This document is Chapter 13 of the Volunteer Estuary Monitoring Manual, A Methods Manual, Second Edition, EPA-842-B-06-003. The full document be downloaded from: http://www.epa.gov/owow/estuaries/monitor/

Voluntary Estuary Monitoring Manual

Chapter 13: Temperature

March 2006

Chapter 13

Temperature

Water temperature is closely connected to many biological and chemical processes in the estuary. For this reason, and because it is easily measured, temperature is commonly monitored by volunteer groups using thermometers or meters.

Photos (l to r): R. Ohrel, R. Ohrel, Tillamook Bay National Estuary Project and Battelle Marine Sciences Lab, U.S. Environmental Protection Agency

Overview

Water temperature is closely connected to many biological and chemical processes in the estuary. For this reason, and because it is easily measured, temperature is commonly monitored by volunteer groups using thermometers or meters.

This chapter explains the significance and variability of estuarine water temperature and provides steps for collecting temperature data.

Why Monitor Temperature?

Temperature, probably the most easily measured parameter, is a critical factor influencing several aspects of the estuarine ecosystem. It influences biological activity and many chemical variables in the estuary.

The Role of Temperature in the Estuarine Ecosystem

Temperature plays many roles in the estuary. As water temperature increases, for example, the capacity of water to hold dissolved oxygen becomes lower. Water temperature also influences the rate of plant photosynthesis, the metabolic rates of aquatic organisms, and the sensitivity of organisms to toxic wastes, parasites, and diseases (USEPA, 1997).

Many species regulate the timing of important events, such as reproduction and migration, according to specific water temperatures. Optimal temperatures (which vary with the species and their life stage) allow organisms to function at maximum efficiency. The slow change of temperature that comes with the seasons permits organisms to acclimate, whereas rapid shifts may adversely affect plants and animals. Temperature shifts of more than 1°-2°C can cause thermal stress and shock (Campbell and Wildberger, 1992). Long-term temperature changes can affect the overall distribution and abundance of estuarine organisms.

Throughout the winter, temperatures remain fairly constant from top to bottom. In spring and summer, the uppermost layer of an estuary grows 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 and increases in density. The surface water mass ultimately sinks when its density becomes greater than that of the underlying water mass. As the surface water moves down, mixing occurs and nutrients from the bottom are redistributed toward the surface. This introduction of nutrients to surface waters fuels phytoplankton growth (see Chapters 10 and 19).

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

- depth;
- season;
- amount of mixing due to wind, storms, and tides;
- degree of stratification (layering) in the estuary;
- temperature of water flowing in from the tributaries; and
- human influences (e.g., release of urban stormwater, warm water discharged from power plants). ■

Sampling Considerations

Where to Sample

Because temperatures change according to the many variables listed above, it is often helpful to measure water temperature throughout the water column and at different surface locations. By collecting samples at different depths, thermal layers within the estuary can be determined. This information, in turn, can be useful for analyzing other environmental parameters.

HELPFUL HINT

Temperature can only be measured at the monitoring site. If samples are to be taken to a laboratory for analysis, temperature should first be measured in the field.

When to Sample

As with other water quality variables, temperature should be measured at the same location and time of day each time volunteers collect data.

Choosing a Sampling Method

Water temperature is measured with a thermometer or meter. Alcohol-filled thermometers are less hazardous, when broken, than mercury-filled thermometers, making them the better option. Under field conditions, using a thermometer armored in plastic or metal will minimize breakage problems.

Some meters used to measure other parameters, such as pH or dissolved oxygen, also measure temperature and can be used instead of a thermometer.

Volunteer monitors usually take a single temperature reading while they collect other water quality data at their monitoring sites. While the single reading is useful, it does not fully provide details about daily trends. Temperature data loggers, which record data at regular intervals (usually hourly), could be deployed at selected monitoring sites. These instruments are able to continuously record data for up to months at a time. The data can then be downloaded directly into a computer database. As the costs of data loggers decline, they may become attractive options for volunteer programs. ■

Thermometer Accuracy

To assure accuracy, check the thermometer against a National Institute of Standards and Technology (NIST) certified thermometer at least once a year.

Confirm the thermometer's accuracy in several samples of water of varying temperatures. Your county health department or the state department of environmental protection may lend an NIST thermometer to the program for these important periodic checks.

Reminder!

To ensure consistently high quality data, appropriate quality control measures are necessary. See "Quality Control and Assessment" in Chapter 5 for details.

How to Monitor Temperature

General procedures for measuring temperature are presented in this section for guidance only. **Monitors should consult with the instructions that come with their sampling and analyzing instruments. Those who are interested in submitting data to water quality agencies should also consult with the agencies to determine acceptable equipment, methods, quality control measures, and data quality objectives (see Chapter 5).**

Before proceeding to the monitoring site and collecting samples, volunteers should review the topics addressed in Chapter 7. It is critical to confirm the monitoring site, date, and time; have the necessary monitoring equipment and personal gear; and understand all safety considerations. Once at the monitoring site, volunteers should record general site observations, as discussed in Chapter 7.

STEP 1: *Check equipment.*

Check to make sure that no separation has occurred in the thermometer liquid before each use.

If you are using a thermometer and not measuring directly in the water, bring a large (at least 2-gallon) clear container that can hold the sample. This will facilitate thermometer reading.

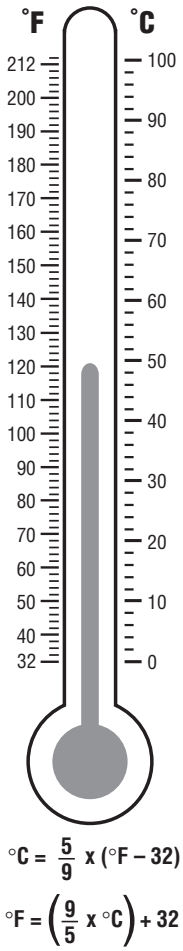

Figure 13-1. Temperature conversion scale.

STEP 2: *Measure air temperature.*

Chapter 7 specifies air temperature as one of the general observations that should be made at each monitoring site. Air temperature can be measured with the same thermometer or meter used for reading water temperature. Prior to measuring water temperature, allow the thermometer or meter to equalize with the ambient or surrounding air temperature for three to five minutes. Make sure the thermometer is out of direct sunlight to avoid a false high reading. **Record the air temperature on the data sheet before measuring the water temperature.**

STEP 3: *Measure water temperature.*

The following section describes two procedures to measure water temperature. If measuring temperature in shallow water or at the surface, follow Procedure A. If measuring temperature from a collected water sample, follow Procedure B.

Procedure A—Measuring temperature directly in shallow water or at the water surface:

- Place the thermometer or meter probe in the water at least 4 inches below the surface or halfway to the bottom (if in very shallow water).
- If using a thermometer, wait until it reaches a stable temperature (3-5 minutes). If using a meter, allow it to reach a stable reading.
- If possible, read the temperature with the thermometer bulb beneath the water surface. Otherwise, quickly remove the thermometer and read the temperature.
- Record the temperature on the field data sheet, using the scale (°C or °F) required by the program (Figure 13-1).
- If the meter probe has a long cable, you may measure temperature at different depths.

Procedure B—Measuring temperature from a collected water sample:

- Make sure the sample holds at least two gallons so that the water remains unaffected by the temperature of the thermometer and the air. The volunteer can use this same sample for many other typical water quality monitoring tests.
- Quickly immerse the thermometer or meter in the water sample.
- If using a thermometer, wait until it reaches a stable temperature (3-5 minutes). If using a meter, allow it to reach a stable reading.
- If possible, read the temperature with the thermometer bulb beneath the water surface. Otherwise, quickly remove the thermometer and read the temperature.
- Record the temperature on the field data sheet, using the scale (°C or °F) required by the program (Figure 13-1).

STEP 4: *Clean up and send off data.*

Thoroughly clean all equipment for proper storage.

Make sure the data sheets are complete and accurate. Volunteers should make a copy of the completed data sheets before turning them in to the laboratory, program manager, or designated drop-off point. ■

References and Further Reading

American Public Health Association (APHA), American Water Works Association, and Water Environment Federation. 1998. *Standard Methods for the Examination of Water and Wastewater.* 20th ed. L. S. Clesceri, A. E. Greenberg, A. D. Eaton (eds). Washington, DC.

Campbell, G., and S. Wildberger. 1992. *The Monitor's Handbook.* LaMotte Company, Chestertown, MD. 71 pp.

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