My Stream's Temperatures

Adapted from: An original Creek Connections activity.
Creek Connections, Box 10, Allegheny College, Meadville, Pennsylvania 16335.

Grade Level: basic, all

Duration: 15 – 45 minutes

Setting: waterway (large wadeable creek is best)

Summary: Students measure and compare temperature at various spots with different physical characteristics in the same waterway.

Objectives: To learn what factors influence temperature in a stream. To observe, identify, and record/map differences in physical characteristics of a waterway. To practice using thermometers properly.

Vocabulary: temperature, biotic, riparian, thermal stratification, thermal pollution

Related Module Resources:
- Temperature Info./ Fact Sheet
- HANDBOOK: p. 51-55
- FIELD MANUAL: p. 40-42
- "Temperature: Air vs. Water vs. More Water" activity

Materials (Included in Module):
- 9 thermometers
- bailer
- sample bottles

Additional Materials (NOT Included in Module):
- additional thermometers
- shoreline dipper (sampling device)
- hipwaders, boots, creek sneakers

ACADEMIC STANDARDS (ENVIRONMENT AND ECOLOGY)

7th Grade
4.1.7.B Understand the role of the watershed.
- Explain factors that affect water quality and flow through a watershed

10th Grade
4.1.10.B. Explain the relationship among landforms, vegetation and the amount and speed of water.
- Analyze a stream's physical characteristics.

4.1.10.C. Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.
- Describe and explain the physical factors that affect a stream and the organisms living there.

4.6.10.A Explain the biotic and abiotic components of an ecosystem and their interaction.
- Analyze the effects of abiotic factors on specific ecosystems.

12th Grade
4.1.12.C Analyze the parameters of a watershed.
- Interpret physical, chemical and biological data as a means of assessing the environmental quality of a watershed
- Apply appropriate techniques in the analysis of a watershed (e.g., water quality, biological diversity, erosion, sedimentation)

BACKGROUND:

Temperature is the measure of how hot or cold an object and it is usually recorded in degrees Celsius (preferred in science research) or in degrees Fahrenheit. Even though temperature is a simple test to perform on waterways, it is a very important parameter. The temperature characteristics of stream water directly and indirectly influence aquatic ecosystem processes, the **biotic** (living) composition of an ecosystem, and other water quality parameters.

The sun's energy affects water temperature, and every waterway's temperature will naturally fluctuate from season to season. The more sunlight that hits the water's surface, the warmer the water will get. Narrow, well-shaded small streams are often cooler than wider, larger streams that are not fully shaded by **riparian** (streamside) forests. However, temperature change caused by the sun is slow. Water absorbs a lot of thermal energy before it changes temperature. Water temperature rises slowly as it warmed by the daily sun or the summer season, and it cools slowly after the sun sets or as the cooler fall and winter season progresses.

In addition to sunlight intensity, the physical dimensions of the waterway will also affect the temperature. Shallow water will fluctuate in temperature faster than deeper water. Running water tends to be cooler than stagnant, still water. In a stream, the shallow riffles or rapids are often cooler than the slow moving, deep pools. The most downstream stretches of creeks and rivers are often warmer than the upstream sections, and may even have a slight **thermal stratification** (temperatures differ at various depths) in these deep, slow sections. Warmer surface water floats on more dense, colder bottom water. Freshwater is most dense, or heaviest, at 4°C and this temperature of water is found at the bottom of a lake or river. Water that is warmer or colder than 4°C will always be on top. If it were not for this important characteristic of water, ice would not float on top of water and would instead accumulate at the bottom where aquatic creatures may be trying to live and hibernate. Creeks, ponds, and lakes would freeze solid.

The source of water for a stream also influences temperature. If the stream water is predominately from rain and surface runoff, it will have different temperatures than a stream that source of water is from underground (groundwater fed). For instance, rivers and streams fed by melting snow (often near 0°C) will be colder than a same sized stream fed by groundwater warmed by underground layers of soil and rock. Because groundwater maintains a more constant temperature throughout the year, the same groundwater fed stream will be cooler in the summer than a stream filled by warm rain and warmer overland flow.

As water temperature rises, it increases the metabolic rates of fish and aquatic insects. Temperature also influences another natural stream process. Under warm conditions, the rate of decomposition (break down of plants and animals) speeds up. Decomposition uses oxygen that is needed by aquatic life and produces carbon dioxide.

There is a natural fluctuation of waterway temperature from season to season, even day and night, and aquatic life can cope with these natural changes. When humans alter the temperature of waterways, it may harm aquatic life; a thermal change of 2^{o}C or more is harmful to stream organisms. All species have a specific range of temperature to which they are adapted. If the temperature of a stream changes, organisms that cannot tolerate the change are stressed and must either reduce activity, move somewhere else, or in extreme cases, perish.

Humans can alter natural temperature characteristics of a stream by direct actions to the waterway or indirectly through alterations to the watershed. **Thermal pollution** refers to the unnatural addition of warmer or colder water that causes an unstable jump in the temperature of a waterway. There are many examples of thermal pollution. Industries and power plants discharge warm water that was used in the manufacturing process (boilers) or to cool machinery and turbines. Humans can alter the land use around a waterway and affect the water temperature. Removing the streamside forests for farming or during timbering eliminates the shade provided to the stream. Sunlight is no longer blocked. The removal of streamside forests and any other actions that promote soil erosion also increase the water temperature as more heat soaking sediment enters the stream. Urbanization is another heat causing pollution source. Rainwater that flows

over hot paved surfaces warms up and eventually enters the stream. Many storm drains on roads and parking lots lead directly to the nearest waterway without any type of treatment.

OVERVIEW: Students measure and compare temperature at various spots with different physical characteristics in the same waterway. They will record data and illustrate their waterways physical characteristics that may influence temperature.

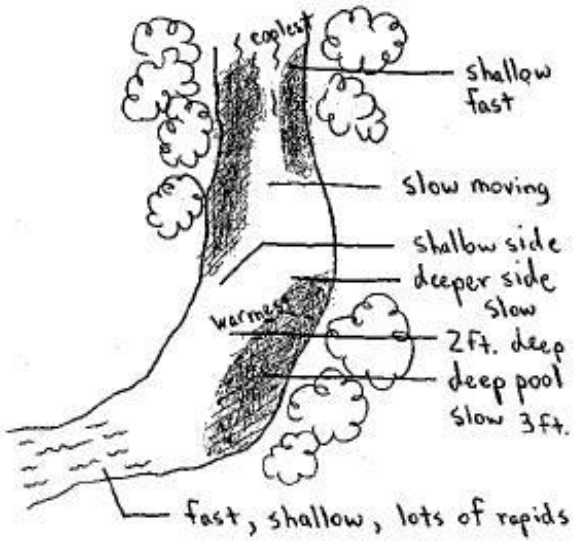
SAFETY PRECAUTION:
This activity should be conducted while wading into a waterway that does not pose safety concerns. Students should watch for fast moving or deep water. Have students be careful while trudging through the stream - many rocks are jagged or are covered with algae and can be very slippery. Make sure that all students that enter the water are wearing waders, boots or creek shoes (no bare feet). IF IT IS COLD OUTSIDE: STAY OUT OF THE WATER. Even in late fall or early spring, students should stay out of the water unless they have on hip-waders or waterproof boots. Even then teachers should consider this type of work or at least have a blanket or extra clothes available in case someone accidentally gets wet. If getting into a creek is unsafe, this activity could be done by collecting water using a bailer from a bridge and a shoreline sampling device.

PROCEDURE:

1. Divide students into groups based on thermometer and proper footwear/wader availability.

2. Optional: Have students map the waterway location they are investigating, indicating where water is moving fast or slow, is deep or shallow, parts of the creek in shade or exposed to sunlight, areas that have aquatic vegetation, and any human influences they see entering the creek (pipes, culverts). As they get into the creek, they may make additions or corrections to their maps.

3. Optional: You may have students predict (either verbally or on their map) where they think the temperature will be the coolest/warmest.



4. Instruct the groups to take the water temperature in the waterway in a number of different spots that have different physical characteristics, amounts of sunlight/shading, depths, distances from shore. Go over safety precautions.

*Possible places in the stream to take temperatures: Sunny area, shady spot, near the surface, deep below the water, various depths, still water (pools), shallow running water (riffles), deeper running water (runs), in aquatic vegetation, above and below a drainage pipe.

5. Remind them to hold the thermometer in place for a minute or more to get an accurate reading.

6. They should then record the values on the data sheet at the end of this activity. Have more than one student take the temperature at each location to increase accuracy. Students can average the values obtained at each location. Also on the data sheet students should be describing the spot where they took the reading.

7. Have the students take and record the air temperature. They could then compare it to the water temperature.

DISCUSSION:

Talk to the students about their findings. Where was the water coolest? Warmest? Why? *See background information for the various factors that influence temperature.*

Were they surprised at how different the temperature could be from spot to spot in the stream?

Do they think the aquatic organisms may be different at these locations based on their temperature preferences? At which spot do they think a trout would prefer to live? *Trout prefer cold water and are often found in swift moving, cooler water, not deep, sunny pools. They also prefer very shady spots like underneath overhanging vegetation, or tree roots along the shore.* Where would a carp be found? Carp *can tolerate warmer locations.*

What would happen to all the temperature differences recorded if the waterway became much higher and faster after a lot of rain? *If the water levels rise and the differing physical dimensions become indistinguishable [pools and riffles just all blend into large runs] and the water is mixing and flowing fast, then the water temperature differences may not be noticeable at all.*

EVALUATION:

- Discussion questions above.
- List factors (natural and unnatural) that influence water temperature in a creek. Explain why temperature is not constant in a stream or from location to location within it.
- Demonstrate proper use of a thermometer to measure water / air temperature.
- Properly complete the data sheet and/or waterway site map.

- Draw a fictitious stream and illustrate locations within it that have differing physical characteristic and sunlight intensity, and record probable temperatures of those locations.

EXTENSIONS AND MODIFICATIONS:

- Over a series of days (about a week or two) have the students measure both the water and air temperature at your site. They can then graph the results versus time and see if there is a pattern. This may be a good idea for student independent research. *(Water changes temperature slower than air does.)*
- To illustrate how temperature affects dissolved oxygen, tell the students to measure dissolved oxygen at every place that they measure temperature. Instruct them to graph the two parameters against each other to show the correlation between them. *(As temperature increases, dissolved oxygen tends to decrease.)*

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

DATA SHEET: MY STREAM'S TEMPERATURES

Student Name _____ Date _____

Waterway Name:_____

Weather in the past 48 hours _____

Air temperature _____

Notes about your study site_____

_____

Sample Location Within Waterway	Temperature Readings	Average Temperature Reading