National Park Service
U.S. Department of the Interior

Northeast Temperate Network
Inventory & Monitoring Division

Northeast Temperate Network Permanent Freshwater Wetland Monitoring Standard Operating Procedures for Acadia National Park

2020 Revision



For more information on NETN's Permanent Freshwater Wetland Monitoring Program and to access documents associated with this protocol, visit NETN's website at https://www.nps.gov/im/netn/freshwater-wetlands.htm

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

Please cite this publication as:

Miller, K.M, B. R. Mitchell, and C. E Seirup. 2020. Standard Operating Procedures for the Northeast Temperate Network Permanent Freshwater Wetland Monitoring Program. Northeast Temperate Network. National Park Service, Woodstock, Vermont.

Northeast Temperate Network Protocol Package Documents:

This is one of a series of documents that collectively describe the objectives, procedures, and data quality of NETN's Permanent Freshwater Wetlands monitoring program at Acadia National Park. Please visit NETN's Freshwater Wetlands Program on the US NPS's Data Store (IRMA Reference Code #2208704) for links to all supporting protocol documents and products associated with this program, including but not limited to:

Protocol Narrative
Quality Assurance Plan (QAP)
Safety Plan
Summary of Major Protocol Changes

ON THE COVER
Big Heath in Acadia National Park
Photograph by K. M. Miller

January 2021

Contents

Page

SOP 1 – Preparation and Equipment List 6
Overview 6
Procedures 6
Staff 6
Planning and Coordination 6
Maps 6
Training 7
Equipment 7
Well Installation 7
Well Measurement 8
Rapid Assessment Monitoring 8
Literature Cited 8
Revision History 9
SOP 2 – Using the Global Positioning System 10
Overview 10
Revision History 10
SOP 3 – Data Management and Quality Assurance/ Quality Control 11
Overview 11
Procedures 11
Rapid Assessment Monitoring 11
Water Level Monitoring 12
Literature Cited 12
Revision History 13
SOP 4 – Rapid Assessment Site Establishment and Data Collection 14
Overview 14
Procedures 14
Revision History 16
SOP 5 – Sentinel Site Establishment 17
Overview 17
Procedures 17
Revision History 18

SOP 6 – Shallow Well Construction, Installation, and Maintenance 19
Overview 19
Procedures 19
Well Construction 19
Well Installation 21
Well Maintenance and Replacement 21
Revision History 24
SOP 7 – Using the HOBO® Water Level Logger and Shuttle 25
Overview 25
Procedures 25
Revision History 29
SOP 8 – Data Analysis and Reporting 30
Overview 30
General Considerations for Writing Reports 30
Data Analysis 30
Sentinel Monitoring Data 30
Rapid Assessment Data 31
Reporting 32
Literature Cited 33
Revision History 34

SOP 1 – Preparation and Equipment List

Northeast Temperate Network

Version 1.04

Overview
This SOP delineates preparations for the summer field season and includes a list of necessary field equipment for intensive and rapid assessment sampling. Preparations should be complete by the start of the summer field season in May or early June.

Procedures
Follow procedures described in Chapter 2 of the EPA Field Operations Manual to prepare for intensive sampling in the sentinel sites for the National Wetland Condition Assessment (NWCA). Refer to section 2.3 of the FOM for a complete list of equipment and supplies required to implement the FOM. Additional procedures specific to implementing this protocol in the Northeast Temperate Network are described below.

Staff
This protocol will be implemented by a 2-person team and will include the NETN Plant Ecologist plus a seasonal technician or volunteer. Additional personnel and network staff may be needed for the following tasks:

- NETN Program Manager to help with contracting, hiring, and potentially participate in data collection
- NETN Air and Water staff to train staff and/or assist with water samples and calibrating equipment
- NETN Data Manager to develop and manage databases for storing non-NWCA data

Planning and Coordination
The Plant Ecologist should ensure that the ACAD Research Permit Reviewer has a current version of the wetland protocol including all SOPs, as well as a current map of sampling locations. A map clearly showing the location of each site must be provided at least one month prior to any soil sampling, to provide time for determination of the presence of cultural artifacts that might be compromised by soil sampling. Note that once a site has been approved, additional approval for soil sampling, as long as the methods have not changed, is not required. Site marking procedures must be cleared by the ACAD Research Permit Reviewer prior to establishment.

Maps
Prior to each field season, the Plant Ecologist should prepare topographic maps and orthophotos showing sampling locations in the annual panel at scales of 1:24,000 or larger. Maps should clearly show location of the sites in relation to topography, roads, trails and park features, and should display preliminary USA-RAM Metric 1 and 2 layers (includes the assessment area and

buffer perimeters, and the eight buffer transect lines), and the buffer plot locations (sentinel sites only). These maps and aerial photographs should be printed on Rite-in-Rain paper using a color LaserJet printer. Center coordinates of each site should be exported, printed, and downloaded directly into the network GPS unit. Trails, park boundaries, and topographic maps should also be loaded on GPS units.

Training

During years that sentinel sites are sampled for the NWCA, the Plant Ecologist and seasonal technician will attend a pre-season EPA NWCA training on the FOM (U.S. EPA 2016). During the four years between the NWCA, the Plant Ecologist will train the seasonal technician on USA-RAM (U.S. EPA 2011) and additional protocol methods.

Training topics that should be covered by NETN staff every year include:

- Regulations and procedures related to use of NPS vehicles
- Guidelines regarding timesheets, credit leave versus comp time, and requesting leave
- Safety and workers compensation
- Proper use of all NETN equipment including a Garmin 60CSX GPS unit, park radio, and digital camera

Equipment

A list of equipment and supplies required to implement the EPA Field Operations Manual is described in Section 2.3 of the FOM. Additional equipment and supplies required to implement this protocol are listed below by task.

Well Installation

PVC threaded cap for 4.2 cm pipe
60 cm of 4.2 cm outside diameter schedule 40 threaded PVC
PVC threaded pipe coupling for 4.2 cm PVC
60 or 120 cm of 4.2 cm slotted schedule 40 PVC pipe with threaded flush joints
PVC threaded point for 4.2 cm PVC
PVC Primer
PVC Cement
1.2 to 1.8 m (depends on length of well) of 1.5 mm stainless steel cable (1 per well)
1.5 mm stainless steel crimp (2 per well)
3/8-16 x2 ½" stainless steel hex bolt and nut (18-8/ 304) (1 per well)
HOBO® U20 Water Level Logger (1 per well)
HOBO® U20 Water Level Logger for barometric pressure calibration (1 unit will cover a radius of 15 km)
HOBO® Waterproof Shuttle
Lens tissue and water (for cleaning HOBO® logger optics)
Heavy duty pliers

Carabiner (must be wider than the inside diameter of the well pipe)
Cordless drill with 0.48 cm and 2 mm drill bits
1.8 m heavy duty U channel fence post (2 per well)
40 cm or longer bubble level

Rigid measuring tape (2 m or longer) for depth to water measurements in wells and distances and heights of well pipe and fence posts.
Panasonic Toughbook laptop with latest version of HOBOware installed

Well Measurement

A HOBO® Waterproof Shuttle
Lens tissue and water (for cleaning HOBO® logger optics)
40 cm or longer bubble level
Rigid measuring tape (2 m or longer) for depth to water measurements in wells
Permanent paint pen (to re-establish faded calibration marks)
Carabiner (must be wider than the inside diameter of the well pipe)
Panasonic Toughbook laptop with latest version of HOBOware installed

Rapid Assessment Monitoring

USA-RAM and vascular plant datasheets (on Rite-in-the-Rain paper)
iPad mini for data entry
USA-RAM Metric 1 and 2 map for each site
Enclosed clipboard (2)
100 m measuring tape (2)
GPS unit
Compass (2)
Flagging and survey flags (5)
Sharpened pencils and permanent markers
45 cm long # 4 rebar with secured metal survey cap
Sealable plastic bags for unknown samples

Literature Cited

U.S. Environmental Protection Agency. 2011. National Wetland Condition Assessment: USA-RAM Manual. EPA-843-R12-001. U.S. Environmental Protection Agency, Washington, DC.

U.S. Environmental Protection Agency. 2016. National Wetland Condition Assessment 2016: Field Operations Manual. EPA-843-R-15-007. U.S. Environmental Protection Agency, Washington, DC.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	August 2011	Kate Miller	Initial version	
1.01	August 2012	Kate Miller	Includes info for USA RAM years and monitoring shallow wells	Update to include both types of sampling events and hydrology monitoring
1.02	January 2013	Kate Miller	Revised site terms	Maintain consistency with NETN and EPA protocols.
1.03	January 2016	Kate Miller	Updated citations and sections to match 2016 NWCA documents. Revised contact info for ACAD RM. Added iPad mini to equipment list. Removed water level meter and carpenter ruler and replaced with rigid measuring tape.	Keep document up to date with EPA protocols. Reflect staffing changes Apply new technology Rigid measuring tape has proven to work best
1.04	January 2020	Kate Miller	Changed SOP number Added literature cited section Updated title for ACAD approver of plot markers	For consistency with Protocol Package

SOP 2 – Using the Global Positioning System

Northeast Temperate Network

Version 1.01

Overview

This Standard Operating Procedure explains the methods that all observers should follow to learn to use Global Positioning System (GPS) with the Garmin GPSMAP 60CSX unit. The GPS will be used to help navigate to and locate pre-existing plots as well as document the location of new plots.

Procedures

Follow the procedures described in Section 2.5.4.3 of the EPA Field Operations Manual (U.S. EPA 2011b). For specific procedures related to using the Garmin GPSMAP 60CSX, refer to the current version of the Using the Global Positioning System (GPS) SOP of the NETN Long-term Forest Monitoring Protocol. Note that all GPS data collected for this protocol will be reported to EPA in decimal degrees and in NAD83 datum, but will be stored in NETN databases as Universal Transverse Mercator (UTM) and NAD83.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	August 2011	Kate Miller	Initial version	
1.01	January 2020	Kate Miller	Changed SOP number	For consistency with Protocol Package

SOP 3 – Data Management and Quality Assurance/ Quality Control

Northeast Temperate Network

Version 1.04

Overview

Careful, accurate collection of data as directed in these SOPs and protocol manuals is critical to the success of Vital Signs monitoring. This SOP describes quality assurance/quality control (QA/QC) procedures for accurate data collection, transcription and stewardship, and assessment of data quality that are conducted during Rapid Assessment Monitoring (RAM) and water level monitoring in sentinel sites. Detailed QA/QC procedures used during sentinel site monitoring are described in the Field Operation Manual (U.S. EPA 2016). More information on data quality standards and QA/QC methods can be found in the NETN Quality Assurance Plan (Miller and Weed 2021).

Procedures

Rapid Assessment Monitoring

Data Entry, Verification, and Management

Where possible, data collected in the RAM sites are digitally entered in the field using a FileMaker app installed on an iPad mini. By using the FileMaker app, data entry errors are minimized through the use of automated methods within the forms (e.g., range limits, pick lists, and calendars) and scripts that check for logical inconsistencies (e.g., a stressor recorded as present, but with a severity rank of 0 instead of 1-3). The app also includes a checker tool that verifies that all required fields are complete and displays any missing data points that are required for a visit. The checker must be cleared in the field before pulling up transect tapes and preparing to leave the site. Upon returning to the office at the end of each field day, a copy of the FileMaker app must be emailed to the Ecologist as a backup.

If the FileMaker app is not available for data entry, RAM data are recorded on datasheets and verified in the field by having technicians review each other's datasheets and recording their initials when completed. Upon returning to the office, datasheets are scanned so that a digital copy of each datasheet is stored on an NPS server. RAM data that were recorded on datasheets are then entered into the FileMaker Pro app (desktop version) and follow a two-step verification process. Data entry is first verified with a 100% check of records to the original datasheets. After the 100% check is completed, a random 10% check is conducted. In the 10% check, 10% of datasheets are randomly selected and the data in the app are checked against the datasheet. If any data entry errors are detected during the 10% check, another 100% check must be conducted, followed by another random 10% check. This process is repeated until no data entry errors are detected during the 10% check. After the data in the app are verified to accurately reflect the original field data, the paper forms are archived and the electronic version is used for all subsequent data activities. After the 10% check is accepted, the checker is run for each visit to identify any data omissions or errors. Errors identified in the check that can be resolved are

corrected on the paper data sheets and in the app. If these errors can not be resolved, they are documented in the location-level notes field for the site, so the data can be checked during the next visit. After the data are verified for a given site, the person verifying records their initials on the top margin of the datasheets for that site.

After all RAM data entry (including all unknowns being identified) and checking are complete for a given year in the FileMaker Pro app, tables are exported to .xlsx files using the Export Tool in the FileMaker Pro app. An MS Access Import Database then loads the exported .xlsx files and appends them to the associated tables in the NETN RAM backend database. Once the RAM data are appended to the NETN RAM backend, further quality control checks are performed to complete the certification process, which are described in more detail in the QAP (Miller and Weed 2021).

Observer Bias

To determine reliability of field data collection, one RAM site is randomly selected every other panel to be resampled for QA/QC by separate observers. The QA/QC sampling schedule balances the need for QA/QC data with the need to minimize trampling impacts in sensitive habitats. Sentinel sites will not be resampled unless randomly selected by the EPA NWCA as a QA/QC site.

Water Level Monitoring

Data collected by pressure transducers should be downloaded twice annually (spring and fall) and stored in the NETN RAM database. During the spring and fall visits, height and distance measurements are taken and well level is checked to determine if the well shifted since the previous visit. If a well shifted, but is still stable, the level line must be reestablished and well height, fence post heights, and distances between the well and fence posts should be remeasured. If a well is leaning more than 10 degrees from vertical, or is unstable, the well must be removed and established in a new location, preferably within 2 m of the center of the AA, but outside of the closest vegetation plot. For detailed instructions on well installation, maintenance and measurements, refer to SOP 6 – Shallow Well Construction, Installation, and Maintenance. For more details on managing water level and temperature data collected by pressure transducers, refer to SOP 7 – Using the HOBO® Water Level Logger and Shuttle.

Literature Cited

Miller, K. M., and A. S. Weed. 2021. Quality Assurance Plan for the Northeast Temperate Network Permanent Freshwater Wetland Monitoring Protocol. Natural Resource Report NPS/XXXX/NRR—2021/XXX. National Park Service, Fort Collins, Colorado

U.S. Environmental Protection Agency. 2011. National Wetland Condition Assessment: USA-RAM Manual. EPA-843-R12-001. U.S. Environmental Protection Agency, Washington, DC.

U.S. Environmental Protection Agency. 2016. National Wetland Condition Assessment 2016: Field Operations Manual. EPA-843-R-15-007. U.S. Environmental Protection Agency, Washington, DC.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	August 2011	Kate Miller	Initial version	
1.01	August 2012	Kate Miller	Well monitoring occurs twice annually. References SOP 7 for managing transducer data.	Revision to minimize loss of growing season data due to well shifting in winter.
1.03	January 2016	Kate Miller	Updated chapter for FOM Added the use of an iPad mini and app for data collection. Added procedures for QA/QC sampling	To match EPA's latest protocol To take advantage of new technology To meet IMD protocol standards
1.04	January 2020	Kate Miller	Changed SOP number Added information relevant to field technicians implementing the protocol	For consistency with Protocol Package

SOP 4 – Rapid Assessment Site Establishment and Data Collection

Northeast Temperate Network

Version 1.03

Overview

This SOP covers procedures that are not covered in the USA-RAM (U.S. EPA 2011) for establishing and sampling the rapid assessment monitoring (RAM) sites. To sample RAM sites, field staff must therefore carry a copy of this SOP and the USA-RAM manual. Prior to the field season, rapid assessment sites will be selected using GIS and the GRTS sampling algorithm to provide a random, spatially balanced sample. It is important that site marking procedures have been approved by the ACAD Research Permit Reviewer prior to establishment.

Procedures

Procedures for establishing and sampling a rapid assessment site follow the USA-RAM with a few additions. First, a metal survey cap attached to a 45 cm long, #4 rebar is installed to permanently mark the center of the assessment area (Figure 1).

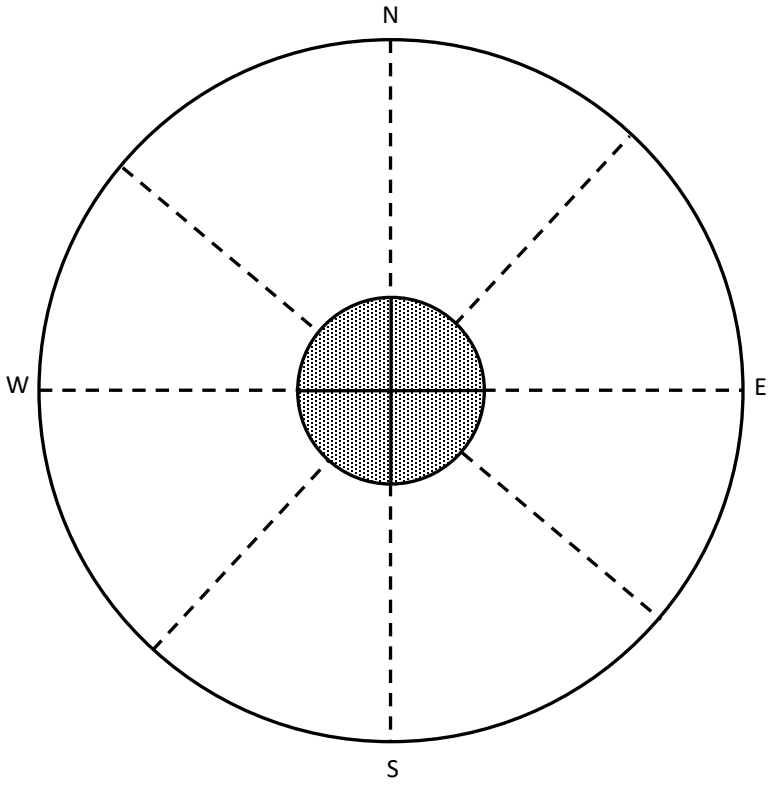


Figure S4.1. Design of rapid assessment site, including a 40-m radius assessment area (◍) broken into quarters, 100-m buffer (white) around the assessment area, and eight 100-m buffer transects (dashed lines).

Once the center of the assessment area is established, the circle should be broken into quarters by running measuring tapes out 40 m in the four cardinal directions. Starting along the north transect and moving clockwise, photopoints should be taken from the center using a landscape orientation followed by a portrait orientation, for each of the cardinal directions. The horizon should be centered in the photo vertically, and the transect should be centered in the photo horizontally. Photopoints should be taken and named following the example below. The first three letters of photopoint file names for RAM sites should always be RAM, followed by a dash and a two-digit site number. If the site number is below 10, it should be padded by a 0 (e.g., RAM-04). The site numbers are followed by an underscore, and then the three-digit transect orientation. For the north transect, use 360. For the east transect, use 090. The south transect is 180, and the west transect is 270. Indicate whether the orientation is landscape or portrait by L or P. Finally add an underscore, then the date in the format of YYYYMMDD.

RAM-21_090L_20190706.jpg

After the four transects are established and photopoints are taken, a 15-minute search is conducted in each quarter of the assessment area, and all vascular species observed in each quarter are recorded. If buffer transects or potential stressors in the 100 m buffer surrounding the AA need to be ground-truthed near a given quarter, field staff should pause the timed search to check the buffer, then resume the timed search after returning to the AA. This ensures that all areas of the assessment area and buffer have been checked for presence of stressors, including invasive species, which are later recorded during the USA-RAM. This also provides a working species list for each site. If a plant species is not identifiable in the field, first determine if the plant is locally rare or abundant. If the unknown species is abundant in the AA, collect a sample for later identification in the office. If the unknown species is rare in the AA, take pictures of the species and include a ruler for scale. After the unknowns are identified in the office, update the species name in the datasheets and/or FileMaker app, and destroy the unknown specimen.

Upon completing the 15-minute searches in each quarter of the assessment area, follow the procedures described in the USA-RAM (U.S. EPA 2011) to complete rapid assessment. For metrics 1 – 3, which characterize the condition of the buffer, record stressors observed while ground-truthing the buffer, and/or examine aerial photos and land cover layers (e.g., roads, developed areas, etc.) to record the presence of any stressors in the buffer. Next, complete Metrics 4 through 7, which characterize wetland form, structure, and composition by strata. In addition, estimate % cover of bryophyte ground cover in the AA following the same procedures outlined in USA-RAM Metric 6 for vascular plant strata. Lastly, record any stressors observed in the AA that could impact water quality (Metric 8), wetland hydrology (Metric 9), soil condition/substrate (Metric 10), and vegetation (Metrics 11 and 12).

Literature Cited

U.S. Environmental Protection Agency. 2011. National Wetland Condition Assessment: USA-RAM Manual. EPA-843-R12-001. U.S. Environmental Protection Agency, Washington, DC.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	August 2012	Kate Miller	Initial version	
1.01	January 2013	Kate Miller	Revised site terms and SOP name. Added site diagram Added directions on sampling in the buffer area.	Maintain consistency with NETN and EPA protocols.
1.02	January 2015	Kate Miller	Added % bryophyte estimation for AA. Added details on photopoints and naming conventions	This is needed to calculate Vegetation Multi-metric Indicator. RAM methods are slightly from EPA FOM
1.03	January 2020	Kate Miller	Added info on unknown species procedures Updated title for ACAD approver of plot markers Changed SOP number Clarified order of sampling of timed plant search and added more information on USA-RAM metrics	Improve clarity, and meet ACAD research permit requirements For consistency with Protocol Package

SOP 5 – Sentinel Site Establishment

Northeast Temperate Network

Version 1.03

Overview

This SOP covers procedures that are not covered in the EPA Field Operations Manual (FOM) for establishing assessment areas in the sentinel sites. Prior to the field season, sampling locations will be selected using GIS and expert judgment (see Sampling Design in the protocol narrative). It is important that plot marking procedures have been approved by the ACAD Research Permit Reviewer prior to plot establishment.

Procedures

Procedures for establishing the assessment area and nested plots are described in Chapter 3 of the FOM. Procedures for establishing buffer plots are described in Chapter 4 of the EPA FOM. In addition to FOM procedures, NETN will install a shallow well at the center of the assessment area (SOP 6 – Shallow Well Construction and Installation), and five 60-cm long fiberglass stakes to mark the vegetation plots in the assessment area (Figure S5.1).

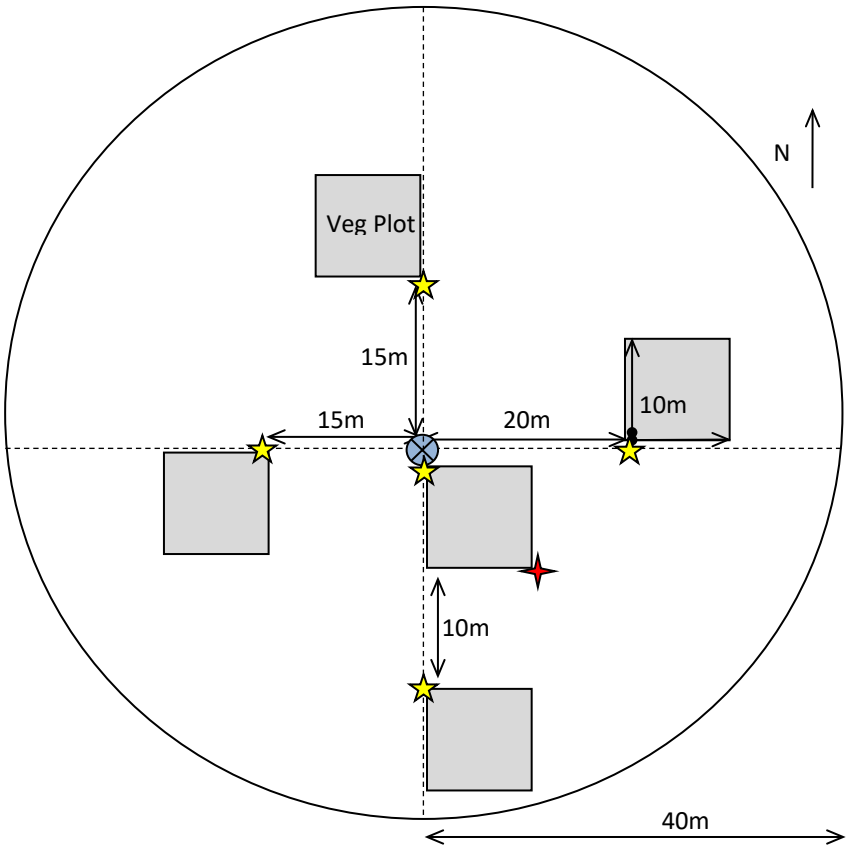


Figure S5.1. Plot design of assessment area, including location of shallow well ( ), vegetation plots (grey boxes), soil sample ( ), and permanent plot markers ( ).

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	August 2011	Kate Miller	Initial version	
1.01	January 2013	Kate Miller	Revised site terms and SOP name.	Maintain consistency with NETN and EPA protocols.
1.02	January 2017	Kate Miller	Revised soil pit location, and fixed plot design diagram (veg. plot on west transect was on wrong side of transect).	Maintain consistency with EPA protocols
1.03	January 2020	Kate Miller	Changed SOP number Updated title for ACAD approver of plot markers	For consistency with Protocol Package

SOP 6 – Shallow Well Construction, Installation, and Maintenance

Northeast Temperate Network

Version 1.05

Overview

This SOP provides instruction for constructing, installing and maintaining shallow wells for monitoring water level in sentinel monitoring sites.

Procedures

Well Construction

The following materials are needed to construct a shallow well in order of assembly from top to bottom (Figure S6.1).

- Riser Cap: polyvinylchloride (PVC) cap for 4.2 cm outside diameter pipe
- Riser: 60 or 120 cm of 4.2 cm outside diameter PVC with threading on one end, and painted in green camouflage colors
- Coupling: PVC threaded pipe coupling for 4.2 cm PVC
- Well Pipe: 60 cm of 4.2 cm slotted PVC pipe with threaded flush joints
- Well Bottom: PVC threaded point for 4.2 cm PVC

All well pieces are composed of schedule 40 PVC pipe. Riser pipe and well pipe should have threads on the ends to allow for the point and coupling attachments. To assemble the well, first make sure the PVC is clean and dust free. Spread PVC primer on the threaded joint of the riser pipe and half of the coupling, and allow to dry. Next spread PVC cement onto the same surfaces and screw the two pieces together. Repeat the same primer and cement process to attach the well pipe to the coupling, and the pointed end to the bottom of the well pipe. Next drill several 2 mm vent holes in the cap, and place cap on the top of the riser pipe.

Once well assembly is complete, the following components of the data logger should be assembled.

- 1.2 m or 1.8 m of 1.5 mm stainless steel cable (depending on well length)
- 2, 1.5 mm stainless steel crimps
- 3/8-16 x 2 ½" stainless steel hex bolt and nut (18-8/ 304)
- HOBO® U20 Water Level Logger (logger)

On each end of the stainless steel cable, thread a 1.5 mm steel crimp through the cable. On one end, make a fold in the cable that is 5 cm long and thread the end of the cable through the other hole in the crimp. Use heavy duty pliers or a crimping tool to tighten the crimp over the cable. Make sure the crimp is tight by tugging on the cable. Repeat the same process for the other end of the cable, but first thread the cable through the hole on the top of the logger (this is the smaller

black end that easily screws off). Finally, drill two holes through the riser pipe approximately 2 cm below the top of the well cap. The 2 holes made should be straight across from each other and 0.48 cm in diameter. Insert the hex bolt through one of the holes in the riser, through the top loop in the cable, and then through the other hole of the riser. This will allow the logger to hang from the hex bolt in the well. The logger should be suspended about 8 cm above the bottom tip of the well. Verify that the bottom of the logger is higher than the lowest slots in the well. This will ensure that the logger records actual water level, and not the depth of residual water collecting in the bottom of the well.

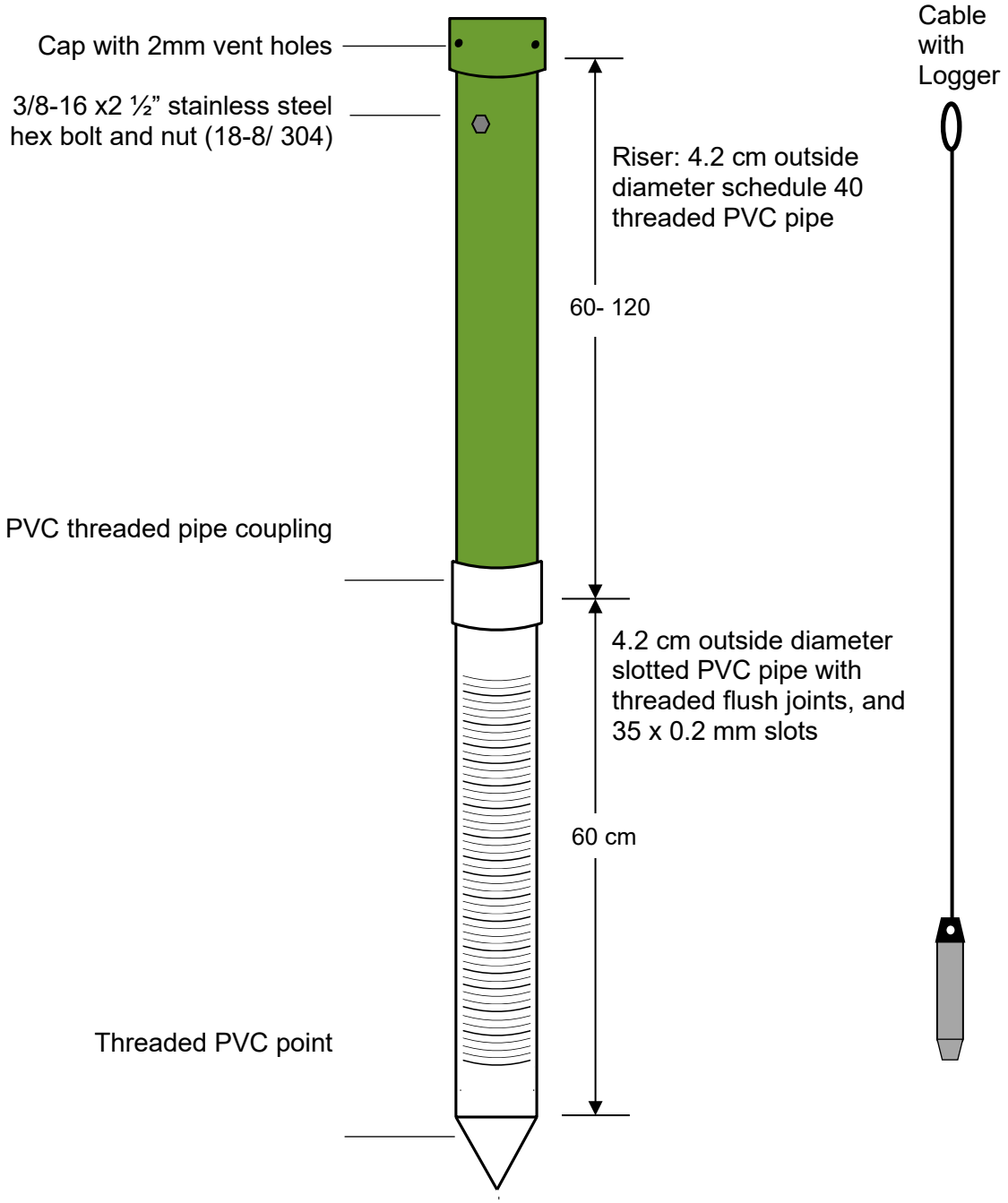


Figure S6.1. Diagram of fully assembled shallow well.

Well Installation

A well will be installed at the center of each sentinel site located on Mount Desert Island. At sites with a deep layer of Sphagnum peat, wells may be inserted directly into the wetland substrate by applying pressure on the top of the well. In areas without a deep Sphagnum peat layer, use a 4 cm diameter or smaller auger to make an opening deep enough to insert the entire slotted pipe end of the well into the substrate. Insert the well into the opening, and use the extracted soil to fill in and tighten around the pipe. Install the well as vertical as possible. A level may be helpful to insure the well is vertical. Once the well is installed, take measurements of well height, HOBO® Water Level Logger (logger) length, and post distances as described below and illustrated in Figure S6.2.

To enable checking if the well has remained at the same height over time, install two 1.8 m heavy duty U channel fence posts. Fence posts should be located approximately 30 cm from the well and at right angles from each post to the well. Insert each fence post into the substrate until it is roughly 20 cm above the top of the well. Use a level (must be at least 40 cm long) to determine the point on each fence post that is level from the top of the closest side of the well to the fence post. Mark the level point on each fence post using a permanent paint pen. Measure the distance between the level point on each fence post and the location used to measure level on the pipe (measure to the inside of the pipe). Assign a "#1" and "#2" fence post, and use a permanent paint pen to write the corresponding number on the fence post, and on the inside of the pipe to denote each location of the level measurement. Attach an ACAD research tag to fence post #1, and write "NETN Wetland Monitoring" on the tag.

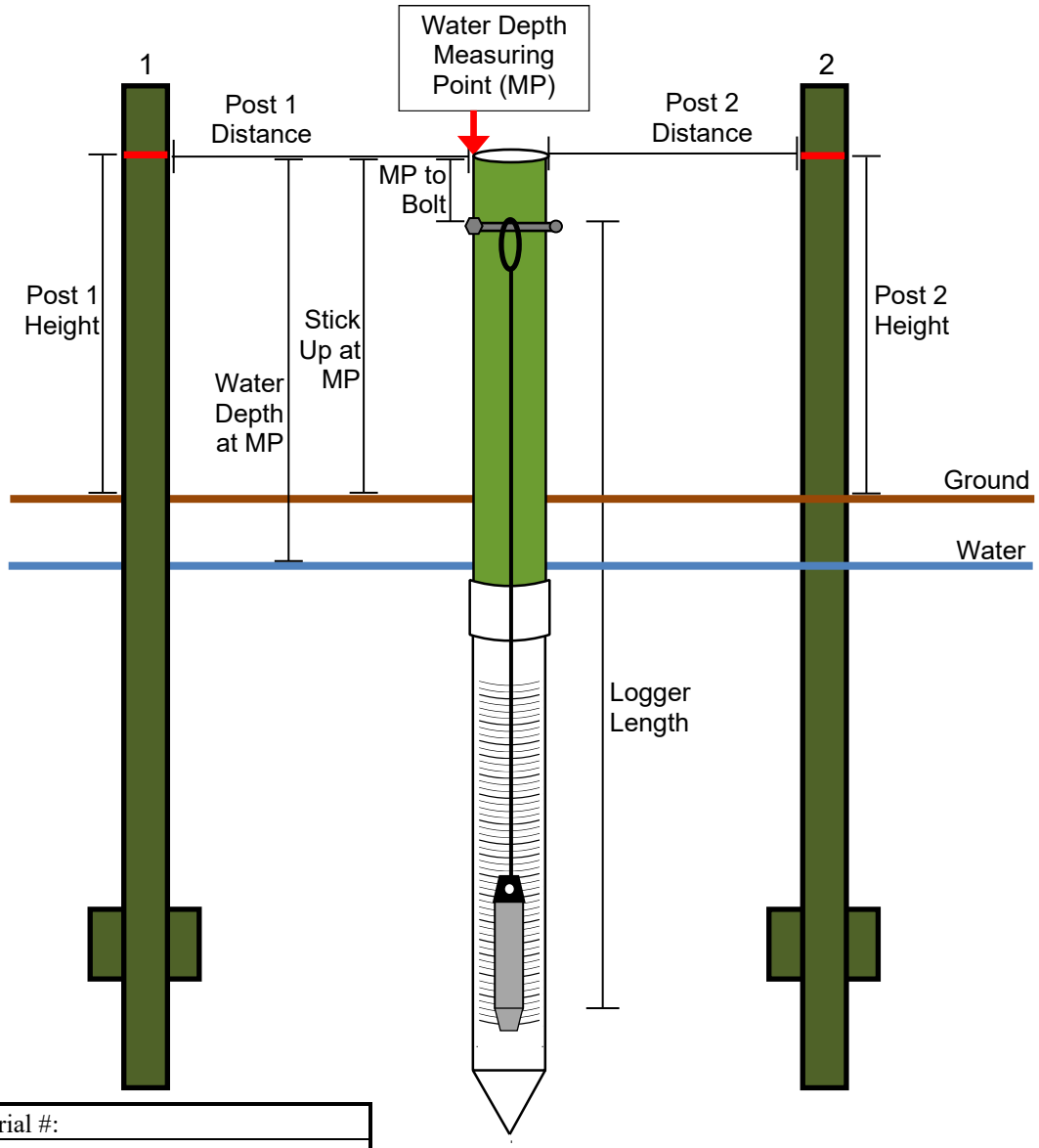
To calculate depth to water from ground, several additional measurements must be performed repeatedly on the pipe. Assign one point on the top of the riser pipe that is directly above one of the bolt holes as the water level measuring point (MP), and record this on the inside of the pipe as an arrow. Measure the distance along the riser pipe from the wetland surface to the MP and the distance between the MP and the top of the bolt hole directly below the MP. Use the rigid measuring tape to determine the depth of water from the top of the well at the MP. After these measurements are complete, and the logger has been downloaded and/or launched (See SOP 7 – Using the HOBO® Water Level Logger and Shuttle), lower the logger down into the well, and make sure the nut on the hex bolt is tight.

Well Maintenance and Replacement

Ideally wells will be visited twice a year. The first visit will be in the spring, and the second season will be in the fall. The spring visit should take place after frost heaves are no longer an issue, but before emerging vegetation can be trampled (mid-April to early May). The fall visit should occur between the end of August and before ice-in (November 1). At each visit begin by taking the following measurements:

- Distance from the surface of the ground to the top of the pipe at the water depth measuring point (MP)
- Distance from the ground to the level point on each fence post
- Distance between the pipe and the level point on the fence posts

Site: _____ **Date:** _____ **Recorders:** _____



Logger Serial #:
Launch Date & Time:
Logging Interval:
Battery Status:

Ground Water Level: _____ - _____ = – / + _____
(Stick Up at MP – Water Depth)

Measurement	Length (cm)	Measurement Notes
Stick Up at MP		Ground to measuring point (MP) on top of pipe
Post 1 Height		Ground to level line on post 1
Post 1 Distance		Shortest distance between edge of post to inside of pipe
Post 2 Height		Ground to level line on post 2
Post 2 Distance		Shortest distance between edge of post to inside of pipe
Logger Length		Top of bolt to bottom line on logger
MP to Bolt		Water depth measuring point to top of bolt.
Water Depth (WD)		MP to top of water surface
WD Meas. Time		Time of water depth measurement

Figure S6.2. Diagram of well and logger measurements and data collected during each field visit.

- Depth to water from the MP using the rigid measuring tape. Note that the logger may need to be unbolted and secured (via a carabiner) above the well opening before the measuring tape can be lowered into the well
- Check level between the top of pipe and the level point on each fence post

Be sure to record the distances even if they have not changed from the original measurements. While large changes in the distance measurements indicate that the well has shifted significantly from the original height, the predominant substrate in these wetlands is a living layer of Sphagnum moss, which shrinks and expands as soil saturation changes. This makes for an unstable measurement surface, and less than ideal measurement accuracy. However, our primary interest is depth of water relative to the wetland surface, rather than absolute water level. Having wetland wells that "float" with changes in the underlying substrate is actually beneficial, provided the wells do not shift or lean relative to the surface. Therefore measurements of level between two independent locations (i.e., fence posts) will be the primary method for checking well status.

To determine if the well has shifted, check if the top of the pipe closest to each fence post is level with the level point marked on the corresponding fence post. If one or both of the fence posts are not level, use the distance measurements from the previous visit to determine which one moved (i.e., the well or the fence post(s)) and record this information in the visit notes. Next, reestablish the level point on each fence post, measure the distance of the new level points from the ground, distance between the well and fence posts, and distance from ground to MP. Finally, check the lean of the well using the level. If wells are leaning more than 10 degrees, or are too loose in the substrate to be stabilized, they will need to be installed (i.e., reset) in a new location. The well should be installed within 2 m of the original location, and the distance and bearing to the center of the sentinel site (original well location) should be measured. Avoid trampling the first vegetation plot (located 2 m south from the center of the site) during reinstallation. If wells prove unstable over multiple sampling years, consider installing longer posts or rebar to bedrock (if possible) and attach wells to posts.

Once well and post measurements are completed, remove the HOBO® logger from the well. Download data from the logger (See SOP 7 – Using the HOBO® Water Level Logger and Shuttle). If only one annual visit is possible, then the well checks and data download should take place simultaneously in the spring. If a well has to be reset in the spring, it must be visited again in the fall to check for shifting.

NOTE: Trampling is a very important concern in wetlands that are repeatedly visited. Wetlands are often slow to recover from trampling, and repeated use of the same path to the well may permanently impact the site. During each visit, be careful not to form trails to the wells. Extreme care should also be taken while performing well maintenance and taking measurements near the wells, since observers can compact the substrate and force water into or out of the well. Observers must never to step within 0.5 m of wells. If, over time, the area surrounding the well shows impacts of trampling, consider using a platform (e.g., stadium bench), a wire frame, or other equipment to distribute weight more evenly and reduce soil compaction while working near the wells.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	August 2011	Kate Miller	Initial version	
1.01	August 2012	Kate Miller	Added fence posts to aid in leveling the well and detecting shifts, revised measurements used for leveling. 2 visits per year.	Revised procedures to enhance ability to detect shifting of wells. Reduce chance of losing growing season data.
1.02	January 2013	Kate Miller	Revised site terms	Maintain consistency with NETN and EPA protocols.
1.03	April 2013	Kate Miller	Minor editorial changes Added that a wire frame may be useful for reducing trampling	Suggestions from external review
1.04	January 2017	Kate Miller	Removed use of electrical tape to mark fence posts. Revised water level and distance/height measurements to use a rigid measuring tape.	Revised methods have proven to be more permanent and/or repeatable over time.
1.05	January 2020	Kate Miller	Changed SOP number	For consistency with Protocol Package

SOP 7 – Using the HOBO® Water Level Logger and Shuttle

Northeast Temperate Network

Version 1.03

Overview

This SOP provides instruction for using the HOBO® Water Level Logger and HOBO® Waterproof Shuttle to monitor water quantity in freshwater wetlands.

Procedures

Launching the HOBO® Water Level Logger

In order for HOBO® Water Level Loggers (loggers) to begin logging data they need to be launched. To launch a logger, connect the HOBO® Waterproof Shuttle (shuttle) to a computer using the provided USB cable, and open HOBOwareHOBOware. If internet is accessible, allow HOBOwareHOBOware to check for and install updates. Next, connect the logger to the appropriate coupler on the shuttle, and squeeze the coupler lever once. The yellow "Transfer" LED light and the green "OK" LED light will each blink once to signal that the shuttle is on, and HOBOwareHOBOware will indicate that the logger is attached.

Once the shuttle with attached logger is turned on and recognized in HOBOware open the "Device" drop down menu and select "Launch". Perform the following tasks in the Launch window:

1. Record the serial number and battery status of the logger. Note that if battery is poor, the logger should be replaced, and the original sent to the manufacturer for battery replacement.
2. Enter a description using the following format:
   Seven digit logger serial number + four-character Sentinel Site Code + Launch Date (YYYYMMDD), with each element separated by an underscore (_).

   Ex: 9997197_BIGH_20110912
3. In the "Configure Sensors" section ensure that the temperature (in degree C) and pressure (in kPa) sensors are both checked to log.
4. In the "Deployment" section set logging interval to 1 hour, and select a delayed start. Set deployment time to the next hour and click on delayed start. <u>Be sure to record the exact date and time the logger is set to begin logging.</u>

Downloading data using the HOBO® Waterproof Shuttle

The preferred method of downloading data from the logger is for the shuttle to be connected to a computer and to perform this process through HOBOware. This reduces the risk of data being lost during the downloading process, and makes it possible to check the battery status of the logger.

When a computer is available for the downloading process, connect the shuttle to the computer using the USB cable and open HOBOware. If internet is accessible, allow HOBOware to check

for and install updates. Connect the logger to the coupler on the shuttle, and squeeze the coupler lever once. The yellow "Transfer" LED and then the green "OK" LED will blink once to signal that the shuttle is on, and HOBOware will indicate that a logger is attached.

Once the shuttle with attached logger is turned on and recognized in HOBOware perform the following tasks:

1. Open the "Device" drop down menu and select "Readout". When the "Stop Logger" window appears, click on the stop button to continue.
2. In the "Save" window, select the appropriate file location and name the file name using the following format:

   Seven digit logger serial number + four-character sentinel site code + download date (YYYYMMDD), with each element separated by an underscore (_).

   Ex: 9997197_BIGH_20120912

3. In the "Plot Setup" window ensure the Temp and Pressure boxes are checked. If available select the barometric pressure file and then click on the plot button. Review the plot and verify that the plot contains the entire logging interval.
4. Check that the battery status of the logger is fair or better before placing the logger back into the well. If battery is poor, replace the logger and send the original to the manufacturer for battery replacement.
5. Before lowering the logger back into the well, check the condition of the optics and O-ring on the logger. If the optics shows signs of corrosion, algae growth, or dirt on the surface, clean with a lens tissue and water before replacing back in well. If O-ring appears brittle or cracked, it must be replaced before deployment.
6. After data have been successfully transferred, all files should be backed up on an external hard drive or a different computer.

If a computer is not available to download data from the logger, attach the logger to the coupler on the shuttle and perform the following tasks:

1. Squeeze the coupler level and watch the LED lights. The yellow "Transfer" light will blink up to several minutes (indicates data are being transferred). When the transfer is complete, the green "OK" LED should blink. Once the "OK" LED light blinks, the logger can be removed from the shuttle and placed back into the well.
2. Once back in the office, connect the shuttle to a computer with the USB cable. Open HOBOware and allow HOBOware to check for and install updates. Once updates are complete, perform the following steps:

   a. Open the "Device" drop down menu and select "Readout".
   b. Check the save box in front of the files to be saved to the computer
   c. Click on "Choose" box and browse to the appropriate location for the data.
   d. Use the following file name format:
      Seven digit logger serial number + four-character Sentinel site code + download date (YYYYMMDD), with each element separated by an underscore (_).
      Ex: 9997197_BIGH_20120912

   e. Click on the "Save checked box"
   f. After the files have been saved from the shuttle, double check that the files were successfully saved to the computer. Next put a check in the box in front of the files to be deleted and click on the "Delete checked" box to clean up the shuttle.
3. Because checking the battery status in the logger is not possible in this scenario, any logger that has been deployed for four years should automatically be replaced with a logger containing a new battery, and the battery status of the original logger should be checked in the office. If the original logger battery status is poor, it should be sent to the manufacturer for battery replacement.
4. Before lowering the logger back into the well, check the condition of the optical sensor and O-ring on the water level logger. If the optical sensor shows signs of corrosion, algae growth, or dirt on the surface, clean with a lens tissue and water before replacing back in well. If O-ring appears brittle or cracked, it must be replaced before deployment.
5. After data have been successfully transferred, all files should be backed up on an external hard drive or a different computer.

Quality Control/Quality Assurance and File Management

Quality Control and Quality Assurance (QA/QC) are important to ensure accurate water level and temperature data. Before examining the water level data, the data must be corrected for barometric pressure, temperature, the difference (if any) in elevation between the barometric logger and the water level logger, and drift (if any) in the water level data between deployments. Two loggers are installed on Mount Desert Island (MDI) to measure barometric pressure for this calibration; one logger is located on the east side of MDI on the NETN storage shed on the park headquarters campus, and one logger is on the west side of MDI next to the well established in the Western Mountain Swamp wetland (NWCA11-R302). The logger closest to each wetland should be used for the calibration. The barometric calibration can be performed through the plot function in HOBOware. However, the preferred method for calibrating the water level data against the barometric pressure is to use functions in the wetlandACAD R package that were developed to handle all of the corrections that are required (e.g., elevation, atmospheric pressure) to convert the pressure data collected by the logger into water level (cm) relative to the wetland surface.

After water level data have collected in the field, they should be exported as .csv files in HOBOware.

The process for converting pressure to water level relative to the ground surface is described below:

1. Convert kPa pressure data to cm of water above the logger (1 kPa = 10.197 cm of water)
2. Calculate water depth relative to surface using the following formula:
   Water Depth = (Step 1 Value) - [(Logger Length + MP to Bolt) – Stick Up at MP]
3. Correct for elevation difference between the between the water level logger in the well and the barometric pressure calibration logger:
   Corrected Water Depth = (Step 2 Value) – (Average Difference between Spring and Fall field water level measurements and Logger Water Level)

These calculations should be performed in R using the wetlandACAD package. The .csv files exported from HOBOware should first be loaded into the R global environment. As long as the

file names have the correct 4-letter sentinel site code, the join_well_data() function will bind together all the water level data from each site. This prepares the data to be stored in the NETN RAM database. The next steps are to compile the ground height measurement (i.e., (Logger Length + MP to Bolt) – Stick Up at MP) and the elevation correction factors for each site by year, then to run the compile_sent_WL() function, which converts measurements to water relative to the surface. Hourly precipitation can also be compiled using the get_NADP_precip() function. For more details, refer to the documentation, including examples, in the wetlandACAD R package (https://github.com/katemmiller/wetlandACAD).

Once the water level data have been converted to water level relative to the surface, further quality control checks should be performed, including inspecting for outliers and data gaps. Outliers are measurements that are > 1 standard deviation from the previous or following hourly measurement, and should be compared with available weather data (e.g., large precipitation events, timing of spring thaw, etc.) to determine whether the data point is truly an outlier or the result of a precipitation event. If no explanation is found for an outlier, then that data point should be removed from the data series. Additionally, water level can take 24-48 hours to acclimate after wells are reset, which appears as a steady climb in water level immediately after the well is reset. Hydrographs from reset wells should be inspected for this pattern, and any data before the water level stabilized should be deleted. After QC checks are completed, the water level data are considered certified and should be uploaded to the NETN RAM database.

Note that a negative value indicates water depth is below the ground surface, and a positive value indicates that water depth is above the ground surface. All original data files and information about any changes to the data (e.g. removal of outliers) must be retained and archived in the NETN RAM database. R Scripts to convert the original data files to water depth relative to ground surface, along with the final corrected data should be stored and archived on network servers.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	September 2012	Kate Miller	Initial version	
1.01	January 2013	Kate Miller	Revised site terms	Maintain consistency with NETN and EPA protocols.
1.02	January 2016	Kate Miller	Removed requirement that loggers be replaced after 4 years. Revised water level correction to use R scripts, rather than HOBOware Added step to correct for elevation difference between water level logger in well and barometric pressure logger Revised how raw pressure data should be converted to water level relative to the surface	Loggers often last longer than 4 years. New methods for converting to water level relative to surface rely on R scripts, which are more transparent than manually calculating values in Excel.
1.03	January 2020	Kate Miller	Changed water level calculation and QC to rely on functions in the wetlandACAD R package, rather than manual Excel calculations. Added details on identifying and handling outliers, including data right after well is reset. Changed SOP number	Compiling raw pressure data for storage in the NETN RAM database and calculating water level now rely on the wetlandACAD R package. To meet QAP standards For consistency with Protocol Package

SOP 8 – Data Analysis and Reporting

Northeast Temperate Network

Version 1.04

Overview

This SOP provides important guidelines related to data analysis and reporting for the Permanent Freshwater Wetland Monitoring Program in Acadia National Park (ACAD). This SOP recommends a multi-tiered approach to reporting, based on the type of data available, and includes a rough schedule for each type of report, potential statistical approaches, and staff responsibilities.

General Considerations for Writing Reports

The NETN will produce a summary status report after each completed 5-year cycle of sentinel and RAM sites. The primary functions of the status reports are to archive the data and document procedures for the year(s) of sampling. Every 10 to 15 years, NETN will produce a trend report that combines results from multiple years of intensive sampling, rapid assessment monitoring, and continuous water level monitoring. Reporting will be the responsibility of the Plant Ecologist with assistance from the NETN Program Manager or other designated staff as needed. All reports will be subject to a thorough peer review process that includes park staff.

It is a recent objective of the National Park Service (NPS) Inventory and Monitoring (I&M) Program to streamline annual reporting; best efforts should be made to comply with new policies. Status reports and trend analysis reports will use the NPS Natural Resource Publications template, a preformatted Microsoft Word template document based on current NPS formatting standards. Both reports should be completed using the Natural Resource Technical Report template.

Data Analysis

Sentinel Monitoring Data

Data collected in the sentinel sites have some important limitations. Because these sites were not selected randomly or systematically, they cannot be assumed to be representative of a larger area. Inference from statistical analyses of the sentinel monitoring data is limited to the site level, and the data should not be used to make statements about ACAD freshwater wetlands as a whole. Nevertheless, any highly significant trend between all sites in ACAD or within a wetland type would be suggestive of a larger-scale trend. Additionally, these data may be suitable for correlative analyses to explore potential causes of long-term trends, but those analyses would need to be followed with manipulative experiments to confirm their findings.

To examine variation in wetland composition, structure and function over space and time, multimetric indices for vegetation, soil, and water will be calculated for each site, using the multimetric indicators (MMI) that were developed using the EPA NWCA data collected in 2011 (Miller et al. 2016). MMIs (sometimes called IBIs) are common tools for assessing condition of aquatic resources, and are often more responsive to disturbance and a better measure of condition

than individual metrics (Stoddard et al. 2008). MMIs are composed of three to four metrics that distinguish between reference and most disturbed sites, are not correlated with each other, and that represent different ecological processes or phenomena. To calculate the MMI, each metric is rescaled and combined to calculate an MMI score from 0 (poor condition) to 100 (best condition), and that can be rated as Good, Fair or Poor based on the distribution of MMI scores in reference sites.

Initial trend analyses will be quite simple, such as paired sample t-tests of metrics for each site between surveys. As the data series becomes longer we will employ more sophisticated approaches, such as a random effects (hierarchical) model, where each sentinel site is considered a random effect and all sites are modeled together. While this approach would still not allow extrapolation beyond sites sampled, it would potentially enable a more complete understanding of the site-level data. Comparisons of the trends in ACAD wetlands can potentially be integrated within the broader sampling efforts of the EPA NWCA. This would provide more power to evaluate local changes in the context of a broader system, and enable consideration of large-scale changes in the environment such as geographic variation in climate.

To analyze the water level data, we will calculate summary statistics of water levels by growing season, defined as May 15 to October 1 in each calendar year. Water level monitoring is focused on the growing season because wells often shift over the winter. Water levels relative to the surface can not be calculated until wells are reset and remeasured during the spring well visit. In addition, the barometric pressure loggers used to calibrate water level loggers may be buried by snow during years with high snowfall (~1 m snow pack) and can not be used for calibration while buried. Note that road closures may prevent collecting water level data until late May or early June, which shortens the period that statistics can be calculated for the growing season. Water level change over the growing season will also be calculated as the difference in the mean June water level to the mean September water level for each year. Hydroperiod will be calculated as the proportion of the growing season that water level is 1) above the surface (i.e., water level is > 0 cm), 2) within 30 cm of the surface, and 3) more than 30 cm below the surface. These break points are important thresholds that drive vegetation patterns in wetlands, as prolonged surface water often selects for emergent vegetation, and prolonged inundation of the rooting zone (upper 30 cm of soil) selects for wetland species over upland species (Cole et al. 1997, Steven and Toner 2004). Wells and loggers in the sentinel sites were installed in the fall of 2012, and have been monitored continuously during the growing season since 2013. More details on water level summaries can be found in Miller and Weed (2017).

Rapid Assessment Data

The USA-RAM data will likely be more amenable to statistical analysis, even though the data collected are more qualitative. This is because the USA-RAM data will be based on a statistical sample with a reasonable sample size (n = 40). USA-RAM data will be used to assess status and trends in wetland condition, presence of wetland stressors, and potential associations between condition and stressors. We will rate the condition of the vegetation in the rapid assessment sites using an adjusted version of the Vegetation MMI (see Miller & Weed 2017). Trend analyses will be performed using a mixed effects model that will allow for estimation of "fixed" effects (i.e., park subunit, or trend over time), while accounting for "random" effects (i.e., randomly located sites). This model will allow us to examine overall trends in ACAD, as well as trends within a site.

Reporting

The general outline of each report, whether it is a status or trend report, should include:

1. A brief Introduction section describing the project along with the goals and objectives.

2. A Methods section detailing data collection procedures and analytical techniques; this may change little between reports but should still be included as part of each report. The section should highlight any changes from previous methods. For status reports, describe any logistic problems that were encountered and provide suggestions for preventing or coping with similar problems in the future.

3. A Results section that describes the content of the summary tables, figures and ecological integrity scorecard (see below; status reports only).

4. For status reports, graphs or tables display current values compared to the average results from previous years. For trend reports, include graphs showing trends in key metrics.

5. A brief Discussion section that highlights and interprets any notable findings, such as detections of unexpected or invasive species, unexpectedly large changes in water quality (> 50% change), or factors such as extreme weather events that might have affected results. Note that the NETN list of invasive species is more comprehensive than the FOM, and includes any species considered invasive by NatureServe and/or the Integrated Plant Atlas of New England (IPANE).

6. An Acknowledgements section thanking individuals and organizations who contributed to the field season or the report.

A status report will be completed every 5 years after all of the data are available from intensive sampling for the NWCA, and a full cycle of USA-RAM sites are sampled. Status reports will include vegetation data summaries for each site, results from the soil and water lab analyses processed by EPA, summaries of the water level data, and a description of important protocol concerns and/or changes from the previous survey. In addition, wetland condition will be interpreted using an ecological integrity framework based on multimetric indicators for vegetation at all sites, and soils and water chemistry in the sentinel sites (Miller et al. 2016). Assessments of buffer condition following methods developed for the EPA NWCA (U.S. EPA 2016) will also be included. Where possible, results in ACAD will also be compared with regional EPA data.

To meet annual reporting requirements, a web-based data visualizer will be updated annually that displays data from the most recent survey of each site. The visualizer includes a map panel that shows vegetation MMI ratings for each site, allows the user to locate sites where a given species or any invasive species were found, and shows photopoints taken from a selected plot. The Hydrograph tab allows the user to view hourly water level relative to hourly precipitation rates during the growing season by site and year, along with a range of growing season statistics for a given site. A Species List tab lists all of the species detected at a site during the most recent survey. More features will be added over time.

Trend reports, which will be completed every 10 to 15 years, will combine results from multiple years of intensive sampling, rapid assessment monitoring, and continuous water level monitoring.

Literature Cited

Cole, C. A., R. B. Brooks, and D. H. Wardrop. 1997. Wetland hydrology as a function of hydrogeomorphic (HGM) subclass. Wetlands 17(4): 456-467.

Miller, K. M., B. R. Mitchell, and B. J. McGill. 2016. Constructing multimetric indices and testing ability of landscape metrics to assess condition of freshwater wetlands in the Northeastern US. Ecological Indicators 66: 143-152.

Miller, K. M., and A. S. Weed. 2017. Freshwater wetland monitoring in Acadia National Park: Northeast Temperate Network 2011-2016 summary report. Natural Resource Report NPS/NETN/NRR—2017/1418. National Park Service, Fort Collins, Colorado.

Steven, D. D., and M. M. Toner. 2004. Vegetation of upper coastal plain depression wetlands: Environmental templates and wetland dynamics within a landscape framework. Wetlands 24(1): 23-42.

U.S. Environmental Protection Agency. 2016. National Wetland Condition Assessment: 2011 Technical Report. EPA-843-R-15-006. U.S. Environmental Protection Agency, Washington, DC.

Revision History

Version numbers will be incremented by a whole number (e.g., Version 1.30 to 2.00) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.06 to Version 1.07) when there are minor modifications that do not affect requirements or procedures included in the protocol. Add rows as needed for each change or set of changes tied to an updated version number.

Revision History Log

Version #	Date	Revised by	Changes	Justification
1.00	November 2012	Kate Miller	Initial version	
1.01	January 2013	Kate Miller	Revised site terms	Maintain consistency with NETN and EPA protocols.
1.02	April 2013	Kate Miller	Clarified how invasive species are defined. Added that a Floristic Quality Index will be a useful analysis tool for USA-RAM data, once it is available.	Suggestions from external review.
1.03	January 2017	Kate Miller	Revised analysis approach for sentinel and rapid assessment sites to rely on the MMIs that we developed in 2016. Removed previous studies and updated citations. Revised hydrology section to focus on growing season trends, rather than annual trends. Revised reporting schedule to better reflect NWCA data availability Updated literature cited	Wells often shift over the winter, making data only reliable during growing season.
1.04	January 2020	Kate Miller	Changed SOP number Added use of visualizer for annual reporting.	For consistency with Protocol Package