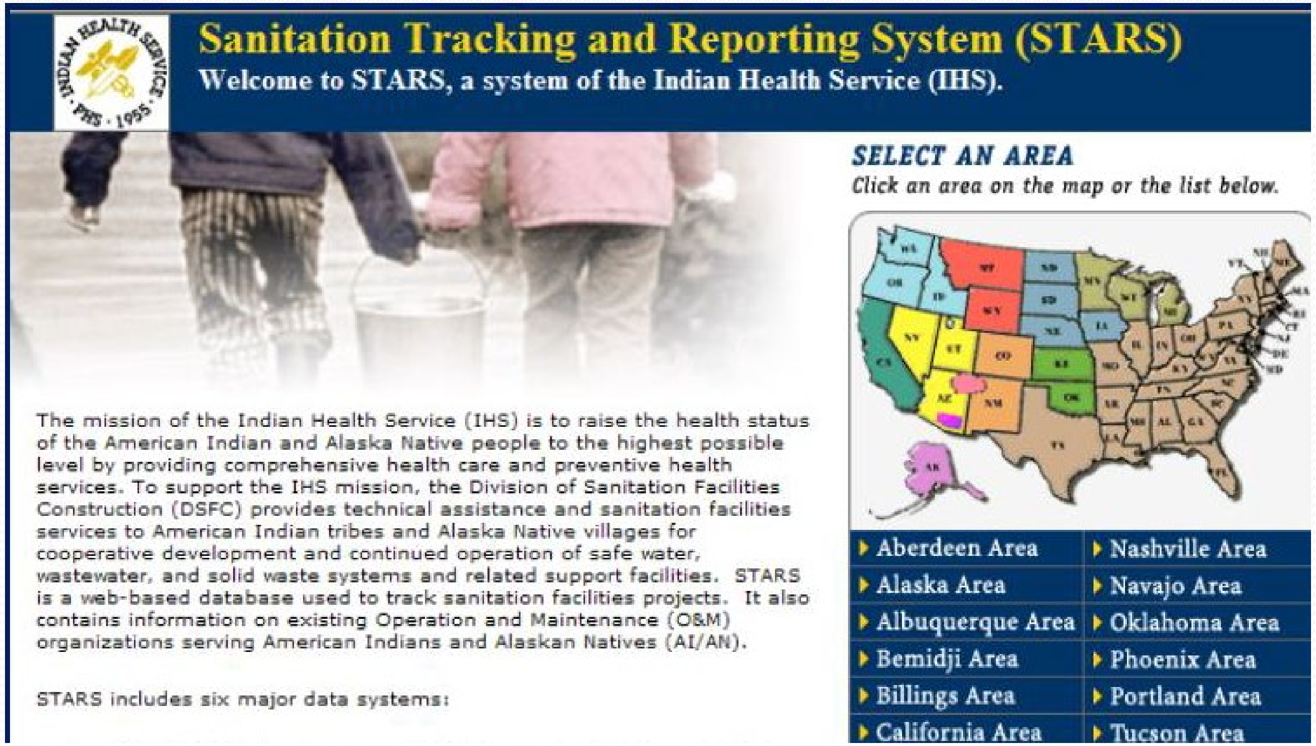
Types of Data to Consider

- 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!

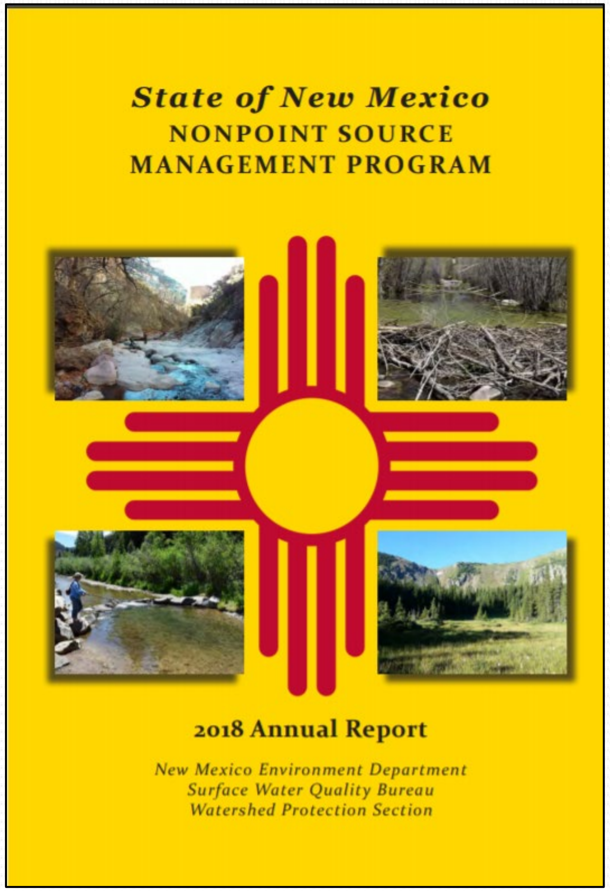
Possible Sources: Tribal Agencies

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



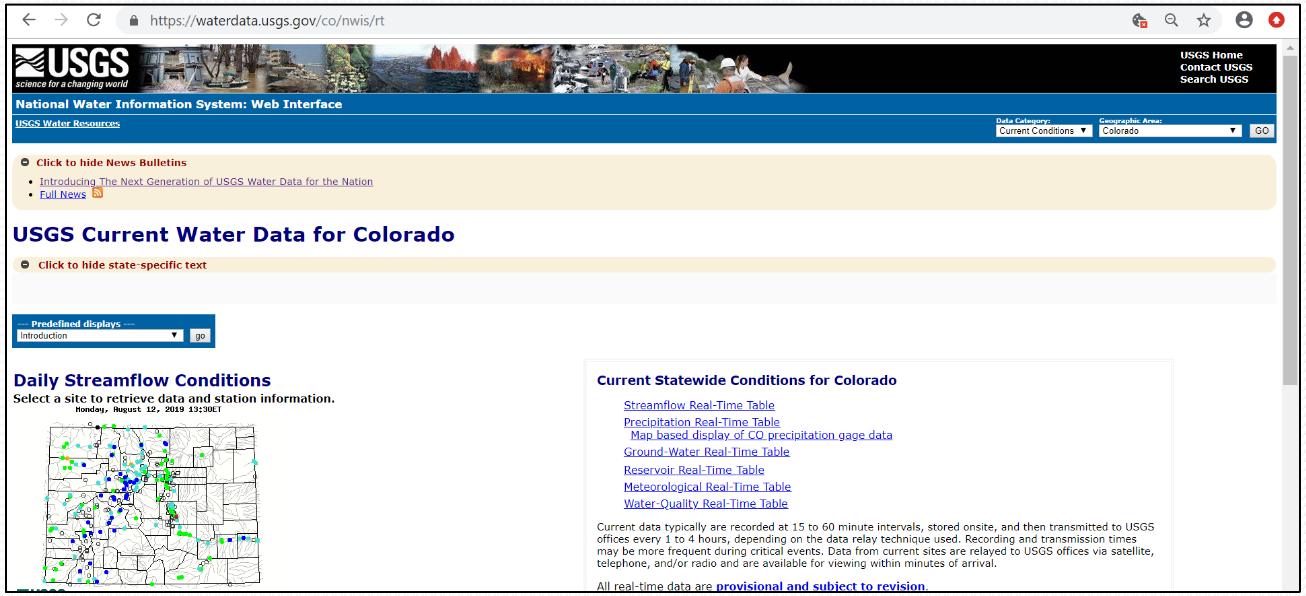
Possible Sources: State and Local Agencies

- 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



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)

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
- EPAs 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)

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

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

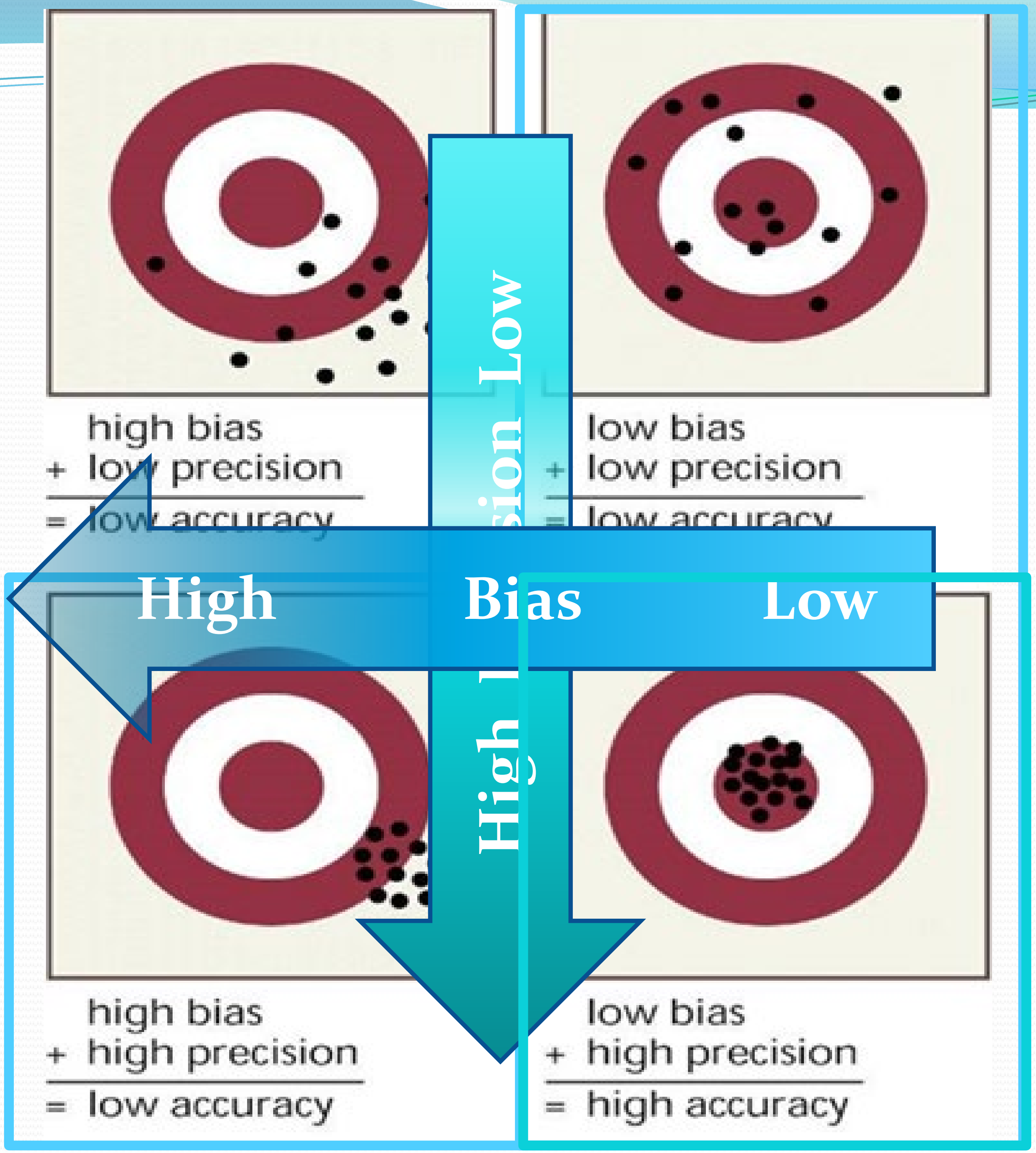
Accuracy

- 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

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

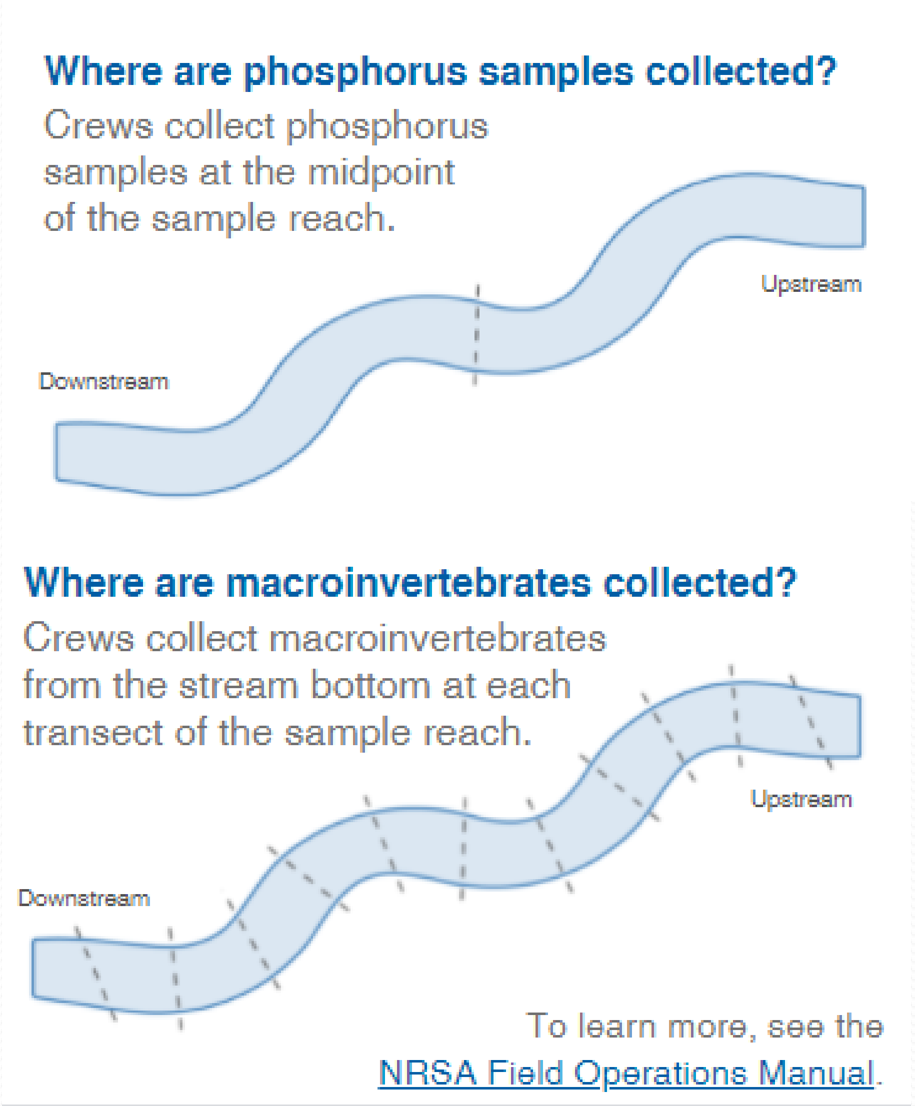
Where: %R = percent recovery of a parameter
R_1 = the observed value for a parameter, obtained via testing/analysis
R_2 = the actual value of the parameter in the sample

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



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

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 = $(e^{(x[\ln(hardness)]+y)})*z$

Parts of a Numeric Water Quality Criterion

Explicit Value = actual number/magnitude

Duration = period of time

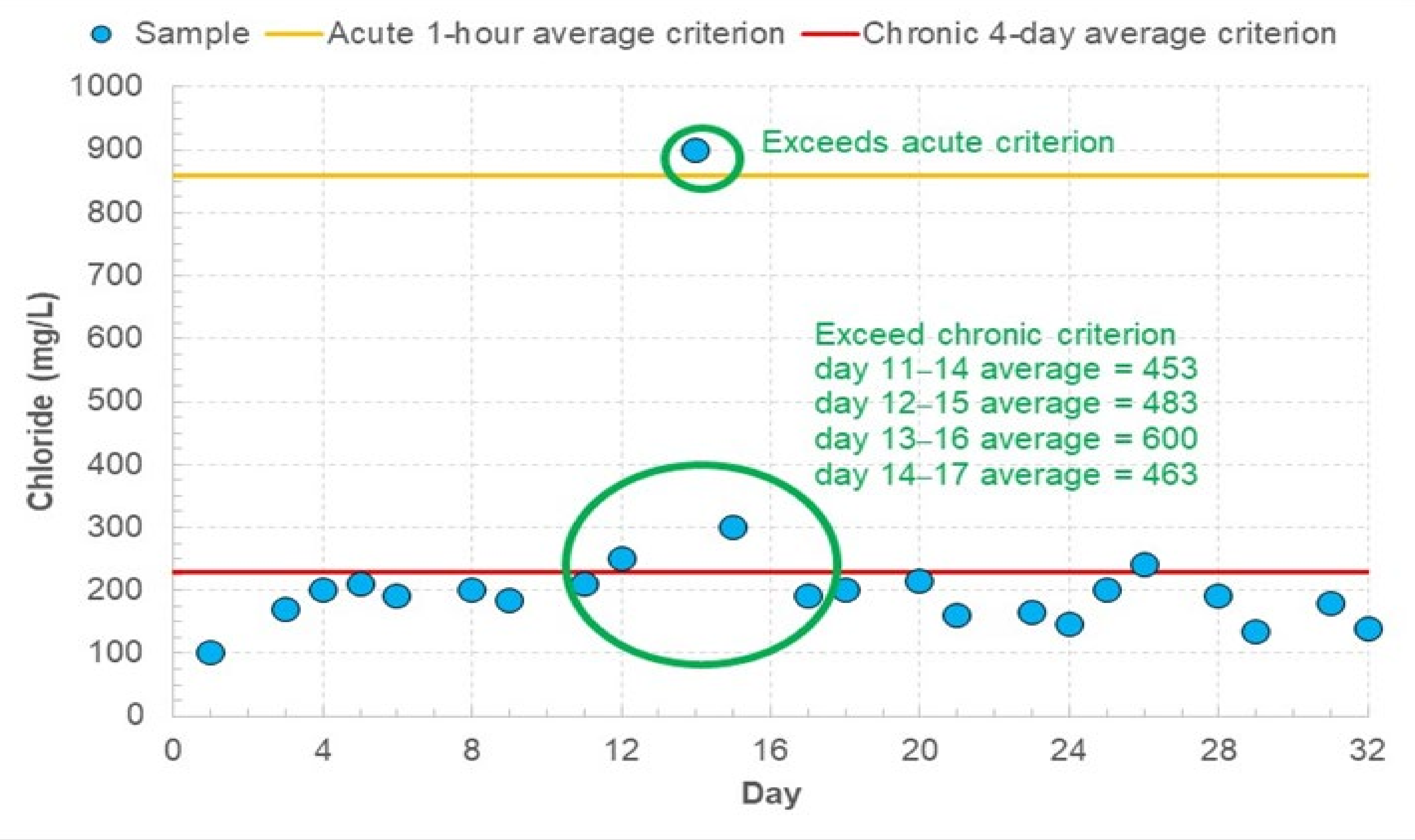
Example: Should not exceed 10 mg/L as an annual average, and cannot be exceeded more than 10% of the time.

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

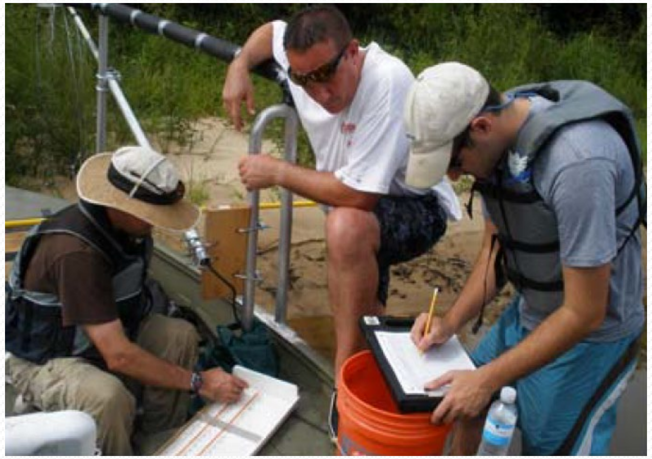


860 mg/L

230 mg/L

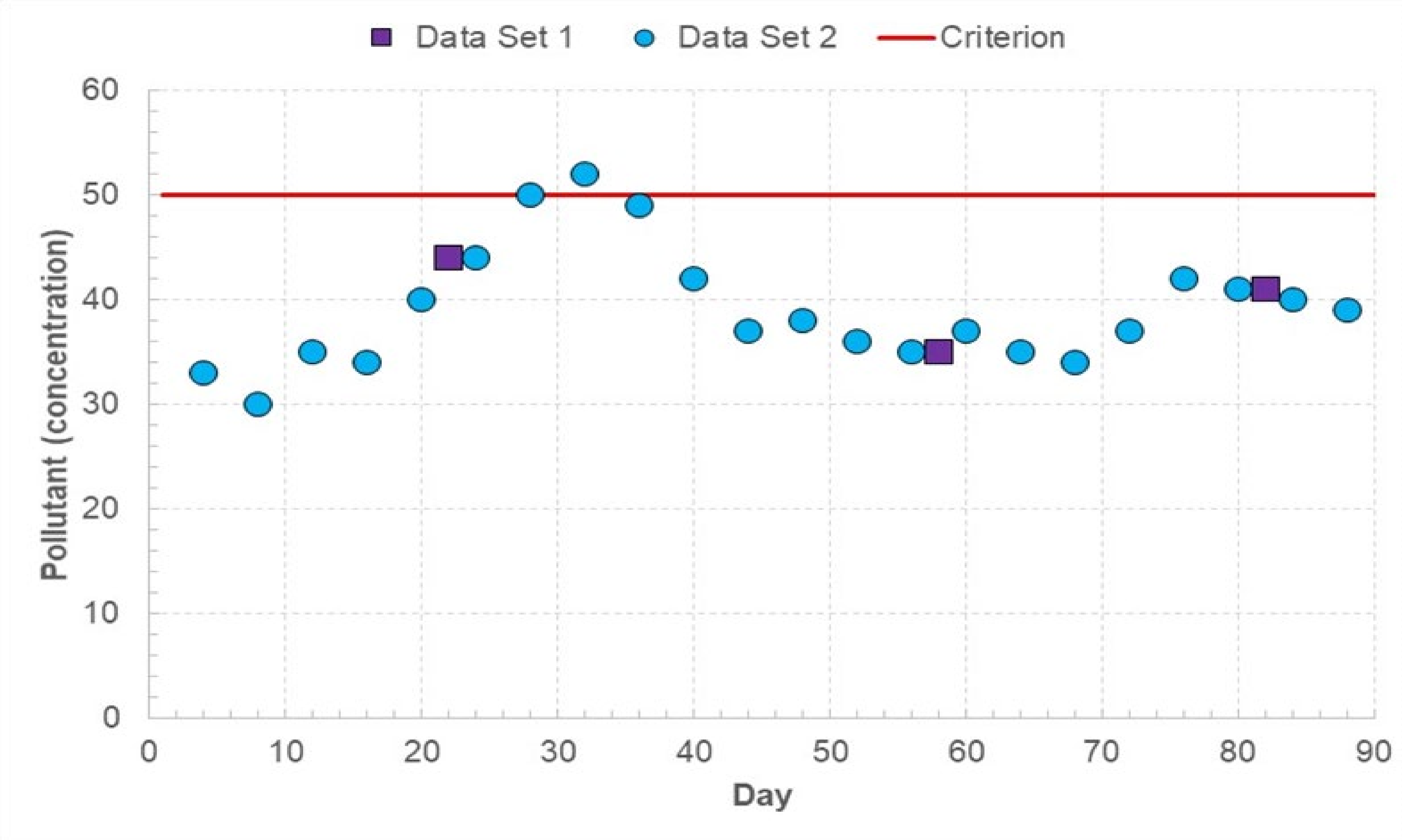
Considerations for Sample Size

- **Sample size should target research questions**:
  - Types of waterbodies to be assessed
  - High/low flow conditions to be considered
  - Parameters of interest & seasonality



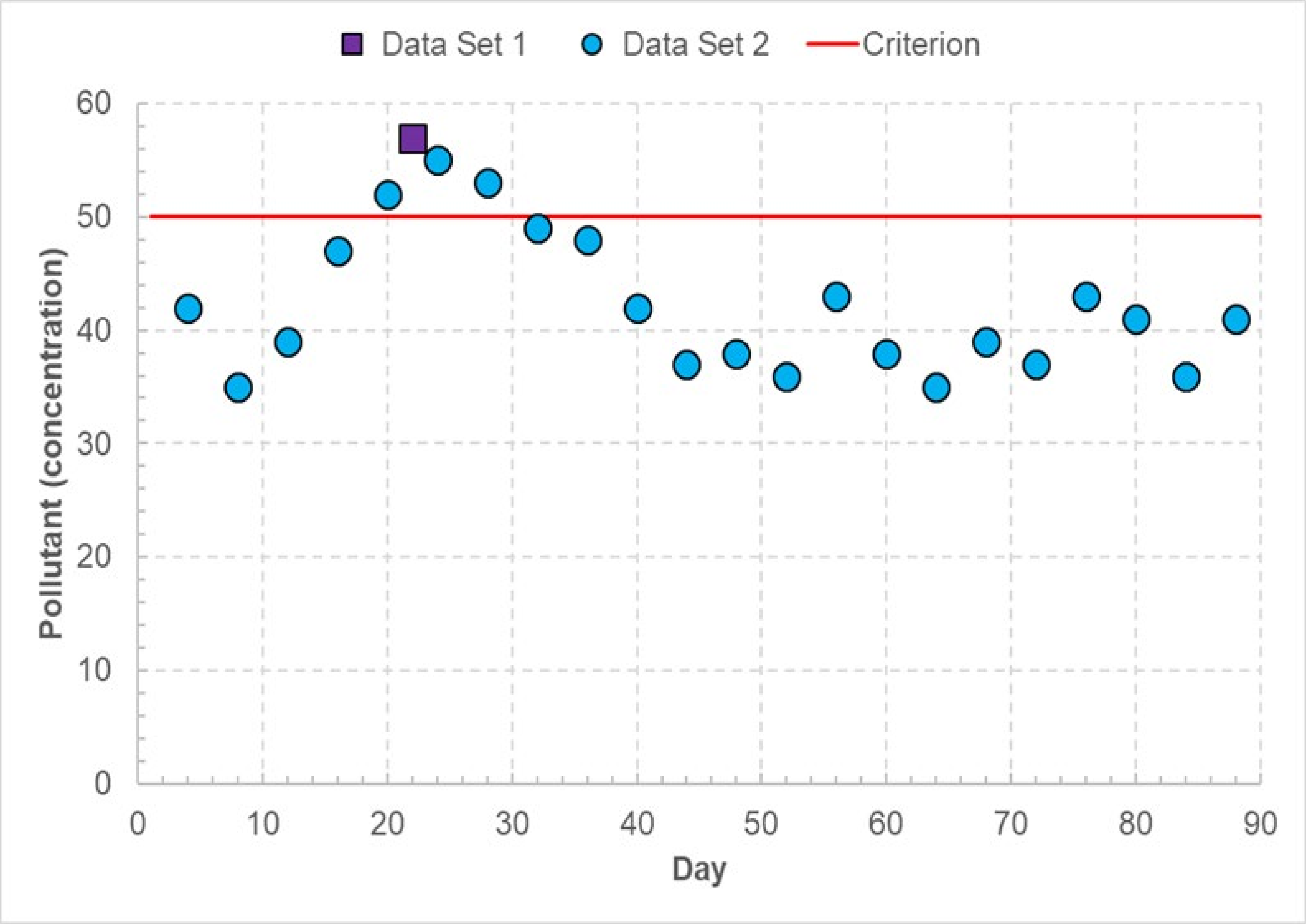
- **Number of samples to be taken**
  - Balance cost and completeness of dataset (seasonality coverage, etc)
  - Note: Not meeting minimum sample size does not always mean you cannot make a decision

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

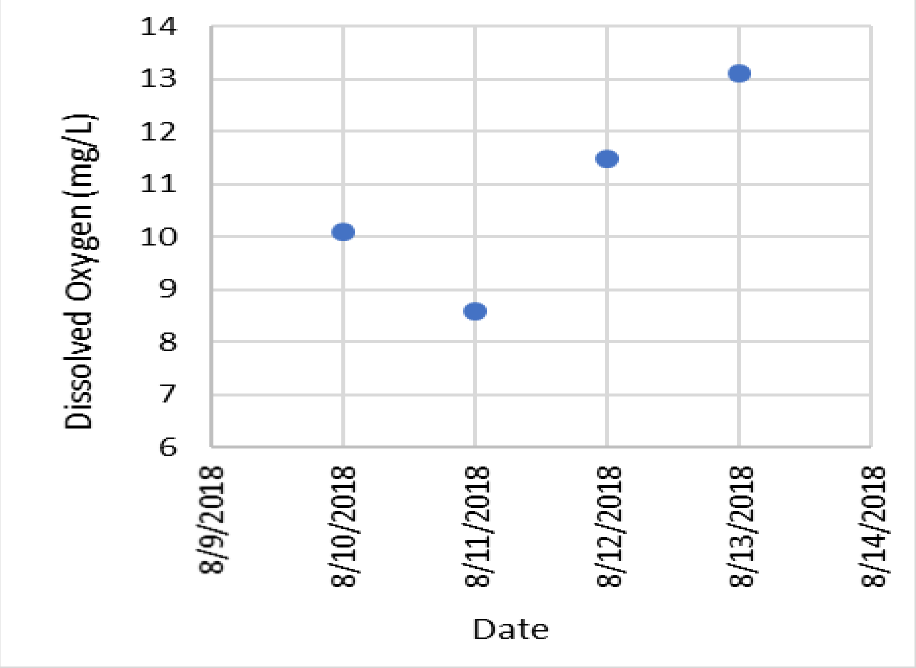
Overview of Water Quality Standards

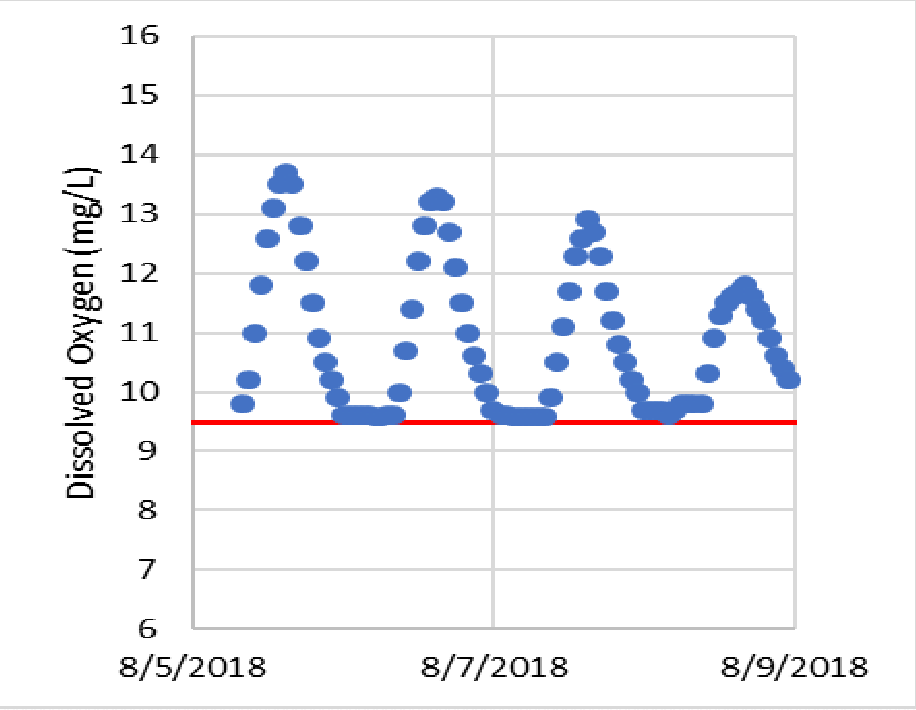
- Conventional: DO, pH, Temperature, Turbidity
- Nutrients

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?

CALIBRATE





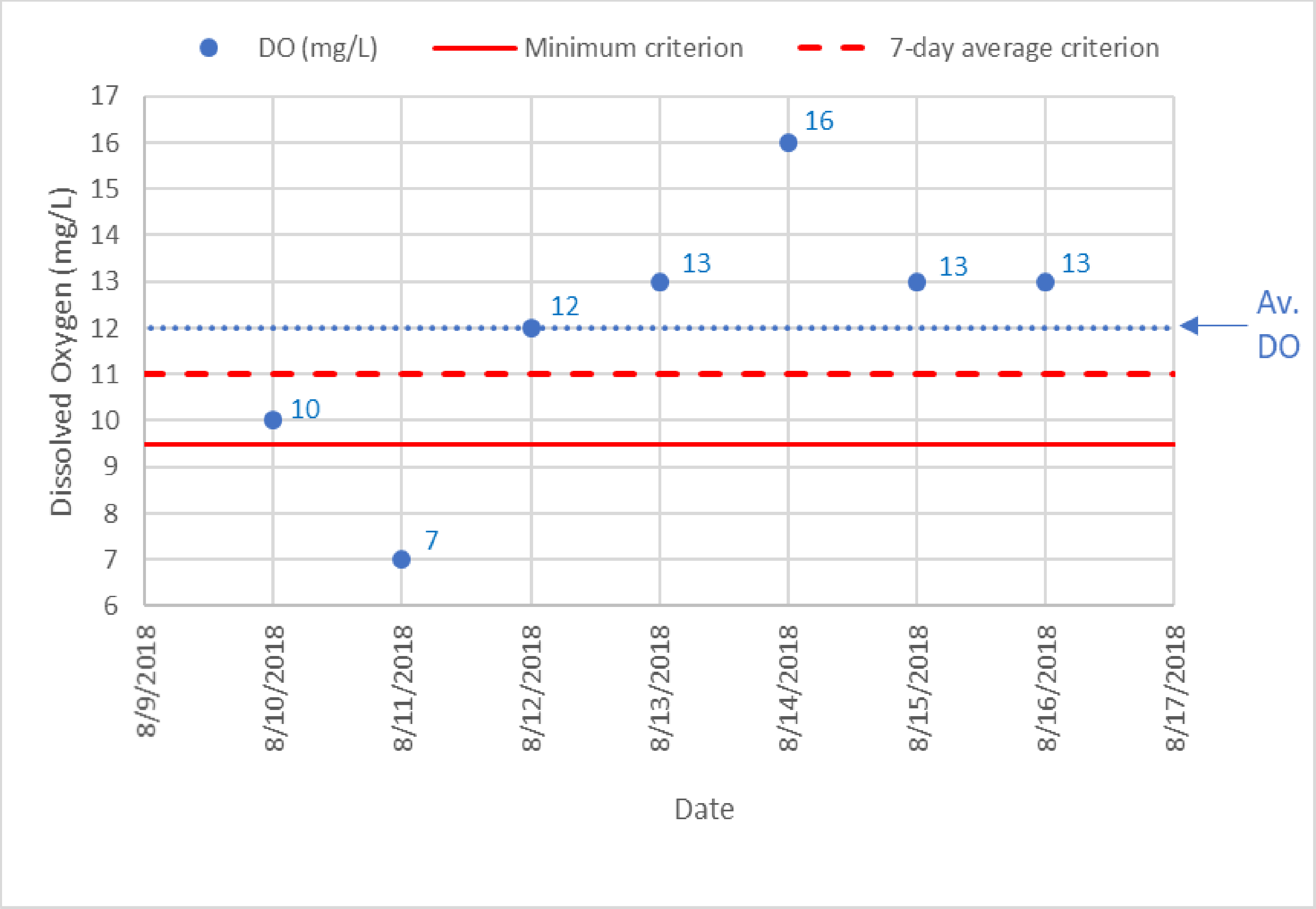
Examples of Dissolved Oxygen Criteria: Makah Tribe

- 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

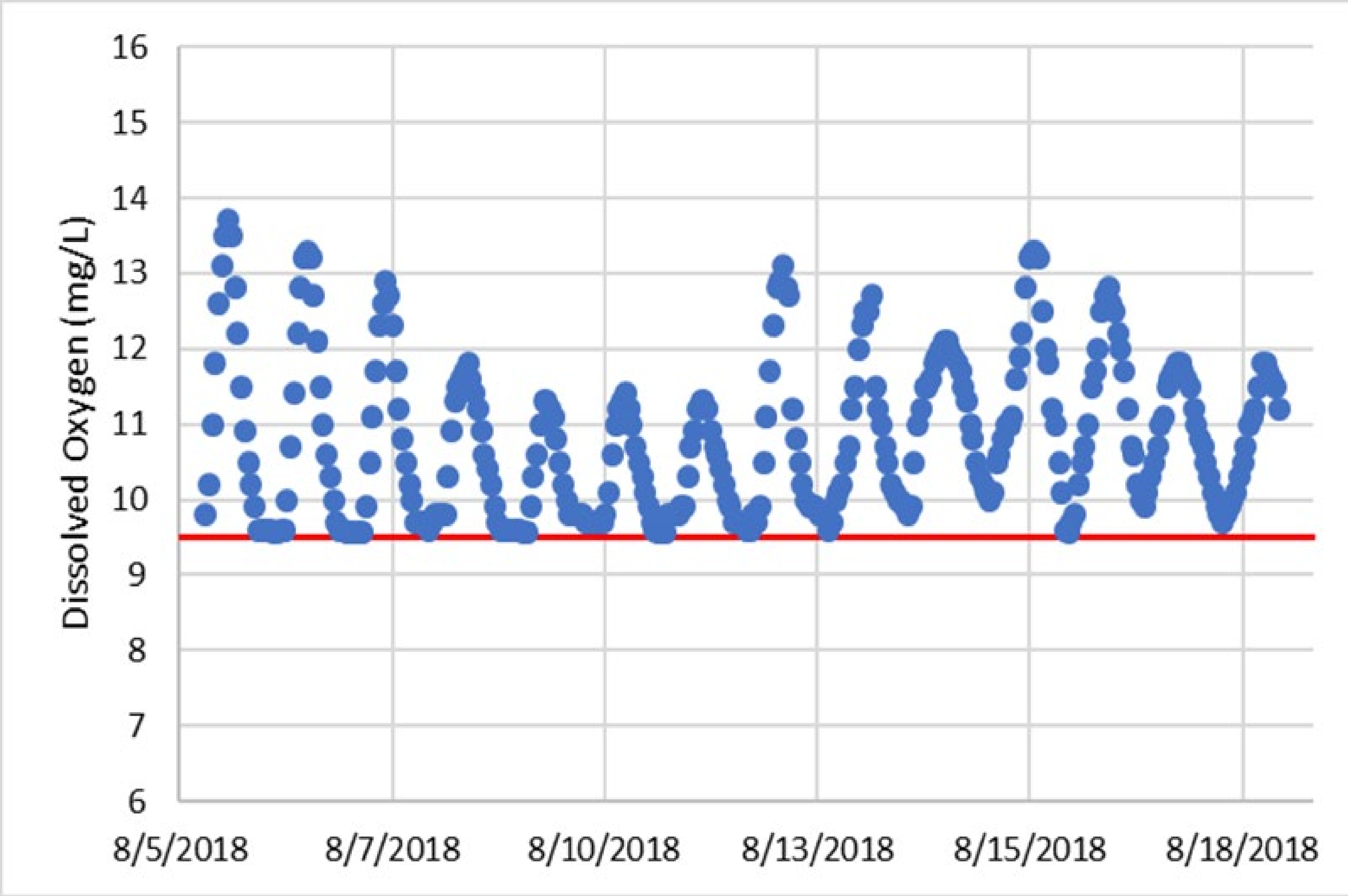
- Salmon and trout spawning water
  - 7-day average of the daily mean dissolved oxygen: 11 mg/L
  - Minimum: 9.5 mg/L
- 7-day average: 12 mg/L
- Range: 7–16 mg/L



Dissolved Oxygen Assessment

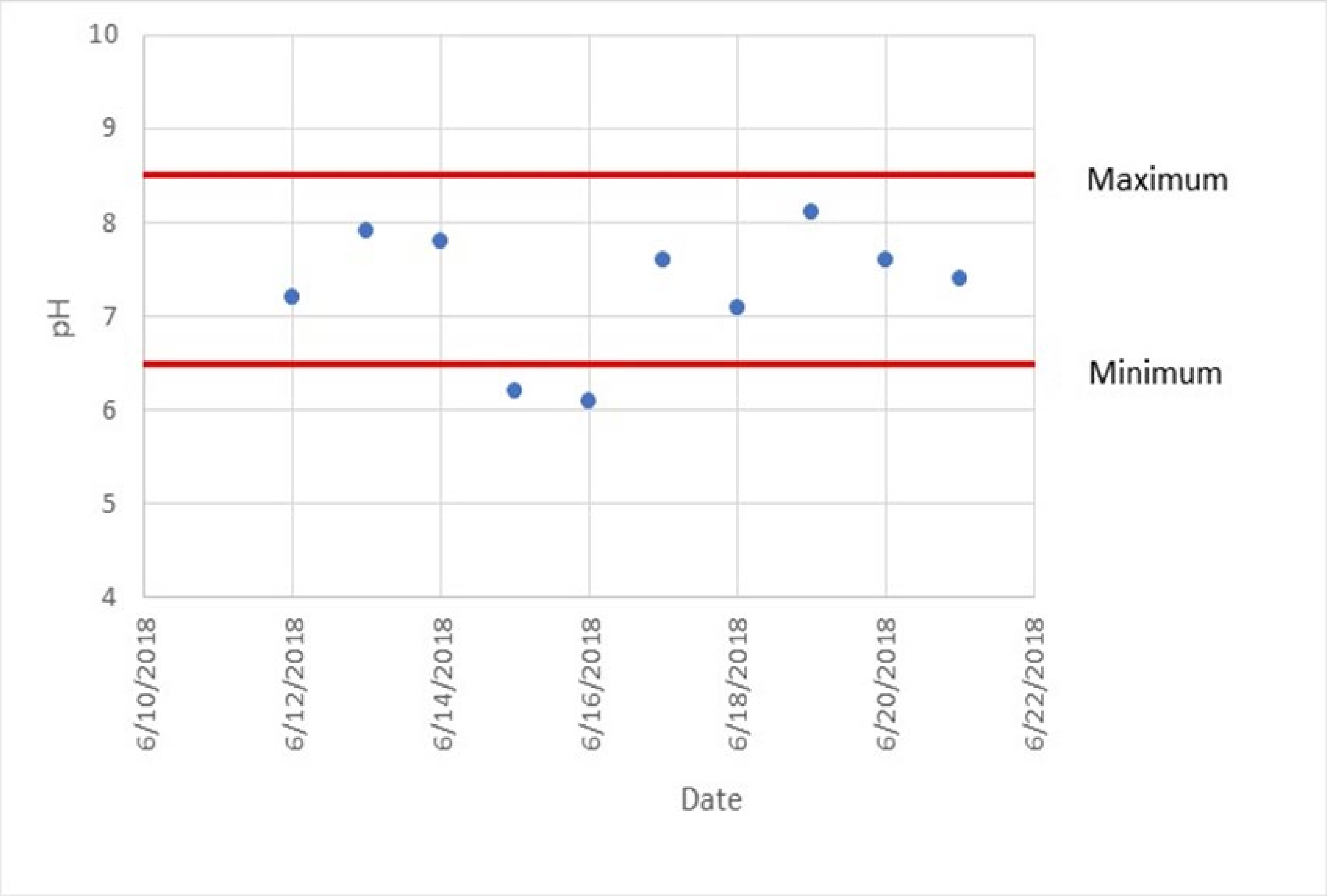
Salmon and trout spawning water criteria:

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



pH Criteria

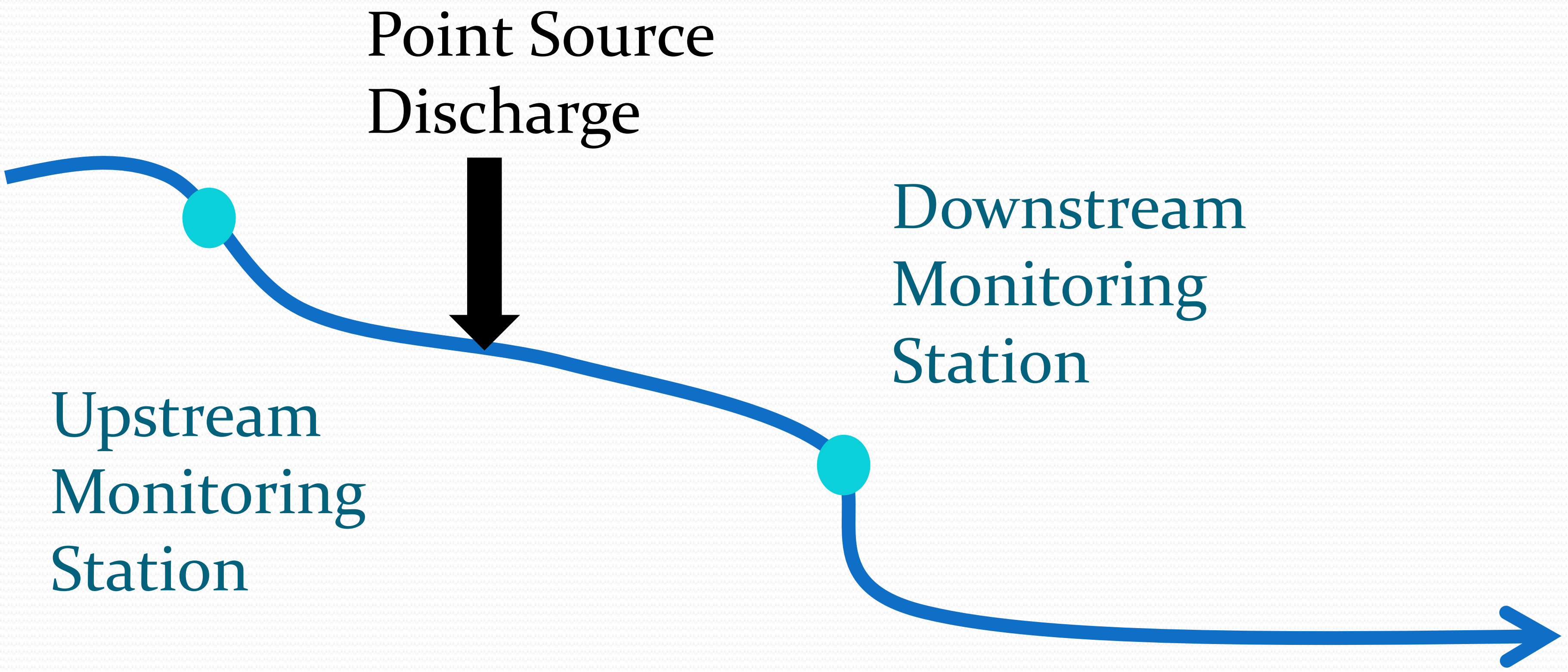
- A measure of acidity and alkalinity of the water
- Criteria require keeping pH within a specific range
  - To protect human health, the pH must be within the range of 5 to 9
  - To protect aquatic life, the pH must be within the range of 6.5 to 9.0 for freshwater and 6.5 to 8.5 for saltwater



Temperature

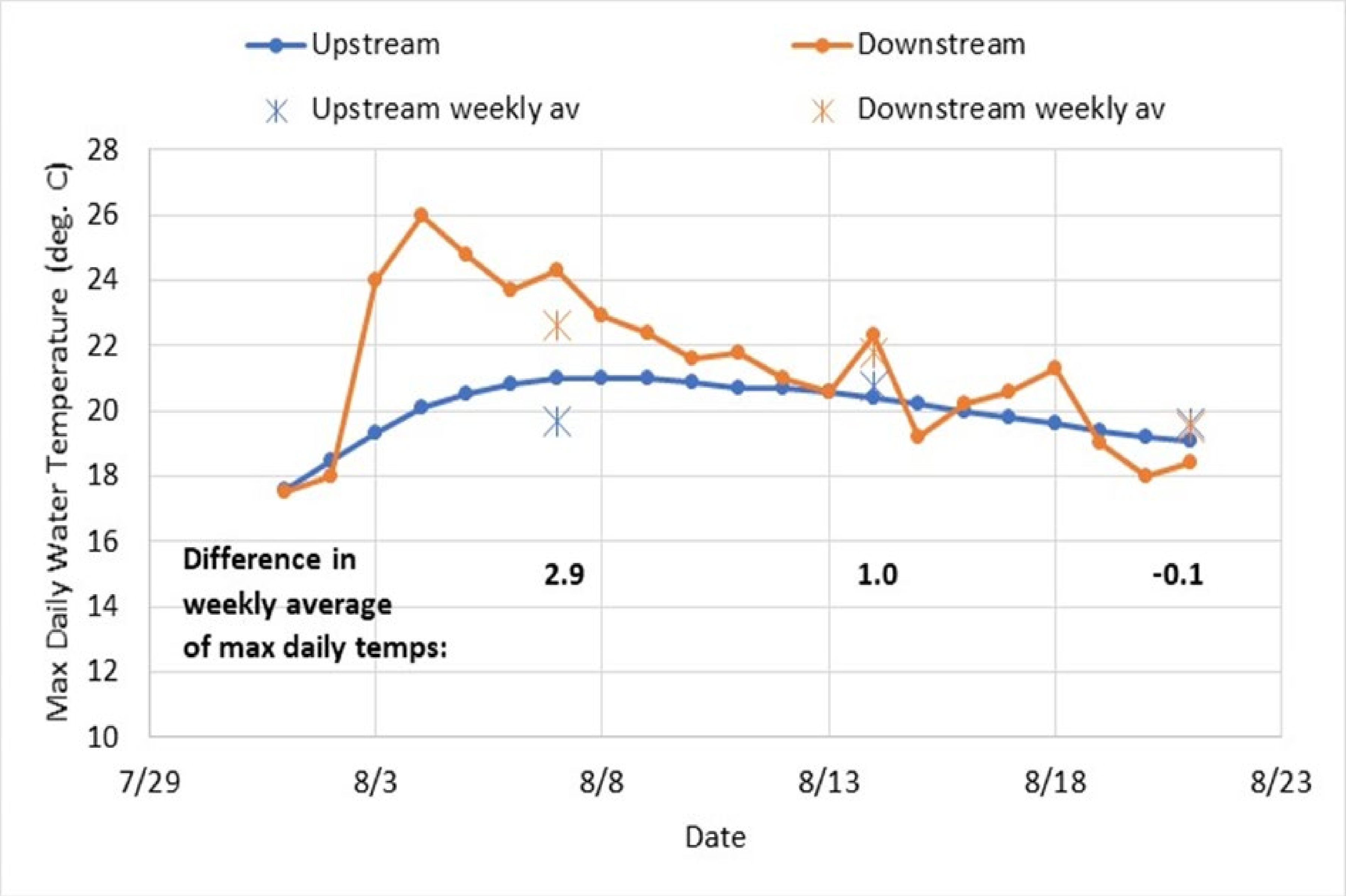
- Criteria focused on aquatic life support—warmwater and coldwater
- "In a stream, the introduction of heat by other than natural causes shall not increase the temperature, as measured upstream from the point of introduction, by more than 2.7° C (5° F), based on the weekly average of the maximum daily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

Temperature



Temperature

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

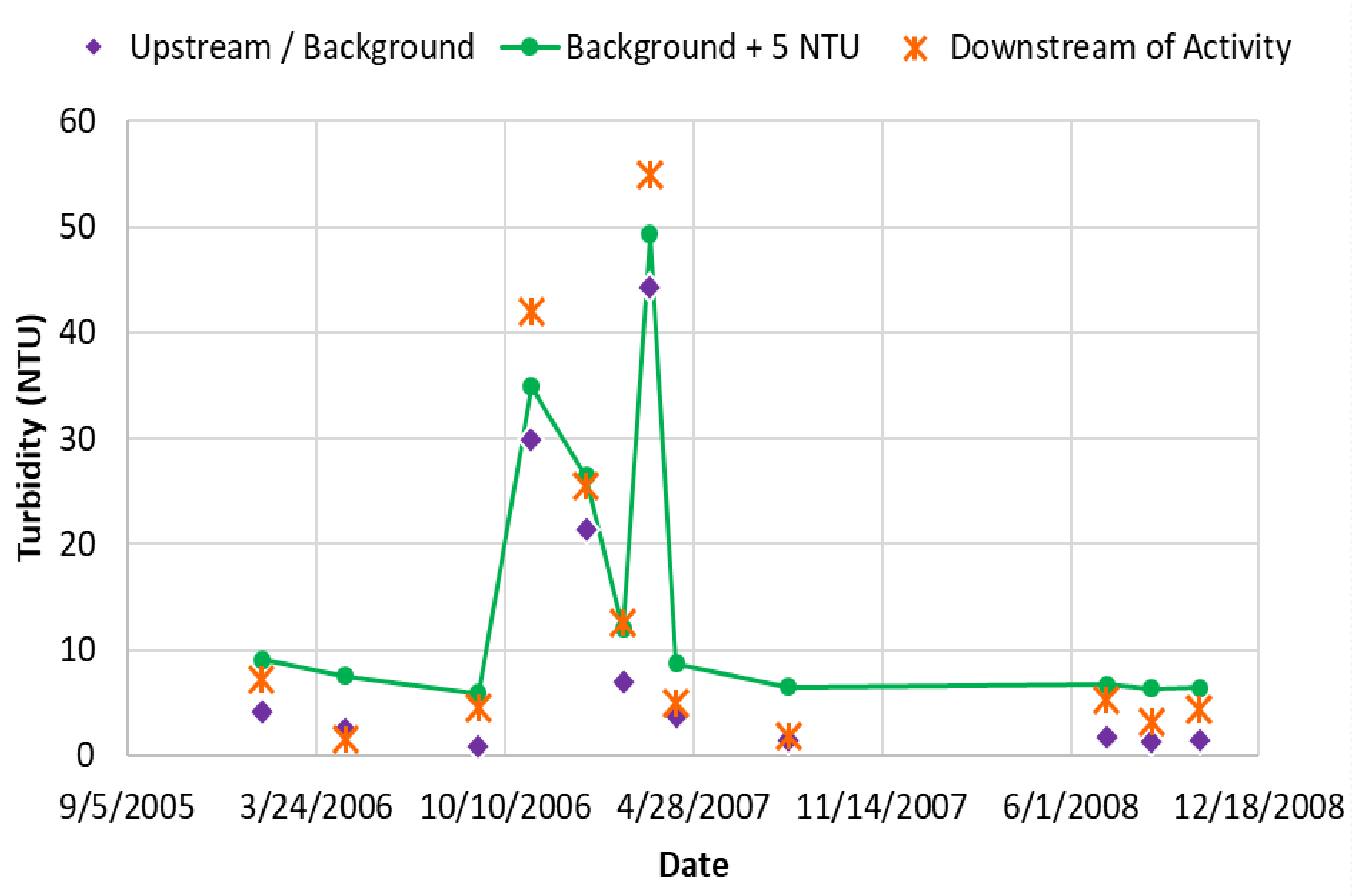


Turbidity

- 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:

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

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(hardness)]
Zinc	$e^{(0.8473[\ln(\text{hardness})] + 0.884)}$	--	0.978

Copper - Assessment

Date	Copper (µg/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

0.960 = WQC

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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