5.3 Temperature

Why is temperature important?

The rates of biological and chemical processes depend on temperature. Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. Optimal temperatures for fish depend on the species: some survive best in colder water, whereas others prefer warmer water. Benthic macroinvertebrates are also sensitive to temperature and will move in the stream to find their optimal temperature. If temperatures are outside this optimal range for a prolonged period of time, organisms are stressed and can die. Temperature is measured in degrees Fahrenheit (F) or degrees Celsius (C).

For fish, there are two kinds of limiting temperatures—the maximum temperature for short exposures and a weekly average temperature that varies according to the time of year and the life cycle stage of the fish species. Reproductive stages (spawning and embryo development) are the most sensitive stages. Table 5.5 provides temperature criteria for some species.

Temperature affects the oxygen content of the water (oxygen levels become lower as temperature increases); the rate of photosynthesis by aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases.

Causes of temperature change include weather, removal of shading streambank vegetation, impoundments (a body of water confined by a barrier, such as a dam), discharge of cooling water, urban storm water, and groundwater inflows to the stream.

Sampling and Equipment Considerations

Temperature in a stream will vary with width and depth. It can be significantly different in the shaded portion of the water on a sunny day. In a small stream, the temperature will be relatively constant as long as the stream is uniformly in sun or shade. In a large stream, temperature can vary considerably with width and depth regardless of shade. If it is safe to do so, temperature measurements should be collected at varying depths and across the surface of the stream to obtain vertical and horizontal temperature profiles. This can be done at each site at least once to determine the necessity of collecting a profile during each sampling visit. Temperature should be measured at the same place every time.

Temperature is measured in the stream with a thermometer or a meter. Alcohol-filled thermometers are preferred over mercury-filled because they are less hazardous if broken. Armored thermometers for field use can withstand more abuse than unprotected glass thermometers and are worth the additional expense. Meters for other tests, such as pH (acidity) or dissolved oxygen, also measure temperature and can be used instead of a thermometer.

How to sample

The procedures for measuring temperature consist of the following tasks.

TASK 1 **Prepare before leaving for the sampling site**

Refer to pages 19-21 for details on confirming sampling date and time, safety considerations, checking supplies, and checking weather and directions. In addition to the standard sampling equipment and apparel, when measuring temperature you will need:

- A thermometer or meter
- A data sheet for temperature to record results

Species	Max. weekly average temp. for growth (juveniles)	Max. temp. for survival of short exposure (juveniles)	Max. weekly average temp. for spawning [a]	Max. temp. for embryo spawning [b]
Atlantic salmon	20°C (68°F)	23°C (73°F)	5°C (41°F)	11°C (52°F)
Bluegill	32°C (90°F)	35°C (95°F)	25°C (77°F)	34°C (93°F)
Brook trout	19°C (66°F)	24°C (75°F)	9°C (48°F)	13°C (55°F)
Common carp	---	---	21°C (70°F)	33°C (91°F)
Channel catfish	32°C (90°F)	35°C (95°F)	27°C (81°F)	29°C (84°F) [c]
Largemouth bass	32°C (90°F)	34°C (93°F)	21°C (70°F)	27°C (81°F) [c]
Rainbow trout	19°C (66°F)	24°C (75°F)	9°C (48°F)	13°C (55°F)
Smallmouth bass	29°C (84°F)	---	17°C (63°F)	23°C (73°F) [c]
Sockeye salmon	18°C (64°F)	22°C (72°F)	10°C (50°F)	13°C (55°F)

[a] Optimum or mean of the range of spawning temperatures reported for the species
[b] Upper temperature for successful incubation and hatching reported for the species
[c] Upper temperature for spawning

(Brungs and Jones 1977)

Table 5.5

Maximum weekly average temperatures for growth and short-term maximum temperatures for selected fish (°C and °F)

Be sure to let someone know where you are going and when you expect to return

TASK 2 **Measure the temperature**

In general, sample away from the streambank in the main current. The outside curve of the stream is often a good place to sample since the main current tends to hug this bank. In shallow stretches, wade into the center current carefully to measure temperature. If wading is not possible, tape your thermometer to an extension pole or use a boat. Reach out from the shore or boat as far as safely possible. If you use an extension pole, read the temperature quickly before it changes to the air temperature.

If you are doing a horizontal or vertical temperature profile, make sure you can safely reach all the points where a measurement is required before trying.

Measure temperature as follows:

1. Place the thermometer or meter probe in the water as least 4 inches below the surface or halfway to the bottom if in a shallow stream.
2. If using a thermometer, allow enough time for it to reach a stable temperature (at least 1 minute). If using a meter, allow the temperature reading to stabilize at a constant temperature reading.
3. If possible, try to read the temperature with the thermometer bulb beneath the water surface. If it is not possible, quickly remove the thermometer and read the temperature.
4. Record the temperature on the field data sheet.

TASK 3 **Return the field data sheets to the lab/dropoff point.**

References

Brungs, W.S. and B.R. Jones. 1977. *Temperature Criteria for Freshwater Fish: Protocols and Procedures.* EPA-600/3-77-061. Environ. Research Lab, Ecological Resources Service, U.S. Environmental Protection Agency, Office of Research and Development, Duluth, MN.