Hurricane Sandy Coastal Resiliency Competitive Grants Program
#42279 DOI/NFWF
Building Ecological Solutions to Coastal Community Hazards

Spring Lake Project Monitoring Plan
Partnership for the Delaware Estuary and Barnegat Bay Partnership

Site: Spring Lake Living shorelines Project

Dates Active: August 2015 –March 2018

Project Lead: Peter Avakian, Matthew Mariano, Georgia Marino, Bryan Dempsey

Partners: NJDEP, NWF, Barnegat Bay Partnership (BBP), Partnership for the Delaware Estuary (PDE), Mayor of Spring Lake, Leon S. Avakian, Inc, Najarian Associates

Project Design Team: Georgia Marino (Najarian Associates) and Peter Avakian (Leon S. Avakian Inc.)

Monitoring Plan Design Team: Barnegat Bay Partnership (BBP), Partnership for the Delaware Estuary (PDE)
Point of Contact: LeeAnn Haaf (PDE), Erin Reilly (BBP), Joshua Moody (PDE), Martha Maxwell Doyle (BBP), Danielle Kreeger (PDE)

Monitoring Implementation Team: Erin Reilly lead, LeeAnn Haaf co- lead

Project Type

Description of the overall project including the type of living shoreline being installed (bio-based, hybrid, etc...) or restoration technique being employed that requires a structured monitoring program.

Bio-based shoreline (grading)

Project Goal and Objectives

List project goal and provide reasoning for this goal being selected (e.g.: erosion control as goal due to value of infrastructure behind shoreline or value of habitat, etc...). State project objectives as monitoring actions that will be taken to assess the ability of the project to meet its defined goal. See PDE monitoring framework for a listing and description of restoration types and goals.

To reduce flooding of infrastructure by grading the shoreline, creating marsh habitat, and planting native plants in the riparian area.

Objectives:

1. Monitor position of graded shoreline
2. Monitor extent of biological (vegetative) communities
3. Monitor topography within project area
4. Monitor ability of materials to persist over time

Project Location

Provide GPS coordinates of project centroid and short description of the project area/location. Provide maps as Figure 1 and 2.

Western Extent: 40.141195, -74.037206
Eastern Extent: 40.142015, -74.034534

Treatment Description

Description of treatment and control (if applicable) designs including: relationships to existing structures on site; replications; and components. Detail should be reflective of the current stage of project and should be updated throughout the course of the project to reflect any, and all, changes or adaptive management activities. Previous entries should not be altered, but a new section should be added by date. This section will serve as a journal of the conception and evolution of treatments/installations.

Shoreline and riparian area of interest extends from a constructed bridge (west) to a point that represents a confluence of North Branch Wreck Pond Brook into Wreck Pond. The shoreline and riparian areas will be graded to create a gradual slope (from MLW, -0.7’ to 3’ NAVD88 over horizontal distance of ~80’) that is more conducive to intertidal vegetation growth. A berm (6’) will also be constructed and planted with native trees, shrubs, and grasses. Exact elevations and planting are likely to vary as water levels are scheduled to change in response to the refitting of an outfall pipe which is the Pond’s connection to the Atlantic Ocean. The outfall pipe will be replaced to allow the passage of diadromous fishes, and the exact effect on water (tides and chemistry, alike) is unknown.

Endpoints

Description of the parametric value or temporal scale that will dictate the completion of the project according to permit(s).

Monitoring Tasks

Metrics of interest required by monitoring plan and associated methods used for data collection. Provide monitoring table from Monitoring Frame work, including reasoning for methodologies chosen. Methods in red indicate techniques that require specialized equipment, knowledge, permitting, or training. Methods in green indicate techniques that do not require and specialized, equipment, knowledge, permitting, or training besides on-site instruction for from trained staff. **Photo documentation is a mandatory monitoring task at ALL visits to a project site as well as a monitoring task on all monitoring dates.**

Table 1 Monitoring metric and method table

Restoration Type and Goal	Class of Metrics	Metric	Method	Reasoning	Sampling Type (See Sampling Design Type)
Bio-based Shoreline for Flood Control	Photo	Appearance	Fixed Photo Points (FPP)	Provides visual documentation of project and site over the course of the monitoring timeline	Photo
	Physical	Structural Integrity of Materials	Observation Logging on Data Sheets	Assessment of ability of materials to withstand local physical forces	Site Level Sampling
		Position and initial slope of constructed berms	RTK GPS Survey; FPP	Assessment of ability of berms to withstand local physical forces over time	Targeted Point RTK Sampling
		Position of Contiguous Vegetated Shoreline (Horizontal Change)	RTK GPS Survey Fixed Photo Points	Measure changes in the horizontal extent of the vegetative community over time as a result of the treatment	Targeted Point RTK Sampling

		Elevation (Vertical Change and Retention of Fill Material)	RTK GPS Survey	Measure changes in the vertical extent and trajectory of the vegetative community over time within the local tidal prism as a result of the treatment and its likelihood of resilience	Targeted Point RTK Sampling
		Water levels	HOBOs	Measures water levels in front of and behind treatment area that is designed to manage flooding	Stratified Physical Sampling
	Biological	Vegetation: Survivorship of Planted Plugs	Counts Logged on Data Sheets	Measure persistence of planted vegetation within the treatment and its likelihood of future survivorship	Stratified Biological Plot Sampling
		Vegetation: Growth	Measurement of Blade Height with Meter Stick	Measure above ground growth of vegetation to determine health of vegetation within the treatment	Stratified Biological Plot Sampling
		Vegetation: Robustness- Light Attenuation	Measurement with light meter logged on data sheet	Measure above ground growth of vegetation to determine canopy robustness of vegetation within the treatment	Stratified Biological Plot Sampling
	Chemical	Water Salinity	YSI or other Acceptable Equipment	Measure local conditions within which to frame the results of other data collected	Site Level Sampling

Sampling Frame

Description of the area within which data will be collected, referenced to existing structures, relative position within the local tidal spectrum, and three-dimensional features of interest (e.g: tops of structural components). GPS coordinates (4 minimum) demarcating the bounds of the sampling frame are to be listed. These coordinates are to be collected during the first survey (see Table 2 below). Include a map of the sampling frame as Figure 2.

Sampling frame extends ~1 m below MLW and back over constructed berm, terminating at the already existing road (Shore Road). Current local tidal spectrum is highly variable due to fetch, storm water runoff, and water constriction at the Pond's confluence with the Atlantic Ocean, so the exact sample frame will be determined once construction of the outfall pipe connecting the Pond to the Atlantic Ocean is complete. Sampling frame coordinates will be finalized after the first monitoring event.

Sampling Frame Coordinates

A. 40.141425, -74.037267
B. 40.142061, -74.034660
C. 40.141142, -74.037095
D. 40.141815, -74.034590

Sampling Design Type

Description of the sampling methodologies/techniques employed (e.g. systematic non-random grid sampling, targeted point sampling, stratified random sampling, etc...) and their associated metrics from Table 1. **All metrics from Table 1 need to be accounted for under one of the Sampling Design Types listed below**.

1. Photo Documentation from Fixed Photo Points: a photo documentation technique in which photographs are taken of a site/project from pre-determined and demarcated photo points.

A. Appearance

2. Targeted Point RTK Sampling: a survey design in which point measurements are taken at specific locations. At this site, metrics that include features of interest are:

A. Position of Contiguous Vegetated Shoreline
B. Elevation (Contours, vertical change and retention of fill material)
C. Position and initial slope of constructed berms

3. Stratified Physical Sampling: a sampling scheme in which the treatment area is divided into strata among which sampling is targeted. Within each strata replicate plots are placed in fixed locations along transects which are re-sampled periodically. At this site, metrics within strata are:

A. Water levels

4. Stratified Biological Plot Sampling: a sampling scheme in which the treatment area is divided into strata among which sampling is targeted. Within each strata replicate plots are placed in fixed locations along transects which are re-sampled periodically. At this site, metrics within strata are:

A. Vegetation: Survivorship of Plants
B. Vegetation: Growth
C. Vegetation: Robustness

5. Site Level Sampling (Measured or Observational): a sampling scheme in which either: data will likely not vary across the AOI (e.g. water temperature, wave climate, etc..) and sub-sampling is not required; or it is not advisable to limit the scope of monitoring within treatment area (e.g. stratified sampling locals), as the data of interest may be aggregated and thus not captured by targeted sampling (e.g. shellfish aggregates).

A. Structural Integrity of Materials
B. Water Salinity

Sampling Spatial Resolution

For each Sampling Design Type, describe the spatial resolution at which the methodologies will be employed, including targeted or delineated (strata) physical or zonated locals. Provide a map (Figure 3) of the spatial resolution of the data collection (e.g. quadrat location, sample well locations, grid system resolution, structural locations, etc...).

Suggested positions for RTK transects and potential layout of vegetation sampling plots are in Figure 3. Location of vegetation sampling plots should only be finalized once planting is complete. Water level loggers should be placed along contour RTK transects, and their positions should be documented with RTK GPS.

1. Photo Documentation from Fixed Photo Points: Fixed photo points will be located, at minimum, at each end of a project site. Any other angles of interest can be added to the photo documentation series. Exact locations of fixed photo points will be provided after the first visit to the site (see Table 2).

2. Targeted Point RTK Sampling: An RTK points capturing latitude, longitude and elevation will be taken 1m intervals along the base of each side and the top of all structures, along the continuous vegetation line, and each transect and within each of the stratified biological sampling plots within the sampling frame.
    A. Stratified Sampling Plots (biological and physical)
    B. Contour (parallel to MHHW line—not shown in Figure 3, number of contours TBD after outfall pipe construction is complete) and position (transverse) transects
    C. Position of any hardened (pre-existing) or newly installed structures
    D. Contiguous Vegetation Line

3. Stratified Physical/Biological Plot Sampling: Transects will be placed transversely across the AOI (n=8). All plots should be point surveyed with RTK GPS, in addition to transects. Biological plot sampling will occur within each transect at the following 4 plots (A-D). Stratified Physical Sampling will occur at A and between A and B if given enough sampling equipment. If not the placement will be adaptively managed.
    A. Lowest mean elevation, front of berm
    B. Front of berm, mid slope
    C. Back of berm, mid slope
    D. Lowest mean elevation, back of berm

4. Site Level Sampling (Measured or Observational): Observations/measurements across entire sampling frame.
    A. Structural integrity will be observed along all pre-existing and installed structures

Sampling Temporal Resolution

Description and table of planned sampling events including large scale factor level events such as site characterization, baseline data collection, as-built surveying and annual monitoring, as well as seasonally focused monitoring such as vegetation monitoring occurring during maximum growth seasons and aerial survey during leaf-off seasons.

Sample data is characterized as being collected "Before Installation", "As Built" and "After Installation" for use in statistical analysis. As of now there is no additional annual monitoring planned for this site.

Table 2 Example Data collection schedule

Date	Temporal Factor Level	Data	Collected by	Collected On
April 2016	Before Installation	Targeted Point Sampling; Photo; Sampling Frame Coordinates	BBP/PDE	May 17, 2016
April 2016	Before Installation	Site Level Sampling; Photo	BBP/PDE	May 17, 2016
TBD	As Built	Targeted Point Sampling; Photo	BBP/PDE	
TBD	As Built	Stratified Biological Plot Sampling; Photo	BBP/PDE	

TBD	As Built	Site Level Sampling; Photo	BBP/PDE	
TBD	After Installation	Targeted Point Sampling; Photo	BBP/PDE	
TBD	After Installation	Stratified Biological Plot Sampling; Photo	BBP/PDE	
TBD	After Installation	Site Level Sampling; Photo	BBP/PDE	

Recommended Minimum Long-Term Monitoring

Description of the recommended monitoring past the duration of the stated monitoring timeline

It is recommended that all metrics with associated methods that do not require and specialized, equipment, knowledge, permitting, or training besides on-site instruction from trained staff (indicated in green in the Monitoring Tasks Table (1) above) continue to be collected once annually subsequent to the end date of the project with the following exception:

- Photo Documentation from Fixed Photo Points (twice annually)
    A. Early Spring (~April): Before or at the beginning of plant emergence
    B. Late Summer (~Aug): When peak vegetative growth is reached

Statistical Methodology

Description of the statistical methods that will be used to evaluate data (e.g. BACI design, 2-way ANOVA, multiple-regression, etc...)

A before-after statistical analysis will be conducted as a one way ANOVA to detect changes in metrics as a result of the installation. Factor levels will be: *Before Installation*, *As-Built*, and *After Installation*. Additionally, changes in metrics of interest will be evaluated for correlation with other metrics collect, or other available data (e.g. meteorological data).

Sampling Methodologies

See Metrics and Methods

Figure 1. Location

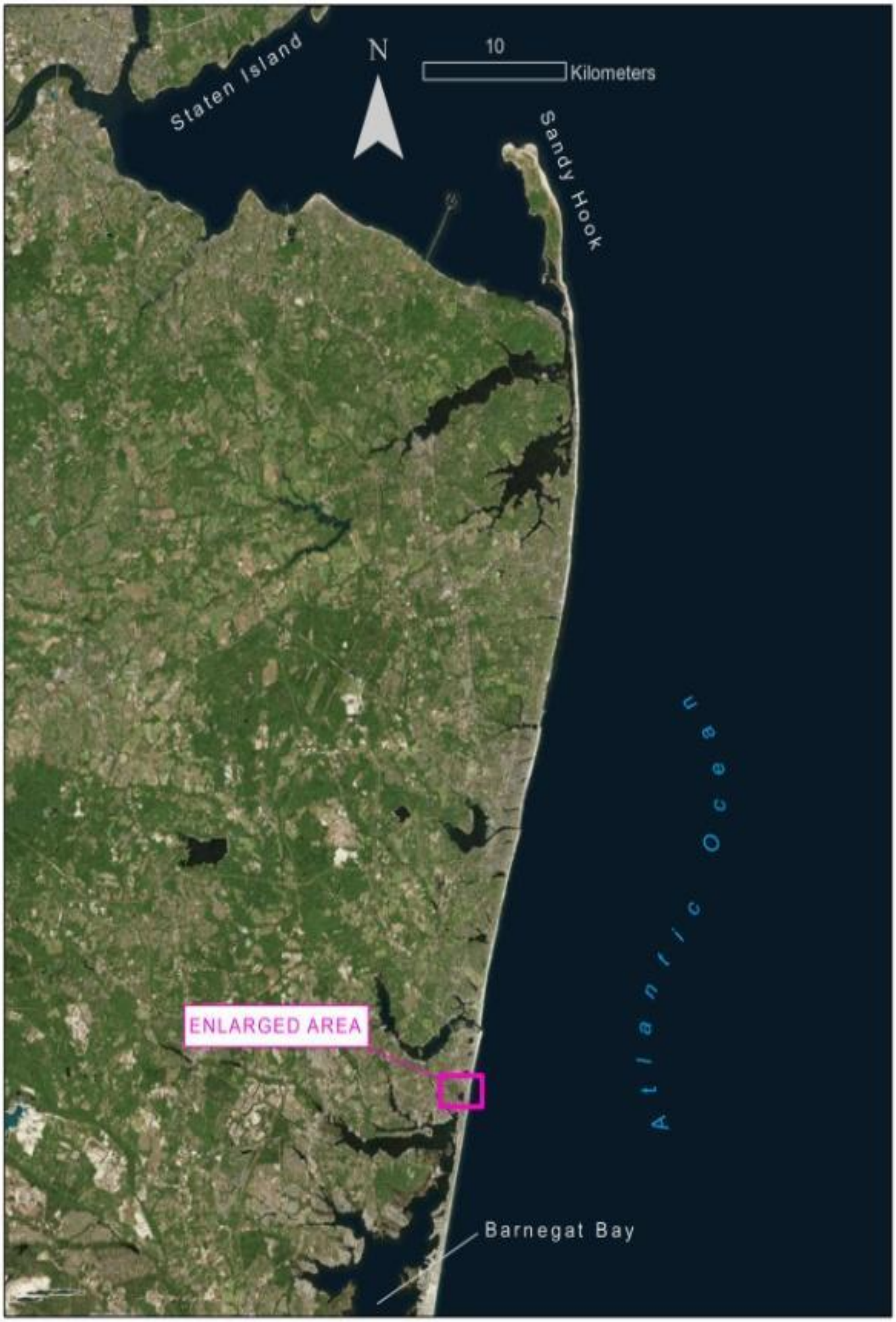


Figure 2.Project Location

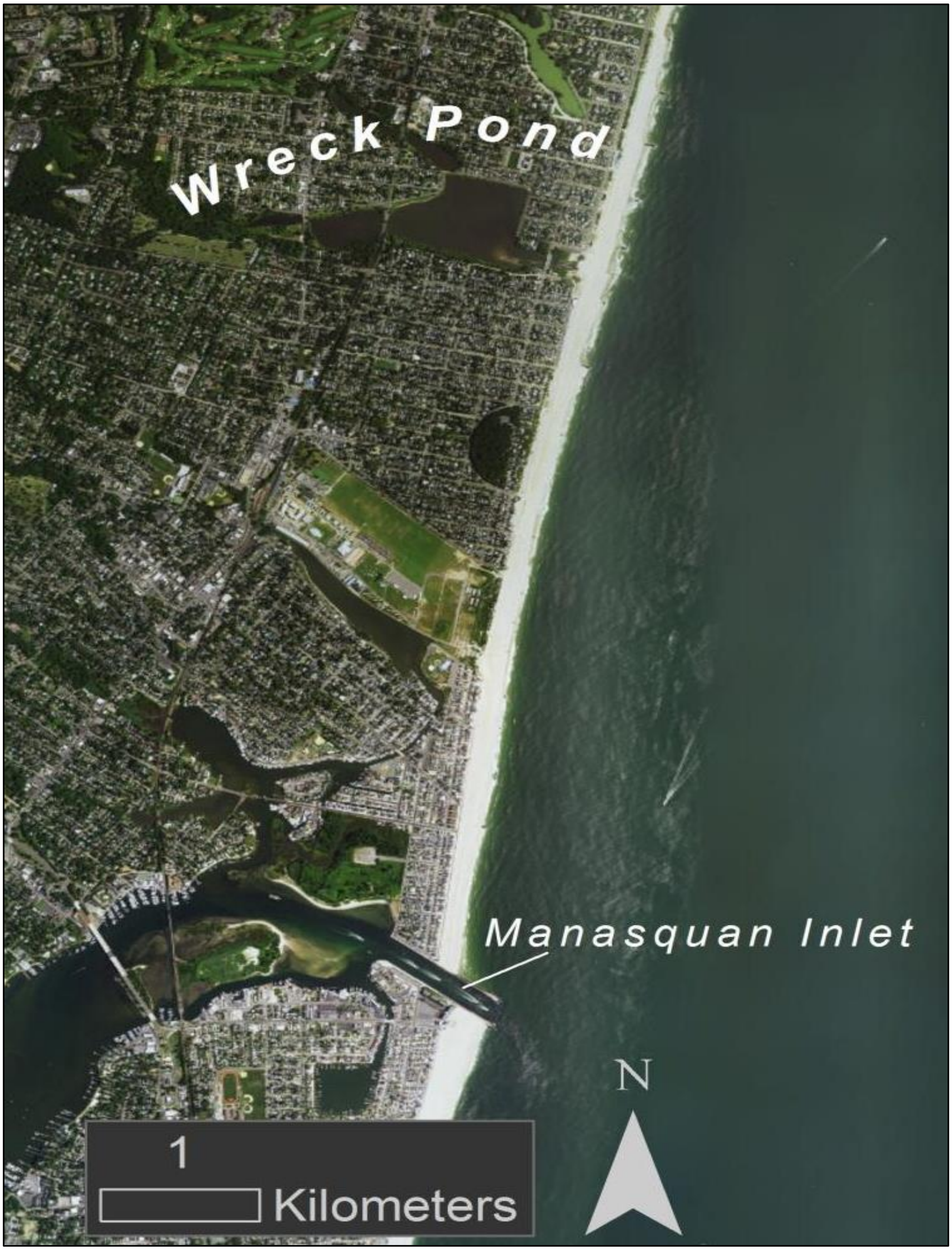
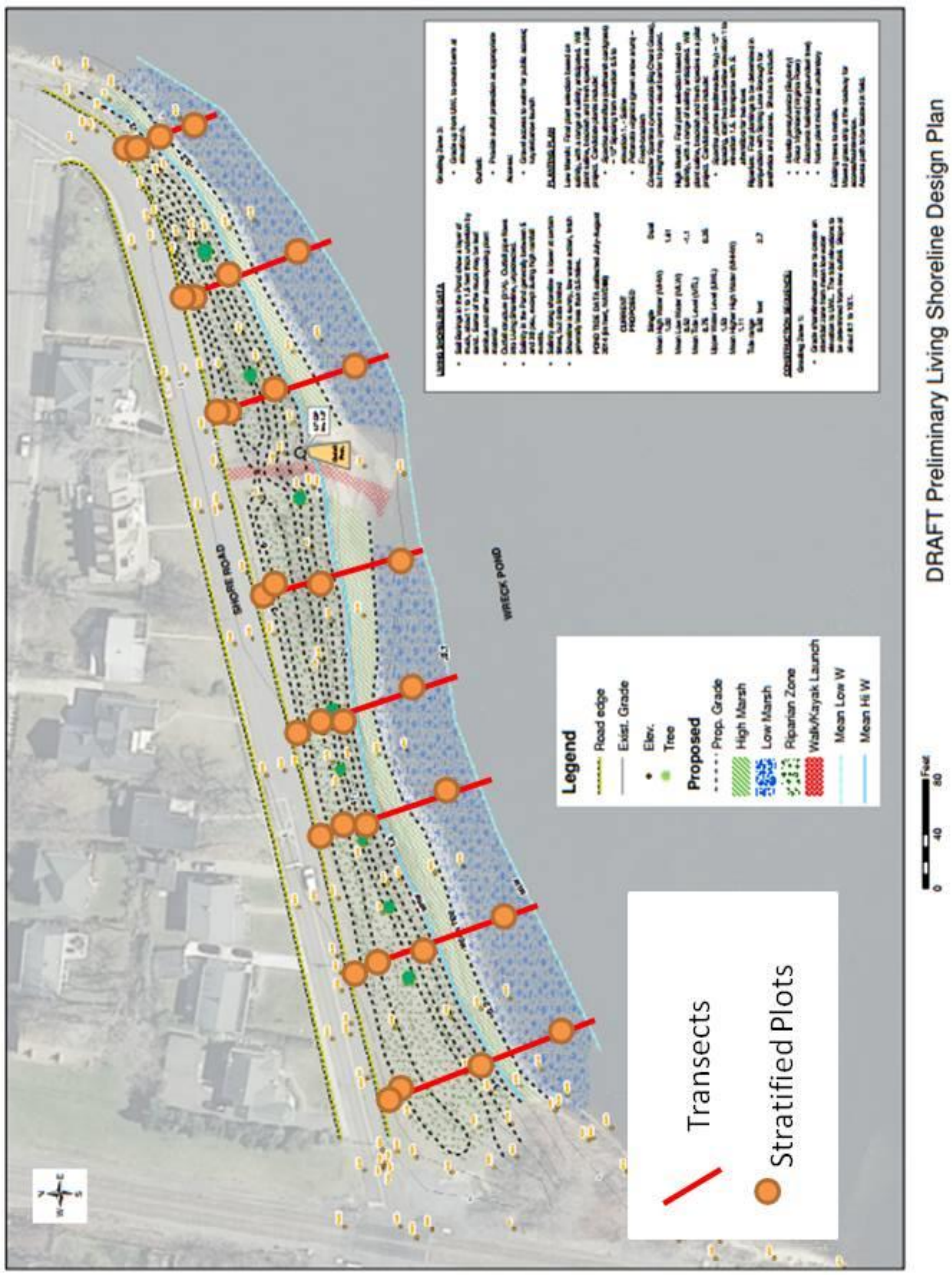


Figure 3 Project shoreline

Figure 4 Sampling Plot locations



Metrics and Methods for Spring Lake

Fixed Photo Points

Standard Operating Procedure No. SOP-XX
Date Prepared: 8/23/16 (v2)
Prepared By: ________________________

Description

This Standard Operating Procedure (SOP) describes the collection of fixed photo points at restoration projects. Photo documentation of a site will be taken from predetermined and demarcated photo points to assess the changes over time of the area. Because locational positioning of restoration structures and relevant areas of interest (e.g. current vegetation line, location of outfalls etc.) is being measured in other ways, it is not critical that photo-point photographs are an exact replicate of previous photos, but rather capture the entire area of interest.

Summary of Approach

Changes over time are critical to document, whether it be for a permit or educational use. By taking pictures at fixed locations, more exact changes can be documented over time. Importantly, when taking fixed photo points, it is crucial to find the location of the fixed position and to identify the features that you are supposed to capture in the photograph. To ensure that this occurs, detailed descriptions of location, direction, and features should be documented so that all photos capture the same area. In addition to fixed photo points, supplementary photographs should be taken at the discretion of the photographers to document other interesting conditions at the site.

Equipment and Materials

- Camera
- Photo Journal/Station Location Guide
- Topographic and/or site map with photo point locations
- Extra batteries for camera (if applicable)
- GPS unit (if applicable)

Optional:

- Aerial photos and previous photos if available
- GoPro with Telescoping Pole for overhead images
- Ruler (for scale on close up views of streams and vegetation)
- Posts for dedicating fixed photo points if the site plan allows for installation

Procedures

1. In the photo journal, record information about the site including site ID, date, photographer name, camera being used and start time. An example can be seen below:

Spring Lake Project
July 6, 2016
D. Stout
PDE Camera 1
Start 10:30 AM

2. Ensure that the date and time in the camera are set correctly. If they are not correct and you cannot figure out how to reset them; make a note of the incorrect time on the datasheet.

3. Confirm photographer location with either existing marker (steel fence post), GPS, or by referencing the description contained within the station location guide. When creating descriptions for the station location guide, descriptions should be detailed enough that someone unfamiliar with the project could capture the same image.

4. Locate the definitive features for the given photo-point and correctly align the features of interest described within the station location guide/photo journal.

5. Take a photograph.

6. With digital cameras, confirm photograph is as close to a complete duplication as possible to the original photograph.

    - Pay particular attention to the corners of the old photo. Does your photo have the same features in each corner?
    - Does your photo look like it is too close or too far away? If so, move accordingly.
    - Is the horizon the same?

7. Record all of the photo numbers in the photo journal along with a detailed description of the features that the photo contains.

8. If possible, attach GoPro to the telescoping pole. Use the station location guide/photo journal to set the height of the telescoping pole. GoPro has a smartphone application that allows you to see what your GoPro will capture. Line up the camera to capture the features described in the station location guide/photo journal. Take the photo. Record the photo number(s) in the photo journal/datasheet.

9. Once all required photos have been taken, survey the site to see if there are any additional features of interest that should be captured (e.g. extensive bycatch, presence of significant wrack, unexpected plants). Record descriptions of any additional photos taken in the photo journal with photo numbers.

10. If applicable, fill out data sheet. For long term monitoring, it is critical to document factors about the photograph that are not contained within the picture. The following information should be recorded with all photo-points and supplementary photographs:

- Photo file name
- Date the photograph was taken
- Name of photographer
- Location (site and stream)
- Description of photograph

11. Photos are to be transferred off of the camera shortly after they are collected.

12. It is important to have file and data management of pictures. Follow appropriate project specific protocols for archiving photos (i.e., PDE-Best Practice #2 Procedure for Archiving Photo Data)

Best Practice #14 Set-Up and Use of the Trimble RTK GPS

9/18/14
Created By: Kurt Cheng, Priscilla Cole, Jessie Buckner

Materials

- Data Logger (Controller)
- Antenna (Receiver)
- Pole (2 sections inside case)
- Mifi
- Battery Pack (2) – for Antenna
- Controller handle (clip) – attaches data logger to the pole
- Case for mifi (waterproof)
- Tape measure/Measuring stick
- Charging device (1), Charging cords (2)
- Pelican Hard Case

Protocols

Day Before

1. Charge three parts:
    a. Battery pack(s) for Antenna - removable packs fit into charger which has cord to plug into electrical outlet
    b. Mifi – cord connects device to electrical outlet (USB)
    c. Data Logger – cord connects device to electrical outlet

Survey Day

Assembly & Setup

1. Turn on mifi and place into waterproof case

2. Assemble the pole by screwing 2 parts together
3. Place charged battery pack into Antenna
4. Turn on Antenna
5. Screw Antenna onto top of pole
6. Measure distance from the base of antenna to the bottom of the pole (typical 1.94m)
7. Turn on Data Controller

Data Controller Settings

1. Main Menu → Setup Internet→wifi
2. Main Menu→Measure→Create New Job→Give the job a name
3. Main Menu→Measure→Measure Points→VRS Rover→VRS-CMRX

Logging Points

Point density of sampling will be determined on a site by site basis. At some sites constructed structures may be GPSed, at others transects may run though the project area, and at others shoreline or creek morphology might be captured. See each projects Monitoring Plan.

1. You should now be on the data capture screen
2. Insert "height to antenna" measurement in height field (#6 under assembly)
3. Naming Scheme – All points need to have a name, but the code-field is optional
    a. Point names will auto-advance in sequential order (numbers or alphabetical), unless otherwise modified.
    b. Code field is just another attribute field to capture additional data. PDE staff often use the code to capture vegetation or sediment types.
4. Press "Enter" (bottom right)
5. Press "Capture Observation" (bottom right)

Error Handling

1. Errors will occur if Mifi is moved too far away from the device.
2. Mifi can get too hot if left in its case for too long on sunny days. Keep the case cool and remove the device from its case if needed.
3. High RMS – Points will not log if movement is too high. In this case, abandon the point and recapture.
4. Cannot connect with satellites – reconnect

Day After

Uploading Files

1. Plug RTK handset into computer using USB cord
2. Power handset ON (green button on bottom left-hand corner)
3. On your computer, when the window pops up click→ Connect without setting up your device
    a. Click→File Management
        i. →Browse the Contents of your Device
            1. →Trimble data
                a. →Living Shorelines

i. →Export
1. Select Site Files
2. Copy (Ctrl-c)
3. Open T:\Science Stuff\GIS\Living Shorelines\SITE Name\RTK_Data
4. Paste Site Files (Ctrl-v)
5. DO NOT DELETE FROM HANDSET

4. On the handset screen, click "X" in the top-right corner to exit
5. Hold power button down for 5 seconds and follow prompts to Shutdown
6. Return handset to library and make sure that the RTK is signed in.
7. Email Data Specialist to alert about new data creation

Best Practice # 18 Field Protocol for Vegetation: Survivorship

3/17/16

Description: Collect data at 1 m^2 vegetation plots to assess vegetation survivorship of planted plugs at restoration sites.

Materials

Required for sampling

- 1.0 m^2 PVC quadrat
- 2 meter stick
- GPS unit-with sites
- Camera
- Writing utensil
- Clip board
- Maps of sites in plastic sheet covers
- Datasheets
- Plant field guide

Protocols

A stratified random sampling technique to determine the location of permanent survey plots will be used. The number of sampling plots depends on the vegetation community, final number of plantings, number and size of planting areas and spacing of plantings. Data should be collected at 3 or more sampling plots to allow for statistical analysis, when possible. Since some of the habitat types that are being re-vegetated could be very narrow bands, it is possible that the plots will not fall within each habitat type.

1. Plots should be marked with at least one PVC stake
2. Maps of the site may be useful if vegetation is thick or cloud cover limits GPS accuracy
3. Lay 1.0 m^2 quadrat over permanent PVC markers or with middle of quadrant at GPS point
4. Record presence or absence of each live plug including each species
5. Record observations regarding plant health (e.g., vigor, evidence of herbivory, evidence of dieback shoots, severe insect infestation, etc.) on data sheet

<u>Best Practice # 19 Field Protocol for Vegetation: Growth</u>

3/17/16

Description: Collect data at 1 m^2 vegetation plots to assess vegetation growth, by linking the blade height to the growth of the plant layer.

<u>Materials</u>

Required for sampling

- 1.0 m^2 PVC quadrat
- 2 meter stick
- GPS unit-with sites
- Camera
- Writing utensil
- Clip board
- Maps of sites in plastic sheet covers
- Datasheets
- Plant field guide

<u>Protocols</u>

Locating Plots

1. Coordinates of plots should be loaded into GPS before work begins
2. Plots should be marked with at least one PVC stake
3. Maps of the site may be useful if vegetation is thick or cloud cover limits GPS accuracy
4. Proceed with data collection as described below

Data collection

1. Lay 1.0 m^2 quadrat over permanent PVC markers or with middle of quadrant at GPS point
    a. Avoid disturbing canopy structure by reassembling quadrat in place
2. Record: Location and its respective plot number; initials of crew on datasheet
3. Use plant guide to correctly identify plants in the plot
    i. If plant is unknown, take sample & photo (note photo # on data sheet), identified *within 48 hr* of sampling
4. Measure blade heights – on blade height datasheet

a. Measure the height, in centimeters, of the first 25 stems of individual plants
    i. Do not use multiple leaves from the same plant
    ii. Start with a corner closest to the water's edge, working diagonally towards opposite corner
    iii. Stems and species are recorded in the order they occur
b. Make any notes if measurements capture average height of all plants in the plot

Best Practice # 20 Field Protocols for Robustness-Light Attenuation

3/17/16

Description: Collect data at 1 m^2 vegetation plots to assess vegetation robustness, by linking the diminished light passing through the canopy cover to the robustness of the plant layer.

Materials

Required for sampling

- 1.0 m^2 PVC quadrat
- Digital light meter
- 1 meter stick
- GPS unit-with sites
- Camera
- Writing utensil
- Clip board
- Maps of sites in plastic sheet covers
- 2 extra pvc markers
- Datasheets
- Plant field guide

Protocols

Locating Plots

1. Coordinates of plots should be loaded into GPS before work begins
2. Plots should be marked with at least one PVC stake
3. Maps of the site may be useful if vegetation is thick or cloud cover limits GPS accuracy
4. Proceed with data collection as described below

Data collection

1. Lay 1.0 m^2 quadrat over permanent PVC markers or with middle of quadrant at GPS point
    c. Avoid disturbing canopy structure by reassembling quadrat in place

2.Record: Location and its respective plot number; initials of crew on datasheet

3.Take light measurements
    d. Ensure that field crew shadows are not cast into plot, as they will interfere with light readings
    e. Record sky conditions for each plot, and attempt to take readings under consistent conditions
    f. Keep light sensor (white dome) clean of dirt, dust, or debris
    g. Visually average readings, look for consistency

h. Take 5 readings at the top; 4 at quadrat corners, and 1 in the middle
i. Ensure top readings are ABOVE the plot canopy
j. Take 5 readings at the bottom; 4 at quadrat corners, and 1 in the middle
    i. Ensure readings are at ground level
    ii. Light meter is not waterproof, so avoid contact with mud or water

4.Estimate plant coverage

k. Use plant guide to correctly identify plants in the plot
    i. If plant is unknown, take sample & photo (note photo # on data sheet), identified *within 48 hr* of sampling
l. Estimate cover visually and agree on approximate covers amongst field crew
    i. Percent cover should reflect one species at a time; overlap may occur, so percentages may not add to 100%— avoid doing arithmetic in the field; *only use "total" cover anecdotally to prevent confusion*

5. Measure blade heights – on separate blade height datasheet
    a. Measure the height, in centimeters, of the first 25 stems of individual plants
        i. Do not use multiple leaves from the same plant
        ii. Start with a corner closest to the water's edge, working diagonally towards opposite corner
            iii. Stems and species are recorded in the order they occur
        b. Make any notes if measurements capture average height of all plants in the plot

PARTNERSHIP FOR THE DELAWARE ESTUARY Science Group

HOBO Water Level Logger Deployment Methodology for Assessing Hydroperiods on Tidal Marsh Platforms

9/26/16
Prepared By: LeeAnn Haaf
Partnership for the Delaware Estuary (PDE) Standard Operating Procedure

Description: HOBO (Onset® brand) water level loggers are placed into protective PVC housing and installed on the surface of a tidal marsh platform to monitor the hydroperiod of that location over approximately one month.

Materials:

Onset HOBO water level loggers (including launching software and hardware)
3" PVC housings (prefabricated for HOBO use)
Stakes (wood or ½"-1" PVC)
Zip ties
Mallet
RTK GPS unit

Instructions:

1. HOBO water level loggers are launched (i.e. beginning logging data) according to the provided manual instructions.
    a. This requires HOBO's software and USB hardware.
    b. HOBO deployment can be delayed, date/time of start should be the day of deployment (preferably a morning time, before they are installed)
    c. Ensure that each HOBO has a unique label (Figure 1.)

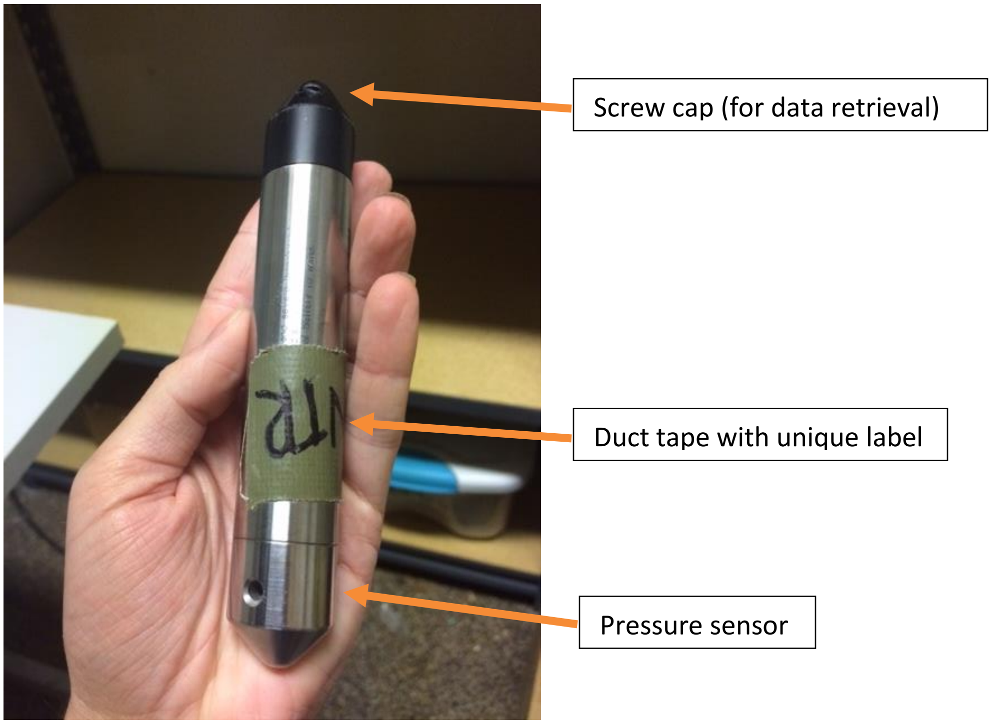


Figure 1. Titanium water level HOBO by Onset®.

2. Loggers are then securely attached to 3" PVC housings using zip ties.
    a. PVC housing should only be slightly longer than the HOBO and holes should be drilled on one side of the housing to assist surface water flow to reach the HOBO, but dissuade precipitation from interfering with data collection.
    b. Zip ties can go through the HOBO's screw cap, and across the body of the HOBO, but care should be taken to avoid strapping zip ties across the pressure sensor (see Figure 1.).
    c. Be sure to match HOBO unit label with housing's label; label must be recorded for each deployment location

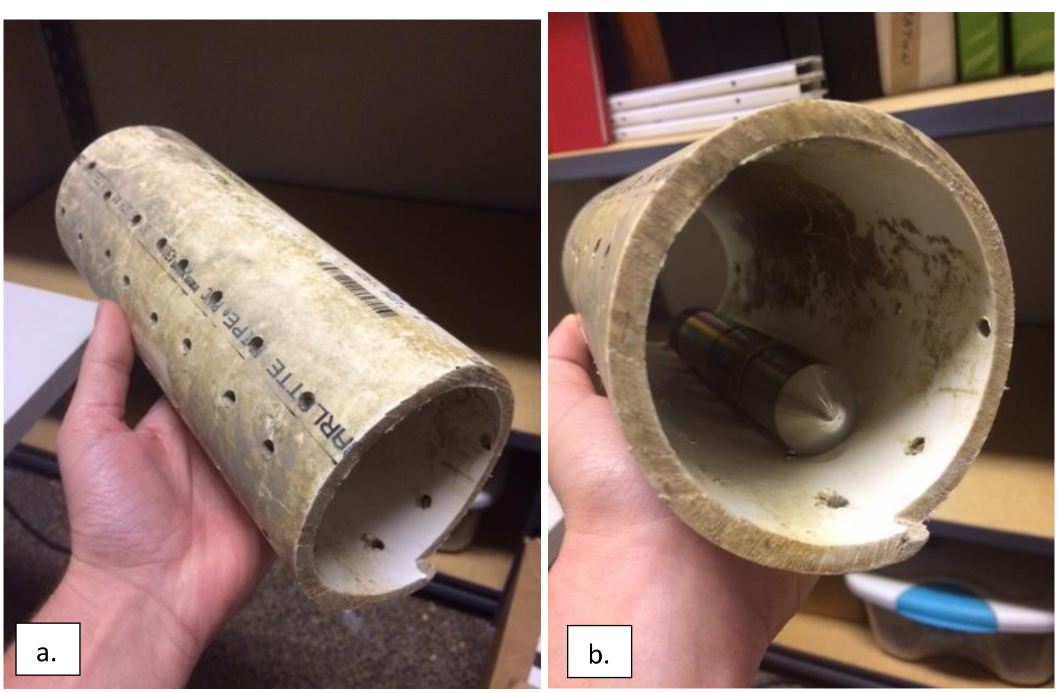


Figure 2. a) PVC housing with holes drilled into the bottom section; b) placement of HOBO within the housing.

3. For marsh surface installation, an RTK GPS point should be taken to ensure that accurate elevation data is available for the logging location (RTK GPS point name should reflect the HOBO's label); HOBO within PVC housing can thereafter be installed onto the marsh surface using PVC or wood stakes and gently hammered in with a mallet
    a. Care should be taken with hammering stakes in as HOBOs can be damaged with the vibrations; it is suggested that stakes be hammered in, and once in position, zip tied to the HOBO's housing.
    b. The correct position of the housing is perpendicular to the main water way; housing should also be flush with the marsh surface.
4. An ambient air pressure HOBO (another water level logger) should be maintained as a control for each deployment site or array.
    a. Water level loggers measure water level by pressure, so an ambient air pressure controls help ensure accuracy.
    b. Housing for an air pressure control should be a 3" dia. PVC that is ~5-6' long with a T joint PVC cap (ensuring air flow, but limiting precipitation interference); height should ensure that water levels do not touch the HOBO.
        i. This should be securely inserted into the marsh (1-2' deep); PVC can be hammered with a mallet, but do so only if it is planned that HOBO is zip tied after PVC is in place.
5. Once secured to the marsh surface, HOBOs can remain for up to 3 months (recording every 15 minutes); when multiple locations are to be surveyed, a minimum of one month is suggested to account for one full lunar cycle.
    a. There is other seasonal variations that may occur, so these factors should be noted and considered for each deployment and data analysis thereafter. Major storm surge event should also be noted to further account for anomalous water levels.
6. At the end of deployment, HOBOs can be collected and data retrieve from each unit.
    a. For this, please follow: *PDE-Best Practices - 17 Procedure for obtaining water level data from HOBO data*

Best Practice # 17-Procedure for obtaining water depth or inundation times from HOBO data

Spencer Roberts 23 December 2015

<u>This first part is needed to determine a reference water level</u>
<u>(For our purposes this will most likely be when water level is 0/ the area in question is not inundated)</u>

1. After HOBO data is exported and saved, open .csv for each plot in Excel.
2. In all plot files except for the control, add two columns for **Control Pressure** and **Control Temperature**
3. Copy and paste the control temperature and control pressure data into each of the plot spreadsheets
4. Create two additional columns
    a. The first – the **delta pressure** aka the difference between the plot pressure and the control at each time point
    b. The second – The **delta temperature** aka the difference between the plot temperature and the control at each time point
5. Combine all the plot .csv files into one database file
6. Sort this master spreadsheet by value in the **delta pressure**

7. Look for all values where the **delta pressure** equals 0
    a. We are especially interested in the LMR/ RIverine plots
    b. We are going to assume if the pressure is the same, then potentially the plot HOBO was exposed
    c. With these LMR sites highlighted, lookup the NOAA tides for this day or some of these days for reference.
    d. We are looking for the times when the pressure is 0 and we can confirm the tide was at low/ falling and close to low tide
        i. i.e. if it was low tide, aka the most likely time for the LMR plot to not be inundated, and the **delta pressure** was 0 for that time then these are the most likely times the **water level** was equal to 0 and will become our reference
    e. It is possible there will be multiple times/ points where everything screams **water level** = 0, that is fine, pick one and highlight or bold it for the next step

<u>The second part is utilizing the HOBO software to give us water level tables</u>

1. Open each HOBO file for each plot, except the Control
2. The HOBOware program will prompt you in a pop-up window
    a. Make sure Barometric Compensation Assistant is highlighted and click on **Process**
3. For fluid density, select the water salinity type that fits best
4. Check use reference water level
    a. Make sure is set to 0 m or ft
    b. In the scroll down menu select the time you highlighted in the Master file
5. Next select **Use Barometric Datafile** and select the Control HOBO file
6. To finish click **Create New Series** and then **Plot**
7. If the reference water level is good, then there should be none or minimal point less than 0 on the graph
8. In a tidal situation, there will be peak and bases to these peak at 0 (or not if the wetland the percent inundation is high)
9. If things seem off, try again and make sure **Constant Barometric Pressure** is not selected and it is using the Control file as a reference for barometric pressure
10. If there are a lot of values under 0, then try a different reference water level time point from the Master database.
11. A new data table from the water level graph can be saved/ exported for further analysis in excel

<u>SOP #42 Field Protocol for Vegetation Assessment at Marsh Futures Bio-Assessment Plots</u>

Joshua Moody 4/30/2015
Adapted from L. Haaf Best Practice #5

<u>Estimate Plant Coverage</u>

c. Use plant guide to correctly identify plants in the plot
    i. If plant is unknown, take sample & photo (note photo # on data sheet), identified *within 48 hr* of sampling
d. Estimate cover visually and agree on approximate covers amongst field crew

i. Percent cover should reflect one species at a time; overlap may occur, so percentages may not add to 100%

PARTNERSHIP FOR THE DELAWARE ESTUARY Science Group

Operation of YSI Professional Plus Instrument

Procedure No. PDE-SOP-#44
3/25/16
Prepared By: Kurt M. Cheng
Spencer A. Roberts

Description

This SOP describes the YSI Professional Plus (Pro Plus) water quality instrument and the proper materials and methods for its calibration, field operation, long-term storage and data extraction.

Terminology and Orientation

The YSI Pro Plus consists of a data logger (handheld computer) that provides real-time measurements and storage of water quality data. A cable connects the data logger to the sonde which contains water quality probes and is designed to be equipped with a sampling guard for use in the field. The YSI Pro Plus is currently equipped to measure and record water quality parameters including water temperature (°C), specific conductivity/conductivity (mS/cm), salinity (ppt), pH, and dissolved oxygen (% and mg/L) where C = Celsius, mS = millisiemens, cm = centimeters, ppt = parts per thousand, mg = milligrams, and L = liters.

Equipment

- YSI Pro Plus handheld data logger
- YSI quatro cable and sonde
- Probe guard
- Guard cover
- O-rings
- O-ring grease
- Size "C" batteries (2)
- USB connector
- USB cable
- YSI data manager software
- Conductivity/temperature sensor
- pH sensor
- DO sensor
- pH 4 buffer standard
- pH 7 buffer standard
- pH 10 buffer standard
- Conductivity 1 mS calibration standard
- Conductivity 10 mS calibration standard
- De-ionized (DI) water
- Spring water
- pH sensor storage container
- Sampling cup
- Small sponge
- Cleaning brush
- Circle wrench
- DO membrane caps
- DO electrolyte solution

Procedure

1. Calibration
   1.1 Temperature
      1.1.1 There is no calibration required for temperature
   1.2 Conductivity
      1.2.1 Power on data logger and connect to sonde with cable
      1.2.2 Rinse the calibration cup and sonde with DI water and fill calibration cup with desired conductivity standard. For freshwater applications, a 1 mS/cm standard should be used. For brackish water applications, a 10 mS/cm standard should be used
      1.2.3 Place sonde into calibration cup and ensure probes are completely submerged adjusting probe to remove any air bubbles
      1.2.4 Press CAL and select **Conductivity**, then select **Specific Conductivity**
      1.2.5 Enter the calibration value of the standard (e.g. 1 mS/cm or 10 mS/cm)
      1.2.6 Let specific conductivity value stabilize and then select Enter
      1.2.7 Select Enter again to continue
      1.2.8 Calibrate conductivity sensor monthly
   1.3 pH
      1.3.1 Power on data logger and connect to sonde with cable
      1.3.2 Rinse the calibration cup and sonde with DI water prior to calibration
      1.3.3 Rinse calibration cup and sonde with desired pH buffer standard
      1.3.4 Fill calibration cup with desired pH buffer standard and place sonde into calibration cup so probe is completely submerged adjusting to remove any air bubbles
      1.3.5 Note the temperature (put the sonde in read mode) for pH calibration
      1.3.6 Press CAL then select **ISE1 (pH)**
      1.3.7 Then select **ISE1 (pH)**
      1.3.8 Enter the solution value in accordance with ambient temperature (temperature specific pH values are listed on buffer solution bottle)
      1.3.9 Wait for pH reading to stabilize and then select Enter to finish calibration
      1.3.10 Repeat steps 1.3.3 through 1.3.9 to calibrate for each pH value (i.e. 4, 7, 10) desired for the expected environment
      1.3.11 Calibrate the pH sensor before each day in the field
   1.4 Dissolved Oxygen
      1.4.1 Power on data logger and connect to sonde with cable
      1.4.2 Allow 10 minutes for warm up
      1.4.3 Rinse calibration cup and sonde with DI water
      1.4.4 Partially fill calibration cup with spring water (one half inch above cup base)
      1.4.5 Place the sonde in the calibration cup and screw cup on 1 or 2 turns, leaving room for air flow.
      1.4.6 Wait 5-15 minutes for sensor to stabilize.
      1.4.7 If DO measurements do not stabilize (e.g. continual decline), service DO probe according to 4.3.
      1.4.8 Press CAL and select **DO** then select **DO%**
      1.4.9 Press Enter to continue
      1.4.10 Calibrate DO sensor before each day in the field
2. Field Use and Short-term storage
   2.1 Field Sampling
      2.1.1 Power on data logger and connect to sonde with cable

2.1.2 Remove calibration cup and screw on probe guard
2.1.3 Submerge sonde into water and continually swirl sonde to maintain adequate water flow over probes. If sampling in swift water, orient sonde perpendicular to flow to avoid damaging probes.
2.1.4 Record data onto datasheet or notebook, or follow 2.2 for storing data
2.1.5 If multiple sites are visited during one day, cover the probe guard with the guard cover to prevent drying out probes throughout the day

2.2 Storing data
2.2.1 To store water quality data press ENTER
2.2.2 Either log data into existing Folder and Site or create a new Folder for that sampling effort
2.2.3 To create a new folder select **FOLDER**
2.2.4 Scroll to the end of the list to **ADD NEW**
2.2.5 For adding a new Site select **SITE** and select **ADD NEW**
2.2.6 Once satisfied with the storage location select **LOG NOW**
2.2.7 To view logged data press FILE and select **VIEW DATA**

2.3 Short-term Storage
2.3.1 After field use rinse sonde with DI water
2.3.2 Keep small amount of DI water in calibration cup with clean sponge
2.3.3 The sensors should not be submerged but kept in a humid environment

3. Long-Term Storage (for storage 30 days or longer)

3.1 pH sensor
3.1.1 Unscrew pH sensor from sonde
3.1.2 Seal sensor port with plug
3.1.3 Fill pH storage container with pH 4 buffer solution
3.1.4 Make sure the sensor is submerged and sealed in container so it does not dry out during storage

3.2 DO sensor
3.2.1 Remove DO sensor from sonde
3.2.2 Seal sensor port with plug
3.2.3 Remove membrane cap and rinse DO probe to clean
3.2.4 Allow to air dry and store dry

3.3 Temperature/Conductivity sensor
3.3.1 Unscrew from sonde and replace with port plug
3.3.2 Clean with conductivity cleaning brush

4. Probe installation

4.1 O-rings
4.1.1 When setting up the YSI Pro Plus after short or long-term storage, check the conditions of o-rings for proper sealing.
4.1.2 If an o-ring appears worn-out or cracked, replace and apply a small amount of o-ring grease

4.2 pH sensor
4.2.1 Remove pH sensor from stage container and solution
4.2.2 Rinse sensor with distilled water
4.2.3 Remove port plug and insert pH sensor into sonde

4.3 DO sensor
4.3.1 Clean sensor with cleaning brush and rinse sensor tip with DI water
4.3.2 Fill a new membrane cap with sensor electrolyte solution
4.3.3 Thread and screw on new membrane cap while removing air bubbles

4.3.4 Remove port plug and insert DO sensor into sonde

4.4 Conductivity sensor

4.4.1 Remove port plug and insert conductivity sensor into sonde using circle wrench

4.4.2 Use cleaning brush if necessary to clean sensor

5. Digital Data Management

5.1 Extracting stored data from data logger

5.1.1 Attach USB connector to the back of the data logger and plug USB cable from connector into a personal computer

5.1.2 Launch YSI Pro Series Data Manager Software and select instrument

5.1.3 Explore and transfer desired data files from the data logger

	Sensor Type	Range	Accuracy	Resolution	Units
Dissolved Oxygen (%) (temp range -5 to 45 °C)	Polarographic	0 to 500%	0 to 200% (±2% of reading or 2% air saturation, whichever is greater) 200% - 500% (± 6% of reading)	1% or 0.1% air saturation (user selectable)	%
Dissolved Oxygen (mg/L) (temp range -5 to 45 °C)	Polarographic	0 to 50 mg/L	0 to 20 mg/L(±2% of the reading or 0.2mg/L, whichever is greater) 20 to 50 mg/L (±6% of the reading)	0.1 or 0.01 mg/L; 0.1% air saturation	mg/L, ppm
Temperature	-	-5 to 70°C	±0.2°C	0.1°C	°C
Conductivity (derived parameters include resistivity, salinity, specific conductance, and total dissolved solids)	Four electrode cell	0 to 200 mS/cm	±1% of reading or 0.001 mS/cm (whichever is greater)	0.001 mS (0 to 500 mS); 0.01 mS (0.501 to 50.00 mS); 0.1mS (50.01 to 200 mS)	µS,mS
Salinity	Calculated from conductivity and temperature	0 to 70 ppt	±1.0% of reading or 0.1 ppt, whichever is greater	0.01 ppt	ppt, PSU

pH	Glass Combination Electrode	0 to 14 units	±0.2 units	0.01 units	mV, pH units
Barometer	Piezoresistive	375 to 825 mmHg	±1.5 mmHg from 0 to 50°C	0.1 mmHg	mmHg, inHg, mbar, psi, kPa, ATM

Datasheets for Spring Lake

NFWF Monitoring

Location Spring Lake Transect #______ Date___________

Site Name ______________

Time of Start& Finish____:____ ____:____ Data Collected by: _______

Water ↑

		Vegetation Robustness and Survivorship			Light Attenuation		Comments:
P	LAT	Plant Species	% Total Cover	#Live Plugs	Top	Bottom	
L							
O	LONG						
T							
1	Camera ID						
	Photo #						

		Vegetation Robustness and Survivorship			Light Attenuation		Comments:
P	LAT	Plant Species	% Total Cover	#Live Plugs	Top	Bottom	
L							
O	LONG						
T							
2	Camera ID						
	Photo #						

		Vegetation Robustness and Survivorship			Light Attenuation		Comments:
P	LAT	Plant Species	% Total Cover	#Live Plugs	Top	Bottom	
L							
O	LONG						
T							
3	Camera ID						
	Photo #						

		Vegetation Robustness and Survivorship			Light Attenuation		Comments:
P	LAT	Plant Species	% Total Cover	#Live Plugs	Top	Bottom	
L							
O	LONG						
T							
4	Camera ID						
	Photo #						

Land

Site Level Observations:

Site-level Fixed Photo Point Identification Numbers and Description:			
	Photo ID #	Description	Comments
1			
2			
3			
4			
5			
6			
7			
8			

Salinity ______________________ppt **Method Used**: YSI_______ Refractometer_______

Are invasive plant species present? Yes_______ No_______

If Yes, which ones? _________________________________

Is debris present? Wrack_______ Trash_______ Other_______ None_______

If Yes, what is the abundance of the debris? High_______ Moderate_______ Low_______

What structures are present? Riprap_______ Coir Log_______ Berm_______ Other______________

Has the structure/site been impacted by ice? Yes______ No_______

What is the condition of the structure? Excellent______ Fair_______ Poor_______

Are shellfish present? Yes_______ No_______

If yes, what type of shellfish? Oysters_______ Mussels_______

Other comments or observations:

NFWF Monitoring Vegetation Growth

___

___

___

Stem Heights (cm)

SPP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23