

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?



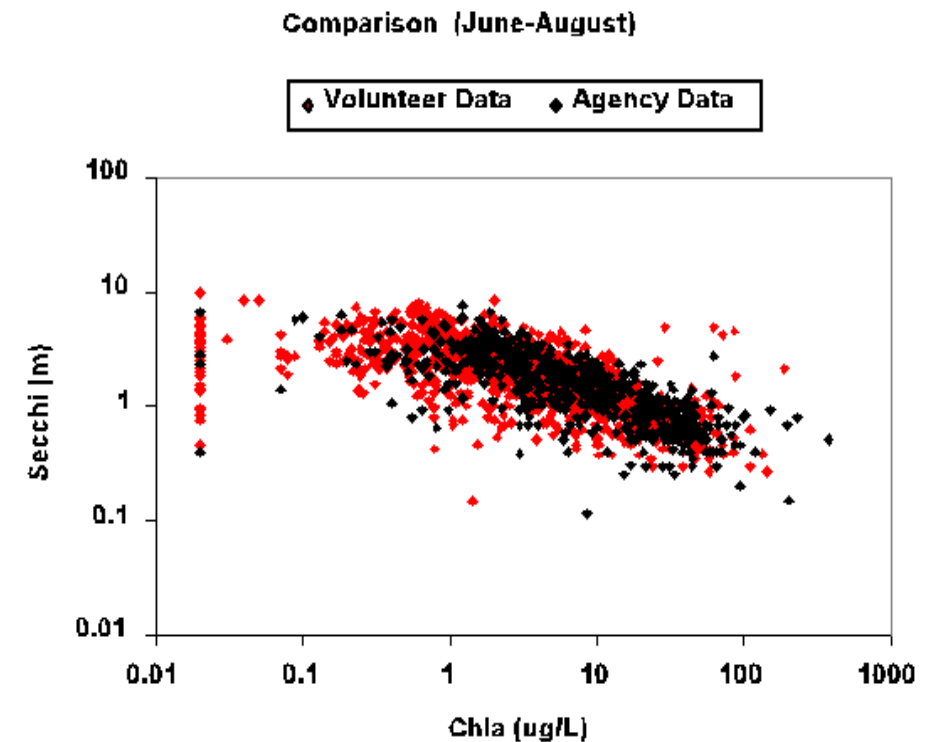
Considerations for Assessing Data

- 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

Activity ID	Medium	Activity Type	Activity Category	Activity Status	Activity Date	Activity Depth	Depth	Sampling Date	Characteristic Name	Result Value	Result Unit	Field/Lab	Field/Lab	Date	Quantification
1	Water	Sample	Routine Sa	5/7/2003	EST	0.1 m	Chlorophyll a, cc/0.0006	mg/L	10200-H	APHA	mg/l	0.0005			
2	Water	Sample	Routine Sa	5/7/2003	EST	0.1 m	Conductivity	266	umhos	2510-B	APHA	umhos			
3	LEE	Water	Sample	Routine Sa	5/7/2003	EST	2 m	Conductivity	265	umhos	2510-B	APHA	umhos		
4	LEE	Water	Sample	Routine Sa	5/7/2003	EST	4 m	Conductivity	265	umhos	2510-B	APHA	umhos		
5	LEE	Water	Sample	Routine Sa	5/7/2003	EST	6.9 m	Conductivity	265	umhos	2510-B	APHA	umhos		
6	LEE	Water	Sample	Routine Sa	5/7/2003	EST	8.1 m	Conductivity	265	umhos	2510-B	APHA	umhos		
7	LEE	Water	Sample	Routine Sa	5/7/2003	EST	10 m	Conductivity	265	umhos	2510-B	APHA	umhos		
8	LEE	Water	Sample	Routine Sa	5/7/2003	EST	12 m	Conductivity	265	umhos	2510-B	APHA	umhos		
9	LEE	Water	Sample	Routine Sa	5/7/2003	EST	14 m	Conductivity	265	umhos	2510-B	APHA	umhos		
10	LEE	Water	Sample	Routine Sa	5/7/2003	EST	16 m	Conductivity	265	umhos	2510-B	APHA	umhos		
11	LEE	Water	Sample	Routine Sa	5/7/2003	EST	18 m	Conductivity	266	umhos	2510-B	APHA	umhos		
12	LEE	Water	Sample	Routine Sa	5/7/2003	EST	19.9 m	Conductivity	265	umhos	2510-B	APHA	umhos		
13	LEE	Water	Sample	Routine Sa	5/7/2003	EST	21.9 m	Conductivity	265	umhos	2510-B	APHA	umhos		
14	LEE	Water	Sample	Routine Sa	5/7/2003	EST	0.1 m	Dissolved oxygen	13.61	mg/l	4500	APHA	mg/l		
15	LEE	Water	Sample	Routine Sa	5/7/2003	EST	2 m	Dissolved oxygen	13.52	mg/l	4500	APHA	mg/l		
16	LEE	Water	Sample	Routine Sa	5/7/2003	EST	4 m	Dissolved oxygen	13.51	mg/l	4500	APHA	mg/l		
17	LEE	Water	Sample	Routine Sa	5/7/2003	EST	6.9 m	Dissolved oxygen	13.49	mg/l	4500	APHA	mg/l		
18	LEE	Water	Sample	Routine Sa	5/7/2003	EST	8.1 m	Dissolved oxygen	13.47	mg/l	4500	APHA	mg/l		
19	LEE	Water	Sample	Routine Sa	5/7/2003	EST	10 m	Dissolved oxygen	13.46	mg/l	4500	APHA	mg/l		
20	LEE	Water	Sample	Routine Sa	5/7/2003	EST	12 m	Dissolved oxygen	13.42	mg/l	4500	APHA	mg/l		
21	LEE	Water	Sample	Routine Sa	5/7/2003	EST	14 m	Dissolved oxygen	13.41	mg/l	4500	APHA	mg/l		
22	LEE	Water	Sample	Routine Sa	5/7/2003	EST	14 m	Dissolved oxygen	13.41	mol	4500	APHA	mol		

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?



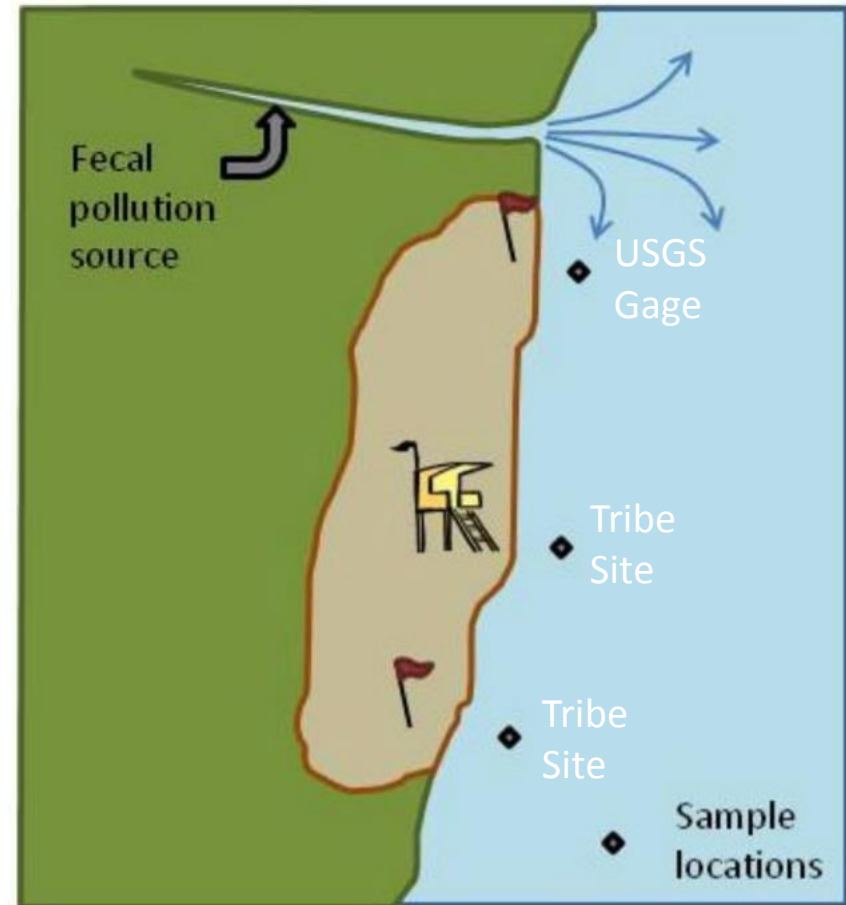
A note about tribal data

- 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!



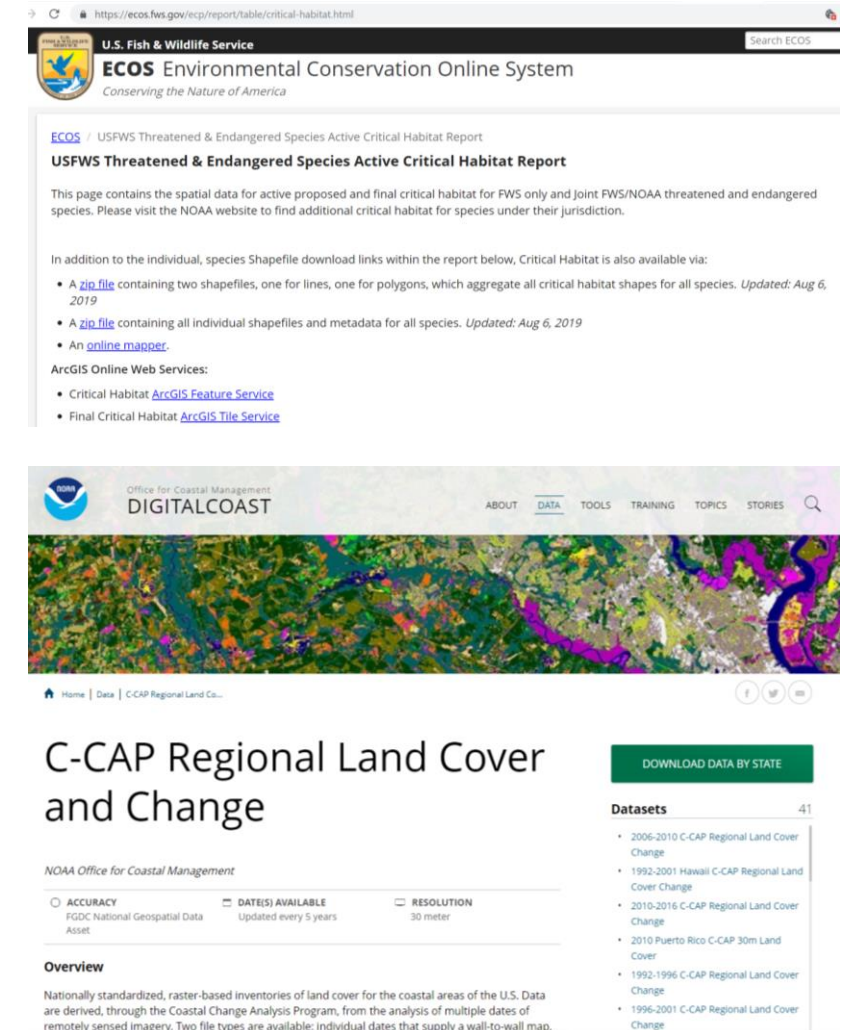
Possible Sources for Additional Water Quality Data: Federal Agencies

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

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 navigation links. The main content area is titled "USGS Current Water Data for Colorado" and features a map of Colorado with various data points. A sidebar on the right lists "Current Statewide Conditions for Colorado" with links to various data tables: Streamflow Real-Time Table, Precipitation Real-Time Table, Map based display of CO precipitation gage data, Ground-Water Real-Time Table, Reservoir Real-Time Table, Meteorological Real-Time Table, and Water-Quality Real-Time Table. The bottom of the screenshot shows the Windows taskbar with the system clock indicating 1:52 PM on 8/12/2019.

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)



The image shows two screenshots of web pages. The top screenshot is from the U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS). It displays a report titled "USFWS Threatened & Endangered Species Active Critical Habitat Report". The page includes a search bar, the agency logo, and a list of download links for shapefiles and an online mapper. The bottom screenshot is from the NOAA Office for Coastal Management's Digital Coast website. It features a map of C-CAP Regional Land Cover and Change, a navigation menu, and a list of datasets available for download by state.

U.S. Fish & Wildlife Service
ECOS Environmental Conservation Online System
Conserving the Nature of America

ECOS / USFWS Threatened & Endangered Species Active Critical Habitat Report
USFWS Threatened & Endangered Species Active Critical Habitat Report

This page contains the spatial data for active proposed and final critical habitat for FWS only and joint FWS/NOAA threatened and endangered species. Please visit the NOAA website to find additional critical habitat for species under their jurisdiction.

In addition to the individual, species Shapefile download links within the report below, Critical Habitat is also available via:

- A [zip file](#) containing two shapefiles, one for lines, one for polygons, which aggregate all critical habitat shapes for all species. Updated: Aug 6, 2019
- A [zip file](#) containing all individual shapefiles and metadata for all species. Updated: Aug 6, 2019
- An [online mapper](#).

ArcGIS Online Web Services:

- Critical Habitat [ArcGIS Feature Service](#)
- Final Critical Habitat [ArcGIS Tile Service](#)

Office for Coastal Management
DIGITALCOAST

ABOUT DATA TOOLS TRAINING TOPICS STORIES

C-CAP Regional Land Cover and Change

NOAA Office for Coastal Management

ACCURACY: FGDC National Geospatial Data Asset
DATE(S) AVAILABLE: Updated every 5 years
RESOLUTION: 30 meter

Overview

Nationally standardized, raster-based inventories of land cover for the coastal areas of the U.S. Data are derived, through the Coastal Change Analysis Program, from the analysis of multiple dates of remotely sensed imagery. Two file types are available: individual dates that supply a wall-to-wall map,


DOWNLOAD DATA BY STATE

Datasets 41

- 2006-2010 C-CAP Regional Land Cover Change
- 1992-2001 Hawaii C-CAP Regional Land Cover Change
- 2010-2016 C-CAP Regional Land Cover Change
- 2010 Puerto Rico C-CAP 30m Land Cover
- 1992-1996 C-CAP Regional Land Cover Change
- 1996-2001 C-CAP Regional Land Cover Change


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




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.



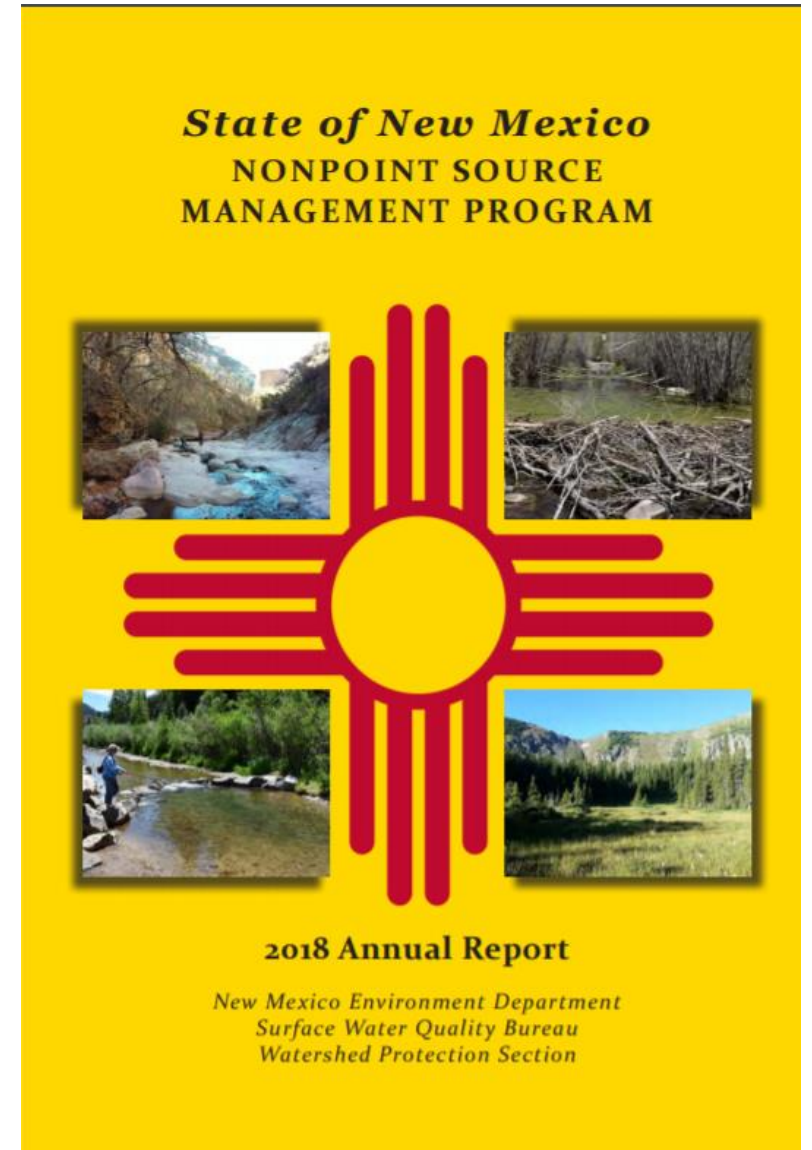
The mission of the Indian Health Service (IHS) is to raise the health status of the American Indian and Alaska Native people to the highest possible level by providing comprehensive health care and preventive health services. To support the IHS mission, the Division of Sanitation Facilities Construction (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

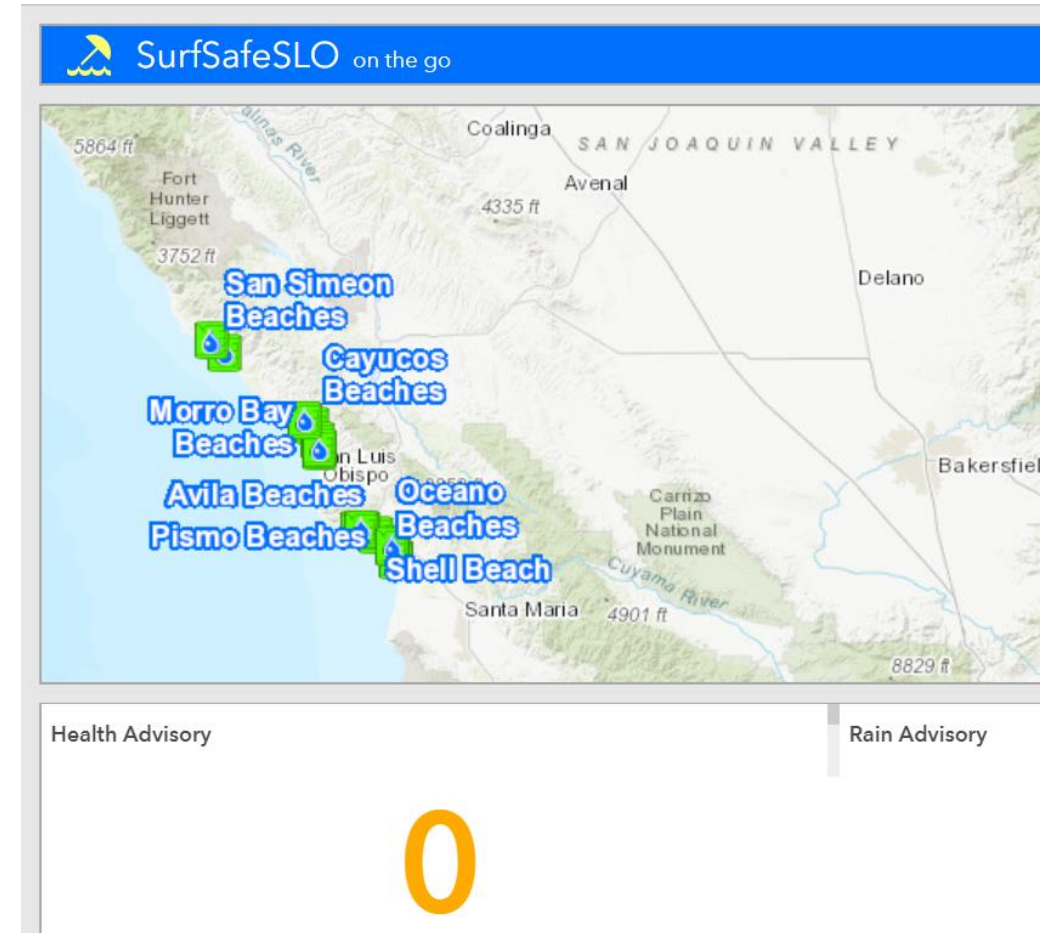
Possible Sources for Additional Water Quality Data: State Agencies

- 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?



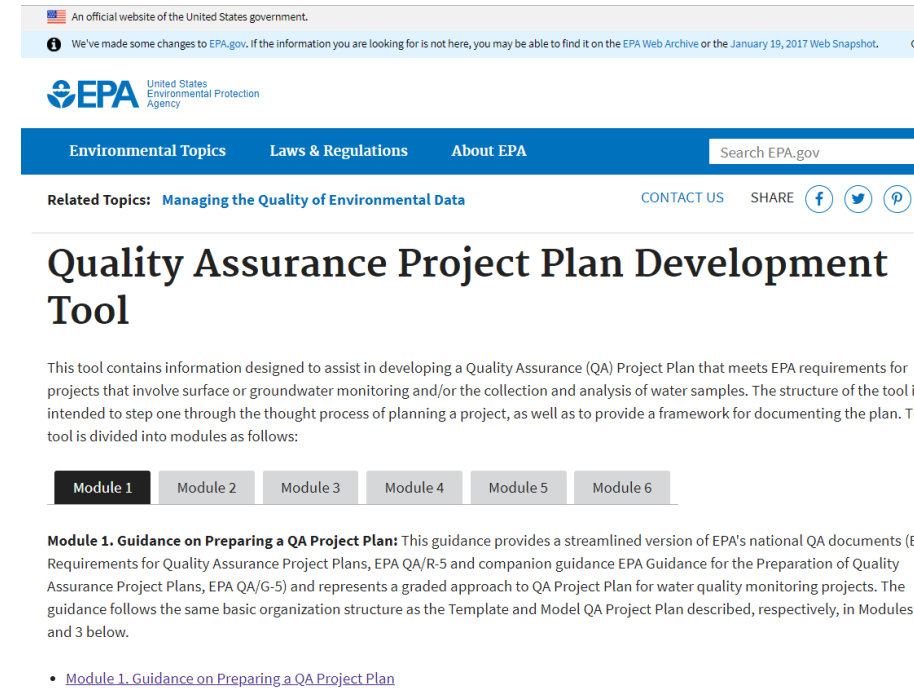
Let's Break Down Data Quality

- 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)






An official website of the United States government.

We've made some changes to EPA.gov. If the information you are looking for is not here, you may be able to find it on the EPA Web Archive or the January 19, 2017 Web Snapshot.

EPA United States Environmental Protection Agency

Environmental Topics Laws & Regulations About EPA Search EPA.gov

Related Topics: [Managing the Quality of Environmental Data](#) CONTACT US SHARE   

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 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
 - Specify tolerable levels of potential decision errors
- 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

- 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)

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

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



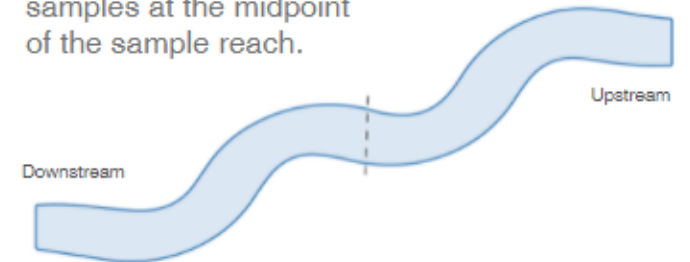
low bias
+ high precision
= high accuracy

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

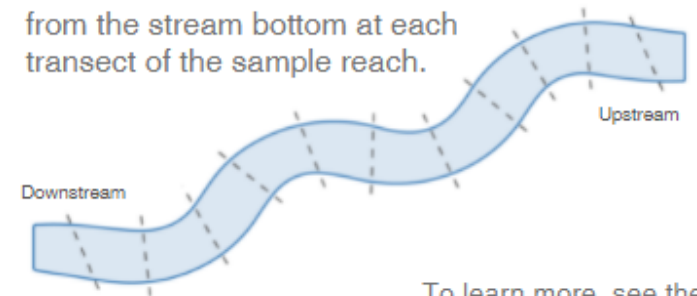
Where are phosphorus samples collected?

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



Where are macroinvertebrates collected?

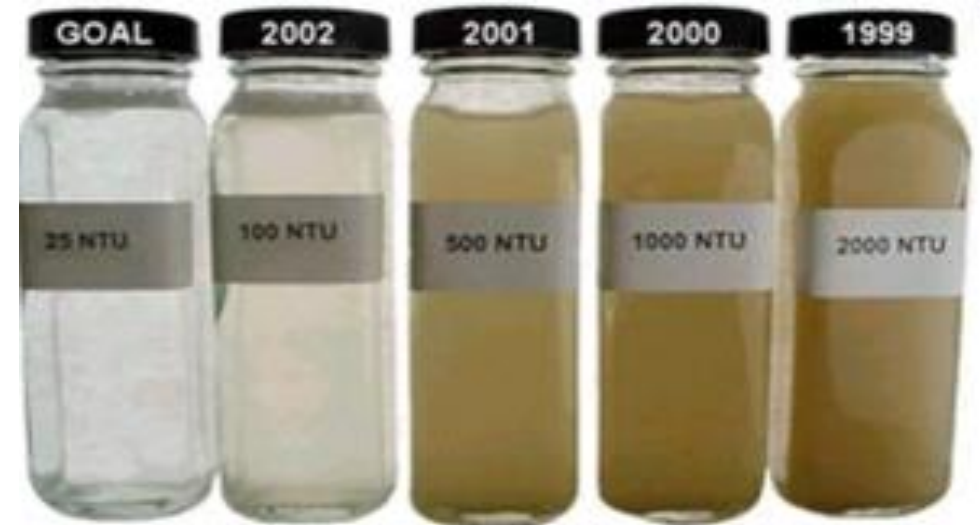
Crews collect macroinvertebrates from the stream bottom at each transect of the sample reach.



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

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.

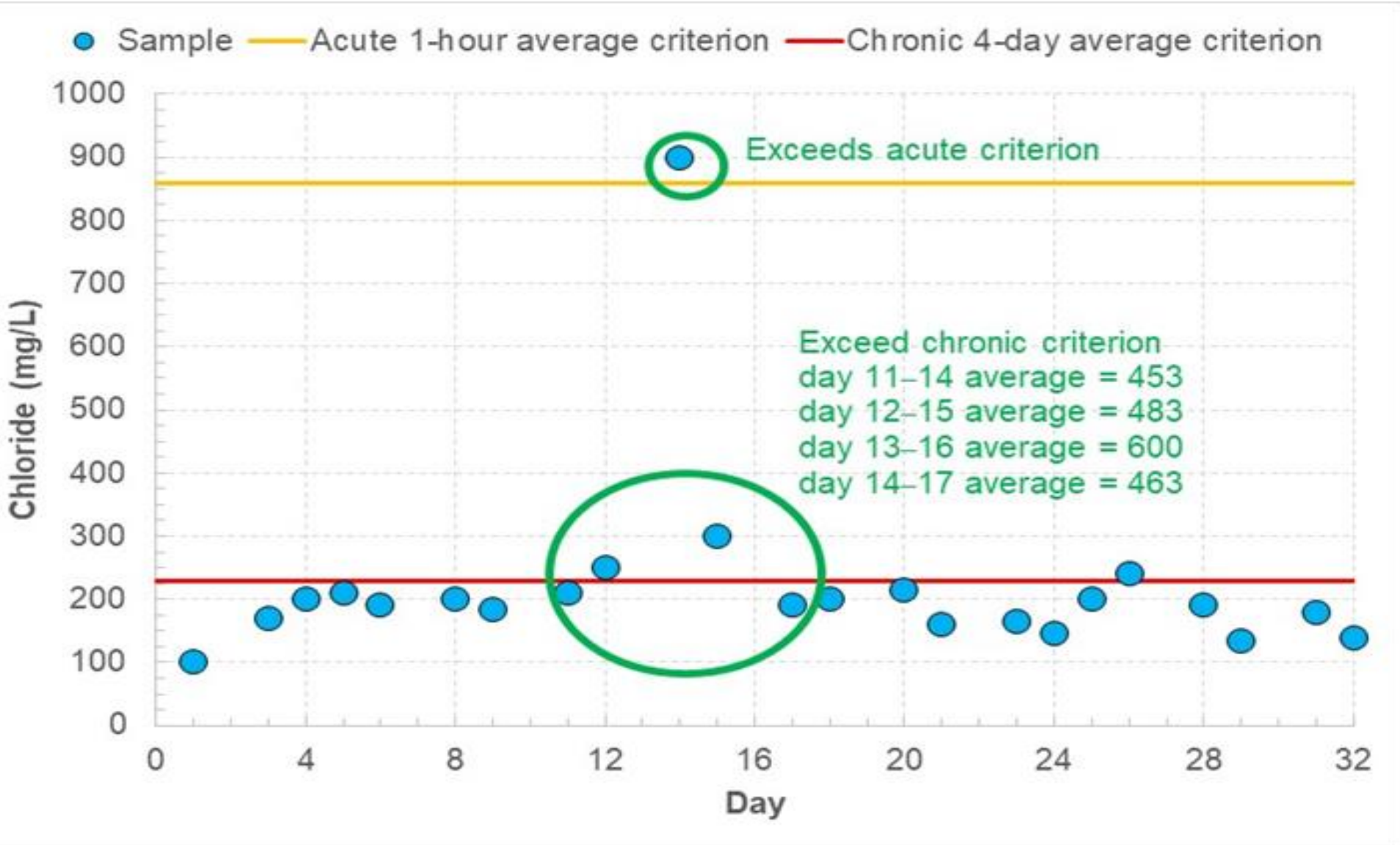
**Frequency =
recurrence interval**

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

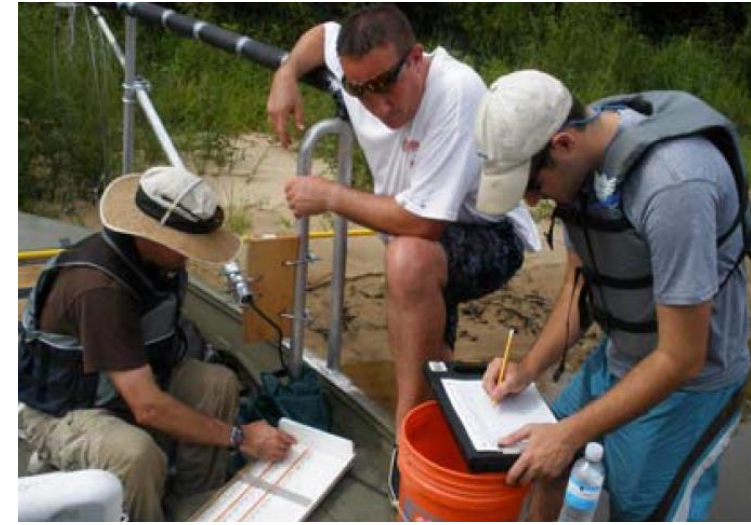


860 mg/L

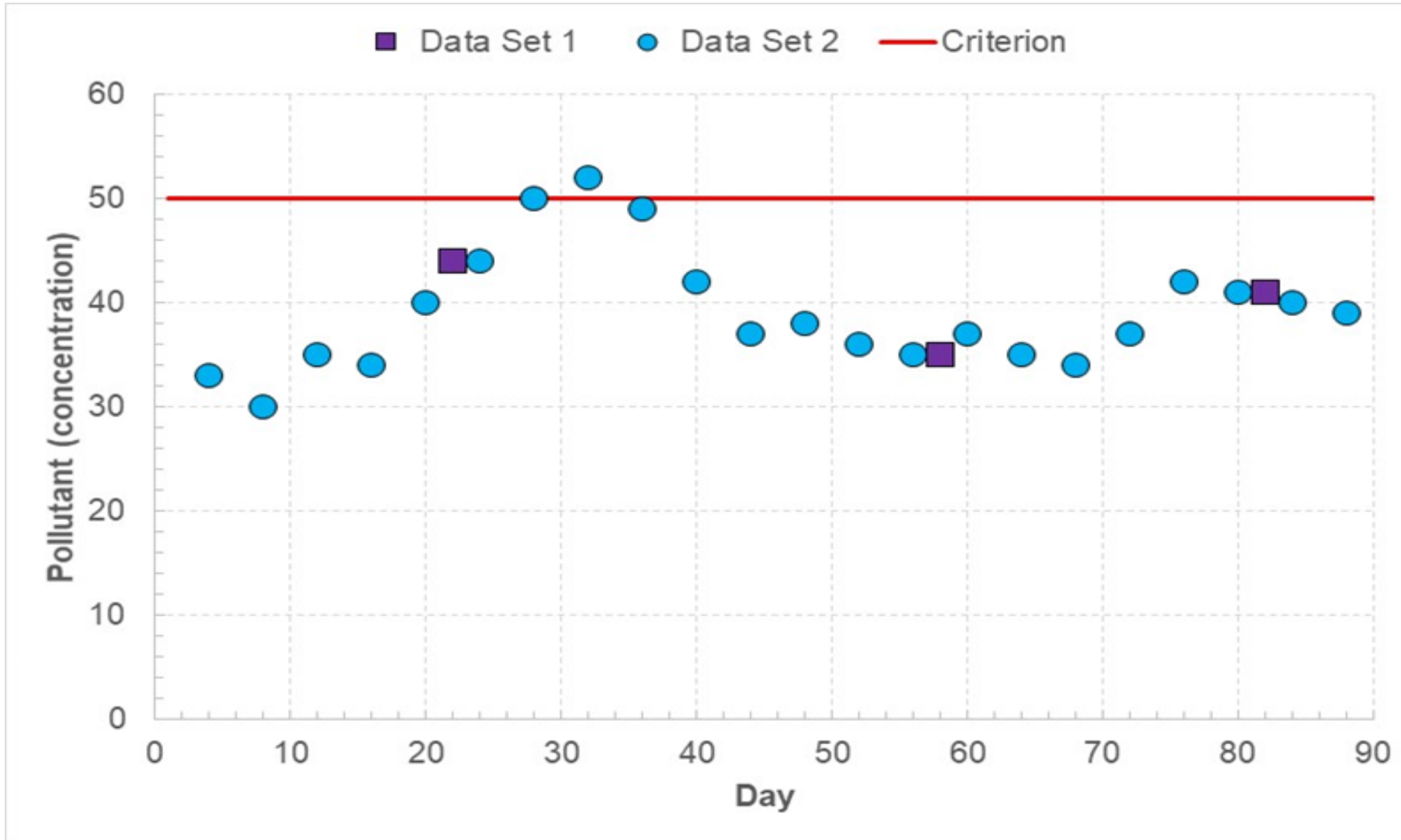
230 mg/L

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

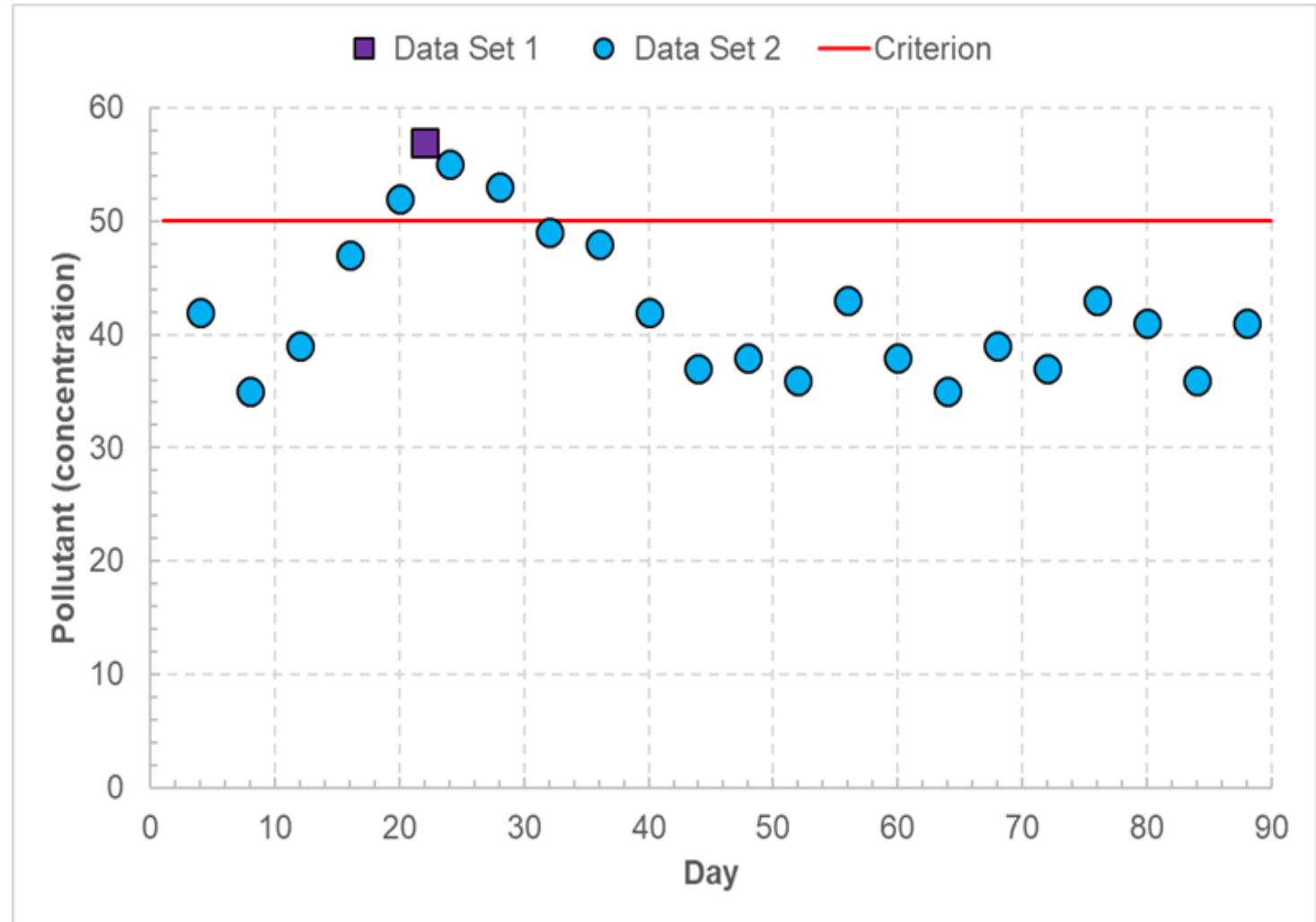


Sample Size Example



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



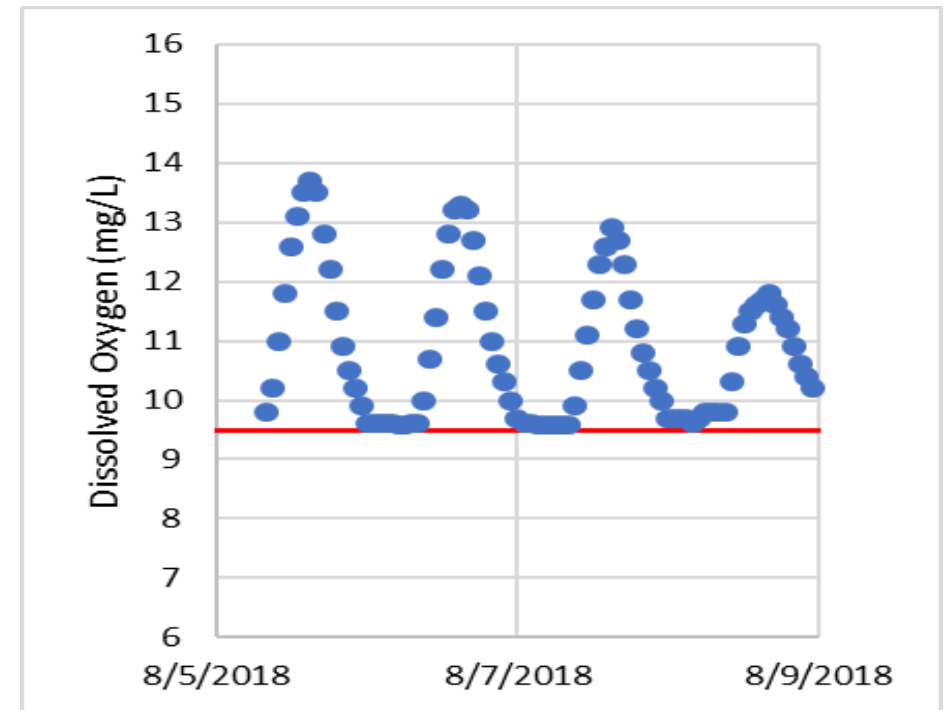
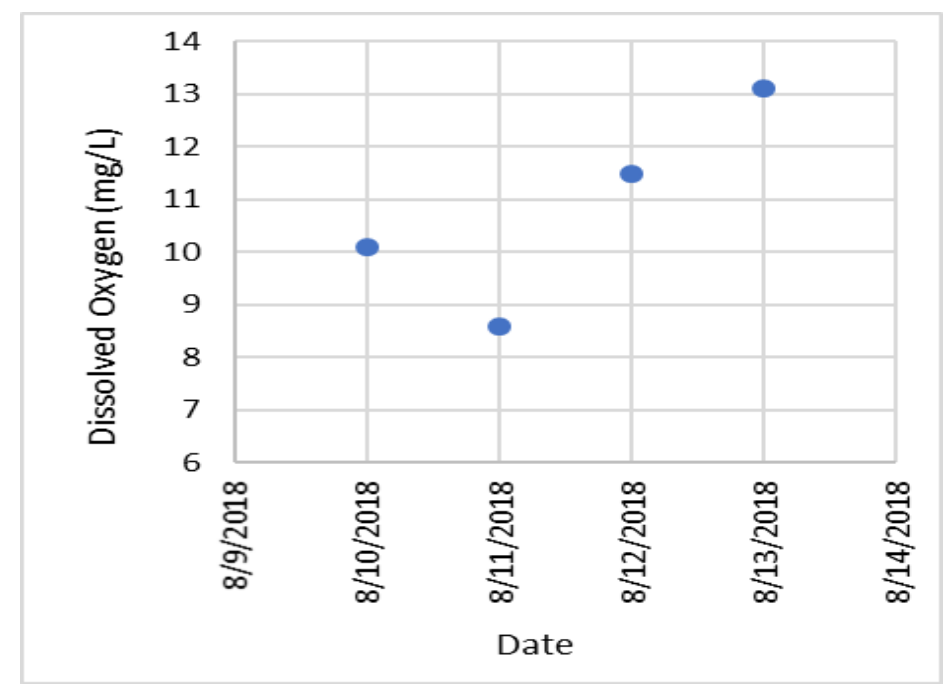
Analysis of Conventional Pollutants

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



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

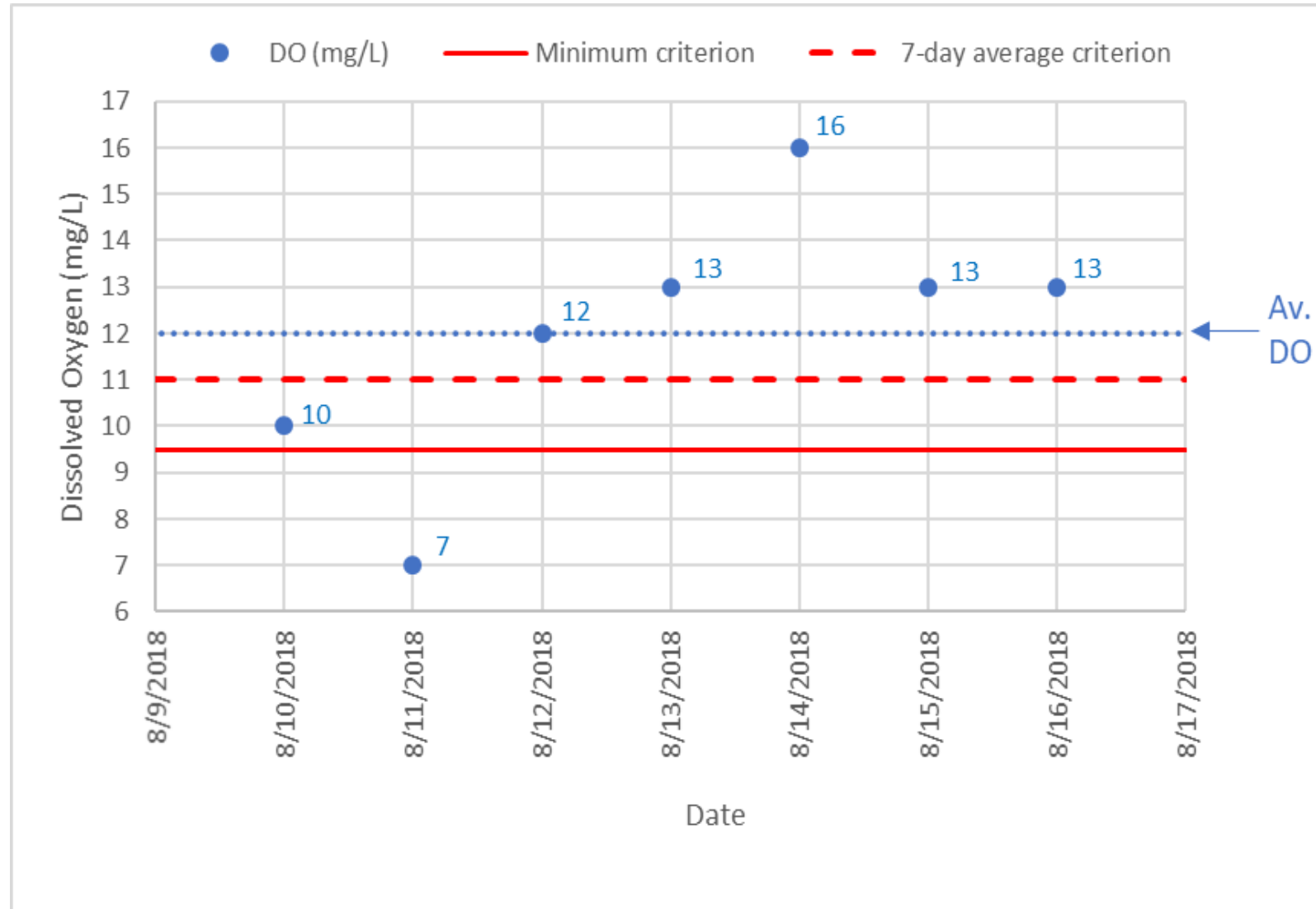
- Salmon and trout spawning
 - 7-day average of the daily mean dissolved oxygen: 11 mg/L
 - Minimum: 9.5 mg/L
- Salmon and trout rearing and migration
 - 7-day average of the daily mean dissolved oxygen: 8.5 mg/L
 - Minimum: 6.5 mg/L



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

Dissolved Oxygen Assessment

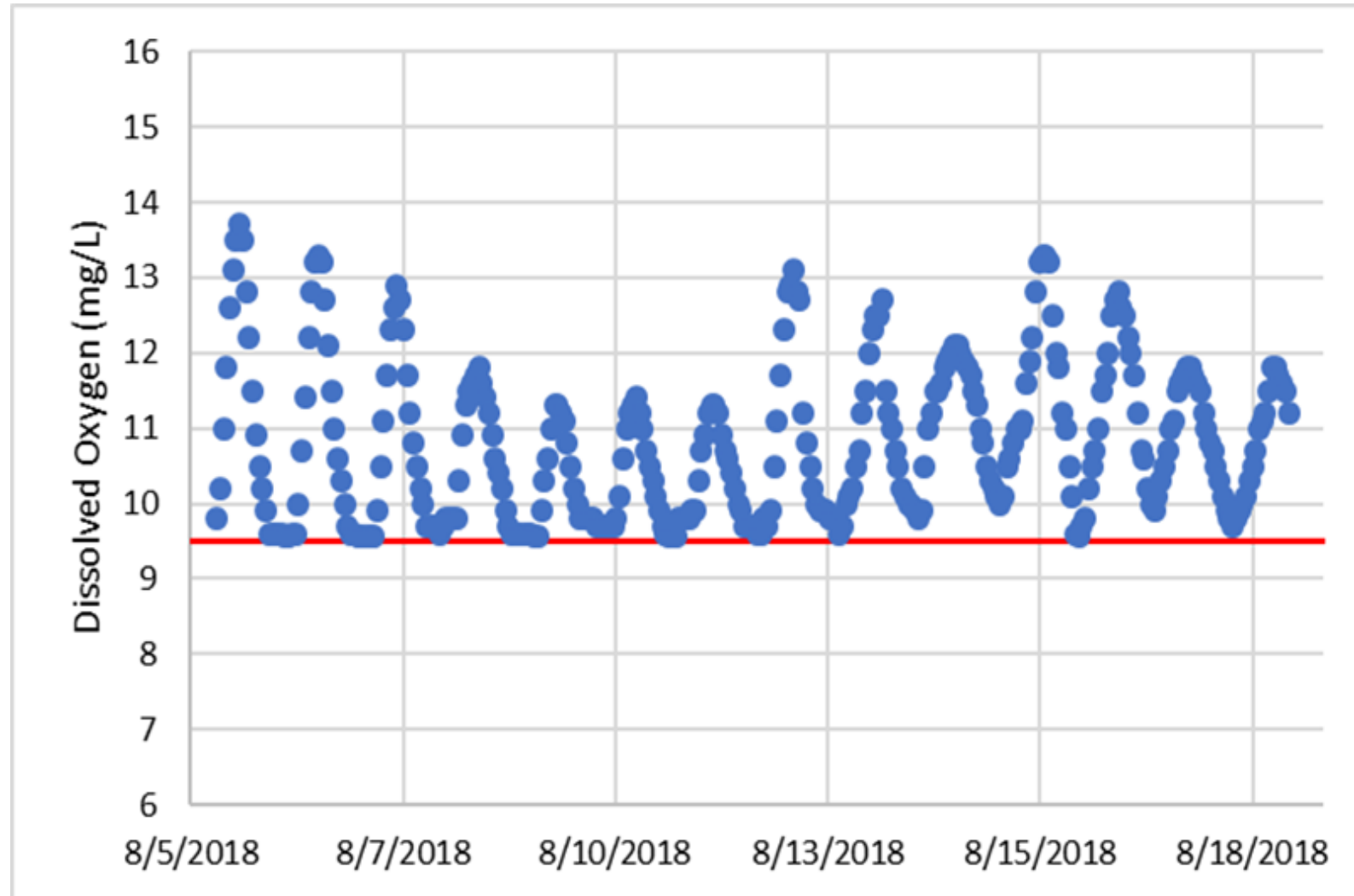
- Salmon and trout spawning water
 - 7-day average of the daily mean dissolved oxygen: 11 mg/L
 - Minimum: 9.5 mg/L
- 7-day average: 12 mg/L
- Range: 7–16 mg/L



Dissolved Oxygen Assessment

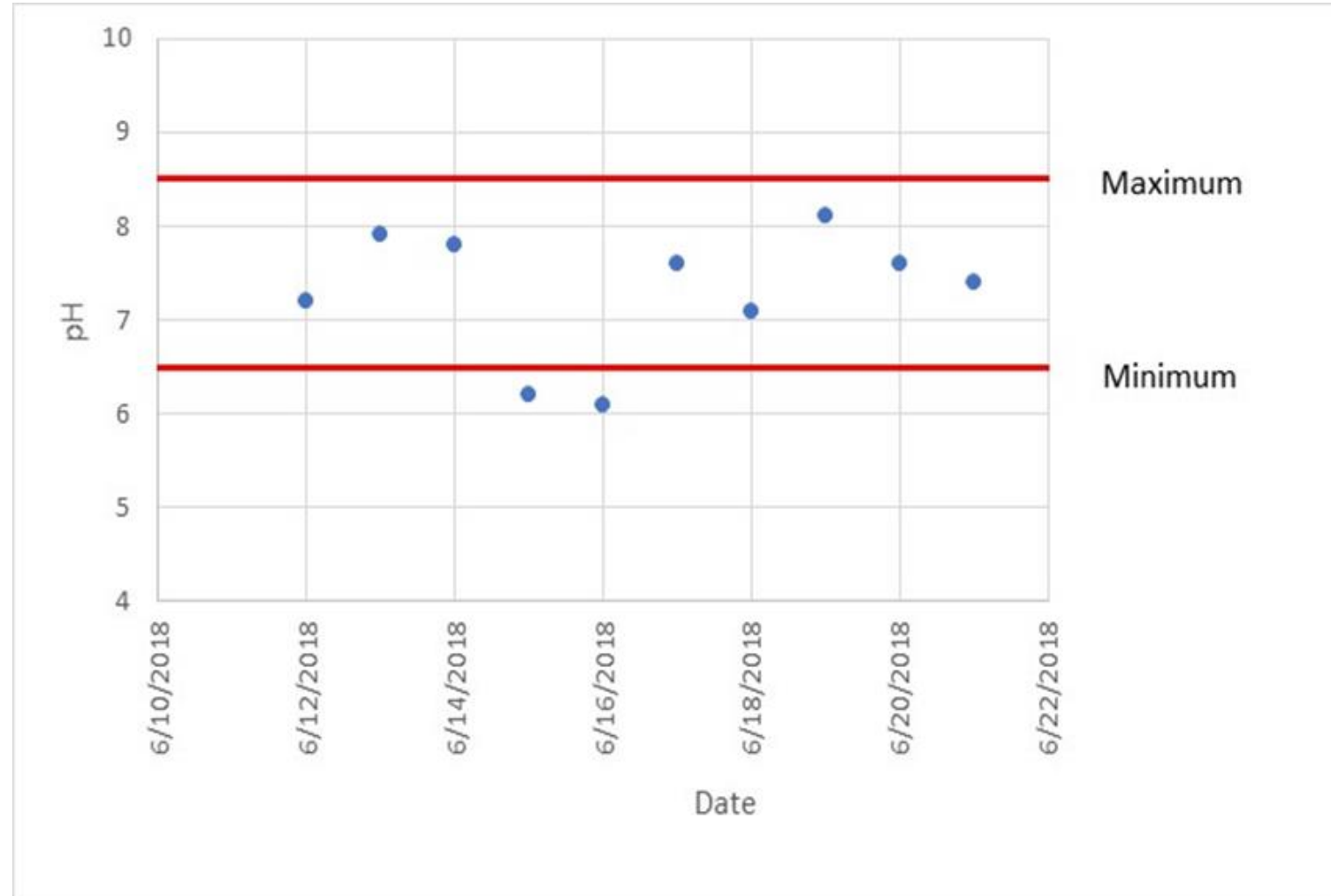
Salmon and trout spawning water criteria:

- 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

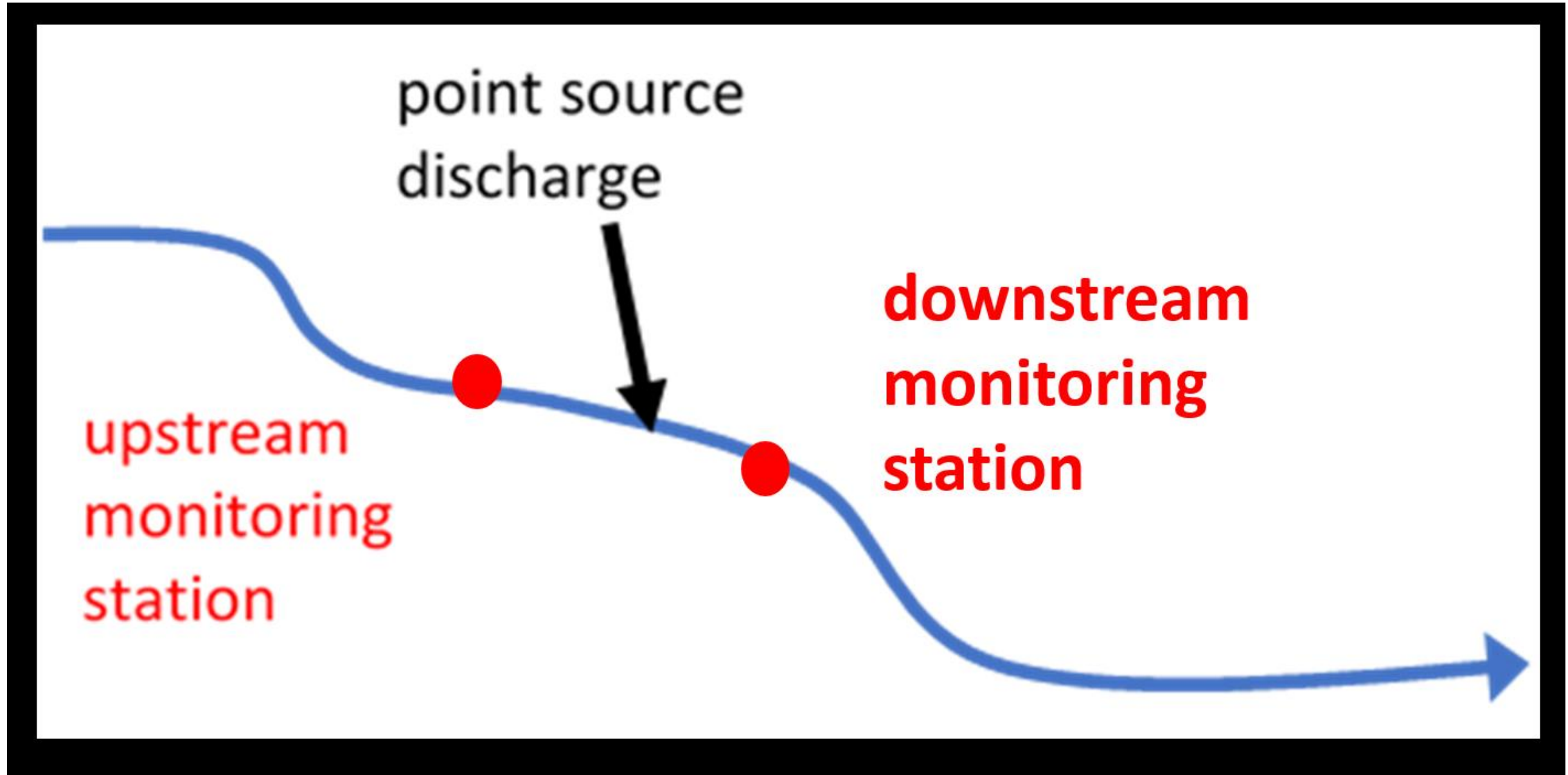


Temperature

- 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.”

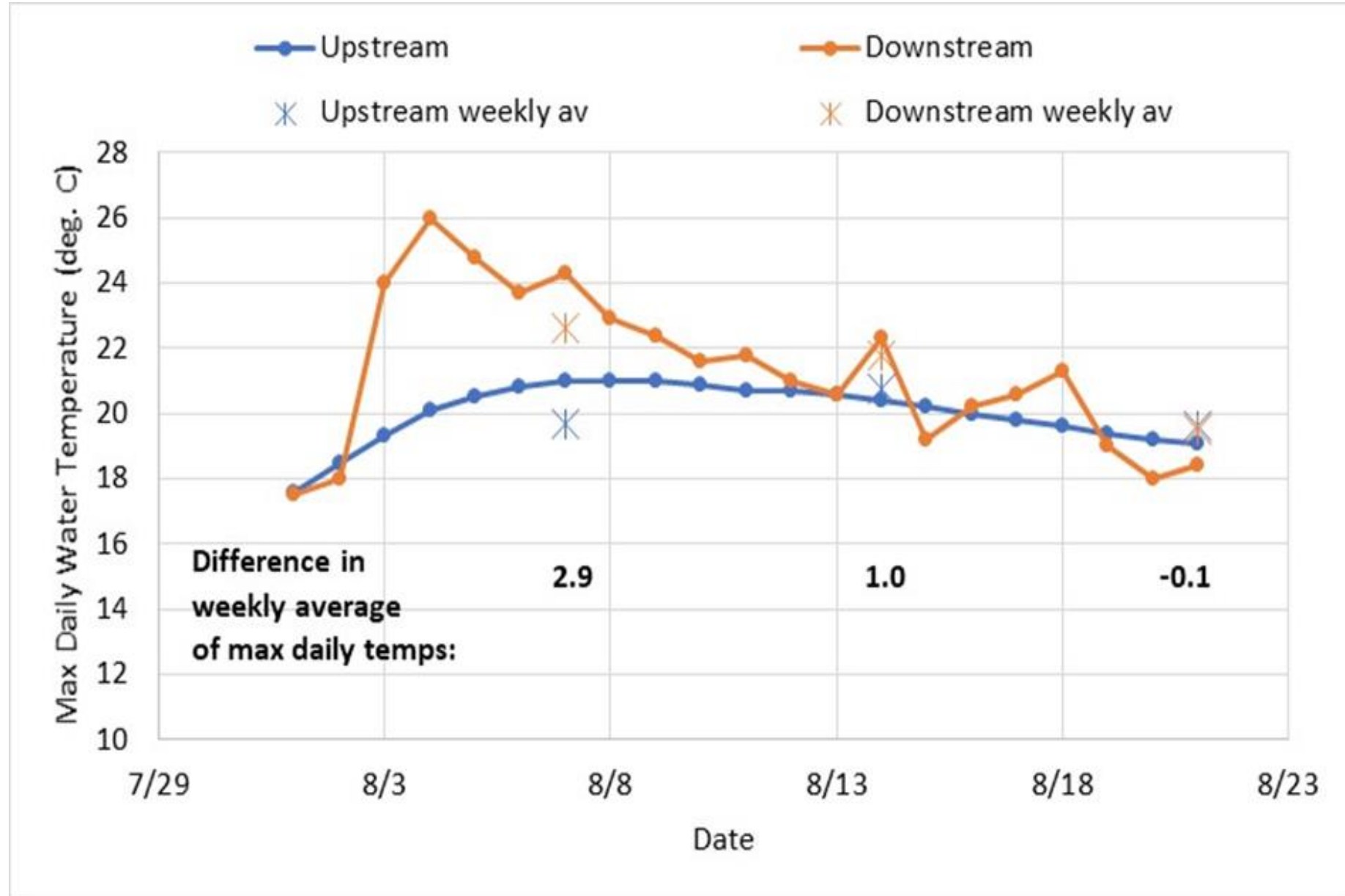


Temperature Criteria Example



Temperature Example

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



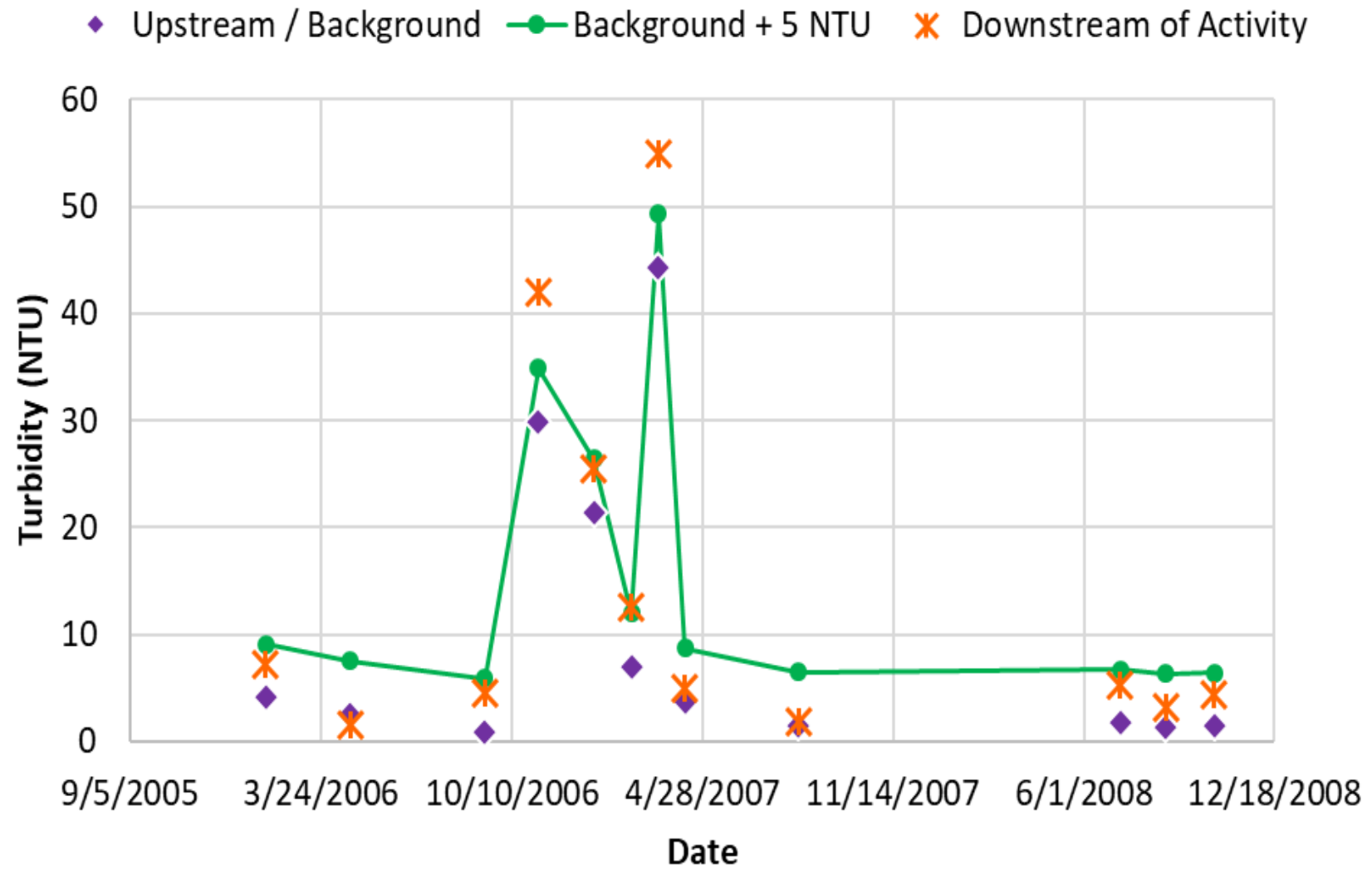
Turbidity

- 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)



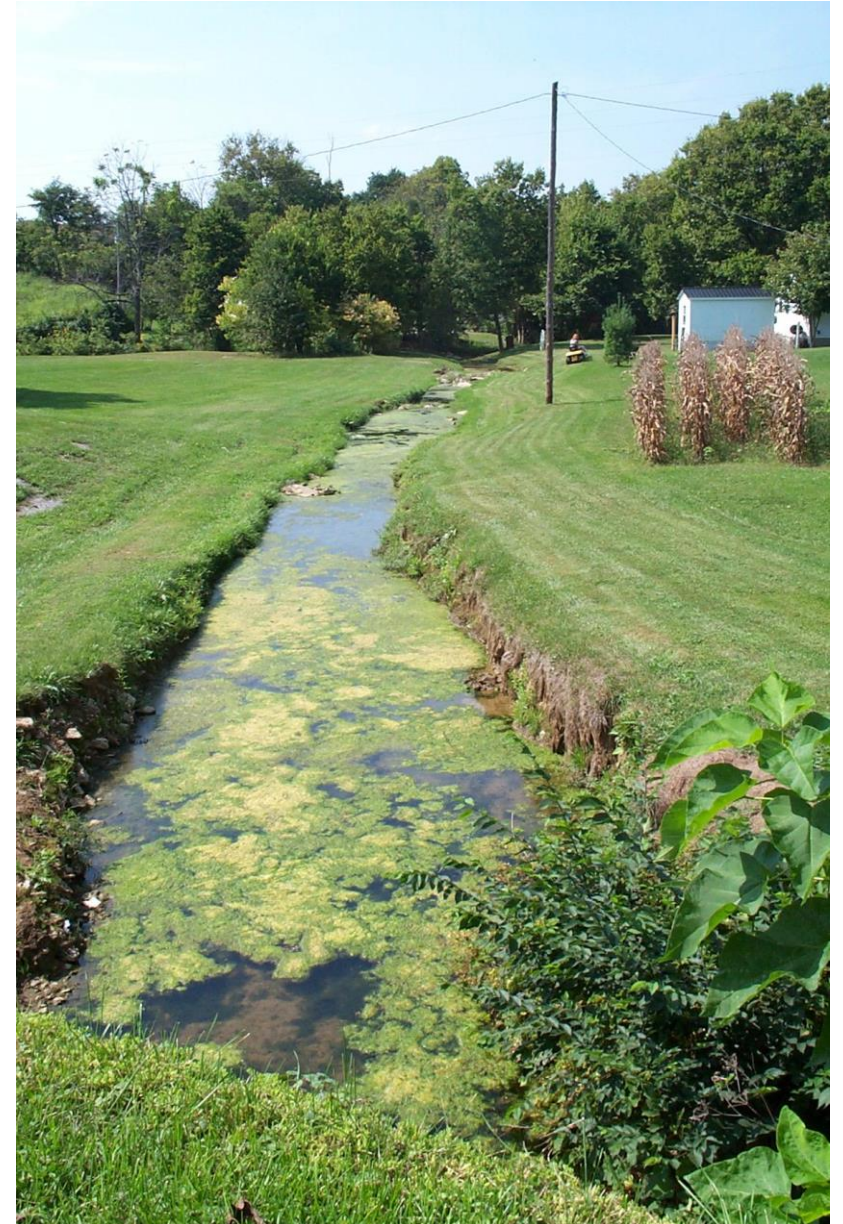
Turbidity: Increase over Background Turbidity Example

- 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

Laura Shumway
shumway.laura@epa.gov



Selena Medrano
medrano.selena@epa.gov