CFWEP Lesson Plan: World Water Monitoring Day Lesson 3: Conclusion

Teachers Resource Guide

For support, equipment and additional information, contact the **Clark Fork Watershed Education Program (CFWEP)**
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Note: For additional definitions and background information, refer to the Teachers Resource Guide for Lesson 1: World Water Monitoring Day Introduction

Average Water Quality Values for Montana:

pH: The typical pH of Montana streams and rivers is about 7-9.
Turbidity: Water that looks clear in a glass of water will usually have NTU < 2. Water that looks cloudy will have NTU between 2 and 10. Water with NTU > 10 is very muddy.
Dissolved Oxygen: The typical DO of Montana streams and rivers is about 6-10 mg/L.
Water Temperature: In Montana streams, trout and other aquatic species become stressed at water temperatures above 20°C (or about 68°F). Gases are less soluble in water at higher temperatures, leading to lower dissolved oxygen concentrations in warmer waters.
Optional: Conductivity: The typical Conductivity of Montana streams and rivers is about 50-500 µS/l. Polluted fresh water typically has a conductivity above this range. Note that high conductivity does not necessarily indicate pollution; sea water has a conductivity of about 40,000.

If students observe an acidic pH (less than 7) then some factor is causing the water body to become more acidic than is typical. Potential causes include Acid Rock or Acid Mine Drainage (the most likely cause in the Clark Fork Basin); the water body flows through a geologic area high in acidic rock such as pyrite; or another human-made cause.

If students observe a basic pH over 9, potential causes include the water body flowing through a geologic area high in basic or alkaline rock, such as limestone; or human-made causes, such as discharge of sewage effluent or other basic human byproduct.

Turbidity is highly variable based on weather and season. Generally, higher turbidity readings will be observed after storm events and during spring or summer runoff. Nearby roads or construction can also potentially increase turbidity. Flooding will also greatly increase turbidity. A very low turbidity would indicate that a water body is likely not affected by these factors at the time of measurement.

Dissolved oxygen is also highly variable based on season and time of day. High air and water temperatures will result in lower DO measurements. Slow or standing water will likely have lower DO readings. Fast flowing or colder waters will likely have higher DO readings. Water bodies high in algae may have lower DO readings. DO readings tend to fall at night and begin rising in the morning as aqueous plants receive sunlight and resume photosynthesis (of which oxygen is a byproduct).

Water temperature will naturally vary with air temperature. An irregular water temperature could indicate the presence of a hot or cold spring, or some type of human-made discharge into the water that either raises or lowers the temperature.

State, National, and Global Water Quality Values:

Note: These values are from the 2007 WWMD Year in Review Report.

Montana
pH: 7.82
Turbidity: 7.41
Dissolved Oxygen: 4.31
Water Temperature: 9.23

Washington State
pH: 7.27
Turbidity: 1.45
Dissolved Oxygen: 6.67
Water Temperature: 11.78

New York State
pH: 7.67
Turbidity: 8.71
Dissolved Oxygen: 5.21
Water Temperature: 17.86

United States
pH: 7.67
Turbidity: 9.68
Dissolved Oxygen: 5.13
Water Temperature: 17.56

North America:
pH: 7.68
Turbidity: 7.44
Dissolved Oxygen: 5.31
Water Temperature: 18.99

Asia:
pH: 7.15
Turbidity: 39.83
Dissolved Oxygen: 4.67
Water Temperature: 23.04

Australia:
pH: 7.00
Turbidity: 21.82
Dissolved Oxygen: 4.41
Water Temperature: 17.50

Europe:
pH: 7.35
Turbidity: 6.07
Dissolved Oxygen: 5.07
Water Temperature: 10.44

South America:
pH: 7.53
Turbidity: 22.71
Dissolved Oxygen: 6.19
Water Temperature: 20.01

Africa:
pH: 7.88
Turbidity: 28.78
Dissolved Oxygen: 4.75
Water Temperature: 23.35

Taiwan
pH: 7.13
Turbidity: 40.25
Dissolved Oxygen: 4.09
Water Temperature: 25.77

Spain
pH: 7.83
Turbidity: 15.67
Dissolved Oxygen: 4.26
Water Temperature: 12.37

Chile
pH: 7.98
Turbidity: 5.49
Dissolved Oxygen: 6.75
Water Temperature: 12.06

Water Quality Points for Comparison:

pH:

Note that all WWMD-reported pH values are over 7, or slightly basic. The vast majority of fresh waters are basic, and aquatic life has correspondingly adapted to that condition. This should illustrate to students how potentially harmful acidic waters can be to aquatic ecosystems

Students should also observe that variations in pH may be due to geological forces

Opportunity for Extension: This could be an avenue for additional research, e.g. is the natural geology of Chile, with waters averaging a pH of 7.98, more basic than Australia, where waters average a neutral pH of 7.00.

Turbidity:

Montana has a lower Turbidity (7.41) than the U.S. average (9.68). What may explain this? Possible answers include Montana's lower population density and significant wilderness acreage, as well as natural conditions.

Why might Turbidity readings from elsewhere (Asia, Australia, Taiwan, Africa, South America) be so much higher than in Montana or North America? Possible answers include higher population densities; greater erosion; more urban areas and human infrastructure (roads and construction); or natural conditions.

Opportunity for Extension: Students could research population densities for several areas (particularly Taiwan and Asia, which have high Turbidity) and correlate population density to Turbidity to determine if there is a connection between the two variables, and the relative strength of that connection.

Dissolved Oxygen:

The Dissolved Oxygen average value for Montana is somewhat surprisingly low. What might explain this? Possible answers include the time of day DO measurements were taken (a hot afternoon could lead to lower than expected DO readings); the type of water body monitored (a still pond will have much lower DO values than a fast flowing river); or other factors.

In these readings, does DO correspond to temperature, as we might predict? For the numbers listed above, the answer is "somewhat". For example, Washington state reported one of the lowest water temperature values (11.78), and one of the highest DO values (6.67), as we might expect based on the established correlation between DO and temperature. However, South America reported high water temperatures (20.01) and also relatively high DO (6.19). There are many possible explanations for such a discrepancy (refer to the factors mentioned in the preceding paragraph), and students should develop some on their own.

Water Temperature:

Students should note that Montana has significantly lower water temperatures than the greater U.S. or North America; this is one of many reasons why Montana has such an excellent reputation for quality trout habitat.

Students should be asked if, based on water temperature and other data, the aquatic life of Montana could survive or thrive in any of these other locations. Students should note that some locations have temperatures that are too high for the kind of aquatic life observed in Montana (e.g. Taiwan, Africa, South America, Asia), and that some other locations have low DO values that could potentially hinder the type of aquatic life observed in Montana (e.g. Australia, Spain, Taiwan, although it should again be noted that DO is highly variable).

Key Definitions:

Point Source: A point source of pollution is a single identifiable localized source of air, water, or other form of pollution. The sources are called point sources because in mathematical modeling, they can be approximated as a mathematical point to simplify analysis. Examples include water pollution from an oil refinery wastewater discharge outlet, or air pollution from the Anaconda smelter stack.

Nonpoint Source: Nonpoint source (NPS) pollution is water pollution affecting a water body from diffuse sources, rather than a point source which discharges to a water body at a single location. NPS may derive from many different sources with no specific solution to rectify the problem, making it difficult to regulate. According to the U.S. Environmental Protection Agency (EPA), nonpoint source pollution is the leading cause of water pollution in the United States today, with polluted runoff from agriculture the primary cause. Other significant sources of runoff include hydrological and habitat modification and stormwater runoff. Another important cause of NPS pollution is urban runoff of items like oil, fertilizers, and lawn chemicals. As rainfall or snowmelt moves over and through the ground, it picks up and carries away natural and human-made pollutants. These pollutants are eventually deposited into bodies of water.

Total Maximum Daily Load (TMDL): TMDL is a regulatory term in the U.S. Clean Water Act (CWA), describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards. This process incorporates both point source and nonpoint source pollutants within a watershed.