Water temperature

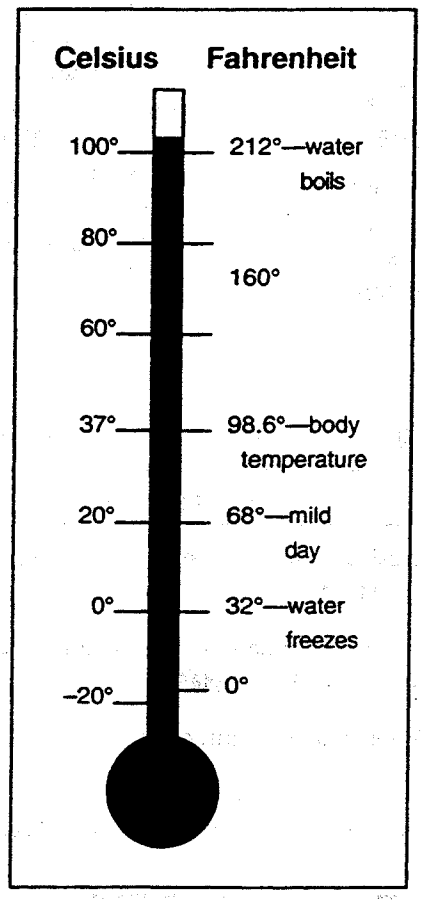
"Worsewick Hot Springs was nothing fancy . . . . There were dozens of dead fish floating in our bath."
— Richard Brautigan

Water temperature is one of the most important factors for survival of aquatic life. Most aquatic organisms become the temperature of the water that surrounds them. Their metabolic rates are controlled by water temperature. This metabolic activity is most efficient within a limited range of temperatures. If temperatures are too high or too low, productivity can decrease or metabolic function cease. The organism can die. These extremes, or lethal limits, vary for different species.

Lethal limits

Within the lethal limits there is an ideal range of temperatures. In this range, an organism is more efficient, and the species has a greater chance of success. Various species of fish have adjusted to upper and lower levels of an optimum temperature range. Spawning, hatching and rearing temperature ranges vary from species to species. In this way, temperature determines the character and composition of a stream community.

In the Pacific Northwest, most streams have had populations of salmon and trout, which prefer temperatures between 40° and 65°F. In the summer, when temperatures are highest and water flows lowest, juvenile fish live in the pools of smaller streams. Pools offer deeper, cooler, oxygen-rich water and increased protection from predators. Because of low water flows, fish can be confined to a limited area. A temperature rise in a rearing pool can kill fish by exceeding their lethal temperature limits.



Plant cover's role

With the exceptions of hot springs and thermal pollution, solar radiation is the cause of increased water temperatures. Shade from riparian vegetation plays a major role in keeping streams cool. During midsummer, adequate shade will keep a stream 7° to 12°F cooler than one exposed to direct sunlight. Even the shade from debris in the water will help keep temperatures low. If there is enough debris, temperatures can be 3° to 8°F cooler than if there was no shade. Once water has warmed, it does not cool rapidly, even if it flows into a shady stretch.

It is important to recognize that water temperatures change from day to night and that cool-water areas exist in a stream.

Warmer temperatures encourage the growth of life forms that adversely affect fish

and human health. Pathogens such as bacteria, as well as several parasitic organisms, thrive in warmer waters.

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Air temperature, surface area

As water in a stream mixes with air through exposure and turbulence at the surface, water is influenced by the air temperature. This mixing action can also increase the evaporation rate.

The greater the surface area of a body of water, the greater its exposure to both solar radiation and air. Because of its increased surface area a wide, shallow stream will heat more rapidly than a deep, narrow stream.

Streambed, streamflow, orientation and sediments

Color and composition of a streambed also affect how rapidly stream temperature rises. A dark bedrock channel will gain and pass to the stream more solar radiation than a lighter-colored channel. Similarly, solid rock absorbs more heat than gravel.

The streamflow, or volume of water in a stream, influences temperature. The larger a body of water, the slower it will heat. Rivers and large streams have more constant temperatures than smaller streams.

The direction a stream flows also affects how much solar radiation it will collect. Because of the angle of the sun's rays, southerly flowing streams receive more direct sunlight than streams flowing north. Eastward or westward flowing streams receive shading from adjacent ridges, trees and riparian vegetation.

Sediments suspended in water can absorb, block or reflect some of the sun's energy depending on their color and position in the water. Particles on or near the surface can have a beneficial influence through reflection, but those with a dark color increase the total energy absorbed from the sun.

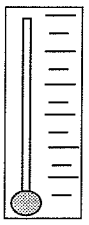
Effects of thermal pollution

Thermal pollution occurs when heated water is discharged into cooler streams or rivers. This heated water generally has been used to cool power plants or industrial processes and can be as much as 20°F warmer than the water into which it is discharged. This increase in temperature can have drastic effects on downstream aquatic ecosystems.

Figure 11. Temperature Ranges (approx.) Preferred by Certain Organisms

Temperature (Fahrenheit)	Examples of life
Greater than 68° (warm)	Redside shiner, crappie, bluegill, carp, catfish, caddisfly, dragon fly, and much plant life
Middle range (55°-68°)	Brown trout, rainbow trout, stonefly, mayfly, caddisfly, water beetles, sculpins, and some plant life
Low range (cold, less than 55°)	Brook trout, sculpins, caddisfly, stonefly, mayfly, and some plant life

Adapted from Claire Dyckman and Stan Garrod, eds., *Small Streams and Salmonids*, p. 73.



Temperature Testing

Water temperature is a controlling factor for aquatic life as it affects the rate of metabolic functions.

Method:

1. Ask for a volunteer to lower the thermometer a few inches below the water surface.

2. Make sure they keep the thermometer in the water for three (3) minutes until a constant reading is obtained. (While waiting, have students look at the 12-hour tolerance limit median (TLm) chart and explain the significance of cool water for fish life.)

3. Have them record the measurement on page *42*, the temperature data record. Remind them that in actual stream monitoring activity temperature would be taken at a minimum of two sites.

4. Encourage them to compare their temperature to the state standards on page *42* and to the 12-hour TLm chart again on page *43*. Ask them to circle which water classification the temperature falls in. What factors could have caused in the stream temperature to be high or low?

Background: Riparian Zone/streamside vegetation

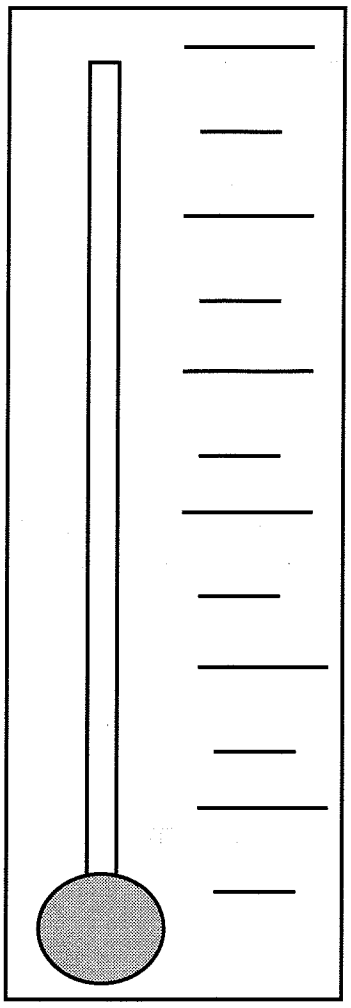
- It provides leaf liter, which comprises the food of aquatic invertebrates in some streams. (Therefore an initial link in the food chain.)

- Vegetative areas stabilize streambeds and prevent erosion.

- Streamside growth is important to create shade to keep water temperatures cool. Cold water holds more dissolved oxygen; aquatic organisms such as salmonoids have high-oxygen requirements and therefore need cold water.

Kits available from Hach Company World Headquarters P.O. Box 389
Loveland, CO 80539. 1-800-227-4224.

Temperature Testing



Testing for water temperature

Method :

1. Lower the thermometer a few inches below the water surface.

2. Keep the thermometer in the water for three (3) minutes until a constant reading is obtained.

3. Record the measurement in the temperature data record.

4. Compare your temperature to federal and state standards in addition to the temperature ranges for aquatic life.

Temperature Fact Sheet

State Standards

Class AA (Extraordinary)	Not to exceed 16.0 degrees Celsius
Class A (Excellent)	Not to exceed 18.0 degrees Celsius
Class B (Good)	Not to exceed 21.0 degrees Celsius
Class C (Fair)	Not to exceed 22.0 degrees Celsius

Source: WAC 173-201A-030)

Reminder: To convert degrees Fahrenheit to degrees Celsius use the following formula: (F° - 32) /1.8 = C°
To convert degrees Celsius to degrees Fahrenheit use the following formula: (C° x 1.8) + 32 = F°

Data Record

Date: _____ Observers: _____

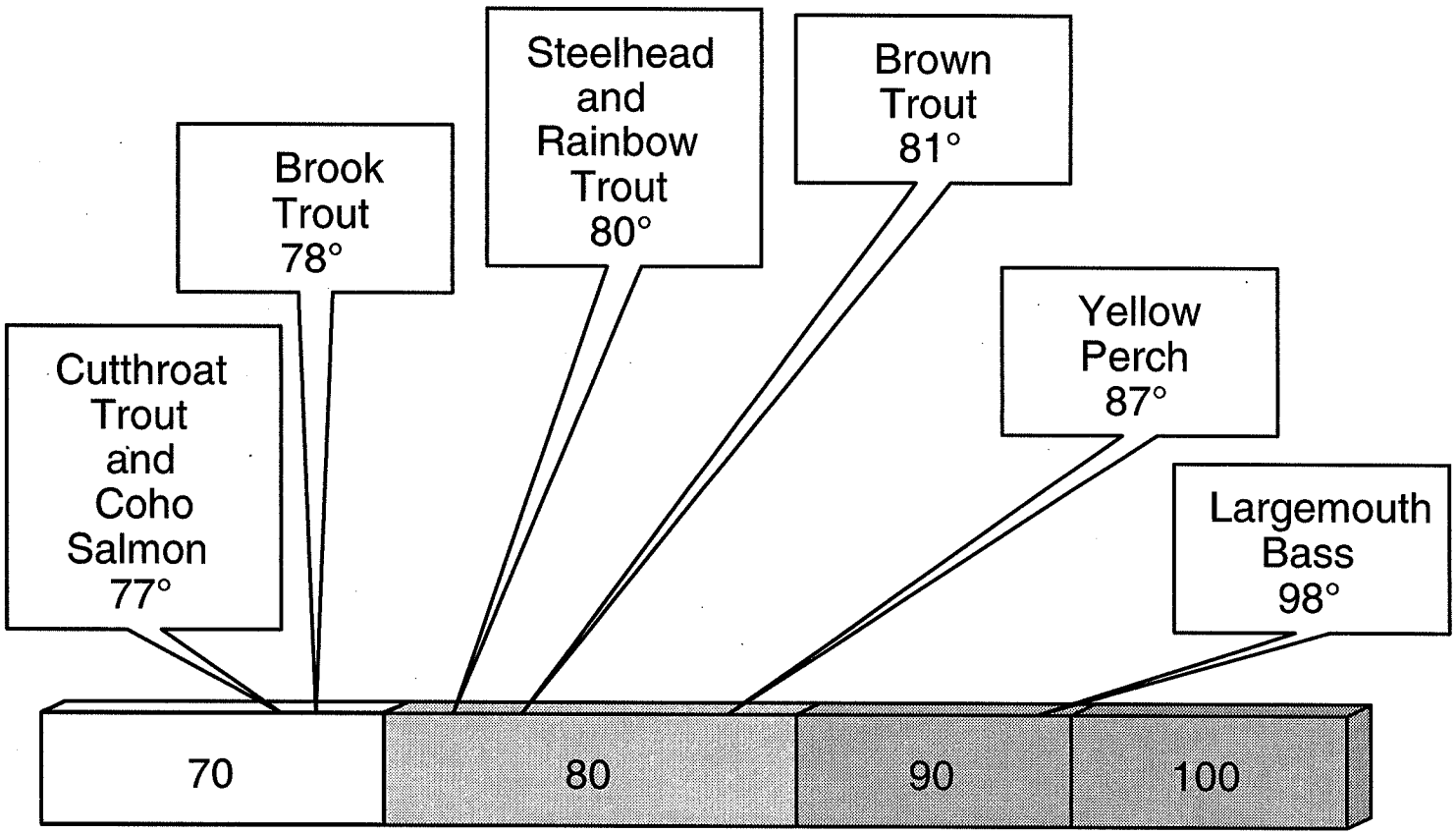
Water Temperature	Time	Which Class does this fall in ?

Reminder: In an actual monitoring situation, a reading would be taken at a minimum of two sites.

FACTORS THAT INCREASE STREAM WATER TEMPERATURES

- Improper grazing practices, logging, mining and commercial industrial development remove the shading and cooling effect of stream-side vegetation.
- Warm water releases from power plants and industrial facilities.
- Slowed water due to small hydropower projects and diversion dams for irrigation.

TEMPERATURE: TLm (tolerance limit median)
12-Hour Tolerance Median for Common Species



12-Hour TLm is the temperature limit that half of a given species will perish at within 12 hours. This is a very important consideration of stream health. (Source: "The Stream Scene")