Module 1, Add on lesson – Water quality and temperature

Student

45 minutes

Purpose of this lesson

- Introduce students to water temperature and how it correlates with water quality
- Introduce students to water quality parameters beyond temperature

Background and discussion

Temperature is one of the most easily measured water quality parameters, but is also one of the most crucial factors in the workings of an aquatic ecosystem. As water temperature rises, biological and chemical activity also increases and physical effects will occur as well.

Temperature is not generally constant from the water surface to the bottom. An aquatic ecosystems' water temperature is a function of:

- Depth
- Season
- Mixing due to wind, storms and tides
- Degree of stratification in the system
- Temperature of water flowing from the tributaries
- Human influences such as release of warm water from power plants

Why is it important to measure water temperature? Temperature can influence several water quality parameters and affects including:

- Dissolve Oxygen (DO)
- Phytoplankton blooms
- Submerged Aquatic Vegetation (SAV)
- Bacteria
- pH
- Thermal Pollution

Dissolved Oxygen

The amount of oxygen that can dissolve in water (DO) depends on temperature. Colder water will have a higher DO level than warmer water. A difference in DO levels may be detected if the water is tested early in the morning when the water is cool and then later in the afternoon on a sunny day when the water temperature has risen. Similarly a difference in DO levels may be seen at different depths of the water if there is a significant change in water temperature.

In the spring and summer, the upper most layer of water tends to grow warmer and mixing between this surface water and the cooler bottom water slows. As air temperatures cool through the autumn, the surface water becomes increasingly cold which increases the density of the water. As the surface water sinks down, mixing occurs. Through the winter, temperatures remain fairly constant from top to bottom (in shallow systems).

Oxygen concentrations are much higher in air, which is about 21% oxygen, than in water, which is less than 1% oxygen. Where the air and water meet, this tremendous difference in concentration causes oxygen molecules in the air to dissolve into the water. More oxygen dissolves into water when wind stirs the water; as the waves create more surface area, more diffusion can occur.

Dissolved oxygen is crucial for most animals and plants in the aquatic system. Both plants and animal require oxygen for respiration – a process critical for basic metabolic processes. The metabolic rates of aquatic organisms increase in warm water. Since metabolism requires oxygen, some species may not survive if there is not enough oxygen in the water to meet their needs. Also, water temperature may affect the reproductive rates of some aquatic species; some species may not be able to reproduce in warmer waters.

Phytoplankton blooms

Sunlight and water temperature as well as nutrient levels of nitrogen and phosphorous are essential and limiting factors for phytoplankton growth. Although nutrients are essential for the growth and survival of aquatic ecosystems plants, including phytoplankton, an excess of nitrogen and phosphorous may trigger a string of events that seasonally depletes dissolved oxygen (DO) in the water.

Oxygen is produced during photosynthesis and consumed during respiration and decomposition. Because it requires light, photosynthesis occurs only during daylight hours. Respiration and decomposition, on the other hand, occur 24 hours a day. This difference alone can account for large daily variations in DO concentrations. During the night, when photosynthesis cannot counterbalance the loss of oxygen through respiration and decomposition, DO concentrations steadily decline. They are lowest just before dawn, when photosynthesis resumes.

Submerged Aquatic Vegetation (SAV)

SAV are important elements of an aquatic ecosystems' health, providing shelter and habitat for some species, food for other species, and contribute to the dissolved oxygen levels available in the system.

Bacteria

Since bacteria and other disease causing organisms grow faster in warm water, the susceptibility of aquatic organisms to disease in warm water increases.

pH

pH quantifies the acidity or alkalinity of water, where 7.0 is neutral and any measurement below 7.0 is considered acidic and any measurement above 7.0 is considered alkaline (basic). Several factors can affect the pH level of water including:

- bacterial activity
- rate of photosynthesis (as DO rises and carbon dioxide declines with photosynthesis, the pH will increase)
- water turbulence
- chemical constituents in runoff flowing into the water body
- human activities both in and outside of the drainage basin

Thermal Pollution
Many species regulate the timing of important events such as migration and reproduction according to specific water temperatures. Optimal temperatures (which vary with the species and their life stage) allow organism to function at maximum efficiency.

Sudden increases in temperature may be a result of thermal pollution which is the discharge of large amounts of warm water from industrial plants. Sudden changes in water temperature may cause thermal shock in some aquatic species and result in the death of that species. Thermal pollution, even if gradual, may disrupt the ecosystem balance in such a way to eliminate heat intolerant species from that area.

Procedure

1. Travel to the field site where you will deploy your sensors.

2. Complete the *Site Characterization* form and document the area surrounding the water.

3. Using the sensors, measure and record the water temperature at various depths.

Assessment

1. Using the information found in the background section, the Site Characterization data and the temperature data collected, develop a one paragraph analysis of the temperature data measured. For example, did you detect stratification in the water temperature profile? Why? Were there large amounts of algae growing on the surface of the water? What implications do you think that might have?

2. Develop a Concept Map