Protocols for Using the Hanna Dissolved Oxygen and Specific Conductance/pH Meters in Rivers, Streams, and Freshwater Wetlands

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May 2004
DEPLW0636

Bureau of Land and Water Quality
Division of Environmental Assessment
Biomonitoring Program

Standard Operating Procedure
Protocols for Using Hanna Dissolved Oxygen and
Specific Conductance/Temperature/pH Meters

1. Applicability. This standard operating procedure (SOP) is used by the Biomonitoring Program to collect from wadeable rivers, streams and freshwater wetlands in Maine the following data:

A. Dissolved oxygen (DO; mg/L) using the Hanna digital, hand-held meter models HI 9142 and HI 9143. Model HI 9143 also measures temperature (°Celsius) but this feature is not used by the biomonitoring unit.

B. Specific conductance (SPC; µS/cm) and temperature (°C; °Celsius) using the Hanna digital, hand-held meter models HI 9635 and HI 991300. Hanna meter HI 991300 also measures pH. Both models also measure total dissolved solids (TDS; ppm) but this feature is not used by the biomonitoring unit.

2. Purpose. This procedure is used to determine instantaneous levels of DO, or of SPC and °C (and pH), in wadeable rivers, streams, and freshwater wetlands using the Hanna DO or SPC/°C/(pH) meters.

3. Definitions

A. Hanna. Manufacturer of DO and SPC/TDS/°C/(pH) meters used by staff of the Biomonitoring Program of the Maine Department of Environmental Protection (MDEP).

B. Probe. Sensing device located at the end of a cable that is attached to the meter.

C. Calibration. Set of procedures established by the manufacturer to ensure that the meter is operating properly; a critical quality assurance step in meter preparation prior to use.

4. Responsibilities

A. Training. It is the responsibility of the team leader to ensure that the individual(s) collecting the DO or SPC/°C/(pH) data have received training in using the Hanna DO or SPC/°C/(pH) meter (see item 5.D.2, below).

B. Data recording. It is the responsibility of the individual collecting the data to record the results and additional qualifying information on standard field sheets obtained from the MDEP Biomonitoring program.

C. Data submission. It is the responsibility of the team leader or the staff member collecting the data to place completed field sheets in the appropriate field sheet folder located in the Biomonitoring staff area.

5. Guidelines and Procedures

A. Sampling Period. In the majority of cases, data will be collected concurrently with the sampling of macroinvertebrates or algae.

B. Dissolved oxygen meter and SPC/°C/(pH) meter preparation. Follow manufacturer's instructions for preparing meter for first use.

C. Data collection

(1) DO meters

(a) For meter type HI 9142, a calibration to a zero DO level must be carried out once at the beginning of the field season, or anytime the probe is replaced, following the manufacturer's instructions. The zero DO solution for calibration purposes can be made by saturating tap water with sodium sulfite.

(b) Both meter types are water resistant. It is recommended however that the meter units themselves be kept in a clear plastic bag (allowing continued use of the meter) if measurements are taken in heavy rain.

(c) DO meters must be calibrated to O_2 air saturation according to the manufacturer's instructions each time they are turned on.

(i) Turn on the meter, and allow it to warm up for at least 10 minutes.

(ii) Take the protective cap off of the DO probe and inspect the membrane to make sure it is intact and that there is no bubble underneath it. If a problem is found, consult instruction manual for corrective action.

(iii) Press and hold the CAL button and allow the numbers to stabilize.

(iv) The meter should read 100. If not, remove the screw cap adjacent to probe cord connector and use a small screw driver to adjust the screw farthest from the connector until the meter reads 100. Stop pressing the CAL button and replace the screw cap. DO NOT ADJUST THE SCREW CLOSEST TO THE CONNECTOR.

(v) If the meter does not calibrate or if it is very slow, the batteries may be running low, the probe may not have enough electrolyte solution, or the membrane may need to be replaced. FRESH BATTERIES ARE VERY IMPORTANT FOR PROPER OPERATION.

(d) Following calibration, immerse the probe in a representative section of the waterbody, making sure that the probe is suspended above the substrate. For rivers and streams, chose sampling location near, and slightly upstream of, location of biomonitoring sampling units.

(e) A water movement of 30 cm/sec is required for accurate DO measurements. If water at the measuring location is slow-flowing, the probe needs to be manually agitated (moved up and down in water column).

(f) Wait until DO reading has stabilized (usually 3 to 5 minutes), read value in ppm, and note on field sheet. Also note on field sheet the meter number as shown on protective case and the back of the meter, and indicate on field sheet if meter was calibrated successfully or not.

(g) Remove probe from waterbody and turn meter off by pressing the 'On/Off' key. Check that the probe is clean, rinse with tap water if it is not or if stream has high conductivity, replace cap, dry meter with towel if it got wet while taking measurements, and return to protective case.

(h) Allow the case and contents to air-dry at the end of each day. This may be accomplished be simply propping the lid open. When contents are very wet, remove the contents and spread out to facilitate drying.

(2) SPC/°C/(pH) meters

(a) Both meter types (HI 9635 and HI 991300) are waterproof and no precautions against water damage are required.

(b) Order for calibrating and taking readings –

Calibration 1. SPC (first time used each day) 2. pH (every time meter is turned on) NOTE: meter will turn off after 10-15 minutes, so plan to calibrate on location rather than at the truck.
Measurement Order 1. pH 2. SPC (units will be displayed as µS)

(c) Inspect probe tip for damage before carrying out SPC calibration according to the manufacturer's instructions. Meter type HI 991300 requires only a 1-point calibration (1413 µS/cm) while type HI 9635 requires a 2-point calibration (84 and 1413 µS/cm). Indicate that a meter was calibrated on the respective field sheet. Temperature calibration is performed during annual maintenance. Calibration for pH is explained below under (j).

(d) During calibration process, dry off probes before transferring them from one calibration solution to another in order to prevent cross contamination.

(e) In the field, remove protective cap and turn meter on by pressing the 'On/Off' key.

(f) Immerse the probe in a representative section of the waterbody, making sure that the probe is suspended above the substrate. For rivers and streams,

chose sampling location near, and slightly upstream of, location of biomonitoring sampling units.

(g) SPC/°C/(pH) meters do not require a certain water velocity for proper functioning.

(h) Start with temperature reading. Wait until the reading has stabilized, i.e. the probe has reached thermal equilibrium, before taking reading; note that in hot weather this may take >10 min. Note temperature in °C on field sheet. Also note on field sheet the meter number as shown on protective case and the back of the meter.

(i) Wait until SPC reading has stabilized (clock icon will disappear), read value in μS/cm, and note on field sheet.

(j) When collecting pH data using Hanna meter HI 991300, the meter must be calibrated each time it is turned on by doing the following.

  (i) Take protective cap off, and follow the manufacturer's instructions for calibration. Before moving from buffer pH 7 to pH 4, dry plastic parts of probe with lint-free towel (so as not to contaminate next buffer). Buffers can be re-used for approximately one week during the field season as long as no contamination occurs (i.e., probe is dried between buffers). Buffers do not need to be kept cold.

  (ii) If the meter is very slow or does not calibrate, try using new batteries even if the meter displays that the battery level is not very low. FRESH BATTERIES ARE IMPORTANT FOR PROPER OPERATION.

  (iii) If the meter blinks 0.00, the probe is not communicating properly with the meter. Try reconnecting the probe or inserting new batteries. If blinking continues something is broken. When you can, switch the probe with a meter that does work to find out if it is the probe or the meter that is broken. Replace the probe if necessary.

  (iv) Once calibrated, immerse probe in stream and take reading as specified in sections 5.C.2.d-h, above.
  For convenience, the pH calibration should be performed before SPC and temperature measurements are taken.

(k) Remove probe from water body and turn off by pressing the 'On/Off' key. Check that the probe is clean; if it is not, or if sample location had high conductivity, rinse probe well with tap water. Replace cap, dry meter with towel if it got wet while taking measurements, and return to protective case.

(l) At the end of the day, put a little pH 7 buffer solution in the cap to help prevent the probe tip from drying out. DO NOT USE DISTILLED WATER.

(m) Allow the case and contents to air-dry at end of each day. This may be accomplished by simply propping the lid open. When contents are very wet, remove the contents and spread out to facilitate drying.

D. Quality Control
   (1) All DO and SPC/°C/(pH) meters used by the MDEP biomonitoring unit are inspected and calibrated by unit staff once at the start of each sampling season (May or June) and again mid-way through the sampling season. Details relating to the work performed must be recorded in the Quality Control Log Book kept in the offices of the MDEP biomonitoring staff.
   (2) At the beginning of each field season, all MDEP staff and field personnel who will use the meters covered under this SOP will have a training/refresher session to (re)familiarize themselves with the contents of this SOP and the particulars of all meters.
   (3) Meters are also calibrated daily during the field season as detailed in section 5. C. (1) and (2), above.

6. Equipment Care

A. Start of field season
   (1) Follow manufacturer's directions for preparation of a new probe. If continuing use of existing meter, arrange for regular maintenance (see section 5.D.1, above).
   (2) Use new batteries at the start of each sampling season. See manufacturer's instructions for correct battery replacement procedures.

B. During field season.
   (1) The following items must be available (in a tackle box or loose) for dealing with minor problems in the field:
      (a) Extra "O" rings for protective cap on DO meter.
      (b) Replacement caps, and whirlpack bags as stand-by replacement caps.
      (c) An extra set of appropriate size batteries.
      (d) Screw driver for removing back of meter to replace batteries.
      (e) Small screw driver to adjust calibration screws on DO meter HI 9142.
      (f) Clear plastic bags for keeping DO meters dry in heavy rain.

   (2) Other supplies that must be brought to the field:
      (a) Towel for drying meters if they got wet.
      (b) For calibration purposes: conductivity calibration solutions, pH buffers, and tap water in squirt bottle at ambient temperature, lint-free towel.

C. End of field season
   (1) Completely dry meter and case and all items in the case before storing.
   (2) Remove batteries.
   (3) Keep meter dry and at room temperature to prevent corrosion of electronic parts.
   (4) Label the meter and case as 'WINTERIZED, (date)' in an obvious manner so users will know the current status of the unit.

7. Specifications:

	DO meter		SPC/TDS/°C meter	
	HI 9142	HI 9143	HI 9635	HI 991300
Meter Detection Limit	DO: 0.0 mg/L		SPC: 0.0 µS/cm	
			Temperature: 0.0 °C	
			-	pH: 0.00
Report limit (resolution)	DO: 0.1 mg/L	DO: 0.01 mg/L	SPC: 0.1, 1.0, 10, 100 µS/cm[1]	SPC: 1.0 µS/cm
			Temperature:0.1 °C	
			-	pH: 0.01
Accuracy	DO: 0.3 mg/L		SPC: 3.0, 30, 300, 4000 µS/cm	
			Temperature: 0.5 °C	
			-	pH: 0.01

8. References. Instruction manuals for Hanna DO meter models HI 9142 and HI 9143, and SPC/°C /(pH) meter models HI 9635 and HI 991300.

[1] Report limits and accuracy for SPC are for the following ranges: 0.0-150, 150-1,500, 1,500-15,000, and 15,000-199,900 µS/cm.

Addendum - List of edits to existing SOP

SOP section	Old text	New text
Edited in June 2006		
5. Guidelines and Procedures, subsection C.(2) (h)	… Also note on field sheet the meter number as shown on protective case.	… Also note on field sheet the meter number as shown on protective case and the back of the meter.
Edited in November 2006		
1. Applicability, subsection B.	Specific conductance (SPC; µS/cm), total dissolved solids (TDS; ppm), and temperature (°C; °Celsius), using the Hanna digital, hand-held DO meters models HI 9635 and HI 991300. Hanna meter HI 991300 also measures pH.	Specific conductance (SPC; µS/cm) and temperature (°C; °Celsius) using the Hanna digital, hand-held DO meters models HI 9635 and HI 991300. Hanna meter HI 991300 also measures pH. Both model also measure total dissolved solids (TDS; ppm) but this feature is not used by the biomonitoring unit. ***Note that all subsequent references to (measurements of) TDS have been removed from the SOP.***
5. Guidelines and Procedures, A. Sampling Period	In the majority of cases, data will be collected concurrently with the sampling of macroinvertebrates (in rock bags or baskets for rivers and streams, or using a D-frame net or stovepipe sampler for wetlands) or periphyton (on periphytometer or natural substratum) during the summer low flow period.	In the majority of cases, data will be collected concurrently with the sampling of macroinvertebrates or algae.
5. Guidelines and Procedures, C. Data collection, subsection (1) (g)	… Check that the meter is clean, rinse with clean water if it is not or if stream has high conductivity, …	… Check that the probe is clean, rinse with tap water if it is not or if stream has high conductivity, …
5. Guidelines and Procedures, C. Data collection, subsection (2) (c)	Carry out SPC calibration according to the manufacturer's instructions. Meter type HI 991300 requires only a 1-point calibration (1413 µS/cm) while type HI 9635 requires a 2-point calibration (84 and 1413 µS/cm). Once meter type HI 991300 has been calibrated, check accuracy with calibration solution 84 µS/cm. Indicate that a meter was calibrated by noting the calibration date in the respective field meter log book. …	Inspect probe tip for damage before carrying out SPC calibration according to the manufacturer's instructions. Meter type HI 991300 requires only a 1-point calibration (1413 µS/cm) while type HI 9635 requires a 2-point calibration (84 and 1413 µS/cm). Indicate that a meter was calibrated on the respective field sheet. …

SOP section	Old text	New text
5. Guidelines and Procedures, C. Data collection, subsection (2) (k)	… Check that the probe is clean; if it is not, or if sample location had high conductivity, rinse probe well with distilled water. Probe with pH meter (HI 991300) must NOT be stored with distilled water on it; instead dry off distilled water and immerse probe in pH 7 buffer again. Replace cap, …	… Check that the probe is clean; if it is not, or if sample location had high conductivity, rinse probe well with tap water. Replace cap, …
5. Guidelines and Procedures, D. Quality Control, subsection (1)	All DO and SPC/TDS/°C/(pH) meters used by the MDEP biomonitoring unit are inspected, calibrated, and, where necessary, repaired, by a technician of Q.C. Services in Harrison, ME, once at the start of each sampling season (May). Details relating to the work performed by Q.C. Services must be recorded in the Quality Control Log Book kept in the offices of the MDEP biomonitoring staff.)	All DO and SPC/°C/(pH) meters used by the MDEP biomonitoring unit are inspected and calibrated by unit staff once at the start of each sampling season (May or June) and again mid-way through the sampling season. Details relating to the work performed must be recorded in the Quality Control Log Book kept in the offices of the MDEP biomonitoring staff.
5. Guidelines and Procedures, D. Quality Control, subsection (3)	One duplicate measurement per 10 locations must be taken for each parameter for quality control purposes. Duplicate measurements must be recorded on the appropriate field sheet as a second value separated from the first value by a '/' and marked with a 'D' for duplicate.	Meters are also calibrated daily during the field season as detailed in section 5. C. (1) and (2), above
6. Equipment Care, B. During field season, subsection (2) (b)	For calibration purposes: conductivity calibration solutions, pH buffers, and distilled water in squirt bottle (store bought is sufficient) at ambient temperature, lint-free towel.	For calibration purposes: conductivity calibration solutions, pH buffers, and tap water in squirt bottle at ambient temperature, lint-free towel.