Water Quality Monitoring Protocol Manual For Maine Atlantic Salmon Rivers

A Guide For Regulatory, Research, and Volunteer Water Quality Monitoring on Atlantic Salmon Rivers in Maine

May 2004

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Prepared
for the
Project SHARE
Research and Management Committee

Prepared
by
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by
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Preface

This document was created for the Project SHARE Research and Management Committee between May 2003 and 2004. The project was funded by the National Fish and Wildlife Foundation. The goal of the manual is to provide guidance to the many volunteers, researchers, and agency personnel who collect water quality information on Maine's Atlantic salmon rivers. This information has been extremely useful in making decisions regarding restoration actions on the rivers.

This manual contains a set of protocols from a variety of sources: government agencies, conservation organizations, the University of Maine, and several instrument manufacturers. The purpose of this document is to consolidate the different protocols in an effort to ensure consistency and quality assurance. Having standard protocols assures the quality of the data and controls the conditions under which the data is collected.

Credits

This set of protocols was compiled with guidance from Mark Whiting, Maine Department of Environmental Protection, Melissa Halsted, Kennebec County Soil and Water Conservation District, Stacey Gambrel, Sheepscot Valley Conservation Association, Richard Dill, Maine Atlantic Salmon Commission, Jim Hawkes, NOAA Fisheries, and Ken Johnson, University of Maine Senator George Mitchell Center.

Special thanks goes to Kleinschmidt Associates for technical assistance in formatting this document.

Water Quality Monitoring Protocol Manual
For Maine Atlantic Salmon Rivers

Table of Contents

CHAPTER ONE
INTRODUCTION

1

In 1997, the Maine Atlantic Salmon Task Force developed the Atlantic Salmon Conservation Plan which established a framework for the protection of salmon and its habitat in 7 Maine rivers. In November 2000, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service listed eight populations of Atlantic salmon, (identified as the Gulf of Maine Distinct Population Segment or DPS), as endangered under the Endangered Species Act. The rivers comprising the DPS include: the Sheepscot, Ducktrap, Narraguagus, Pleasant, Machias, East Machias, and Dennys Rivers and Cove Brook.

In an attempt to address the concerns cited in the Conservation Plan and the Listing, several government agencies, research institutions, and conservation organizations have begun collecting water quality information and data. To date, the following entities have collected water quality data on Atlantic Salmon rivers in Maine:

- Maine Atlantic Salmon Commission
- National Oceanographic and Atmospheric Agency Fisheries Division
- Maine Department of Environmental Protection
- Eight Watershed Councils
- Sheepscot Valley Conservation Association
- Wellspring Land Alliance
- University of Maine
- U.S. Geologic Survey
- U.S. Fish and Wildlife
- Kennebec County Soil and Water Conservation District

Although water quality monitoring has been conducted on Maine rivers for several decades, there has been no previous need to establish universal protocols or to coordinate monitoring activities and data. The Listing, however, has established a clear and immediate need to document and standardize protocols and to coordinate activities among the various agencies. This document is a guide to the accepted protocols currently used in the Atlantic salmon rivers in the state of Maine.

While most of the protocols listed in this document are approved by MDEP/EPA, the document does not include background information or many protocol details. The reader is encouraged to refer to the following references for more detailed information including how to plan a study, when and where to sample, what kinds of samples to take, how to interpret the results, and how to write reports:

- EPA Volunteer Stream Monitoring: A Methods Manual, EPA, 1997
- Adopt-A-Stream Foundation Streamkeeper's Field Guide

CHAPTER TWO
TEMPERATURE

2

2.1 Mercury Thermometer Reading

Mercury Thermometer

(From Maine Department of Environmental Protection, 2003)

Measurement

1. Place the thermometer in the water at least 4 inches below the surface or halfway to the bottom if you are sampling in a shallow stream. Temperature should be measured away from the streambank in the main current, if possible.
2. Leave thermometer in water for at least three to five minutes to allow enough time for it to reach a stable temperature, making sure not to handle the thermometer bulb.
3. Read the thermometer while the bulb is below the surface of the water.
4. Wait one minute, with the thermometer bulb still below the surface of the water, and read the temperature again. If your temperature reading is the same, record the temperature on your field data sheet. If not, repeat the entire procedure until both your first and second reading are the same.
5. Record the temperature on your field data sheet, to the nearest 0.5 degrees C, ex. 10.5˚C.

CHAPTER TWO
TEMPERATURE

2.2 Digital Thermometer

Portable Waterproof Microprocessor K-Type Thermocouple Thermometer

(From Hanna Instruments)

Remove the instrument from the packing material and examine it carefully to make sure that no damage has occurred during shipping. If there is any noticeable damage, notify your Dealer or the nearest Hanna Office.

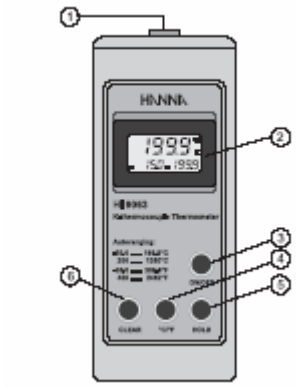
Note: Save all packing materials until you are sure that the instrument functions correctly. Any defective item must be returned in the original packaging together with the supplied accessories.

SPECIFICATIONS

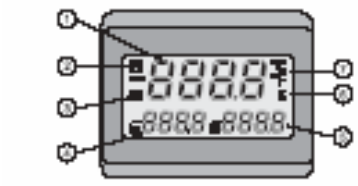
Range (*)	-50.0 to 199.9°C / 200 to 1350°C -58.0 to 399.9°F / 400 to 2462°F
Resolution	0.1°C (up to 199.9°C) / 1°C (outside) 0.1°F (up to 399.9°F) / 1°F (outside)
Accuracy (@20°C/68°F)	±0.2% F.S. excluding probe error
Typical EMC Deviation	±3°C (with HI 766 probes) ±6°F (with HI 766 probes)
Display	Dual-Line LCD
Battery Type Life	4 x 1.5V AA (IEC LR6) approx. 2000 hours of continuous use
Probe	K-type thermocouple (see "Accessories")
Environment	-10 to 50°C (14 to 122°F); RH 100%
Dimensions	196 x 80 x 60 mm (7.7x3.1x2.4")
Weight	425 g (15 oz.) meter only

(*) Range may be limited by probe.

Functional Description



1. Temperature probe connector
2. Liquid Crystal Display
3. ON/OFF Key
4. Measuring unit selection key
5. HOLD measurement key
6. HI/LO values reset key



1. Current temperature value
2. HOLD indicator
3. Low Battery indicator
4. Minimum temperature value
5. Maximum temperature value
6. K-type probe indicator
7. Measuring scale, °C or °F

General Description

HI 9063 is a waterproof, microprocessor-based, K-type thermocouple thermometer, which provides very accurate measurements in a wide range of temperatures. The meter is also provided with low battery detection and BEPS (Battery Error Preventing System), which turns the unit off when the batteries are discharged avoiding erroneous readings caused by low battery level.

HI 9063 features include auto ranging capability, dual-level LCD for simultaneously displaying of maximum and minimum measured temperatures, °C/°F selection button and hold function. Each meter is supplied complete with 4 x 1.5V AA batteries and instruction manual.

Factory Recalibration

All Hanna Instruments thermometers have been accurately pre-calibrated at the factory. It is generally recommended to have all thermometers recalibrated at least once a year. For an accurate annual recalibration, contact your nearest Hanna Service Center.

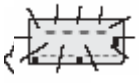
Warranty

All Hanna Instruments meters are warranted for two years against defects in workmanship and materials when used for their intended purpose and maintained according to instructions. Sensors and probes are warranted for a period of six months. This warranty is limited to repair or replacement free of charge. Damages due to accidents, misuse, tampering or lack of prescribed maintenance are not covered.
If service is required, contact the dealer from whom you purchased the instrument. If under warranty, report the model number, date of purchase, serial number and the nature of the failure. First obtain a Returned Goods Authorization number from the Customer Service department, then return the instrument with the Authorization # included along with shipment costs prepaid. If the repair is not covered by the warranty, you will be notified of the charges. When shipping any instrument, make sure it is properly packaged for complete protection.

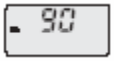
Operational Guide

Initial Preparation

Each meter is supplied complete with batteries. Remove the back cover, unwrap the batteries and install them while paying attention to their polarity. Connect a K-type thermocouple probe to the meter.



To switch on, press the ON/OFF key on the front of the meter. If the meter does not come on, make sure that the batteries are correctly installed. The thermometer will carry out a self diagnostic test routine, the LCD will show all segments for a few seconds (or as long as ON/OFF is held), followed by the percentage indication of the remaining battery life. The thermometer then enters normal measurement mode. If a temperature probe is plugged in, the meter displays the measured temperature. If no probe is plugged in, or if reading is over-range, the display shows flashing dashes. If a measurement is slightly over the range

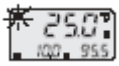


of the meter specifications, the display flashes the closest full-scale value. To switch the thermometer OFF, press the ON/OFF key.

Measuring Scale

The instrument is factory set to the °C scale, but measurements can be performed in either the Celsius or Fahrenheit scale. Press the °C/°F button to select the desired scale.

Hold Mode



The HOLD function is activated by pressing the HOLD key. The measured temperature is held on the display until HOLD is pressed again. The "H" tag blinks on the display to indicate the HOLD mode. Note: Although the display is frozen, internally the meter continues measuring and updating Hi and Lo values.

High Low Temperatures

The maximum and minimum temperatures are continuously monitored and displayed in the lower portion of the LCD.

Note: When reading goes over-range, the Hi and Lo values display dashes until cleared.

Clear Function

Upon pressing the CLEAR key, the current reading is assigned to the highest and lowest temperature values. The High/Low values may be cleared at any time during measurement.

Battery Replacement

The instrument is powered by four 1.5 V alkaline batteries and is provided with the Battery Error Prevention System (BEPS), which turns the unit off when a low battery signal is detected. When the remaining battery level is less than 10%, a warning symbol blinks on the display to indicate a low battery condition. It is recommended to replace the batteries as soon as the low battery condition is detected. Battery replacement must only take place in a nonhazardous area using four 1.5V alkaline batteries. In order to replace rundown batteries, simply remove the two screws on the rear cover of the instrument and replace the four batteries with new ones paying attention to the correct polarity. Reattach the cover and tighten the two screws.

CHAPTER TWO
TEMPERATURE

2.3 Optic Stowaway Loggers

Optic Stowaway Temperature Logger

(*From Maine Department of Environmental Protection, 2003*)

Materials

Optic Stowaway Temperature Logger
Cable Ties (to anchor logger in deployment location)
Rebar (to anchor logger in deployment location)
Optic Stowaway Temperature Logger Tracking Sheet and clipboard
Waders (if necessary)

Precautions and Limitations

1. The Optic Stowaway Temperature Logger is suitable for measurements in the range of 23°F to 99°F. (–5 to 35°C). This is a good range for aquatic deployments but not for land or air measurements.
2. Use other loggers for deployments in other conditions.

Pre-deployment

Perform the following quick test for accuracy on the Optic Stowaway Logger to be deployed if it has not been done within a month previous of deployment.

1. Place crushed ice (preferably made from distilled water), in an insulated container that is large enough to hold the loggers that you are testing. It is important to crush the ice to maintain as consistent and uniformed a temperature as possible.
2. Fill the container with distilled water to just below the level of the ice and stir the mixture around.
3. Submerge the loggers that you are testing and place the entire container in a refrigerator to minimize temperature gradients.
4. Allow enough time for the logger to acclimate. The ice will melt slowly, so the actual temperature should settle around 0°C if the ice bath was prepared correctly.
5. Note the indication on the logger. If the indication is 0°C ± .23°C, the check is completed satisfactorily. If the indication falls outside this range, repeat the check. If the check fails a second time, contact Onset Computers for troubleshooting instructions.
   a. Connect the Optic Base Station to a host computer that has the BoxCar software installed using the appropriate interface cable. Slide the Optic Stowaway Temperature Logger into the Optic Coupler on the Optic Base Station.
   b. Run the BoxCar software program and use IAW reference B.

c. Launch the logger using either the software or the optional triggered launch. To launch in the field via the triggered launch option, you must choose the triggered launch option in the software and then use a strong magnet near the "O" in Onset on the logger. There is also a magnet in the Optic Coupler to trigger the logger if desired.

Deployment

1. Determine a suitable site for deployment in line with the project's objectives and the instrument's temperature range (23°F – 99°F).
2. Secure the logger to the deployment location by driving a metal rod (such as rebar) into the bed of the stream. Attach the logger to the rod with the sensor end down using cable ties. Another method may be used to secure the logger to the deployment location if desired.
3. Flag or mark the area of deployment to aide in retrieval of the logger at a later date. It may also be beneficial to record GPS coordinates of the location if available.
4. Log the time, serial number, location, and any other information necessary for retrieval in the future.

Recovery

1. Recover the logger from the field utilizing logs, flagging, marking, or GPS coordinates as necessary.
2. Note the LEDs on the logger to determine if the logger has recorded out of range conditions. The green LED blinks during use when it has not recorded out of range conditions. If it has recorded out of range conditions, the RED LED will blink. If the logger is full, neither LED will blink.
3. Recover the data by connecting it to a host computer via the Optic Base Station, or by connecting it to the Optic Shuttle in the field and adhering to the BoxCar software or shuttle instructions as applicable.

Care and Maintenance

1. After use, clean the logger using only a non-abrasive mild soap and warm water with a non-scratching sponge or cloth. Any scratches on the logger's surface may impair communication. If necessary a plastic polish may be used for tougher cleaning jobs.
2. Be sure to keep the logger free from dirt and dust when not in use.

References

Optic Stowaway Temp User's Manual, Onset Computer Corporation, Bourne, MA

BoxCar Pro User's Manual, Onset Computer Corporation, Bourne, MA

CHAPTER TWO
TEMPERATURE

2.4 Temperature Logger Protocol

Temperature Loggers

(Modified f*rom Maine Atlantic Salmon Commission, Maine Atlantic Salmon Rivers Temperature Monitoring Procedures Manual, 2003*)

Pre-Deployment Procedures

Selecting Monitoring Equipment (Loggers)

The recent availability of inexpensive, user-friendly digital temperature loggers and powerful desktop computers and software has greatly simplified temperature data collection and assimilation. It is important to select a logger type with a measurement and accuracy resolution appropriated for the purposes of the study, which also fits into each study budget. One data logger manufacturer, Onset Computer Corporation, is leading the way with new and dependable data logger technology. They offer small, affordable loggers for around $100-$200 which read in the range of –5 to +37 ^{o}C and are accurate to +/- 0.2 ^{o}C (Table 1).

The software used for launching the loggers and retrieving data, BoxCar 3.5 and 4.0 (also produced by Onset but purchased separately), is user friendly, produces graphs of temperature data and allows for easy exporting of data to Microsoft Excel and Lotus 123 software packages. Suppliers of temperature data loggers are listed in Table 1.

Table 1. Name, phone number, and web site address of common temperature data logger manufacturers and/or distributors.

Manufacturer	Phone Number	Web Site Address
Onset Computer Corporation	(800) 564-4377	www.onsetcomp.com
Forestry Suppliers, Inc.	(800) 647-5368	www.forestry-suppliers.com
Ben Meadows Company	(800) 241-6401	www.benmeadows.com
Ryan Instruments	(425) 852-3047	www.ryaninst.com

Logger Accuracy-Check

To maintain data quality, all new loggers should be accuracy-checked prior to deployment in the field. Older loggers should be taken out of the field and checked periodically (annually if possible) as they may begin to drift when battery life begins to get low. There are 2 acceptable methods to accuracy-checking data loggers used by the ASC.

The most precise accuracy-check is performed by comparing the readings of each data logger in both a cold and ambient temperature water bath against the readings taken with a thermometer certified by the National Institute of Standards and Technology (NIST) accurate to +/- 0.2^{o}C (see Appendix A for Accuracy Check standard operating procedure). Loggers certified as accurate under this method (+/-0.7^{o}C) will be considered able to produce high quality data. Refer to Appendix B for an example of a logger accuracy-check form.

NIST certified thermometers are a major expense; therefore, a second method used to accuracy-check data loggers is to simultaneously launch multiple loggers recording temperature at the same interval. An average of all the logger temperatures can be calculated for each recording interval. A logger is considered accurate if it reads within +/-0.7^{o}C of the average of all the loggers. Loggers deemed accurate using this method might have data flagged as lesser in quality.

Loggers reading outside the acceptable range (+/-0.7^{o}C) should have batteries changed, be sent back to the manufacturer for replacement or repairs, or discarded (units with non-replaceable batteries). It should be noted that occasionally even a newly purchased logger will not function properly right from the factory, thus reinforcing the need for routine logger accuracy checks.

Deployment Procedures

Site Selection

Site selection for data loggers should be based upon the objectives of the study at stream locations that can provide useful, representative data. There are three basic levels of consideration: (1) the sample location is chosen to represent temperature at the *site level;* (2) multiple sites provide information at the *reach level;* and (3) multiple reaches within a drainage provide information at the *watershed level.*

Site Level.

1. Data loggers should be deployed at sites representative of the stream.
2. Site should be somewhat turbulent and providing mixing such as riffles, runs, or cascades.
3. Toward the deepest part of the channel (thalweg) and likely to provide flow throughout the summer and early fall months.
4. Not directly exposed to sun.
5. Not directly affected by groundwater or tributary input.

Choosing the reach.

A reach can be described as a section of a river or stream with relatively homogeneous characteristics including gradient, valley form, discharge, vegetation, and substrate or soils. Some studies might concentrate on true distinct river reaches, while others might be targeting a subreach, for instance a particular type of land use or discharge source. In either case in order to characterize a reach loggers need to be placed upstream and downstream within the reach or directly adjacent to the reach.

Choosing reaches within a drainage can be very scientific or very subjective, based upon objectives, experience, and resources. In an ideal world we would place our loggers just inside the exact boundaries of a reach, however this type of precision rarely exists. With some knowledge about a particular drainage, educated guesses can be made as to river reach breaks. At the very least, initial stages of monitoring can be done with a shotgun type approach with loggers being spread throughout the drainage.

(3) Watershed level.
Data loggers placed properly along multiple reaches within a drainage can describe variations in stream temperature throughout the drainage. Sites monitored continuously over several years can help to take noise out of data sets and paint the true picture of what is going on with regards to water temperatures throughout the drainage.

Launch Logger

Launch loggers according to the manufacturer's directions. The BoxCar software provides a "Description" dialog box as part of the launching sequence which allows the user to enter pertinent deployment information such as the river and site the logger is destined for (e.g. Narraguagus – Route 9). If the exact location of deployment has not been determined for each logger before it leaves the office, then be sure to write down the serial number of each logger on its corresponding Field Deployment Form (Appendix D) as it is deployed. The loggers should be programmed according to the specific objectives of the study (e.g., 60 minute intervals). Loggers should be programmed to record water temperatures in degrees Celsius. If degrees Celsius are not an option for a particular logger, Fahrenheit to Celsius conversions ($^oC = [(Temperature\ ^oF - 32)/1.8]$) can be made as part of the data editing process. If the logger has a delayed start function be sure to note what the delayed start time and date is on the Field Deployment Form.

DO NOT choose "Wrap Around Data" in ADVANCED OPTIONS as this will result in overwriting existing data if a logger should not be recovered before the memory is full. If you have an option for "Multiple Sampling", choose "Off" unless you are looking for specific kinds of data – it drains battery life faster. Make sure your computer time is accurate as well as the timepiece you use in the field. It is a good idea to synchronize them. In addition to the data above, record the serial number, destined deployment location, date launched, interval and duration of temperature sampling, ownership of logger, battery status, and comments on an ASC logger Field Deployment Sheet, or deployment sheet of your own design.

Finally, certain data logger models are not waterproof and require a watertight housing. Before placing the data logger in the housing be sure to lightly lubricate any O-rings of the housing with silicone to ensure a watertight seal. Place several desiccant packs inside the housing along with your pertinent contact information should the logger be found.

Protective Housing and Anchor Devices

Data loggers such as Onset Stowaways and Tidbits with exposed thermocouples likely to come in contact with the river bottom can be secured inside of a piece PVC pipe. A 4"-

6” piece of gray 1½”-2” diameter PVC pipe with adequate holes (predrilled or precut) to allow for securing points and normal stream flow around the data logger works well. First secure the logger inside of the PVC pipe, and then secure the pipe to the anchor. Standard white PVC pipe that is painted with camouflaging colors will also work.

Anchors should be relatively small in size (less than 1 foot square) and a color that is somewhat consistent with the substrate of the river bottom to reduce visibility. The type of anchor used will probably depend on the type of data logger to be deployed and the best available way of securing the data logger to the anchor.

Heavy-duty zip ties, which can be purchased at most hardware or home improvement stores, work well for securing data loggers to anchors. At least 2 should be used at each securing point. Heavy braided nylon line also works well, but is susceptible to knots coming undone when subjected to extended exposure to river current. Coated airplane wire with proper synching/clamping devices is another option if available. A combination of different securing devices works well for guarding against potential loss.

Loggers should be attached to their anchor in a way that reduces the likelihood of the logger’s sampling surface (thermocouple) to be in contact with anything but river water. Materials that ASC has used for anchors include concrete blocks, bricks with prefabricated holes, heavy metal piping, and mushroom anchors. Anything that is sturdy, heavy, nonpolluting, and inexpensive which allows the data logger to be securely attached in a way that does not impede function and is somewhat camouflaged will work.

Data loggers can also be secured to permanent structures such as dock and bridge buttresses, weirs, and dams. In this instance be sure that the logger will be well down in the water column, in the shade and not likely to be in the way of debris moving downstream that could cause damage.

Logger Placement

Often data loggers are deployed early in the field season during times of high spring flows, therefore it is highly recommended that field crews consist of at least 2 people equipped with personal floatation devices (PFDs) and proper footwear/boots. At the river edge turn on the GPS (note Map Datum GPS is working in, preferably NAD 83) and allow it to warm up and stabilize for at least 3 minutes after acquisition of satellites. GPS points should be taken at the exact stream location of the logger, conditions permitting. If conditions are too extreme for inflow recording, take a GPS reading at the closest point of land and record this on the field form. While waiting for the GPS to warm up, begin recording pertinent information available at that time on the field form.

Move out into the river looking for a deep, well mixed, shaded spot unlikely to be exposed even during the driest year. Try to pick a spot represented by a permanent landmark unlikely to be mistaken-for at retrieval time. The backside of a large boulder, a distinctly colored boulder, or alignment with an onshore object such as a large tree or a rock works well. Place the anchor with the logger attached to it in the river such that it is unlikely to be seen easily from shore and unlikely to be affected by change in stream flow conditions. Small rocks (smaller than the size of a football) can be used to conceal

loggers and to help hold them in place. Record on the deployment field form the exact time that the logger was placed, the stream temperature at that time, the GPS coordinates either from that location or the closest point of land, permanent landmarks to be used for retrieval, and sketch the site.

In addition, photos (especially digital) can be used for documenting logger placement. Landmarks are easily recognized at a later date and one can literally stand in the same spot the photo was taken from and instantly pick out the placement site. Photos can be stapled to the field sheet to aid in midseason site checks and end of season logger retrieval.

Midseason Site Check

Each data logger site should be visited at least once during the sampling season. Agency staff can work this into normal fieldwork as it occurs in the area. Watershed groups and volunteers should schedule a site check with a 2-3 week window dependent on weather as part of its overall sampling plan. A section on the original field sheet is provided for a Midseason Site Check. Remember to bring a copy of the original deployment field form with attached photo (if applicable), a thermometer, and a GPS. Water temperature, time, and condition of the site/logger should be noted. If the logger must be moved at the time of the Midseason Check (e.g. low water conditions), or if a logger is missing or has been moved from its original deployment location, notes should be taken on the back of the field form with all pertinent information included (new landmarks, new GPS points, site sketch, site conditions, explanation). Project or team leaders should be notified ASAP about problems at any of the sites.

Logger Retrieval

Loggers should be retrieved at the end of the sampling season taking into account typical onset of local fall and winter seasonal conditions. Loggers at sites prone to autumn high water or site access problems should be retrieved as early as needed to guard against loss of equipment and data. Be sure to bring along a copy of the original field sheet with attached photo (if applicable), a thermometer, a GPS and any other gear that might be needed for retrieval (e.g. canoe, life jackets, paddles, pick pole). Fill out all information requested on the field sheet. Once a logger has been retrieved, it should be returned ASAP to the Agency, Project Leader, or the person responsible for data retrieval from the logger.

References

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CHAPTER TWO
TEMPERATURE

2.5 YSI Temperature Loggers

YSI Temperature Logger

(*From NOAA Marine Fisheries Service and YSI)*

Required Field Equipment

1. Either laptop with DC/AC inverter or YSI 610-DM or YSI 650 datalogger.
2. Cable to connect sonde to computer (serial # 006067-10) or 610 (serial # 5116/D 088) or 650 (serial # 006191-25-CE)
3. Towel
4. Clipboard
5. ½", 9/16" wrench and an adjustable wrench.
6. pH meter and pH buffers (pH 4.00 and 7.00)
7. Conductivity meter and standard (either 72 uS/cm or 1413 uS/cm)
8. Thermometer
9. Something to write on and pencil only
10. YSI maintenance kit (DO membranes, etc)
11. At least 8 brand new AA batteries for each YSI – you never know when you will get bad batteries.

Determining drift of calibrated electrodes

1. You must first determine how the sonde is reading the various standards to determine correction factors for the data. It is easiest to do this using the "**Run**" feature in the Main Menu (either using a laptop and the EcoWatch software or a YSI 610-DM or 650 datalogger) – you should do this after uploading the data but BEFORE calibrating. Select "**Discrete sample**" and then "**enter**". The sonde is now taking measurements, but not logging them. Simply place a buffer into the cap, close and wait for the readings to equilibrate. This may take 3-4 minutes. It is important to have the standards at about the temperature of the river water (or the temperature you expect the river to be until you check the sonde in a few weeks). You must thoroughly rinse the standards from the probes and cap before using a new standard.
2. See the YSI datasheet

If using a LAPTOP to upload and calibrate

1. Remove sonde from protective PVC case using the keys and the wrenches.
2. Remove protective cap at top of sonde. Attach field cable to sonde.
3. If field cable is already attached to sonde (as is for depth readings), simply connect the field cable to the computer.

4. Connect the 9 pin end of the cable into the computer.
5. Start up the computer (you can do #2,3, and 4 in any order if you like)
6. Open **EcoWatch**…..select **Comm**…then **Sonde**.
7. If you are connected, you will see the "**#**" prompt. Type "**Menu**"
8. To get the data off the sonde, select number 3 (File), then select upload.
9. You will see all of the files on the sonde. Select the appropriate one.
10. **Definitely select "comma delimited" for save as file type!!!!!!!!!**

Determine the pH, conductivity and Dissolved oxygen drift first (see above).

Calibrating the Sonde.

1. Select "**calibrate**" from the main menu
2. Select "**pH**"……..select "**2 point**"…….type in the pH of the buffer you will calibrate first, MAKE SURE that you have put that buffer into the cap and that the pH probe is fully submersed in the buffer…..Hit the "**Enter**" key….**see notes on pH!**
3. The sonde asks you to hit "Enter" when the reading is stable. Do just that!
4. Now follow the instructions for the next pH buffer.
5. Conductivity……..select "**SpCond**"….type in the conductivity of the standard…….AGAIN, make sure the standard is in the cap and the conductivity probe is fully submersed in it! Follow the instructions and you are soon done.

Deploying the Sonde

1. Select…"**Run**" from the Main Menu…."**Unattended sample**"…and select "**stop logging**" and then "**yes**".
2. Select "**file**" and type in the new filename (8 characters of fewer). Make sure the time is set correctly and that the start, end and intervals are correct. Select "**start logging**".
3. Always check the battery and memory lives. You should have a buffer of 30+ days for battery. If not, change the batteries. You will not need to re-calibrate nor re-deploy after changing the batteries, but it is a good idea to make sure the deployment info is still correct.

Using the YSI 610-DM field logger

To upload data

1. Remove sonde from protective PVC case using the keys to the lock and the wrenches.
2. Dry the entire area around the protective cap. Remove protective cap at top of sonde. Attach field cable to sonde **OR…simply attach 610-DM to field cable that is already attached to the YSI meter**
3. The 610 may already be in 'run' mode…**press 'exit'…..select …**then **communications**.
4. Select **Kermit 610←sonde**.
5. Select **upload**, then the file you wish to upload
6. **Definitely select "comma delimited" for save as file type**

To calibrate

1. Select "**calibrate**" from the main menu
2. Select "**pH**"……..select "2 point"…….type in the pH of the buffer you will calibrate first, MAKE SURE that you have put that buffer into the cap and that the pH probe is fully submersed in the buffer…..Hit the "**Enter**" key….**see notes on pH!**
3. The sonde asks you to hit "**Enter**" when the reading is stable. Do just that!
4. Now follow the instructions for the next pH buffer.
5. Conductivity……..select "**SpCond**"….type in the conductivity of the standard…….AGAIN, make sure the standard is in the cap and the conductivity probe is fully submersed in it! You should completely fill the cap with conductivity standard. Follow the instructions and you are soon done. You can also use the river water as a standard…..first, determine the conductivity (or SpCond) using a separate conductivity meter. Use this value as the standard value and make sure you use river water in the cap when calibrating to this value.

<u>To create a new file and deploy sonde</u>

1. Select…"**deploy sonde**"….skip the "**calibrate**" mode and select "**stop logging**" and then "**yes**".
2. Select…"**Run**"…."**Unattended sample**"
3. Select "**file**" and type in the new filename (8 characters of fewer). Make sure the time is set correctly and that the start, end and intervals are correct. Select "**start logging**".
4. Always check the battery and memory lives. You should have a buffer of 30+ days for battery. If not, change the batteries. You will not need to re-calibrate nor re-deploy after changing the batteries, but it is a good idea to make sure the deployment info is still correct.

<u>Using the YSI 650 field logger</u>

To upload data

1. Remove sonde from protective PVC case using the combination lock (4449) and the wrenches.
2. **OR…simply attach 650 to field cable that is already attached to the YSI meter**
3. Place the calibration cup (filled ~1/3 with pH7 or pH4 buffer) over the electrodes – keep the electrodes wet or moist (don't let them dry out). Dry the entire area around the protective cap (the small cap, not that around the electrodes). Unscrew protective cap at top of sonde. Attach field cable to sonde – screw it on snugly by hand only
4. On 650, select **Sonde Menu.**
5. Select **File**.
6. Select **Upload data**.
7. Select the file you wish to upload
8. Select **Proceed** and the file will begin uploading…it will take about 2 minutes/month of data.
9. Definitely select **comma delimited** for save as file type

To determine drift of values:

1. Use the **ESC** button to return to the Main Menu for the sonde.
2. Select **Sonde Menu** from the YSI 650 main menu (you may be there already).
3. Select **Run** from Main menu when connected to the sonde.
4. Select **Discrete sample**
5. Select **Start sampling.**
6. Wait for the pH value to become stable and record both this value and the pH mV value into the YSI datasheet. Note: the mV should be +30 to –30 for pH 7 buffer and about +170 more for pH 4 buffer. (e.g., if pH 7 buffer is –20mV, the pH 4 buffer should be about +150mV).
7. Press **ESC** to stop running. Discard the pH buffer (not into the river), rinse the calibration cup and electrodes thoroughly with river water and fill the calibration cup with the other pH buffer.
8. Repeat steps 5 - 7.

To calibrate

1. Press **ESC** to return to the sonde **Main** menu. Select **Calibrate** from the **Sonde Menu**
2. Select **pH**……..select **2 point**. Type in the pH of the buffer you will calibrate first (pH is temperature sensitive – type the pH value that the buffer should be at the calibration temperature). MAKE SURE that you have put that buffer into the cap and that the pH probe is fully submersed in the buffer. Select **Enter**
3. Select **Enter** when the reading is stable.
4. Repeat steps 2 and 3 with the other pH buffer.
5. Press **ESC** to back up to the calibration menu.
6. Thoroughly rinse the electrodes and calibration cup with river water (or deionized water) and then with the conductivity standard!!!!
7. Select **Conductivity**……..select **SpCond**….type in the conductivity of the standard…….AGAIN, make sure the standard is in the cap and the conductivity probe is **fully submersed** in it! You should completely fill the cap with conductivity standard. Follow the instructions and you are soon done. You can also use the river water as a standard…..first, determine the conductivity (or SpCond) using a separate conductivity meter. Use this value as the standard value and make sure you use river water in the cap when calibrating to this value. If you measure Conductivity, calibrate the sonde to Cond (not SpCond).
8. To calibrate Dissolved Oxygen – select **DO**…**%**. Enter the barometric pressure indicated on the bottom right of the 650 screen (the 650 may already have it in the enter field). The meter takes 40 seconds to equilibrate. When the readings are stable, press the **ENTER** key – The meter may calibrate automatically without pressing the **ENTER** key.

<u>To create a new file and deploy sonde</u>

1. Select **Run**….**Unattended sample.** Select **Stop logging** at the bottom of the menu. Select **Yes**.
2. Select **file** and type in the new filename (8 characters of fewer). Make sure the time is set correctly and that the start, end and intervals are correct.

3. Check the battery power of the sonde batteries. Select **Sonde Menu**, **Run**, **Unattended sample**, and then scroll down to check the **battery volts** and **Logging days remaining**. Also, check the **free memory remaining** and remove files from the sonde to free up some memory if needed. Record these data into the YSI datasheet
4. Select **start logging** at the bottom of the menu. Select **yes**
5. From the menu entitled, '**650 main menu'**, remove the **check mark** from **Power sonde** (this is 3 rows down). Use **ESC** to back up to the **650 Main menu**.
6. Always check the battery and memory life. You should have a buffer of 30+ days for battery. If not, change the batteries. You will not need to re-calibrate nor re-deploy after changing the batteries, but it is a good idea to make sure the deployment info is still correct
7. Place the screw cap back onto the top end of the sonde (if the cable is not permanently attached to the sonde). Place the sonde back into the protective PVC tube. Put the chain through the wire on the sonde AND around the bolt that goes through the PVC – this is done to take pressure off the YSI wire (which is pretty cheap!). Tighten the nuts a little more than hand-tight – too tight in cold weather may crack the PVC.

Notes on pH

1. **pH measurements are temperature sensitive**. Therefore, you MUST ALWAYS calibrate the meter at a temperature as close to the expected river temp as possible. If the temp will fluctuate widely during deployment, try to use an intermediate calibration temperature. Refer to the pH of the pH calibration solutions for the calibration temperature (e.g., pH 7 buffer is really pH 7.13 @ 25°C).
2. **ALWAYS rinse the probes between buffers. This means rinsing the entire probe chamber – including the conductivity sensor – and the cap. Any buffer left over can change the pH of the next buffer.**
3. pH is not perfect! The sonde will most likely not be in perfect calibration 1 week after deployment. Therefore, it is essential that another device is used to check the pH upon retrieval and deployment. If one is not available, you can use the sonde's pH measurement after it is recalibrated – but you won't see this data until you retrieve it again.
4. The sonde needs time for the pH readings to be accurate after calibration. The pH buffers are very high in conductance and the pH probe must equilibrate before the readings are accurate. This is usually 1-2 hours in my experience, but the manual says 15 minutes.
5. See also… HORIBA : The story of pH : index

Notes on Conductivity

1. Conductivity is a measure of the total charged ions in solution. The sonde measures the resistance between two metal probes over a 1cm distance. Because conductivity is affected by temperature, this value is unique at every temperature. Specific conductance is the same value but normalized at 25°C. For example, if the conductivity is 20uS/cm at 10°C, it will be around 35uS/cm at 25°C.

2. See for more info on conductance.
   http://global.horiba.com/story_e/conductivity/index.htm

Solution preparation

Conductivity:

1. These solutions will have the specific conductance specified. That is, it is the conductance normalized for 25C and 760 torr (mmHg) atmospheric pressure. If you choose 'SpCond' when calibrating, you need to enter these exact values for the standard.

   For freshwater analysis in Maine:

uS/cm	g KCl / L
1413	0.746
70.65	0.0373

For seawater analysis:

mS/cm (notice the units)	g KCl / L
12.86	7.44

pH standards:

1. Purchase commercially available standards

   From Fisher:

Product #	**Description**
SB107-4	pH 7.00 buffer solution
SB101-4	pH 4.00 buffer solution

Troubleshooting with YSI

1. Contact YSI at the above link http://www.ysi.com and go to the environmental home. I did not include the exact link here as the links may change in the future. Surfing the site in a logical manner should get you to the required info. If all else fails, call technical support. They are very willing to help. Phone #s for YSI Technical support are: (937)767-7241 I often talk to David who is a master of water quality and the YSI meters. Or (800) 897-4151 - they can connect you with tech support and possibly David.

Data uploading.

1. Upload the data to the computer using EcoWatch software.
2. Open Ecowatch, Select **Comm, Sonde** from the drop down at the top, Select the appropriate Com port and hit **Enter**
3. On the YSI 650 logger, Select **File, Upload to PC,** then select the file**.**
4. The uploading should start right away. If not, do step 3, and then step 2.
5. Turn off the YSI 650.

Data auditing:

1. Open **Excel**, open the uploaded file (it is a .dat file) - make sure you change the **Files of type** at the bottom of the Open window to **All files**.
2. It will be in the default directory C:/Ecowwin/data
3. Select **Delimited, Next**, **Comma delimited,** click on the **Date format** button to make it in MDY format**,** click **OK**
4. Save the File with the appropriate JOIN ID-like name. (e.g., NG-LF-YSI-20010531-20010619) The Date is in yyyymmdd-yyyymmdd format and indicates the dates that are included in the file…..i.e., the dates that the YSI meter was logging data.
5. Copy and Paste the data into the appropriate file that contains all YSI data collected at that site.

Data 'correction'

1. I first remove the first and last rows of each file's data when I copy it into the site data file.
2. Enter all field datasheet information into the site calibration and deployment file. There is a separate worksheet for each type of data (pH, etc). Each worksheet has the same 1st four columns: Date, Time, Upload filename, Person tending, Serial #.
3. Close this file.
4. Open the Site data Excel file (e.g., Chemistry – Little Falls)
5. To 'correct' the pH data, you must determine the amount of drift that has occurred since the last calibration. Look at the **Raw pH column** for the last and the current uploaded data. The 2nd pH datum point should be the correct pH value because it is the first pH value after the sonde was calibrated and equilibrated in the river (equilibration usually takes about 15 minutes or so after being placed back into the river).
6. Simply apply the appropriate correction factor into the **Correction factor** column and copy the formula in the **Corrected pH** column down to the end of the last (not the current) uploaded data. This means that you can only correct the pH data from the last data file – you cannot correct the pH data from the current file until you have uploaded the pH data that is being logged on the YSI at that very moment (i.e., there is a lag between the correct data and the file you just uploaded to the computer).

YSI Datasheet

Date: Upload Filename:
River: New Filename:
Site: **Battery Volts:**
Sonde model and serial #: **Logging days remaining:**

Standard	Sonde read @ ____°C	Calibration OK?	Comments	Person tending
pH 7 with mV in ()				
pH 4 with mV in ()				
Conductivity (__uS/cm)				
Dissolved O_2 (100%)				

River	Reading	Meter used	Person tending
Temp			
pH			
Conductance (uS/cm)..or.. Specific conductance			
DO (%) or (mg/L)			

Comments:

Date: Upload Filename:
River: New Filename:
Site: **Battery Volts:**
Sonde model and serial #: **Logging days remaining:**

Standard	Sonde read @ ____°C	Calibration OK?	Comments	Person tending
pH 7 with mV in ()				
pH 4 with mV in ()				
Conductivity (__uS/cm)				
Dissolved O_2 (100%)				

River	Reading	Meter used	Person

			tending
Temp			
pH			
Conductance (uS/cm)..or.. Specific conductance			
DO (%) or (mg/L)			

Comments:_____

CHAPTER THREE
DISSOLVED OXYGEN PROTOCOL

3

3.1 Dissolved Oxygen Kit (Winkler Titration)

Dissolved Oxygen Chemical Kits

(Modified from Lamotte Water Quality Test Kit Instruction Manual)

Collecting the Sample

1. Rinse the water-sampling bottle with sample water, tightly cap the bottle, and submerge it to the desired depth.
2. With bottle still under water, remove the cap and allow the bottle to fill
3. Tap the sides of the bottle to dislodge air bubbles and replace the cap while the bottle is still submerged.
4. Retrieve the bottle and make sure that no air bubbles are trapped inside.

Adding Reagents

NOTE: Be careful not to introduce air into the sample while adding the reagents.

1. Remove the cap from the bottle and immediately add 8 drops of manganous sulfate solution and 8 drops of alkaline potassium iodide azide.
2. Cap the bottle and mix by inverting several times. A precipitate will form.
3. Allow the precipitate to settle below the shoulder of the bottle.
4. Remix thoroughly. Allow precipitate to settle well below neck of the bottle again.
5. After the precipitate has settled, add 8 drops of sulfuric acid, 1:1.
6. Cap and gently invert the bottle to mix the contents until the precipitate and the reagent have totally dissolved. The solution will be clear yellow to orange if the sample contains dissolved oxygen.

NOTE: At this point the sample has been "fixed" and contact between the sample and the atmosphere will not affect the test result. Samples may be held at this point and titrated later.

Wait a minimum of 15 minutes after fixing the sample before proceeding with titration.

Titration

1. Fill the titration tube to the 20 mL line with the fixed sample. Cap the tube.
2. Depress the plunger of the titrator and insert it into the plug in the top of the sodium thiosulfate titrating solution.
3. Invert the bottle and slowly withdraw the plunger until the bottom of the plunger is opposite the zero mark on the scale. **NOTE:** If small air bubbles appear in the

titrator barrel, expel them by partially filling the barrel and pumping the titration solution back into the reagent container. Repeat until bubble disappears.

4. Turn the bottle upright and remove the titrator. **NOTE:** If the sample is very pale yellow, go to step 9.
5. Insert the tip of the titrator into the opening of the titration tube cap.
6. Slowly depress the plunger to dispense the titrating solution until the yellow-brown color changes to a very pale yellow. Gently swirl the tube during the titration to mix the contents.
7. Carefully remove the titrator and cap. Do not disturb the titrator plunger.
8. Add 8 drops of starch indicator solution. The sample should turn blue.
9. Cap the titration tube. Insert the tip of the titrator into the opening of the titration tube cap.
10. Continue titrating, drop by drop, until the blue color disappears and the solution becomes colorless.
11. Record the test result where the titrator tip meets the scale. Record as "ppm dissolved oxygen." Each minor division on the titrator scale equals 0.2 ppm.

Disposal and Maintenance

1. Do not return un-used reagents to their bottle. It will result in contamination of the chemicals and results will be unreliable.
2. Discard used reagents and sample on land at least 10 feet from water, or dispose of in a wastewater treatment system.
3. Rinse used bottles and syringe and let dry.
4. Note that reagents have an expiration date. They must be replaced each year.

CHAPTER THREE
DISSOLVED OXYGEN

3.2 Dissolved Oxygen Meter

Dissolved Oxygen and Temperature
Instantaneous Measurement using Electronic Meters

(*From MDEP River Assessment Program, Augusta, ME 2002*)

Preparation

1. Follow manufacturer's instructions for preparing D.O. meter for use.
2. The probe cable should be marked in one-meter increments. If using tape to do this, the tape should be periodically checked to assure the tape has not moved or some of the marks are missing.
3. Each meter should be equipped with a dissolved oxygen saturation table to assure proper meter calibration. Tables should be photocopied from the latest addition of Standard Methods.
4. Each meter should be equipped with the following items so that field repairs can be undertaken as necessary:
   - Extra KCl fluid and membranes for probe.
   - Extra " O " rings for probe.
   - Field record book/card for recording QA and repairs.
   - Scissors for trimming membrane.
   - Screw driver for removing back of meter to replace batteries.
   - Pencil with eraser.
5. The meter should be kept as dry as possible. Ideally, the meter should be in water-resistant case with closed-cell padding to protect it from damage. Each meter should be equipped with a transparent plastic bag that should be used during rain events. The meter can still be operated within the plastic bag.
6. The meter should be turned on before leaving and traveling to the sampling location. If you forget to turn the meter on, keep in mind that the meter should be on for a minimum of 20 minutes before a reliable calibration can be achieved. If practical, also check meter probe (# see 7) at this time.
7. Remove probe from the calibration chamber and make sure the sponge is damp. If sponge is dry, wet the sponge and squeeze out excess water. Check the membrane for air bubbles and wrinkles. If bubbles or wrinkles are present, remove membrane, refill with KCl solution, and replace membrane (see Instruction Manual). Check to make sure no drops of water are clinging to the membrane and remove if present.
8. The meter should be checked for accuracy initially at the beginning of the sampling season and periodically throughout the summer. Temperature should be compared to a calibrated thermometer, and dissolved oxygen to a Winkler

titration or two other reliable meters. It is especially important to check meters in the lab prior to a large sampling event (i.e. three-day-intensive survey).

9. Replace meter batteries as necessary. Most meters are equipped with a low battery indicator that allows up to 50 hours of additional run time after low battery power is indicated.

Calibration

1. Make sure that all steps necessary for meter preparation are employed.
2. Meter calibration is a necessary step that must be undertaken in all sampling to assure that dissolved oxygen readings are accurate.
3. If possible, the calibration should be undertaken at locations with stable environmental conditions, i.e. air temperature similar to water temperature. A shady area or indoor environment are ideal for this, but not always possible. In situations where the air temperature is more $5^{o}C$ greater than the water temperature, the probe calibration chamber can be placed in ambient water, being careful not to wet probe in this process. The probe can be wetted prior to calibration to hasten the cooling process.
4. If a barometer is available, use appropriate barometric pressure in the calibration process. If a barometer is not used, assume the appropriate level of oxygen for that temperature at 1 atmosphere (sea level or 760 mm. Hg).
5. Calibrate the meter assigned to your sampling team according to manufacturer instructions (YSI Instruction Manual). The saturated air method is used to calibrate all DEP electronic dissolved oxygen meters. Make sure there are no water droplets on probe membrane. The sponge in the calibration chamber should be damp, but not overly wet. (If sponge is too wet or dry, calibration won't be accurate.)
6. Recheck the calibration to assure temperature and dissolved oxygen readings have remained steady. If readings are not steady re-calibrate meter.
7. Crosscheck meters with other sampling teams. Re-calibrate if your meter does not agree well with other meters.
8. Calibration should be rechecked at the first sampling location and as necessary thereafter (usually every second or third sampling location). Each meter calibration check should be recorded on field sheet by entering the time of day and meter adjustment (= 0 if no adjustment). In situations when stable environmental conditions cannot be obtained, it is recommended to not calibrate in-between stations, but instead rely on calibrations before and after the sampling run, i.e. meter cross checks.

Measurement

1. Meter calibration and proper meter preparation should be undertaken prior to measurement.
2. The calibration chamber should be removed just prior to submerging into the water for measurement and replaced after probe is removed from the water after measurement is completed.

3. After a meter has been turned on for use on a particular day, it should be left on until all sampling is completed for that given day.
4. Other relevant information such as weather, samplers, meter #, and time of day at each location should be recorded on the sampling sheet in addition to the dissolved oxygen and temperature readings.
5. A desirable location for sampling along the width of a given transect is that location with the most current in shallow depth situations, or the most depth in quiescent situations. Eddies should be avoided as sampling locations.
6. Follow the Instruction Manual for operation of the meter for dissolved oxygen and temperature measurement. The manual explains that water movement of 1 ft/sec is needed across the probe membrane to obtain an accurate measurement of dissolved oxygen. This can be obtained by jigging of the probe and cable in a vigorous up and down motion. Jigging is not necessary if sampling in a strong current or if the meter and probe are equipped with a stirrer. (Without water movement, dissolved oxygen readings from the meter would be much lower than the actual dissolved oxygen.)
7. The probe should be submerged long enough at each measurement location until a stable reading occurs. The amount of time necessary for this will vary according to which meter is used (typically 15 seconds or slightly more).
8. If the sampling location has an overall depth of less than a meter, sampling is undertaken at mid depth. In locations exceeding a meter in depth, sampling should be undertaken in one-meter profiles starting at the water surface and ending at the last meter increment above the river bottom. In very deep situations, where it is known from prior experience that readings do not vary significantly vertically, profile increment greater than a meter (2 meters, typically) may be satisfactory.
9. If undertaking profile readings where there is significant depth, care should be employed to assure the cable is being lowered vertically and not scoping. In most situations, if sampling from a boat, anchoring of the boat is necessary to insure vertical measurement. The exception is where there are very strong currents such as tidal estuaries, where drifting is sometimes preferable to anchoring.
10. When sampling in marine waters, salinity corrections must be made to each dissolved oxygen reading. A meter with salinity compensation should be used for this. (If a meter with salinity compensation is not available, the corrections can be made after sampling is completed. This takes considerably more time.) The order for sampling parameters is as follows. Salinity readings are measured first and recorded on the sampling sheets. After recording the temperature on the field sheet, the salinity reading is then duplicated on the meter's salinity compensation knob. The dissolved oxygen reading can be recorded on the field sheet after switching the mode knob on the meter to this parameter.

Sample Location and Timing

1. Location - In river studies, the following factors determine the selection of sampling locations:
    - Maintaining adequate coverage
    - Accessibility
    - Control points (background)

- Highly impacted locations where low dissolved oxygen is expected (i.e. above dams, below significant point source inputs)
- Oxygen sources (tributaries, below dams with spillage, below waterfalls, end of long stretch of rapids)

2. Timing – Dissolved oxygen and temperature are usually taken twice per day; in the early AM to capture the lowest daily reading and in mid-afternoon to capture the highest daily reading. If data are to be used for assessing attainment status of dissolved oxygen criteria, at a minimum, the early morning data should be collected. The follow guidelines should be followed:
    - The AM data collection should begin at dawn as soon as there is enough light to safely sample. It is preferable to have all data collected before 8 AM. In some situations, this may not be possible. Data collected later than 9 AM may not be useable in attainment assessments.
    - The PM data should begin in early to mid-afternoon with the goal of trying to capture the maximum daily dissolved oxygen and temperature. It is usually not known when this occurs beforehand. As day-length shortens, the time of the maximum becomes earlier. As guideline sampling shouldn't start earlier than 1 PM and should be completed by 5 PM.

Quality Control

1. Cross-Checking of Meters - When undertaking multi team sampling efforts, meters of different sampling teams need to be cross-checked to assure consistency of data. All meters are cross-checked with water obtained in a sampling bucket before and after each sampling run. The dissolved oxygen and temperature within the bucket should be similar to ambient conditions that you will be sampling. In most studies, dissolved oxygen and temperature are taken twice a day, which requires three to four meter cross checks per day. The dissolved oxygen and temperature of all meters including the backup meters should be checked and should agree to within 0.3 ppm and 1.5^{o}C, respectively. If agreement cannot be achieved, meters should be re-calibrated and cross-checked again. Meters that can't reach agreement should be discarded until the proper repairs can be made. The following procedure should be followed
    a. Before sampling
        - Calibrate all meters
        - Undertake cross-checks of dissolved oxygen and temperature in bucket
        - Record readings and time on QA sheet
        - Re-calibrate if QA objectives (see above) are not met
        - Cross-check and record readings again
        - Use only those meters, which satisfy QA objectives
    b. After completing a sampling run
        - Do not calibrate meters prior to cross-check
        - Undertake cross-checks of dissolved oxygen and temperature in bucket
        - Record readings and time on QA sheet*
        - Calibrate if QA objectives (see above) are not met

- Cross-check and record readings again

*This information is used to help validate data

2. Meter Requirements – It is preferable for each sampling team to have a backup meter available in the field, which can be employed in the event of failure of the primary meter. In any multi-team sampling effort, a minimum of one backup meter and three total meters are needed for any sampling effort. In a single team sampling effort, at least one backup (meter or Winkler) is needed to assure proper QC.
3. Suspect Readings – Dissolved oxygen or temperature readings that look unusual or are much different from other readings should be re-checked. When doing a profile, readings could be re-checked as you are raising the probe to the water surface. In a wide river, readings should be repeated in a different location along the transect to assure the location that you chose is typical of that given transect. The backup meter should also be used to verify unusual readings.
4. Duplicate sample stations are selected randomly in river studies. Coverage rates are typically 10%. In duplicate sampling, everything is repeated as an independent event. In a profile, all dissolved oxygen and temperature readings are repeated. Agreement should be within the meter crosscheck specifications.
5. Meters should periodically be checked in the laboratory for accuracy. Following the protocols for meter preparation and care should result in minimal operational problems.
6. Data validation – The following is used as guidelines:
   A. Data Validated – Dissolved Oxygen, temperature, and salinity all meet QA objectives
   B. Data Validated with Adjustments – Parameters fall outside QA objectives but still within 10% of objectives.
      - Temperature – Determine if error is consistent (i.e. $1^{o}C$) or inconsistent (varies with temperature). Apply correction to temperature directly with the former and with a correction curve with the latter. Calibrate DO based upon corrected temperature. Temperature could be corrected after the fact but it should be noted on sample sheet if recorded temperature is corrected or uncorrected.
      - Salinity- Apply corrected salinity to dissolved oxygen meter compensation knob.
      - Dissolved oxygen – If correction results from temperature or salinity adjustments, determine the difference this makes in the saturated dissolved oxygen reading. The correction is the product of this reading and the dissolved oxygen % saturation. If the dissolved oxygen reading of a sampling team fails to comply with QA objectives at the end of the sampling run before calibration, a straight line correction is normally made to their data, using the QA check information obtained at the beginning and end of the run.
   C. Data Rejected – If any of the parameters are greater than 10% outside of QA objectives, the data for that particular parameter must be rejected. The data for the other two parameters may be acceptable, as long as any adjustments do not violate the 10% criteria.

Meter Care

1. Proper meter care is essential for accurate measurements.
2. Meters should be kept as dry as possible when being used in the field. When sampling is completed for a given day, the meter should be stored indoors in a dry place. The lid to the meter box should be opened during initial storage to facilitate drying. If very wet, remove meter and contents from storage box to facilitate drying.
3. The probe should be kept within the calibration chamber whenever it is not submerged in water for measurement to prevent excessive drying of the probe membrane.
4. Both the meter and the probe are very sensitive to shock. Avoid hitting the probe against such items as rocks, bridge abutments, the side of the boat, or the river bottom if in a cobble or rocky substrate. It is preferable to transport the meter within the cab of a truck rather than in the back of the truck where it can slide and be banged around and damaged.
5. Troubleshooting - If the meter does not calibrate or readings do not satisfy QC objectives, the following measures should be taken.
    a. Membrane – A faulty membrane is usually the problem. Change the membrane using directions in Instruction manual. The life of a membrane depends upon usage and sampling conditions, but 2 to 4 weeks is average.
    b. KCl Solution - If changing the membrane doesn't fix the problem, empty KCl solution within probe, flush out probe with distilled water, and replace with new KCl solution in addition to replacing the membrane. See Instruction Manual explaining how to replace fluid.
    c. Probe – The problem could be a faulty probe. Before replacing the probe, try swapping the probe of the faulty meter with the probe from a meter known to be in good working order. If this fixes the problem, the probe needs to be replaced. If not, then the probe is not the problem.
    d. Batteries / Corrosion – The batteries and their connections could be checked for corrosion. Replace batteries and clean any corrosion and recheck. Similarly all connections in probe and meter to cable should be checked for corrosion. Corrosion is a common problem if the meter is being used frequently in salt-water environments.
    e. Operating knobs – Corrosion here can also create problems. If you don't feel comfortable disassembling the electronic components of the knobs, send the meter out for repair.
    f. Repair – If all else fails, send the meter out to repair ASAP. Don't forget to notify others who may be using the meter, that it will be unavailable.

6. Winterizing – After you know use of the meter is completed for the field season, the following steps should be taken for long term storage.
    - Completely dry meter and case and all items in the case before storing.
    - Remove batteries.
    - Remove membrane and "O" ring.
    - Remove KCl fluid including pumping diaphragm.

- Rinse entire probe chamber with distilled water.
- Cover top of probe with membrane to keep dust and dirt out for winter.
- Keep meter dry and in a heated storage place to prevent corrosion of electronic parts.
- Record winterization date and equipment repairs in Equipment Log.
- Label the meter and case as 'WINTERIZED' in an obvious manner (so users will know the current status of the unit).
- Now is the time to send the meter for repair if there are known pending problems, rather than waiting to do this during next year's field season.

7. If you and the meter are accidentally submerged into the water, the following steps should be taken.
    - Disassemble meter cover on back and remove batteries.
    - When you are back at the office, dry the electronic components of the meter with a hair dryer.
    - If the meter is an older model with a needle indicator, the window portion should be disassembled and dried. After allowing sufficient time for the needle to dry, carefully remove any corrosion with a very soft long bristle paint brush (Warning! The needle is very sensitive and easily damaged)
    - After the meter has been allowed to dry for 24 hours or more, reassemble and conduct QA checks. If QA checks are unsatisfactory after undertaking all troubleshooting steps (see 4), send meter out for repair.

CHAPTER FOUR
WATER CHEMISTRY PROTOCOL

4

4.1 Field pH

Field Ph Using Oakton pH Pen or Meter

(*From Maine Department of Environmental Protection, 2003)*

Preparation

1. Keep pH probe moist during storage. A wet sponge inserted in the cap (use tap water) will work well for the Oakton pH tester (pen style meter). The probe of the YSI or Oakton 600 meter must be stored in its plastic storage container with pH 4 buffer or a special storage solution. For short-term storage (a few days) you can keep the probe in the hollow on the side of the meter with a sponge wetted with some tap water. Distilled water or de-ionized water may be used to rinse probes, but must never be used for storage. They cause excessive loss of filler solution and rapid aging of the probe. A probe that has dried out may be ruined and may cost up to $230 in replacement costs.
2. Rehydrate pH probe at least 20 minutes prior to use by placing it in tap water or river water. Allow buffers and samples to come to approximately the same temperature (room temperature or outdoor air temperature). Your meter will compensate for temperature *within certain limits*, but there are limits. Your meter will not work properly if you use room temperature buffers and measure near-freezing water samples.

Calibration

1. Calibrate your meter. Follow the directions that came with the meter (each model is different). Use a 2 point calibration (it is more accurate than a one point calibration). Use two buffers that are likely to bracket the pH of your sample. Use pH 4 and 7 buffers on the Downeast rivers. You may use 4 and 7, or 7 and 10 on the Sheepscot, St George, Ducktrap, and West Branch of the Union. Always begin with a pH 7 buffer and then go to the acidic or alkaline buffer next. Introduce probe into buffer and stir gently to homogenize. Rinse probe and sample cup well between buffers. If you have one of the YSI pH meters you will have to use the graduated cylinder to hold your samples/buffers (it needs a deep solution to cover the temperature sensor).
2. Test your meter by taking a reading of distilled water. Rinse probe and container with distilled water. Pour a small amount of distilled water into the container. Introduce probe and stir gently. Read pH on a quiescent sample. Distilled water will read a pH of 5.6 to 5.7 when in equilibrium with CO_2 in the air. Your sample might read high if it is not in equilibrium with the air. It will help if your distilled water is kept in a bottle with some air space (i.e., only partially filled). It will also not read true if it is contaminated (it does not take much to contaminate pure water**). An acceptable reading will be from 5.5 to 5.9. Do not go on to record**

sample readings if you cannot get an acceptable reading on distilled water. Record the reading you got with distilled water in the "Notes" part of your data sheet.

3. You may also test the meter by taking a reading of a standard acid solution (we will use pH = 4) or a borax solution (pH ranges from 9.2 at room temperature to 9.5 at freezing). Record your reading in the "Notes" section. Do not return used solutions to their bottle.

Measurement

1. Rinse pH probe and container three times with river water. Pour some river water into a cup. Introduce probe and stir gently. Record your pH value on a quiescent solution when the reading stabilizes.
2. If you are doing several sites in a single day, you may recalibrate the meter at each stop or you may fill clean nalgene bottles, wait until the last sample site and calibrate the meter once and measure each sample. Between samples, rinse your pH probe with some water from the next sample. This minimizes contamination. Your meter directions suggest that your meter will "remember" a calibration between samples even if it is turned off (or if it turns itself off). This may not really be true. The calibration generally drifts if the meter is turned off. This is why we recalibrate the meter each time. You may also refrigerate your samples and measure them at home or even the next day. The total holding time is ideally less than 24 hours, but may go as long as 72 hours for clean water.
3. Rinse pH probe with tap water and return to storage conditions. Dispose of used buffers and solutions by placing in a collection jar for proper disposal back in the lab. Do not dispose of any chemicals on the ground or in the water.

Trouble shooting

1. Follow directions with your meter. If you cannot make it calibrate without getting error messages, contact your watershed coordinator or Mark Whiting, Maine DEP, at 941-4566.
2. You can get a reading from a meter that is having trouble, but it will not be accurate and will not be a useful reading. Make a note of any measurement that is suspect.
3. Your watershed council may have multiple meters available. When possible, it is good to have two pH meters along. Properly working meters should give you the same reading to the nearest tenth place. If they do not agree, use the one that is not giving error messages and agrees with the standard solutions (the distilled water, standard acid, or borax solution).
4. If neither meter is working, take a bottle of water for later measurement of pH. The holding time is about 72 hrs with refrigeration.
5. An acceptable pH value for the distilled water test is 5.5 – 5.9. If your test is outside this range try calibrating the pH meter again, try another meter, condition the probe by additional soaking in tap water (soaking overnight often helps), or store the sample and pass it along to someone else.

Safety

1. Buffers, diluted acid and borax are mildly toxic and strongly corrosive. They can be disposed of by diluting them with tap water or river water and by pouring them on land, provided you are several feet from the water. The can also be dumped in a domestic drain (but not a kitchen sink). Rinse the sink afterward. Wash your hands too. Clean up any spills on clothing or on your car with lots of water.
2. The pH 4 buffer is a phthalate. It can be absorbed through the skin and may affect the endocrine system of vertebrates. Wash your hands after use!
3. Some natural waters have high bacteria levels. Wash your hands with an alcohol towelette or other disinfectant. In downtown areas you may want to wear gloves and wash.

CHAPTER FOUR
WATER CHEMISTRY PROTOCOL

4.2 Lab Analysis Sampling (Sampling for Lab Analysis of pH, Cations, Anions, etc.)

Sampling for Laboratory Analysis

(*From the Senator George J. Mitchell Center, Orono, ME. April 2003*)

These directions are for stream sampling from shore. If site access is via boat, perform item 2 and 4-7 on shore, to let sample containers equilibrate with sample water (see items 6 and 7 below) while you are paddling to the center of the lake. The remainder of the directions are the same as outlined below.

1. Streams: sample in an area where the water is moving, but not turbulent. Lakes: sample near the center of the lake and approximately over the deep hole if practical. For streams or lakes, avoid any possible influence of sediment or other debris in the water.
2. Before the labels get wet, label all containers with site name and sample type (e.g. Bean - O = Bean Pond outlet), dd/mm/yy date, project name, and your initials.
3. Sample containers as provided by the Mitchell Center contain de-ionized water as the last step in the cleaning process. The containers are usually emptied of de-ionized water at the trailhead or vehicle. If not, empty all sample containers of DI water, downstream of sample site or on shore. Do not stir up sediment or erode any soil into the stream. Save the small plastic cap on the syringes. *Do not let any part of sample bottles touch soil or vegetation except the bottom of the bottle. Do not let any part of a syringe touch soil or vegetation. Lay them on plastic bags or rocks.*
4. Rinse the syringes and plungers with sample 3 times. Fill the syringe bodies with sample water, insert plunger underwater, and let stand to equilibrate with the water from the sample site.
5. Rinse bottles with sample, pouring water over cap to rinse. Repeat 3 times, pouring each rinse downstream of the sample site (or on-shore).
6. After rinsing, fill bottles with sample, cap loosely, and let the container equilibrate with water from the sample site while rinsing the remainder of the containers, and recording field notes.
7. Record date and bottle tag information in field book, including full name(s) of field crew. Do not use abbreviations in the notebook (i.e. spell out ‘outlet’ or ‘epilimnion’) so that comparisons can be made between the bottle and field book to explain uncertainties.

8. Note the approximate air temperature (we use *water* thermometers, so air temperature will be approximate). Put thermometer in water, slightly downstream from sample site, or over the opposite side of the boat from where you will collect sample and let it equilibrate to temperature during tasks 9-11.
9. Record water temperature, site conditions (wind, weather, ice and snow status, anomalies in area, changes in access, trail issues, interesting trivia) while the containers equilibrate with sample water.
10. After the brief sample soak for the containers, empty all sample containers *at the same time* to avoid mix-ups, then re-cap loosely. Rinse them once more just before you collect the 'real' sample. Place cap loosely on bottle(s) and submerge in water to at least several inches below surface, elbow depth for lakes. Remove cap and fill bottle *without skimming water directly from the surface*, then re-cap underwater (many contaminants adhere to particulates on the water surface, especially those from dry deposition. Hydrophobic contaminants such as gasoline are all found at the water surface). Minimize the air bubble in the bottle.
11. Remove plunger from body of syringe(s) and submerge both parts in water several inches. Replace plunger into syringe body *underwater*, pushing the plunger into the body of the syringe until you hear the 'click', then push plunger approximately another cm so that the plunger is stable during transport. (D**o** *not* draw sample into syringe by pulling back plunger because cavitation of the water will de-gas CO_2 and raise the pH. Holding the syringe, tip up, in front of your eyes, to be sure that there is no air in the syringe (push it out with slight depression of the plunger if necessary). Replace the cap over the tip of the syringe.
12. Replace in sample bags and put samples in pack/cooler for trip home. In warm weather, cool the samples with ice.

CHAPTER FIVE
BACTERIA PROTOCOL

5

5.1 Bacteria Sampling for the Maine Health and Environmental Laboratory

Bacteria Sampling for Processing at the Maine Health and Environmental Testing Laboratory

(*From Sheepscot Valley Conservation Association, 2001)*

Preparation

1. Bacteria samples must be kept on ice (below 4° Celsius--39° F).
   a.) Inspect the ice chest for dirt or other contamination and clean as needed prior to adding ice.
   b.) Fill the chest with enough ice so the sample bottle can be covered at least up to the shoulder (just below the bottom of the cap) after the sample is collected. THE ICE CHEST MUST BE TAKEN WITH YOU TO THE SAMPLING SITE.
2. Bring an extra sample bottle on each sampling date. DO NOT USE ANY DAMAGED OR CONTAMINATED BOTTLES. Return any contaminated containers to the project manager. Note: store unused bacteria sample bottles to avoid exposure to heat, light, dirt and any other sources of contamination between sampling dates.
3. You should have a pre-coded blue tracking sheet from the laboratory for each sample bottle.

Collection

1. When wading, disturb as little of the bottom sediment as possible. Try to avoid collecting a water sample with sediment from bottom disturbance. If needed, (1) take one or two steps upstream and/or (2) wait a minute or two for the sediment to settle.
2. Where site conditions and safety allow, position yourself in moving water (not stagnant) deep enough to submerge the sample container to mid-depth. USE CAUTION WHEN ENTERING THE RIVER. AVOID SLIPPERY AND UNSTABLE AREAS. Take samples ONLY in areas you can safely stand. When collecting samples in less than 2 feet of water, note the river depth and record on the field sheet. (You can estimate depth by simply noting the water level on your leg and measuring the distance later).
3. Stand facing upstream (so the flow of water is coming toward you) and collect your sample on the upstream side.

4. Remove the cap from the sample container just before collecting the sample. Do not lose the cap. DO NOT RINSE OUT THE SAMPLE BOTTLE. DO NOT

USE ANY CONTAINER THAT HAS BEEN CONTAMINATED. Avoid touching the lip of the bottle or the inside of the bottle or cap. If the container is contaminated, use an alternate bottle.

5. Grasp the bottle firmly around the body and below the shoulder as demonstrated in your training session. The bottle should be horizontal (not straight up or down) and the open mouth should be pointing upstream away from you.
6. With a sweeping motion plunge the bottle into and through the water in an arc in front of you (upstream of your body). The container should be submerged to mid-depth (1/2 way between the surface and bottom).
7. DO NOT FILL THE SAMPLE BOTTLE. Leave some air space in the bottle (apx. ½ inch); this is necessary to process the sample at the laboratory. The bottle will hold 250 ml full and 100 ml is needed for testing.
8. Quickly, pull the bottle up and cap it immediately.

Storing, Recording and Delivering Your Sample

1. Freshwater samples for bacteria testing can be held a maximum of 6 hours from the time of collection. Samples must be kept at a maximum of 4° C (34° F). If you are also collecting samples for DO testing, gather your bacteria sample first and ice it before gathering and fixing a sample for DO measurement.

2. The sample should be iced as quickly as possible. The container(s) must be stored upright and covered with ice completely or at least up to the shoulder (the bend just below the lip where the container gets wider). The chest must be closed to avoid exposing the sample to light and transported to the courier pick up point by 9:00 a.m.

3. Report any delays in delivery or other problems to the Project Manager. This information is required by the EPA to assure the quality of data collected by the project.

4. Record the following information on the blue lab-tracking sheet (see the example in your sampling packet):

01 Sample Date	= the sampling date
02 Sample Time	= the time you collected the water from the stream
03 Sampled By	= Your name (please print)
06 Sample Point	= Grab
10 Name of Establishment	= the site number assigned

5. Each blue tracking sheet and sample bottle is labeled with a pre-coded tracking number (the tracking number is just above the bar code). Record the date and the tracking number at the bottom of the blue sheet under “Sample Number.” Keep the bottom of the tracking sheet for your records and send the rest of the completed sheet to the lab with the iced sample(s).

6. Record the sample tracking number on the field data sheet along with the other sampling information. Be sure to note the sampling depth when samples are taken in less than 2 feet water.

CHAPTER FIVE
BACTERIA PROTOCOL

5.2 Bacteria Sampling for MDEP or MDMR Laboratories

Sampling for Fecal Coliform Bacterial Analysis at the MDEP or MDMR Laboratories

(*From Maine Department of Marine Resources, 2003*)

The following standard operating procedure (SOP) is to be used by all DMR staff and volunteers when collecting water samples for fecal coliform analysis by the DMR Lab. As this is a bacterial analysis, cleanliness and careful attention are necessary to ensure a reliable sample.

Equipment and Safety

Equipment
The following equipment is needed:

maps and directions to sampling stations	sample tongs
water-proof boots	watch or automobile clock
Water Quality Report forms	freezer boxes or wire sample racks (to keep bags upright in cooler)
"Whirl-Pak" 120 ml sampling bags	metal dial field thermometers
waterproof marker to label bags	pencil to record data on WQ
glass liquid-filled cooler thermometers	cooler & ice packs to keep samples chilled

Safety

1. Collecting water samples involves walking over uneven surfaces and working in sometimes cold, wet, and slippery conditions. For some, it involves operating or collecting samples from a boat. When working from a boat, make sure your boat is inspected, registered and carries all appropriate safety equipment.
2. The validity of the DMR water quality sampling program is dependent upon the samples being collected according to the established sampling schedule. However, the safety of the sample collector is paramount. It is important that weather conditions do not jeopardize the health and well-being of the sample collector. Always listen to a local weather report on the morning of sampling. If you have concerns about safety, do not collect the samples. Notify the lab of any cancellations as soon as possible by contacting one of the following: the DMR Volunteer Coordinator, the Water Quality staff person for your area,

or the Water Quality lab staff, in that order (see the staff contact information in Section VI). Your sampling run will be rescheduled for another day.

3. Also, always have a first aid kit either with you or in your vehicle. When possible, work in pairs. If you are working alone, make sure someone locally knows that you are sampling and your route on that day. Make sure you bring foul weather gear and dress for the weather. Avoid cotton clothing as it offers no insulation when wet. Wool, polypropylene, or polar fleece will keep you warm when wet. If it is a hot, sunny day, make sure to bring sunscreen and plenty of water to avoid dehydration.
4. When collecting your sample, you must wade into the water almost to your knees so proper footwear is very important. Knee-length or higher rubber boots are best, especially when walking through mud flats. In cold weather, keeping your feet warm and dry is critical. Rinse any clothing exposed to salt water when sample day is completed. Salt deteriorates clothing, rubber, and other fabrics and materials.

Preparation

1. Before you begin your first volunteer sampling work and annually thereafter, the DMR Volunteer Coordinator and your area's Water Quality Staff will meet with you for a comprehensive training on the Water Quality Sampling Program and visit the sampling locations that you will be sampling. You will receive the equipment and coaching on the sampling technique that you will need to successfully collect high quality samples. Initially, you may find the sampling technique awkward but practice will improve your proficiency.
2. The DMR Volunteer Coordinator and the Water Quality staff for your area will establish an annual sampling schedule by early January of each year. This schedule will specify the dates on which you are expected to sample and the list of stations that you will be sampling. If a DMR staff will be transporting your samples to the lab, the schedule will also specify the time and location of sample pick-up for each sample run date.
3. Make sure that you have all of the equipment needed before you start your sampling trip. A check list of equipment is included at the end of the SOP. Make sure that the ice packs are frozen and that you have enough sample bags. Plan to have at least one extra bag per sample site on every sample run because the quality of some sample bags is poor and the bags might leak. If a bag leaks or tears, discard the sample and collect another sample using a new bag.
4. Decide the order in which you plan to visit each station. The status of the tide often dictates the order in which you must sample some stations.
5. Please remember to stick to your sampling schedule as provided by DMR staff. The schedule is extremely important to the validity and acceptability of the DMR Water Quality Program. Your schedule is "random" meaning that it is meant to get data from different tidal stages, different seasons, and different weather conditions. By creating the sampling schedules at the start of each sampling year, the DMR staff is randomly selecting dates with no prior knowledge of the exact conditions that will exist on any particular date thus ensuring that samples over time at any given site will represent all the various

conditions that may affect water quality. Once an area has been classified, it requires a maintenance-sampling schedule of at least six samples a year. Over time, this results in a high probability for a wide distribution of weather, season, tide, and other environmental conditions.

6. Remember, safety is the most important consideration. Water sampling schedules are important, but are secondary to your safety. If your sample day is unsafe you should call the DMR Volunteer Coordinator, Water Quality staff or lab staff to notify them that you will not be sampling. You and the DMR Volunteer Coordinator will reschedule your run depending on your availability and the lab's sample analysis schedule.
7. Filling in the data sheet correctly helps the lab personnel to quickly and correctly analyze your samples. Missing or non-legible information will compromise the data. Please use a pencil, which can be easily erased to make corrections, NOT your waterproof marker, which can be hard interpret. Before you begin to sample for the day, you may fill out general information that is not specific to a single site. This would include the header information on the form. A sample Water Quality Report form follows.

Fill in the data at the top of the form:

Field	Content
Collected by:	the acronym for your group/ your name (e.g. YSC/John Smith)
Date Collected:	the water sampling date
Area Name:	the geographic name of the area*
Area Letter:	the DMR shellfish growing area identifier (A - Z)*

* Check with the DMR Volunteer Coordinator or your WQ staff for the area name and the shellfish growing area identifier.

8. The "Initiated by:" and "Date Initiated:" fields will be filled in by DMR lab staff - leave these blank. Similarly, the fields in the top right hand corner, "Entered by:" and "Date:" will be filled in by the DMR staff who enters the information into the computer database program.
9. In the "REMARKS" section below the data entry columns, put any additional information that may be helpful to staff when interpreting the analysis results. Did you see something that you do not usually see at the station that might be a source of fecal pollution? Was there land runoff due to a recent storm event? Were there signs of waterfowl or wildlife populations in the area? Did you miss a station normally sampled and why? The purpose of the remarks is to give supporting information to the staff. When you are collecting samples, you are the eyes in the field. You see the conditions in which the samples were collected, and sometimes these remarks will help the staff to understand the reasons for a certain water score or point to a persistent pollution problem.
10. For water samples to be considered credible and valid, DMR must be able to account for the handling of the samples from the time they are collected until the time they are analyzed and the results recorded on the Water Quality Report. This record of handling is called Chain of Custody. If you are collecting samples and deliver them to the lab, you are responsible for the

handling of the samples until someone at the lab receives them. In this case you would sign as the relinquisher and a DMR lab staff would sign as the receiver and fill in the date and time that the samples were delivered to the lab. If you collect the samples and give them to someone else to deliver to DMR lab, you would still be the relinquisher and the transport person would become the receiver, marking the time and date. However, once the samples are delivered to the lab, the transport person then becomes the relinquisher and signs on the second line, while the DMR staff person who accepts the samples becomes the second receiver.

Labeling and Data Recording

1. When you arrive at a sampling station, perform the following steps:

Add data to the Water Quality Report Form

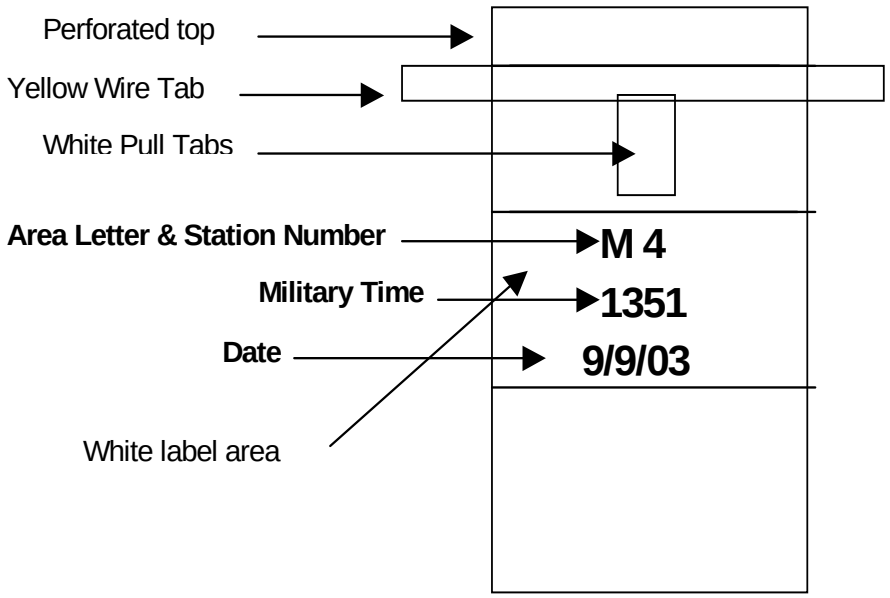
Station Number	Record the station number only (e.g. 17) – the area letter is recorded in the Report Form header so it is not repeated in the Station Number column.
Military Time	24 hour clock - military time – no colon (e.g. 1400 vs 2:00 PM)
Boat or Land	"L" = if the sample was taken from land or "B" = if the station was sampled from a boat
Water Temp	temperature to the nearest degree Celsius °C measured at sampling station using your metal dial field thermometer
Random or Adverse	"R" for random (unless you are otherwise instructed)
Adversities	use the letter code(s) taken from the Adversities List on the reverse side of the Report Form (eg. boats, wildlife, precipitation etc) that best describes the potential pollution sources that you observed in the field
Open or Closed	see your sample schedule for the current *status* (e.g. Open or Closed)
Approved, Prohibited, etc.	see you sample schedule for the current *class* (e.g. Approved, Prohibited, CA conditionally approved, etc.)

Your annual sampling schedule will provide you with information regarding the current status and class of the stations that you are responsible for sampling at the beginning of each sampling season. Please consult your schedule when filling out these columns of your Water Quality Report Form.

2. Label the bag:

Make sure that you are using "Whirl-Pak" brand bags. These have a yellow wire tab printed with the "**Nasco *WHIRL-PAK***" brand name across the top and a broad white label across the middle of the bag front. If you have been volunteering for several years you may still have a supply of the old style bags with the white wire tab across the top of a clear bag with no label. Please do not use these bags. Ask the VOLUNTEER COORDINATOR, WQ, or lab staff to replace your old bags with Whirl-Pak bags.

EXAMPLE WQ SAMPLE BAG WITH SAMPLE LABEL



3. The sterile sample bags are made of transparent polyethylene and sealed with a perforated top which is torn off just before you collect your water sample. Each sample bag must be labeled with the identifying information explained below using a waterproof marker before you collect your sample. You will be supplied with a "Sharpie" permanent marker for this purpose. ***It is impossible to write on wet bags so remember to label BEFORE you sample.*** Please try to keep the information within the white label area on the front of the bag. If you must stray outside of this area, use the area just below (rather than above) the label so that the information is visible after the bag is whirled closed. You will find it easiest to label your bag before you leave your vehicle as you double-check your sampling schedule to confirm that you are at the correct sampling site and check the time which must be recorded on both the sample bag and the Water Quality Report Form.
4. Be sure to include both the area letter and the station number on the bag. Record the time (in military format) that you read in your vehicle unless you have an unusually long walk (more than a couple of minutes) to your sampling site.

5. Write the following data in the white label area on the front of the sample bag:
   area letter and station number
   time (military format)
   date (month/day/year)

Collection

Sampling tongs are used to hold the bag during sample collection to minimize the handling and contamination of the bag. The tongs also make it possible to collect the water sample from below the surface to avoid debris that may be floating on the water surface. The sampling bag is secured to the sampling tongs by clamping the alligator clips onto the white pull tabs on either side of the yellow wire tab. Hooking the bag to the clips is an awkward procedure but with practice you will develop a technique that works best for you. Here is a suggested technique:

1. Start by holding the tongs under your arm with the clips parallel to the ground with the opening of the clips facing toward the middle of your body. Place the bag between the alligator clips with the yellow wire tab parallel to the ground and with the bag mouth facing in the same direction as the opening of the clips, toward the middle of your body. Take the white pull tab on one side of the yellow wire tab and securely clamp it into the teeth of the clip on that side; repeat on the opposite side.
2. Wade into the water to a depth of at least one foot to eighteen inches. Try to step gently to avoid stirring up the bottom too much.
3. Pull the top perforated flap from the bag and put the top in your pocket. **Do not touch the top of the bag with your fingers**.
4. **KEEPING THE BAG CLOSED UNTIL IT IS SUBMERGED TO SAMPLING DEPTH,** plunge the bag 8 to 10 inches below the surface. Allow the tongs to open after the bag is submerged. Quickly draw the bag through the water to fill the bag completely. Be careful to avoid getting any sediment into the bag. **CLOSE the BAG by BRINGING the CLIPS BACK TOGETHER WHILE BAG IS STILL SUBMERGED** before pulling it back up to the surface and out of the water.
5. Withdraw the sample bag from the water and remove the bag from the tongs, holding it by its yellow wire ends. The bag should be filled to the 100 ml fill line which appears in the white label on the front of the bag. If you have too much water, squeeze the bag by pinching it a third of the way down, to expel the extra water. **Allow some air to enter the bag before closing it.** ***Critical – the bags must be shaken by the lab staff prior to analysis to ensure that the sample is well mixed. The air pocket provides the extra space in the bag to allow for this mixing.***
6. Twirl the bag closed by holding it by its yellow wire ends on either side of the bag opening and spinning the bag three or four turns. This will create a firm pillow-like bag with an air pocket. There should be an air-pocket of an inch or so and the bag should **feel firm**. Secure the bag by crossing the two yellow wire tabs above the closed bag to form an "X". Fold one tab towards the front of the bag and one tab towards the rear of the bag. **DO NOT TWIST THE TABS** as you would a bread bag. Gently squeeze the bag to check for leaks and to make sure that it is

securely fastened. The folded tab "X" closure creates a secure closure that is easy for the lab staff to open and keeps the wire tabs away from the bag (and adjacent bags) to avoid accidental puncturing during sample transport.
If you notice a leak, label a new bag and take another sample. If you have left the sampling site and notice that you have a leaking bag, label a new bag and using aseptic technique, carefully transfer the sample from the leaking bag to the new labeled bag. DO NOT place the leaking bag into a new bag because the water which leaks out of the sample bag into the new bag must be considered contaminated and can not be used for analysis.

7. When you return to your vehicle, stand the bags upright in a plastic freezer box (Boothbay lab) or wire rack (Lamoine lab) in a cooler with ice packs and a cooler thermometer.

Measuring Water Temperature

Preparation

1. Water temperature is a standard environmental parameter and is routinely measured any time water samples are taken for any type of analysis. Temperature may be correlated to the growth or presence of various marine organisms and microorganisms and may be helpful in explaining the analysis results and understanding the impact of conditions observed in the field.
2. The dial bimetallic field thermometer that is used by DMR has a round, dial face and a metal stem, which is the sensing unit to be immersed in the water. These thermometers are mechanical; meaning that the temperature recorded on the dial is the result of the expansion of the metal wire housed in the stem and connected to the thermometer dial. The thermometer's scale, -10°C to 110 °C, is in degrees Celsius. The temperature should be read to nearest 1°C.
3. All thermometers are relatively fragile instruments requiring special treatment for accurate measurements. Rough handling of these dial thermometers can affect the connection between the dial and the stem. When not in use, store thermometers in a protected location such as your sample cooler to reduce handling and abuse.
4. For ease of use in the field, you may want to equip your thermometer with the following: a small float (simply push the pointed metal stem gently through a small block of styrofoam or a cork) which will keep the dial face above the water for easier reading, and a string (tied around the metal stem under the dial face) which will provide a tether to keep the thermometer from being swept away from you by the wind or waves.
5. Although each thermometer is annually calibrated against a NIST-certified thermometer by the lab staff, you should also check your thermometer at the start of each field day to make sure that it is responding appropriately. Place your metal field thermometer in your sample cooler along with your cooler thermometer before you start on your sampling trip. When you get to your first sampling site, compare the temperature readings on both thermometers. They should be within a degree of one another. If you find a larger discrepancy, make a note of the difference in readings on your Water Quality Report form and request a replacement thermometer from the VOLUNTEER COORDINATOR or WQ staff.

Measuring the water temperature

1. Drop your field thermometer into the water before you collect your water sample. The metal stem should be completely immersed. The metal equilibrates to the ambient water temperature quickly; typically in less than one minute.
2. After collecting your water sample, check the thermometer dial to be sure that the reading has stabilized and read the temperature on the dial face to the nearest °C. **Keep the thermometer's stem immersed while you read the temperature.** The thermometer responds too quickly to temperature change to allow an accurate reading if the thermometer is pulled from the water to be read.
3. When you return to your vehicle, record the temperature in the "Water Temp" column of the Water Quality Report form.

Completing the Water Quality Report Form

If you have not already done so, complete the data required in the Water Quality Report heading as described above. After you have collected each sample you will need to enter your station number, sampling time, water temperature, and your field observations.

Observe the Site

1. You are our eyes in the field during your sampling trip. Look around your sampling location to check for **adverse conditions** which may be potential sources of fecal pollution. Examples include birds, streams or stormwater pipes which flow only during wet weather, etc.. Look on the reverse of your Water Quality Report form for a list of **Adversities** and the codes to be used on the field sheet. Also, in the remarks section, please note if there has been **precipitation** in the past 24 - 36 hours. You may have had a local rainstorm that was not recorded by any of the rain gauges that are monitored along the coast.
2. If you see something which can not be adequately described with a code, enter your description in the "REMARKS" space. Be sure to specify which station the information pertains to or, if it is relevant to all stations, make that clear as well.

Returning the sample to the DMR Laboratory

1. Once you have completed your sampling run, you will either return the samples to the DMR laboratory or to a prearranged pick-up site from which a WQ staff will transport them to the lab. In either case, you must keep the samples properly cooled by checking the cooler thermometer and adding more ice packs if needed. The goal is to chill the samples quickly and to **maintain the samples at < 10 C.** You may transfer the samples from your cooler to a refrigerator until pick-up or you may add or replace ice packs to maintain the cooler at < 10 C. In cool weather, a layer of ice or ice packs covering the bottom of the cooler is sufficient, however during hot weather you will need an additional layer on top of the samples in order to keep the temperature at <10 C.

Sample pick-up

1. Get your samples to the pick-up spot by the agreed upon time. If you are running late, try to reach the staff who will be picking up the samples to let them know what time you will be at the pick-up location. Make sure that your cooler is

adequately iced to maintain the proper temperature given the temperature of the pick-up spot.

2. **Remember to complete the Chain of Custody Record** on your WQ Report form: sign your name after "Relinquished by".

Sample delivery to DMR Lab

At the West Boothbay Harbor lab: (Lamoine lab staff will coach you on your first delivery)

1) Get sample racks from top of refrigerator (to your right through the door into the inner lab).
2) Read the temperature on your cooler thermometer and record on your datasheet(s).
3) Place your samples in the rack in the order that they are listed on your datasheet: The first sample goes in the lower left front space in the rack; sample two goes immediately behind it and so on; when you fill the first row front to back, place your seventh sample in the front of the rack in the next row to the right; again fill the rack front to back and left to right..
4) Put your filled sample racks in the lab refrigerator (the one with the sample racks on top of it).
5) **Remember to complete the Chain of Custody Record** on your WQ Report form: sign your name after "Relinquished by".
6) Put your datasheet on the bottom clipboard hanging on the wall to the left of doorway that goes into the lab prep room.
7) Fill in the data needed on the form above this clipboard. Most of the information is self-explanatory except "type of sample", put A1 in this space.

CHAPTER SIX
TURBIDITY PROTOCOL

6

6.1 Transparency Tube

Measuring Water Transparency Using a Transparency Tube

(*Modified From EPA, Volunteer Stream Monitoring: A Methods Manual, 1997)*

1. You do not need to make a turbidity measurement unless there is obvious cloudiness (turbidity) in the water. In order to standardize the lighting conditions, make sure that transparency tube measurements are made in the shade with the sun to your back. If there is no shade, hold the transparency tube in your shadow.

2. It generally takes two people to use a turbidity tube, one to hold the tube and another to pour water from a bucket. One person can make a turbidity reading by filling the tube in the river and then opening the drain. Take your sample from a well-mixed part of the river, but do not compromise on safety. Rivers at high flow are dangerous.

3. Different individuals may see the bottom of the transparency tube appear/disappear at different water depths. For this reason, the transparency observations should ideally be made by at least one other person.

4. Transparency and turbidity are opposites. A high turbidity reading from an electronic reading (say more than 10 NTU) represents poor visibility. A high turbidity tube reading (say more than 100 cm) means that visibility is good. A secchi depth reading from a lake is not the same as a turbidity tube reading from a river, since the targets are very different sizes. In Maine, we like to see secchi depths of several meters.

    a. Close the drain hose by squeezing the crimp clamp.

    b. Fill the transparency tube with the water sample. Wait for bubbles to make their way to the top of the transparency tube. Bubbles will strongly affect your ability to see the target on the bottom.

5. While looking down through the opening of the tube, partially open the drain and allow sample water to flow slowly out. (Control the flow by squeezing the clamp)

6. When the black and white target at the base of the transparency tube first begins to appear, plug the drain immediately.

7. Record this water depth on your data sheet to the nearest 1 cm.

8. To improve the accuracy of the measurement, you can take one reading while you are filling the tube and another while it is draining. If the readings are different, you can take an average.

9. **Note:** If you can still see the image on the bottom of the tube after filling it, simply record the depth as >120cm, the depth of the tube.

CHAPTER SIX
TURBIDITY PROTOCOL

6.2 Turbidity Meter

Lamotte 2020 Turbidimeter

(From Kennebec County Soil and Water Conservation District and Lamotte)

The Lamotte 2020 Turbidimeter is used by volunteers of the Sheepscot River Watershed Council and the Kennebec County Soil and Water Conservation District. The instructions are available in PDF format on their website at:

http://www.lamotte.com/pages/common/pdf/manuals/1799.pdf

CHAPTER SEVEN
CONDUCTIVITY PROTOCOL

7

7.1 Conductivity Meter

Conductivity Meter

(From Oakton Waterproof ECTester)

Preparation

Before you begin, remove electrode cap. Soak electrodes for a few minutes in alcohol to remove oils.

Calibration

The ECTester is factory calibrated. However, to ensure accuracy, calibrate on a regular basis. Select a calibration standard appropriate for your Tester. It is best to select a standard close to the test solution value:

TDSTestr Low: from 200 to 1990 ppm
TDSTestr High: from 2.00 to 10.00 ppt
ECTestr Low: from 200 to 1990 æS
ECTestr High: from 1.00 to 19.90 mS

1. Open battery compartment lid (end with lanyard loop). The two white buttons are Increment (INC) and Decrement (DEC) calibration keys.
2. Rinse electrode in deionized water, then rinse it in calibration standard, then dip it into a container of calibration standard.
3. Switch unit on (ON/OFF key). Wait several minutes for display to stabilize.
4. Press the INC or DEC keys to adjust reading to match the calibration standard value.
5. After 3 seconds without a key press, the display flashes 3 times, then shows "ENT". The tester accepts calibration value; returns to measurement mode.
6. Replace battery cap.

Operation

1. Remove electrode cap. Switch unit on (ON/OFF key).
2. Dip electrode into test solution. Make sure sensor is fully covered.
3. Wait for reading to stabilize (Automatic Temperature Compensation corrects for temperature changes). Note reading.
4. To hold the display, press the HOLD key to freeze display. Press HOLD again to release.
5. Press ON/OFF to turn off Tester. Replace electrode cap. Note: Tester automatically shuts off after 8.5 minutes of nonuse.

Maintenance

1. To improve performance, clean the electrodes by rinsing them in alcohol for 10-15 minutes. Remove white plastic cup insert to clean viscous solutions.
2. Replace all batteries if low battery indicator appears, or if readings are faint or unstable.
3. If you experience drift, periodically let electrode fully dry. When you need a new electrode, see "Electrode Replacement."

CHAPTER EIGHT
SALINITY PROTOCOL

8

8.1 Hydrometer

Hydrometer Procedure

(From Sheepscot Valley Conservation Association)

1. Fill a hydrometer jar about ¾ full with water to be tested.
2. Hang the thermometer in the jar so that it is totally submerged.
    - **NOTE:** Make sure that the thermometer does not interfere with the hydrometer - the hydrometer must float freely.
3. Lower the hydrometer carefully into the jar. Allow it to float freely in the jar. Avoid splashing drops onto hydrometer stem above the water level.
4. Viewing the thermometer through the clear jar, read and record the temperature.
5. Read and record the specific gravity from the scale in the hydrometer stem at the point where the scale crosses the surface of the water sample in the jar, not at top of meniscus.
    - **NOTE:** The water seems to creep up the glass stem of the hydrometer. The correct reading is obtained at the water level, not at the higher point called the meniscus.
    - **NOTE:** Be sure your eye is even with the water level in the hydrometer jar. Viewing down or up at an angle can give an incorrect reading.
6. The specific gravity may be read to the fourth decimal place using the lines printed between the labeled graduations.
7. Use Table 1 to convert the hydrometer reading and temperature to SALINITY in parts per thousand (ppt).

    EXAMPLE: The observed hydrometer specific gravity (S.G.) reading is 1.0110 and water temperature in the hydrometer jar is 25° column. The number found, 16.9, is the SALINITY in parts per thousand (ppt).

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0
0.9990							0.0	0.1	0.2	0.3
1.0000	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.4	1.5	1.6
1.0010	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.5	2.7	2.8
1.0020	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.0	4.1	4.2
1.0030	4.4	4.5	4.6	4.8	4.9	5.0	5.1	5.3	5.4	5.5
1.0040	5.7	5.8	5.9	6.1	6.2	6.3	6.4	6.6	6.7	7.0
1.0050	7.1	7.1	7.2	7.4	7.5	7.6	7.7	7.9	8.1	8.3
1.0060	8.4	8.5	8.7	8.8	8.9	9.1	9.2	9.3	9.4	9.6
1.0070	9.7	9.8	10.0	10.1	10.2	10.4	10.5	10.6	10.7	10.9
1.0080	11.0	11.1	11.3	11.4	11.5	11.7	11.8	11.9	12.0	12.2
1.0090	12.3	12.4	12.6	12.7	12.8	13.0	13.1	13.2	13.4	13.6
1.0100	13.6	13.7	13.9	14.0	14.1	14.3	14.4	14.5	14.8	14.9
1.0110	14.9	15.0	15.2	15.3	15.4	15.6	15.7	16.0	16.1	16.2
1.0120	16.2	16.3	16.5	16.6	16.7	17.0	17.1	17.3	17.4	17.5
1.0130	17.5	17.7	17.8	17.9	18.0	18.3	18.4	18.6	18.7	18.8
1.0140	18.8	19.0	19.1	19.3	19.5	19.6	19.7	19.9	20.0	20.1
1.0150	20.1	20.4	20.5	20.6	20.8	20.9	21.0	21.2	21.3	21.6
1.0160	21.4	21.7	21.8	22.0	22.1	22.2	22.3	22.5	22.7	22.9
1.0170	22.9	23.0	23.1	23.3	23.4	23.5	23.6	23.8	24.0	24.2
1.0180	24.2	24.3	24.4	24.6	24.7	24.8	24.9	25.2	25.3	25.5
1.0190	25.5	25.6	25.7	25.9	26.0	26.1	26.4	26.5	26.6	26.8
1.0200	26.8	26.9	27.0	27.2	27.3	27.4	27.7	27.8	27.9	28.2
1.0210	28.1	28.2	28.3	28.5	28.6	28.9	29.0	29.1	29.2	29.5
1.0220	29.4	29.5	29.6	29.8	30.0	30.2	30.3	30.4	30.7	30.8
1.0230	30.7	30.8	30.9	31.2	31.3	31.5	31.6	31.7	32.0	32.1
1.0240	32.0	32.1	32.2	32.5	32.6	32.8	32.9	33.2	33.3	33.4
1.0250	33.3	33.4	33.7	33.8	33.9	34.1	34.2	34.5	34.6	34.7
1.0260	34.6	34.7	35.0	35.1	35.2	35.4	35.6	35.8	35.9	36.0
1.0270	35.9	36.2	36.3	36.4	36.5	36.7	36.9	37.1	37.2	37.5
1.0280	37.2	37.5	37.6	37.7	37.8	38.1	38.2	38.4	38.5	38.8
1.0290	38.6	38.8	38.9	39.0	39.1	39.4	39.5	39.7	39.9	40.1
1.0300	39.9	40.1	40.2	40.3	40.6	40.7	40.8	41.0	41.2	41.4
1.0310	41.2	41.4	41.5	41.8	41.9	42.0	42.1	42.3	42.5	

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0
0.9980							0.1	0.2	0.3	0.6
0.9990	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.5	1.8	1.9
1.0000	1.8	1.9	2.0	2.1	2.4	2.5	2.7	2.9	3.1	3.2
1.0010	2.9	3.1	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5
1.0020	4.4	4.6	4.8	4.9	5.0	5.1	5.4	5.5	5.7	5.9
1.0030	5.8	5.9	6.1	6.2	6.3	6.6	6.7	6.8	7.1	7.2
1.0040	7.1	7.2	7.4	7.5	7.7	7.9	8.0	8.3	8.4	8.5
1.0050	8.4	8.5	8.7	8.9	9.1	9.2	9.3	9.6	9.7	10.0
1.0060	9.7	9.8	10.1	10.2	10.4	10.5	10.7	10.9	11.0	11.3
1.0070	11.0	11.3	11.4	11.5	11.7	11.9	12.0	12.2	12.4	12.6
1.0080	12.4	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.7	13.9
1.0090	13.7	13.9	14.0	14.1	14.4	14.5	14.7	14.9	15.0	15.3
1.0100	15.0	15.2	15.3	15.6	15.7	15.8	16.1	16.2	16.5	16.6
1.0110	16.3	16.5	16.7	16.9	17.0	17.3	17.4	17.5	17.8	17.9
1.0120	17.7	17.9	18.0	18.2	18.3	18.6	18.7	19.0	19.1	19.3
1.0130	19.1	19.2	19.3	19.5	19.7	19.9	20.0	20.3	20.4	20.6
1.0140	20.4	20.5	20.6	20.9	21.0	21.2	21.4	21.6	21.8	22.0
1.0150	21.7	21.8	22.0	22.2	22.3	22.5	22.7	22.9	23.1	23.3
1.0160	23.0	23.3	23.4	23.5	23.6	23.9	24.0	24.3	24.4	24.7
1.0170	24.3	24.6	24.7	24.8	25.1	25.2	25.3	25.6	25.7	26.0
1.0180	25.6	25.9	26.0	26.1	26.4	26.5	26.8	26.9	27.2	27.3
1.0190	27.0	27.2	27.3	27.6	27.7	27.8	28.1	28.2	28.5	28.6
1.0200	28.3	28.5	28.6	28.9	29.0	29.2	29.4	29.6	29.8	30.0
1.0210	29.6	29.8	30.0	30.2	30.3	30.6	30.7	30.9	31.1	31.3
1.0220	30.9	31.2	31.3	31.5	31.7	31.9	32.0	32.2	32.5	32.6
1.0230	32.2	32.5	32.6	32.8	33.0	33.2	33.4	33.5	33.8	33.9
1.0240	33.7	33.8	33.9	34.2	34.3	34.5	34.7	35.0	35.1	35.4
1.0250	35.0	35.1	35.2	35.5	35.6	35.9	36.0	36.3	36.4	36.7
1.0260	36.3	36.4	36.7	36.8	36.9	37.2	37.3	37.6	37.7	38.0
1.0270	37.6	37.8	38.0	38.1	38.4	38.5	38.8	38.9	39.1	39.3
1.0280	38.9	39.1	39.3	39.4	39.7	39.8	40.1	40.2	40.5	40.7
1.0290	40.2	40.5	40.6	40.8	41.0	41.2	41.4	41.6	41.8	
1.0300	41.6	41.8	41.9							
1.0310										

Table 1. Salinity in parts per thousand (ppt)
NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0	32.5	33.0
0.9980	0.7	0.8	1.1	1.2	1.5	1.6	1.9	2.0	2.3	2.4
0.9990	2.0	2.3	2.4	2.5	2.8	2.9	3.2	3.4	3.6	3.8
1.0000	3.4	3.6	3.7	4.0	4.1	4.4	4.5	4.8	4.9	5.1
1.0010	4.8	4.9	5.1	5.1	5.4	5.5	5.8	5.9	6.2	6.4
1.0020	6.1	6.3	6.4	6.6	6.8	7.0	7.2	7.5	7.6	7.9
1.0030	7.4	7.6	7.7	8.0	8.1	8.4	8.5	8.8	9.1	9.2
1.0040	8.8	8.9	9.2	9.3	9.6	9.7	10.0	10.1	10.4	10.5
1.0050	10.1	10.2	10.5	10.6	10.9	11.0	11.3	11.5	11.7	11.9
1.0060	11.4	11.7	11.8	12.0	12.2	12.4	12.6	12.8	13.1	13.2
1.0070	12.8	13.0	13.1	13.4	13.6	13.7	14.0	14.1	14.4	14.7
1.0080	14.1	14.3	14.5	14.7	14.9	15.2	15.3	15.6	15.7	16.0
1.0090	15.4	15.7	15.8	16.1	16.2	16.5	16.6	16.9	17.1	17.3
1.0100	16.7	17.0	17.1	17.4	17.5	17.8	18.0	18.2	18.4	18.7
1.0110	18.2	18.3	18.6	18.7	19.0	19.1	19.3	19.6	19.7	20.0
1.0120	19.5	19.6	19.9	20.1	20.3	20.5	20.6	20.9	21.2	21.3
1.0130	20.8	21.0	21.2	21.4	21.6	21.8	22.1	22.2	22.5	22.7
1.0140	22.2	22.3	22.6	22.7	23.0	23.1	23.4	23.6	23.8	24.0
1.0150	23.5	23.6	23.9	24.0	24.3	24.6	24.7	24.9	25.2	25.3
1.0160	24.8	25.1	25.2	25.5	25.6	25.9	26.1	26.3	26.5	26.8
1.0170	26.1	26.4	26.5	26.8	27.0	27.2	27.4	27.7	27.8	28.1
1.0180	27.6	27.7	27.9	28.1	28.3	28.5	28.7	29.0	29.2	29.4
1.0190	28.9	29.0	29.2	29.5	29.6	29.9	30.0	30.3	30.6	30.8
1.0200	30.2	30.4	30.6	30.8	30.9	31.2	31.5	31.6	31.9	32.1
1.0210	31.5	31.7	32.0	32.1	32.4	32.5	32.8	33.0	33.3	33.4
1.0220	32.9	33.0	33.3	33.4	33.7	33.9	34.1	34.3	34.6	34.8
1.0230	34.2	34.5	34.6	34.8	35.0	35.2	35.5	35.6	35.9	36.2
1.0240	35.5	35.8	35.9	36.2	36.4	36.5	36.8	37.1	37.2	37.5
1.0250	36.8	37.1	37.2	37.5	37.7	37.8	38.1	38.4	38.6	38.8
1.0260	38.2	38.4	38.6	38.8	39.0	39.3	39.4	39.7	39.9	40.2
1.0270	39.5	39.8	39.9	40.2	40.3	40.6	40.8	41.0	41.2	41.5
1.0280	40.8	41.1	41.2	41.5						

CHAPTER NINE
DECONTAMINATION

9

9.1 Disinfection

Disinfection Procedures

(Modified *From Maine Atlantic Salmon Commission, Bangor, ME. August, 2003*)

1. The **cleaning** protocol is recommended for all equipment, boats and vehicles at the end of the day. Remember that the seeds of loosestrife and several invasive grasses are almost microscopic. The **disinfection** protocol is recommended any time you are handling animals or equipment that comes in contact with animals (like fish nets), and any time equipment is to be used in a different watershed. The disinfection protocol is especially critical in the Maine salmon rivers and for vernal pools. Amphibians are thought to be especially at risk from red leg bacteria, rana virus, and parasites.

2. A disinfecting area should be established at each office. The disinfecting area needs to have an outside water faucet and an adequate length of garden hose with sprayer. Ideally, the area should have excellent drainage or percolation.

3. Vehicles and equipment should be kept clean and free of dirt and mud, which can harbor pathogens, invasive plant seeds and other pests, and prevent effective disinfection. Normal soap and water goes a long way in accomplishing this.

Equipment needed: 1 large (40+ gal.) trash can
Large stiff bristle brush
Spray bottle
Nolvasan disinfectant
Rubbing alcohol

Crew vehicles:

Wash periodically during the field season.

Transport trucks and tanks:

All transport trucks and transport tanks are to be disinfected before they are used to haul fish from different river systems. **Care must be taken to run all recirculation pumps and aerators during disinfection and rinsing. Be sure equipment is rinsed thoroughly!** Disinfection is accomplished with a 2oz. Nolvasan/gallon water solution or chlorine bleach at 250 ppm.

Field equipment:

All field equipment must be disinfected before use between river systems. Disinfection for most equipment is accomplished with a 2oz. Nolvasan/gallon water solution in the large trash can. A chlorine bleach solution of 250 ppm may also be used. Equipment that comes in constant contact with stream water, such as waders, dip nets, seines, gloves, live cars, shocker wand and tail, fish boards, etc., should be allowed to sit in solution for 10 minutes then rinsed thoroughly. Delicate equipment, such as electronic scales, conductivity meters, thermometers, etc., should be sprayed with alcohol and allowed to air dry. **Again, be sure all equipment is rinsed thoroughly!**

CHAPTER TEN
QUALITY CONTROL

10

10.1 General Quality Control

General Quality Control

(*From Maine Department of Environmental Protection, Augusta, ME 2003)*

1. Volunteers should be trained once a year at the beginning of the field season.

2. Use the manufacturer's directions with electronic meters and kits. Make sure that chemicals are fresh and have not expired. In general, do not reuse chemicals. Buffers can be reused once or twice before they are discarded. It is better to discard a buffer that might be contaminated than to take a chance of getting poor results. Chemicals are cheap in comparison to our time and effort. The same is true of mistakes made while doing DO titrations. It is best to toss out the sample and start over than to accept dubious results. The titrations take about 10 minutes, and you spend much more time than that on the road to get the samples.

3. When samples are taken for lab analysis, take a few extra samples as replicates and/or split samples. Replicates are samples from the same place and time in different bottles. A split sample comes from taking one bottle and splitting the water into two halves for analysis. Replicates are a test of the lab's ability to reproduce its results (i.e., a quality check on the lab). The split sample is a check for the cleanness of the bottle. Splits and/or replicates are especially good for bacteria sampling due to the naturally high variability of bacteria distributions in water and the ease with which bacteria are spread as contaminants. A good number of replications/splits are about 10% of the total number of samples.

4. Replicates are also useful for testing the ability of volunteers to reproduce a result in the field (i.e., a test of their "lab technique"). This is especially a good idea for the DO kits, as experience does increase procedure accuracy. All beginners should duplicate the DO titrations (i.e., two titrations from the same sample bottle). Your "lab technique" is good when the titrations give you the same results or you are within 0.2 ppm of the previous result.

5. When you have the chance, test meters and other equipment against other teams or with your watershed coordinator.

10.2 Quality Assurance Project Plans

Quality Assurance Project Plans

(Modified from the Sheepscot Watershed Quality Assurance Project Plan, 2001)

A river-specific Quality Assurance Project Plan (QAPP) should be created for every WQM Project. The objective of a QAPP is to clearly outline the WQM project objectives, as well as provide guidance for training, record keeping, and sampling quality control. The typical QAPP includes the following topics:

- Project Organization
- Definition of Problem
- Project Description
- Measurement Quality Objectives
- Training Requirements and Certification
- Documentation and Records
- Sampling Process Design
- Sampling Method Requirements
- Sample Handling and Custody Procedures
- Analytical Methods Requirements
- Quality Control Requirements
- Instrument Testing & Inspection
- Instrument Calibration
- Inspection/Acceptance Requirements
- Data Acquisition Requirements
- Data Management
- Assessment and Response Actions
- Reporting
- Data Review, Validation, and Verification
- Reconciliation with Data Quality Objectives

APPENDIX A

GENERAL WQM EQUIPMENT LIST

Equipment List

(*From Maine Department of Environmental Protection, Augusta, ME, August 2003*)

pH meter and buffer kit (spring, fall and unknown streams)
- Standard acid solution or borax for quality control test
- Distilled water for quality control
- Plastic beaker or paper cup
- Rinse water in squirt bottle

Turbidity kit (spring and fall)
Hand held thermometer
Dissolved oxygen kit (summer and fall)
Field forms and clipboard
Pencil and Sharpie magic marker
Large Nalgene bottles for water samples
Ice chest with ice or reusable ice packs
Peel-off labels
Rubber bands to secure labels
Roll of paper towels
Safety vest
Waders or waterproof boots
Collection bucket on a string (bridges)
Ladle (bottle on a broomstick)

Rain gauge (at home/office)

Bacteria Sampling:

Whirl pack bags
Tongs
Disposable gloves
Sharpie
Ice chest and ice packs

Temperature Loggers:

Onset Tidbit or similar logger
Hand held thermometer
Anchor and PVC case
Shuttle and docking unit for uploads
Crescent wrench and pliers
Special field form

Optional Equipment:

Cell phone
GPS unit
Camera
Snow shoes or ice cleats (spring)
Ski poles or walking stick

APPENDIX B

CHECKING ACCURACY OF TEMPERATURE DATA LOGGERS

B

Standard Operating Procedure: **Checking Accuracy of Temperature Data Loggers**

Revision 2
September 25, 2002

General Discussion

A. Principle: This procedure is to check the accuracy of temperature data loggers prior to their deployment in the field.

B. Interferences: In order to check accuracy and precision data loggers must be tested in a controlled environment using a certified thermometer.

Equipment List

- 1-2 medium sized coolers.
- 1-2 calibrated thermometers (NIST) accurate to 0.2oC
- Temperature logger calibration forms.
- Temperature loggers and watertight cases (if needed).
- Timer (clock) synchronized with data loggers (computer).
- Water.
- Ice.

Procedure

A. Preparing Data Loggers

Set the delay start time of each data logger so they will all begin recording temperatures at the same time (e.g., 9:00am) and at the same interval (e.g., 2 minutes). If working with loggers that do not have a delay start option record the time at which the logger was initially launched. Synchronize the computer and data logger clocks and the timer (watch) to be used during the actual procedure. Set up all loggers to be tested prior to getting the ice bath ready. Begin filling out an Accuracy Check Form for each individual data logger.

B. Ice Bath

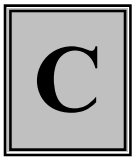
1. Place water and ice into a cooler creating thick slurry. The level should be high enough to completely cover the loggers. It is best if the slurry is consistent to the bottom of the cooler. Allow at least 30 minutes for the ice bath to equilibrate.
2. Place the loggers in the ice bath at least 15 minutes before they are to begin recording temperatures to allow them to equilibrate. Be sure that the thermocouple of the data logger is not touching any surface of the cooler.
3. Place the certified thermometer in the bath as well. It should be as close to the loggers as possible without touching any of them. Secure it so that it is not touching the bottom or sides of the cooler. A ring stand and clamp work best.
4. At the set start time (e.g., 9:00am) begin recording time and instantaneous temperatures of the thermometer at each interval (e.g., every 2 minutes). Continue recording until the desired calibration time is completed. Record the stop time.

5. Take the data loggers out of the ice bath and up load the temperature information. Create a spreadsheet for times vs. temperatures recorded for the thermometer and each data logger.
6. Compare the temperatures recorded by each data logger to the temperature of the thermometer for each time interval.
7. Calculate and record any observed differences.
8. If there is no difference in temperature between the data logger and instantaneous thermometer readings, or if any observed difference is less than +/- 0.7^{o}C, the data logger requires no further testing at this temperature.
9. If the difference of the instantaneous thermometer readings vs. any data logger reading for the same time interval is greater than +/- 0.7^{o}C repeat the ice bath procedure for each out of bounds data logger.
10. If the difference is no longer greater than +/- 0.7^{o}C, the procedure should be repeated a third time to verify the results.
11. If the difference is again greater than +/- 0.7^{o}C do not use the logger and contact the manufacturer.

C. Room Temperature

1. Set up a cooler in a shaded room half full of tap water at least 12 hours prior to beginning.
2. Prepare data loggers as described above in **Procedure** (Section A. Preparing Data Loggers).
3. Place loggers in the cooler at least 15 minutes before they begin recording temperatures and close lid to allow them to equilibrate.
4. Place the certified thermometer in the bath as well. It should be as close to the loggers as possible without touching any of them. Secure it so that it is not touching the bottom or sides of the cooler. A ring stand and clamp work best.
5. At the set start time (e.g., 9:00am) begin recording time and instantaneous temperatures of the thermometer at each interval (e.g., every 2 minutes). Continue recording until the desired calibration time is completed. Record the stop time.
6. Take the data loggers out of the cooler and up load the temperature information. Create a spreadsheet for times vs. temperatures recorded for the thermometer and each data logger.
7. Compare the temperatures recorded by the each data logger to the temperature of the thermometer for each time interval.
8. Calculate and record the any differences
9. If there is no difference in temperature between the data logger and instantaneous thermometer readings, or if any observed difference is less than +/- 0.7^{o}C, the data logger requires no further testing at this temperature.
10. If the difference of the instantaneous thermometer readings vs. any data logger reading for the same time interval is greater than +/- 0.7^{o}C repeat the room temperature bath procedure for each out of bounds data logger.
11. If the difference is no longer greater than +/- 0.7^{o}C, the procedure should be repeated a third time to verify the results.
12. If the difference is again greater than +/- 0.7^{o}C do not use the logger and contact the manufacturer.

APPENDIX C
LOGGER ACCURACY CHECK FORM



TEMPERATURE LOGGER ACCURACY CHECK FORM

Reported by _____Organization _____

Date _____ Drainage to be used in _____

Model _____ Serial #_____

Drainage Logger ID#_____

TIME	BATH TEMPERATURE (^{O}C)	LOGGER TEMPERATURE (^{O}C)	DISCREPANCY (^{O}C)

Logger Field Equipment List

- Data logger.
- Watertight housing (if applicable)
- Anchoring devices.
- Zip ties, heavy braided line, wire
- GPS receiver
- Thermometer (Digital, accurate to +/- 0.2^{o}C)
- Field sheet (on Rite-N-Rain).
- Contact Info Paper (small piece of paper or business card placed inside the logger that includes name of organization and contact information. Also, serial #, site name, etc. optional).
- Permanent Marker (for labeling the site on the unit's case and date on the battery)
- Desiccant packs for watertight cases (very important – if blue they are good; if pink bake them in an oven at 250 degrees)
- Launch/Download Data Sheet

Other Miscellaneous Items

- Flagging
- Duct Tape
- Cutting Tool
- Watch Bucket
- Spray paint – green, black, brown (to camouflage white or clear logger cases)
- Gaff (rarely necessary)

APPENDIX E

FIELD DEPLOYMENT FORM

Deployment ID_____

TEMPERATURE LOGGER FIELD FORM

Pre-Deployment

Reported by _____ Organization _____ Date _____

Drainage _____Branch _____Subreach _____

Town _____County _____ Site Name _____

Logger type _____ Logger ID #_____ Thermal Scale: ^{o}C or ^{o}F

Delayed Start _____

(Date/Time)

Logger Deployment

Reported by _____ Organization _____ Date _____
Time _____

UTM Coord. (Map Datum: NAD 83)
_____E _____N

Time _____hours Water temperature _____ ^{o}C

Check Instrument _____

Site characteristics (Percent canopy cover, stream stage or velocity, adjacent land use, location of known surface water and ground water influences, water depth at logger placement)

_____
_____

Permanent landmark

_____
_____

Site Sketch

Midseason Site Check

Reported by _____ Organization _____

Date _____

Time _____hours Water temperature _____ ^{o}C

Check Instrument _____

Condition of site/logger

_____

_____

Logger Retrieval

Reported by _____ Organization _____

Date _____

Time _____hours Water temperature _____ ^{o}C

Check Instrument _____

Condition of site/logger

_____

_____

APPENDIX F

Temperature Data Handling – BoxCar to Microsoft Excel

Download Data
Follow the manufacturer's procedures to download the data from the logger or shuttle to your personal computer (PC). Loggers should be downloaded soon after they are retrieved in order to save battery life for future deployments. Software such as BoxCar allows for viewing the data graphically but typically does not allow for editing of anomalous data. Common anomalies in temperature logger data include air temperature values which can occur pre- and post-deployment, or if a site should dry up during the sampling season. Anomalies can often be identified by extreme spikes in the data or a deviation from normal diurnal temperature patterns.

Step 1:
Exporting Data as Text File

To export a file from BoxCar to Microsoft Excel select:

File → Export → Microsoft Excel

An "Export Screen" will appear, select "Export". On the "Save As" screen choose the destination to which the file will be saved. Type in a unique file name (e.g. NG-Rt9-2003), and select "Save". The file is now saved as a text document (*.txt).

Step 2:
Importing Text File to an Excel Spreadsheet

To import the saved text document into an Excel document open a blank Excel spreadsheet. Select:

File → Open→

At the top of the "Open" screen, in the "Look-in" box, choose the folder where the original text file exported from BoxCar was saved. At the bottom of the "Open" screen be sure the "File Type:" is listed as "Text Files (*.prn; *.txt; *.csv)". The text file should be listed as one of the files available to open. Click on the file and select "Open".

A series of three "Text Import Wizard" screens will appear with options allowing you to format the data before it is imported to Excel.

> **Screen 1:** Be sure the "Delimited" option is checked. The options "Start import row at:" should be 1, and the "File origin" should be Windows (ANSI).
>
> →Next

Screen 2: Under "Delimiters" check both "Tab" and "Space". This option separates the data out into the proper columns. "Treat Consecutive Qualifiers As One" should be checked, and the "Text Qualifier" should be double quotation marks. A "Data Preview" box is included at the bottom of the screen.

➔Next

Screen 3: This screen allows you to set the data format for each column. Select the date column in the "Data Preview" box and under "Column Data Format" check "Date". The time and temperature columns should be left as "General". Finally, for the last column (*C) select "Do not import column".

➔Finish

Step 3:
Converting the Text File to an Excel File

The data should now be in an Excel spread sheet, however it is still a text document (*.txt). Highlight the entire Time column by right clicking on the letter heading of the column (B). Select "Format Cells" and then the "Number" tab. In the "Category" option select "Time" and then under "Type" select "13:30"

➔Format Cells ➔Number ➔Time ➔13:30

Now select "File, Save-as". In the "Save in:" box choose the location that you would like to save this file to. At the bottom of the screen in "Save as type:" click on the down arrow (▼) and select "Microsoft Excel Workbook (*.xls)". Finally click on the "Save" button.

Step 4:
Editing the Excel File

The file is now an excel document and any anomalies in the data can be edited out of the file. Retain the original raw text data file in its unaltered state for future reference. Referring to the Field Deployment Sheet, delete any data that was recorded before the deployment date and time and after the retrieval date and time. In addition, for further data quality control, delete the first 2 and last 2 hours of the actual deployment data.

Refer back to the original BoxCar file to identify anomalous data such as spikes or abnormal daily water temperature patterns. Be sure to refer to Midseason Site Check(s) section on the deployment sheet for any instances that the logger was found moved from its original deployment location or out of the water, and flag any such dates. All values that represent anything but water temperatures must be edited out of the file prior to any analysis.