Water Quality – Temperature

The temperature of a body of water influences its overall quality. Water temperatures outside the “normal” range for a stream or river can cause harm to the aquatic organisms that live there. If the water temperature changes by even a few degrees, it could indicate a source of unnatural warming of the water or thermal pollution.

Thermal pollution caused by human activities is one factor that can affect water temperature. Many industries use river water in their processes. The water is treated before it is returned to the river, but is warmer than it was before. Runoff entering a stream from parking lots and rooftops is often warmer than the stream and will increase its overall temperature.

Shade is very important to the health of a stream because of the warming influences of direct sunlight. Some human activities may remove shade trees from the area which will allow more sunlight to reach the water, causing the water temperature to rise.

Another factor that may affect water temperature is the temperature of the air above the water. The extent of its influence has a great deal to do with the depth of the water. A shallow stream is more susceptible to changes in temperature than a deep river would be.

While many factors can contribute to the warming of surface water, few cause it to be cooled. One way water can be cooled is by cold air temperatures. A second, natural method of cooling a river or lake comes from the introduction of colder water from a tributary or a spring.

Factors that Affect Water Temperature

- Air temperature
- Amount of shade
- Soil erosion increasing turbidity
- Thermal pollution from human activities
- Confluence of streams

Effects of Water Temperature

- Solubility of dissolved oxygen
- Rate of plant growth
- Metabolic rate of organisms
- Resistance in organisms
One important aspect of water temperature is its effect on the solubility of gases, such as oxygen. More gas can be dissolved in cold water than in warm water. Animals, such as salmon, that require a high level of dissolved oxygen will only thrive in cold water.

Increased water temperature can also cause an increase in the photosynthetic rate of aquatic plants and algae. This can lead to increased plant growth and algal blooms, which can be harmful to the local ecosystem.

A change in water temperature can affect the general health of the aquatic organisms, thus changing the quality of the stream. Table 1 lists the optimal temperature ranges of some selected aquatic organisms. When the water temperature becomes too hot or too cold, organisms become stressed, lowering their resistance to pollutants, diseases, and parasites.

### Table 1: Optimal Temperature Ranges

<table>
<thead>
<tr>
<th>Organism</th>
<th>Temperature Range (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trout</td>
<td>5 – 20</td>
</tr>
<tr>
<td>Smallmouth bass</td>
<td>5 – 28</td>
</tr>
<tr>
<td>Caddisfly larvae</td>
<td>10 – 25</td>
</tr>
<tr>
<td>Mayfly larvae</td>
<td>10 – 25</td>
</tr>
<tr>
<td>Stonefly larvae</td>
<td>10 – 25</td>
</tr>
<tr>
<td>Water boatmen</td>
<td>10 – 25</td>
</tr>
<tr>
<td>Carp</td>
<td>10 – 25</td>
</tr>
<tr>
<td>Mosquito</td>
<td>10 – 25</td>
</tr>
<tr>
<td>Catfish</td>
<td>20 – 25</td>
</tr>
</tbody>
</table>

### Expected Levels

Water temperatures can range from 0°C in the winter to above 30°C in the summer. Cooler water in a stream is generally considered healthier than warmer water, but there are no definitive standards. Some sample data are listed in Table 2.

<table>
<thead>
<tr>
<th>Site</th>
<th>Season</th>
<th>Temperature (°C)</th>
<th>Season</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hudson River, Poughkeepsie, NY</td>
<td>Winter</td>
<td>5</td>
<td>Summer</td>
<td>25</td>
</tr>
<tr>
<td>Missouri River, Garrison Dam, ND</td>
<td>Winter</td>
<td>3</td>
<td>Summer</td>
<td>14</td>
</tr>
<tr>
<td>Rio Grande, El Paso, TX</td>
<td>Winter</td>
<td>16</td>
<td>Summer</td>
<td>21</td>
</tr>
<tr>
<td>Mississippi River, Memphis, TN</td>
<td>Winter</td>
<td>7</td>
<td>Summer</td>
<td>29</td>
</tr>
<tr>
<td>Willamette River, Portland, OR</td>
<td>Winter</td>
<td>9</td>
<td>Summer</td>
<td>22</td>
</tr>
</tbody>
</table>

### MATERIALS

- Computer
- Vernier computer interface
- Logger Pro
- Vernier Temperature Probe
- Small paper or plastic cup (optional)
**PROCEDURE**

1. Water temperature must be measured on site by either placing the probe directly in the stream or by collecting a sample and immediately measuring its temperature. If you need to collect a sample to measure on site, it is important to obtain the water sample from below the surface of the water and as far away from the shore as is safe. If suitable areas of the stream appear to be unreachable, samplers consisting of a rod and container can be constructed for collection.

2. Position the computer safely away from the water. Keep water away from the computer at all times.

3. Connect the Temperature Probe to the Vernier computer interface.

4. Prepare the computer for data collection by opening the file “10 WQ Temp” in the *Earth Science with Vernier* folder.

5. You are now ready to collect temperature data.
   a. Place the tip of the probe into the stream, or into a cup with sample water just taken from the stream.
      Submerge the probe tip to a depth of about 6 cm.
   b. Monitor the temperature in the meter for 30 seconds.
   c. If the temperature appears stable, simply record it on the Data & Calculations sheet and proceed to Step 7.

6. If the temperature value displayed in the meter window is fluctuating, determine the mean (or average) temperature. To do this:
   a. Click [Collect] to begin a 10 second sampling run. **Important:** Leave the probe tip submerged for the 10 seconds that data is being collected.
   b. When the sampling run is complete, click on the Statistics button, [Stats], to display the statistics box on the graph.
   c. Record the mean temperature on the Data & Calculations sheet.

7. Return to Step 5 to obtain a second reading.

8. Calculate the average of the two temperature readings and record it on the Data & Calculations sheet.
DATA & CALCULATIONS

Temperature

Stream or lake: _____________________________ Date: _________________________________

Site name: _________________________________ Time of day: __________________________

Student name: ______________________________ Student name: __________________________

Student name: ______________________________ Student name: __________________________

<table>
<thead>
<tr>
<th>Reading</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
</tr>
</tbody>
</table>

Field Observations (e.g., weather, geography, vegetation along stream) ___________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Test Completed: _________________ Date: ______
Vernier Lab Safety Instructions Disclaimer

THIS IS AN EVALUATION COPY OF THE VERNIER STUDENT LAB.

This copy does not include:
- Safety information
- Essential instructor background information
- Directions for preparing solutions
- Important tips for successfully doing these labs