5. Water Quality

Purpose

Aquatic organisms such as fish and macroinvertebrates have varying tolerances to dissolved oxygen, temperature, conductivity, salinity, and pollution. Measuring water quality parameters at a barrier removal site offers insight regarding the quality of habitat available and the species that can be supported at that site. Conductivity data can show evidence of pollution and groundwater sources of surface water. Salinity, when measured at an intertidal barrier, may be used predict the aquatic species as well as vegetation that may colonize an area after the barrier is removed.

This section describes how to measure temperature, dissolved oxygen (DO), conductivity, and salinity at a barrier removal site. We recommend that the user monitor these parameters at least once per week for eight weeks during August and September (see Sampling Frequency below for further discussion). Monitoring should be done as close to dawn as possible. This monitoring design will allow the user to describe how a barrier is impacting water quality at a site and how conditions change with barrier removal. This design is intended as a minimum, and the user may choose to conduct more monitoring to answer questions specific to a particular barrier removal project.

Minimum Equipment

- ❑ Pencils
- ❑ Clipboard
- ❑ Multi-parameter probe
- ❑ Equipment calibration solutions
- ❑ Data sheets (see Appendix E)
- ❑ Bucket (if necessary)
- ❑ Watch
- ❑ Air thermometer
- ❑ Chest waders
- ❑ Boat

Equipment Considerations

Water temperature, conductivity, and salinity are most commonly measured using electrometric equipment. Temperature, conductivity, and salinity probes and meters are available from a number of vendors. Conductivity is often reported in terms of specific conductance (i.e., conductivity results that have been adjusted to what it would be at 25°C). Most conductivity probes have a feature that can automatically convert conductivity readings at any temperature to specific conductance values. Probes and meters are available that measure all three of those parameters—temperature,

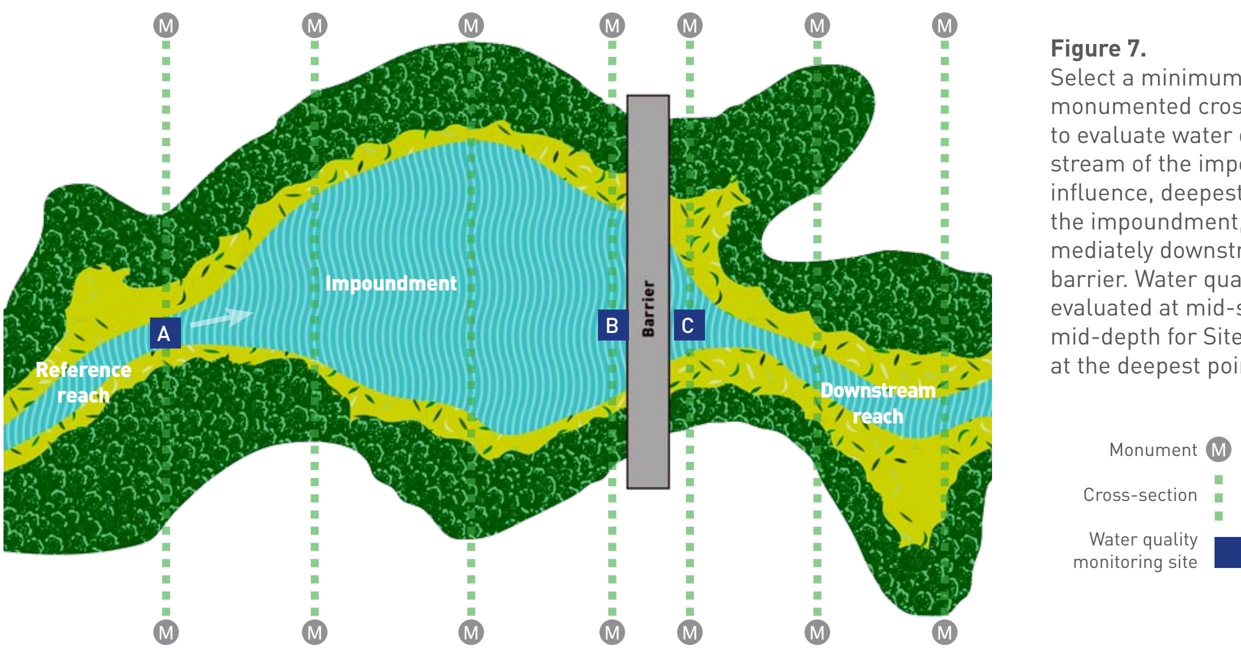

Figure 7.
Select a minimum of three monumented cross-sections to evaluate water quality: upstream of the impoundment influence, deepest point within the impoundment, and immediately downstream of the barrier. Water quality should be evaluated at mid-stream and mid-depth for Sites A and C and at the deepest point for Site B.

conductivity, and salinity—plus dissolved oxygen (DO) (see below). Calibration, use, and maintenance will vary among equipment and between manufacturers. Careful treatment and regular equipment maintenance are essential for accurate data collection. Salinity need only be measured if barrier removal is occurring in an intertidal area and the removal is expected to restore tidal flow. If it is necessary to collect data along a vertical profile, be sure to purchase or secure the use of a probe with a long cord so that the data can be collected at the appropriate depth.

Two methods are commonly used for measuring dissolved oxygen: the Winkler method and the electrometric method. Each requires different equipment. The choice of method depends on the desired accuracy, convenience, staff training level, and available equipment. In general, the Winkler method is held to be more precise and accurate than a meter and probe. However, the results can be influenced in the field by such factors as nitrite, organic matter, iron, and the capabilities of the person collecting the data. A comparison of the two methods is beyond the scope of this document; refer to sources such as Standard Methods for the Treatment of Water and Wastewater (APHA, 2006) and the National Environmental Methods Index (www.nemi.gov) for detailed information about both methods.

The Winkler method is a titration procedure based on the oxidizing property of dissolved oxygen (USEPA, 1983). Samples analyzed with the Winkler method can be analyzed on site or fixed (stabilized), refrigerated, and analyzed in the lab up to six hours after collection. Several vendors sell kits that include the necessary equipment, chemicals, and detailed instructions for analyzing water samples. The user must read Material Safety Data Sheets (MSDS) for all chemicals and take safety precautions.

The electrometric method relies on the diffusion of oxygen across a membrane located in a probe-based sensor. Measurements must be taken either in the stream or impoundment itself or immediately after collection in a bucket. DO instruments are available from a number of commercial vendors. The instructions for calibration, use, and maintenance may differ from instrument to instrument and among manufacturers. Therefore, the user is encouraged to read the instructions carefully and follow them closely. DO probes in particular are extremely sensitive. Careful treatment and equipment maintenance are essential for accurate data collection. The U.S. Geological Survey offers a thorough discussion of dissolved oxygen equipment calibration in its National Field Manual for the Collection of Water-Quality Data (Wilde, 2005). Note that if DO is being measured in a saline environment, a correction factor must be applied after the data are collected.

Monitoring Design

This monitoring design is based on the cross-section design described in section IV.B.1. The sampling design will describe water quality conditions upstream of the zone of influence of the barrier, just upstream of the barrier, and downstream of the barrier. These data will reveal how the barrier is affecting water quality before barrier removal. After the barrier is removed, returning to the previously monitored sites will show how barrier removal has affected water quality at the site.

Sampling Protocol

1. Identify three water quality data collection sites.
Site A should be upstream of the area influenced by the barrier, preferably along the furthest upstream cross-section (Figure 7). Water-quality data should be collected mid-stream and at mid-depth.

Site B should be along a cross-section that traverses the deepest part of the impoundment, and water-quality data should be collected at the deepest point. If there is no impoundment, Site B should be located along the cross-section immediately upstream of the barrier.

Site C should be located along the cross-section just downstream of the barrier. Water-quality data should be collected mid-stream and at mid-depth (Figure 7).

2. Document location of each water-quality monitoring site so user may return to sites in the future.
Describe the location of each monitoring site in relation to the cross-sections and in relation to any permanent markers or landmarks at the site, making sure to note cross-section number. Document with GPS the location of each monitoring site. Compile this information so that it can be accessed as necessary.

3. Prepare for field data collection.
Review the instruction manuals for each meter and probe being used. Make sure that probes are undamaged and are functioning properly. Inspect electrical connections and batteries. Install new batteries if necessary. Test calibration. Collect and inventory field equipment. If the Winkler titration method is being used, review the method, and make sure that the reagents have not expired. Before handling chemicals, check Material

Safety Data Sheets (MSDS) for safety precautions.

4. On the day of field data collection, calibrate the meters, being sure to follow the manufacturer's instructions. Record all calibration data. Bring calibration solutions into the field in case recalibration is necessary.

5. Collect water quality data.
Data must be collected early in the morning, preferably close to daybreak, in order to capture the lowest dissolved oxygen readings of the diurnal cycle. The USGS National Field Manual for the Collection of Water-Quality Data (Wilde, 2005) has an excellent discussion of surface-water sampling. All data should be collected in situ. Record the time of each water-quality measurement.

Sites A and C: Collect dissolved oxygen, temperature, and specific conductance data mid-stream at mid-depth. Follow manufacturer's instructions for meters and probes. For the Winkler titration method, it will be necessary to collect a water sample in a labeled "Biological Oxygen Demand" bottle.

Site B: If this site is located in an impoundment, collect a water-quality vertical profile. Collect dissolved oxygen, temperature, and conductivity information just below the surface of the impoundment and then at foot-intervals below the surface until the probe is located just above the bottom of the impoundment.

Step 6. Maintain equipment.
After the field visit, clean equipment and conduct any necessary maintenance.

Sampling Frequency
All data should be collected weekly for eight weeks during August and September. Data should be collected early in the morning, as close to dawn as possible. This is necessary in order to collect information on dissolved oxygen when it is at its lowest point in the diurnal cycle.

Macroinvertebrate data will complement the water-quality data. If macroinvertebrate data are not being collected, however, then water-quality data should be collected weekly from June through October or through continuous monitoring. Data should be collected at least one year prior to barrier removal at a minimum, immediately after barrier removal, and annually thereafter for five years. Additional water-quality monitoring prior to barrier removal projects is preferred.

Table 5. Recommended precision and accuracy levels for water quality data.

Parameter	Precision	Accuracy
Dissolved oxygen	+/- 2% or 0.2 mg/L, whichever is greater	+/- 2% of initial calibration saturation or 0.2 mg/L, whichever is greater
Conductivity	+/- 5%	+/- 5% against a standard solution
Temperature	+/- 0.2° C	+/- 0.2° C (checked against a NIST-certified thermometer)

Site-specific Considerations
If the barrier is located in an intertidal area, salinity should be added to the monitoring protocols at all sites before and after barrier removal. Refer to Lane and Fay (1997) for guidance on safety procedures (e.g., sample collection safety, wading in streams, boating safety, chemical handling).

Analysis and Calculations
We recommend precision and accuracy levels for the data collected rather than specific pieces of equipment. Water-quality equipment varies widely in its precision and accuracy. State and provincial governments may prefer different types of equipment, and project budgets may vary. The user is encouraged to use equipment available through project partners or that fits their budget, as long as the data meet the recommended precision and accuracy guidelines (Table 5). QA/QC samples should be collected at a frequency of 1 in 10, or 10%.