MEASURING SUCCESS: MONITORING NATURAL & NATURE-BASED SHORELINES IN NEW YORK STATE

Project Overview

Supported by:

Photos: NYC Parks and NYS DEC
NNBF Planning Landscape

**NYS Salt Marsh Monitoring Guidelines (2000)** provide a framework for salt marsh restoration, including planning, design, implementation, and long-term monitoring in New York State.

**NYS 2100 Commission Report (2013)** includes recommendations to improve the strength and resilience of the Empire State’s infrastructure and makes recommendations on assessing options for using natural systems to protect coastal communities, encouraging the use of green and natural infrastructure. It specifically recommends building living shorelines, new wetlands, reefs, etc. to help protect NY Harbor communities. This report is a critical component leading to NY’s commitment towards more nature-based approaches.

**The NY Community Risk and Resiliency Act (2014)** aims to mainstream consideration of climate change through five major provisions, including the adoption of sea-level rise projections into regulation, consideration of future physical risk into applications for permits and funding, and developing guidance on the use of natural resources and natural processes to reduce risk.

**The Coastal Green Infrastructure Research Plan for New York City (2014)** was developed in collaboration between the Hudson River Estuary Program and the Mayor’s Office of Recovery and Resiliency and Department of City Planning, this report is a research plan on the use of nature-based features (or coastal green infrastructure) to protect the coastal areas from New York City from erosion and flooding.

**USACE Coastal Risk Reduction and Resiliency: Using The Full Array of Measures (2013)** discusses a variety of approaches through which coastal risk reduction can be achieved, including natural and nature-based features, nonstructural interventions, and structural interventions.

**USACE Use of Natural and Nature Based Features for Coastal Resilience (2015)** was developed after Hurricane Sandy to study the use of natural and nature-based features (NNBF) to improve coastal resilience. It is an accompaniment to the USACE North Atlantic Coast Comprehensive Study (NACCS) and the first report to embrace the use of NNBF by the USACE. The report classifies NNBF (based on the geomorphic classification of coastlines that are already in use by the Corps), presents methods for assessing coastal vulnerability, provides a framework for developing performance metrics, incorporates regional sediment management, addresses monitoring and adaptively managing from a systems perspective, and presents key policy challenges.
NYS DEC Guidance for Living Shorelines (2016) was produced by the state to describe natural and nature-based solutions to better protect New Yorkers and the state’s coastline and help guide communities in permitting and installing living shorelines in New York’s marine district.

USACE Living Shorelines Nationwide Permit 54 (2016) is the first ever nationwide permit for living shorelines, making the permitting process faster and easier for property owners and contractors to permit and construct modest scale living shorelines, in the hope that more property owners will choose living shoreline projects to stem erosion while maintaining important natural shoreline features.

NYC Parks Salt Marsh Restoration Guidelines (forthcoming) provide a framework for selecting monitoring approaches to help answer a range of questions about the condition of restored saltmarshes, focusing on guidance for designing and implementing a monitoring plan that reflects available resources and can meet a range of monitoring objectives.

NY Community Risk and Resilience Act Guidance (forthcoming) will help guide New York State agencies, permit applicants, and stakeholders in the use of natural resilience measures to mitigate risks associated with sea-level rise, storm surge, erosion, and flooding.
Natural Features

Nature-Based Features

Ecologically-Enhanced Hard Structural Features

Hard Structural Features
Shoreline managers need to better understand natural and nature-based features, compared to hard structural features, to support resilience and adaptation.

Information is needed to know where different types of shoreline management techniques can be used to optimize the benefits they can provide.

A coherent monitoring framework will produce that information and lead to better understanding of NNBFs and hard structural features by generating comparable data.
PROJECT GOAL

Create a monitoring framework to guide data collection to inform more consistent shoreline management decisions in New York State, particularly as it relates to NNBF.
The framework is meant to inform…

Shoreline managers across NYS…

…who can be property owners, property managers, engineers, contractors and agencies
Shoreline managers need comparative data collected through consistent protocols. So, the framework will *first* be *used* by...

Partners collecting data...

...that can be scientists, stewardship groups, citizens, and shoreline managers
HOW OUR MONITORING FRAMEWORK FITS INTO DECISION-MAKING

MONITORING FRAMEWORK

EVALUATION ROADMAP
establishes an agreed-upon set of performance goals for shoreline features against which the performance these features can be comparatively evaluated and a framework for relating these goals with specific metrics or indices by which achievement of or progress towards such goals might be evaluated. This framework allows for the selection, development and prioritization of relevant monitoring protocols.

RESILIENCE
SERVICE
ECOLOGICAL FUNCTION
HAZARD MITIGATION & STRUCTURAL INTEGRITY
SOCIO-ECONOMIC OUTCOMES

WHY do / will you value the shoreline?

PERFORMANCE PARAMETER / GOAL

WHAT would you measure to assess this performance?

INDICATOR / METRIC

HOW would you measure this?

MONITORING PROTOCOLS
agreed-upon methods for gathering comparable data about various shoreline features relevant to identified goals and indicators/metrics.

PROTOCOL
CONSIDERATIONS:
Frequency and duration
Who will be doing the monitoring
Geography and context
Qualitative vs quantitative
Applicability across shoreline types, scales, and regions

FEEDBACK

EVALUATION

How does it perform relative to the performance goals?

ANALYSIS

What did you learn from what you observed?

DATA COLLECTION

COLLECTION OF RELEVANT LONG-TERM DATA SETS
NETWORK OF MONITORING PARTNERS
PROJECT OBJECTIVES

A. Identify key performance and resiliency benefits of NNBFs through a stakeholder-driven process.

B. Develop standardized protocols to generate better comparative data across the diverse shorelines of New York State.

C. Help decision makers determine whether benefits are realized at shoreline sites.
PROJECT OUTCOME

A coherent framework for monitoring and evaluating the performance of nature-based shoreline features compared to structural and natural, non-structural approaches throughout New York State’s diverse coastal environment based on a strong scientific and technical foundation and with broad buy-in from agencies, practitioners, and civic groups.
ANTICIPATED OUTPUTS + OUTCOMES

PROJECT OUTPUTS (PROJECT DELIVERABLES)
- GOALS/INDICATORS & METRICS
- PROTOCOLS
- PILOT PROJECT DATA (to inform refinement of protocols)
- COMMUNITY NETWORK (informed, engaged, connected stakeholders)
- DATABASE (pilot project data storage)

NEAR-TERM OUTCOMES
- COLLECTION OF RELEVANT LONG-TERM DATA SETS
- NETWORK OF MONITORING PARTNERS
- COHERENT + COMPARABLE EVALUATION OF SHORELINE MEASURES

LONG-TERM OUTCOMES
+ BUY-IN FROM AGENCIES/PRACTITIONERS ON THE EVALUATION FRAMEWORK & MONITORING PROTOCOLS
+ STATE-WIDE UPTAKE/ADOPTION BY ENTITIES INVOLVED WITH PERMITTING + DESIGN + CONSTRUCTION
+ INCREASE IN IN-SITU MONITORING OF FEATURES USING THE PROTOCOLS
MEASURES OF SUCCESS

• The framework and guidance are accessible, intelligible, and usable by data collectors.
• The data collection protocols are cost-effective and relatively simple, but still credible.
• The framework and protocols are applicable to and comparable across different types of shorelines.
• Number of sites being monitored using framework following the project
• Moderate/high level of satisfaction that the framework will improve planning, design, and permitting process of NNBF features
1. Synthesize literature and existing monitoring programs into Draft Monitoring Framework and Protocols that promotes data collection to assess the ability of different shorelines to provide ecological function, hazard mitigation, and socio-economic outcomes.

2. Solicit feedback from stakeholders and develop monitoring partnership through Regional Workshops, in each of four coastal regions, and a Permit Reviewers meeting to revise Monitoring Framework.

3. Develop a database and explore how a data management system could support widespread implementation.

4. Test the framework at pilot sites through partnerships with government agencies and other stewards, resulting in a Final Monitoring Framework.

5. Document and share key findings with a community network of shoreline stakeholders in New York and others nationwide to help better identify where and how best to deploy these important tools.
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<th>Name</th>
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<th>Title</th>
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<td>DOI-MEG</td>
<td>Department of the Interior (Metrics Expert Group)</td>
<td>Recommendations for Assessing the Effects of the DOI Hurricane Sandy Mitigation and Resilience Program on Ecological System and Infrastructure Resilience in the Northeast Coastal Region</td>
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<td>A framework for developing monitoring plans for coastal wetland restoration and living shoreline projects in New Jersey</td>
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<td>Waterfront Facilities Maintenance Management System Inspection Guidelines and Manual</td>
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<td>Stoddard</td>
<td>Stoddard, Larsen, Hawkins, Johnson, Norris in Ecological Applications</td>
<td>Setting expectations for the ecological condition of streams: the concept of reference condition</td>
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<td>ABT</td>
<td>ABT Associates</td>
<td>Developing Socio-Economic Metrics to Measure DOI Hurricane Sandy Project and Program Outcomes</td>
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<td>6</td>
<td>USACE</td>
<td>United States Army Corps of Engineers</td>
<td>North Atlantic Coast Comprehensive Study, Use of Natural and Nature-Based Features for Coastal Resilience</td>
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<td>7</td>
<td>USGS-FI</td>
<td>United States Geological Survey</td>
<td>Fire Island Coastal Change</td>
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<td>8</td>
<td>MARCO</td>
<td>The Mid-Atlantic Regional Council on the Ocean</td>
<td>Working towards a robust monitoring framework for natural and nature-based features in the mid-Atlantic using citizen science Atlantic regional council on the ocean</td>
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<td>NYS</td>
<td>New York State Department of State and Department of Environmental Conservation</td>
<td>New York State Salt Marsh Restoration and Monitoring Guidelines</td>
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<td>United States Geological Survey</td>
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<td>HRNERR</td>
<td>Hudson River National Estuarine Research Reserve</td>
<td>(a) Hudson River sustainable shorelines project phase I: mitigating shoreline erosion along the Hudson River estuary's sheltered coasts; (b) sustainable shorelines along the Hudson river estuary: phase II, promoting resilient shorelines and ecosystem services in an era of rapid climate change; (c) assessing ecological and physical performance</td>
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<td>Coast-wide Reference Monitoring System in Louisiana</td>
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<td>RCF</td>
<td>Reef Check Foundation</td>
<td>Reef Check California Instruction Manual: A guide to rocky reef monitoring</td>
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MONITORING PROTOCOLS
agreed-upon methods for gathering comparable data about various shoreline features relevant to identified goals and indicators/metrics.

RESILIENCE SERVICE

PERFORMANCE PARAMETER / GOAL

WHY do / will you value the shoreline?

WHAT would you measure to assess this performance?

INDICATOR / METRIC

HOW would you measure this?

PROTOCOL

CONSIDERATIONS:
Frequency and duration
Who will be doing the monitoring
Geography and context
Qualitative vs quantitative
Applicability across shoreline types, scales, and regions

DATA COLLECTION

COLLECTION OF RELEVANT LONG-TERM DATA SETS
NETWORK OF MONITORING PARTNERS

what services/benefits does the shoreline provide?

How does it perform relative to the performance goals?

What did you learn from what you observed?

FEEDBACK

EVALUATION

ANALYSIS
Resilience Services
The high-level grouping / categorization of the type of services and benefits that shoreline management features provide to communities and ecosystems.

- Ecological function
- Hazard Mitigation & structural integrity
- Socio-Economic Outcomes
- Additional information (size, cost, etc.)
How to read the draft framework

For each resilience service you will find:

– Introduction / note from the technical working group (TWG)
– Monitoring framework “matrix”
– List of preliminary potential protocols
– One “example” protocol
Brief introduction to the resilience service from the TWG

HAZARD MITIGATION & STRUCTURAL INTEGRITY

DRAFT MONITORING FRAMEWORK MATRIX

Hazard Mitigation: How well does this feature reduce risk? While shoreline management features cannot prevent hazards from occurring, they can mitigate their negative effects on people or assets by reducing their exposure or vulnerability to that hazard. By hazard, we are referring to a potential source for damage, harm or other adverse effect like flooding and coastal erosion.

Structural Integrity: How well will the shoreline management feature “hold up” and still maintain other performance goals (goals related to hazard mitigation, ecological performance, or community benefits)? These metrics should consider material performance and physical condition over time among other things. Note: This topic is relevant to the other resilience service areas, and may be its own resilience service, but for now has been examined alongside hazard mitigation.

The Hazards Mitigation and Structural Integrity group developed the evaluation readout to specifically address the following performance parameters:

• In the evaluation of topographic change due to natural coastal processes and large storm events, a feature should be designed to maintain natural coastal processes, allow a shoreline to adapt to sea level rise, as well as reduce shoreline erosion that can have adverse effect on people, property, and native ecosystems.
• In the evaluation of the coastal flooding hazard, a feature should be designed to reduce the exposure or vulnerability to coastal flooding that can have adverse effect on people, property, and native ecosystems.
• In the evaluation of structural integrity, a feature should be designed and built to sustain structural integrity over time within context of natural coastal processes, as well as large storm events.

To evaluate these three performance parameters, eleven distinct indicators or metrics were identified. To facilitate measurements of these indicators/metrics, eleven protocols have been developed. The TWG is cognizant of the fact that additional protocols may be necessary to facilitate different levels of expertise required to evaluate the identified indicators or metrics.

PRELIMINARY PROTOCOLS

The TWG developed eleven protocols to evaluate performance goals, and more specifically the identified metrics/indicators. The protocols developed by the TWG drew from existing published protocols when possible, as well as best professional judgment. While many of the published protocols are based upon natural shorelines or NWSFs, the TWG intended to develop protocols that are not specific to asset types (i.e., inclusive of both “gray” and “green” shoreline types).

The TWG recognizes that current protocols require a higher level of expertise, or are more intensive field protocols. Future revisions may address the following to better reflect input from theRWG:

• Simplify existing protocols, or develop parallel protocols that are more directed to citizen science.
• Develop more qualitative protocols to address (1) evaluation of grey degradation, and/or (2) degradation, local scour, visible erosion, accretions.
• Modify existing protocols to better address regionally specific storm events or seasonality of monitoring.
• Customize existing protocols for tide level and boat use.

QUESTIONS FOR THE RWG

• We need feedback regarding the scope of metrics and practicality of implementing outlined protocols.
• Are these metrics/indicators that should be added?
• Are there protocols that need to be added, modified or built upon?
• Do metrics/protocols adequately address shorelines in your region?
• Are protocols too intensive? Can protocols be simplified, but still retain ability to accurately evaluate identified metrics/indicators? Or should TWG develop parallel protocols more directed towards citizen science?

Some questions to think about (from the TWG)
## Monitoring framework “matrix”

Relates parameters / goals & metrics & potential protocols

### HAZARD MITIGATION & STRUCTURAL INTEGRITY MATRIX

<table>
<thead>
<tr>
<th>RESILIENCE SERVICE</th>
<th>PERFORMANCE PARAMETER</th>
<th>POTENTIAL PERFORMANCE GOAL STATEMENT</th>
<th>INDICATOR/METRIC</th>
<th>PROTOCOL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maintain natural coastal processes while reducing or avoiding increase in exposure of people, property, and ecosystems to coastal hazards through shoreline erosion</td>
<td>Change in vertical elevation of asset.</td>
<td>2-Asset Elevation</td>
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<tr>
<td></td>
<td>Topographic Change</td>
<td></td>
<td>Change in shoreline position / sea level rise adaptability.</td>
<td>1-Elevation Pit Install - NYDDR*</td>
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<td></td>
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<td>Change in horizontal position of asset.</td>
<td>1-Asset Aerial Dimension</td>
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<tr>
<td></td>
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<td></td>
<td>Loss or gain of sediment updrift/downdrift.</td>
<td>1-Asset Aerial Dimension</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2-Asset Elevation</td>
</tr>
<tr>
<td></td>
<td>Coastal Hazards</td>
<td>Reduce exposure or vulnerability of people, property, or ecosystems to coastal flooding hazards (storm surge, wave attack, high tide flooding, sea level rise, currents, etc)</td>
<td>Wind driven wave height / wave periods landward/seaward of asset.</td>
<td>3-Wave Measurement</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Boat wave wave height / wave periods landward/seaward of asset</td>
<td>3-Boat Wave monitoring - NYDDR*</td>
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<td></td>
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<td></td>
<td>Change in water elevation landward/seaward of asset</td>
<td>3-Net Level monitoring - NYDDR*</td>
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<tr>
<td></td>
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<td></td>
<td>Currents adjacent to asset.</td>
<td>3-Current Measurement</td>
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<tr>
<td></td>
<td>Structural Integrity</td>
<td>Avoid structural failure and sustain the structural integrity of the shoreline feature</td>
<td>Change in vertical elevation of asset.</td>
<td>2-Asset Elevation</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Change in horizontal position of asset.</td>
<td>1-Asset Aerial Dimension</td>
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<tr>
<td></td>
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<td>Change in vegetation, shellfish, or other biomass of structure</td>
<td>1-Asset Vegetation, Shellfish, or Other Biomass</td>
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<td></td>
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<td></td>
<td>Local scour, visible erosion, etc.</td>
<td>1-Asset Aerial Dimension</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Gray material degradation</td>
<td>1-Asset Aerial Dimension</td>
</tr>
</tbody>
</table>

*May not apply to all regions

### Performance parameter

A factor that determines the relative effectiveness of a shoreline management feature in providing the resilience service.

### Performance Goal

A specified statement for each performance parameter that describes what is desired that the shoreline features / NNBF achieve or support.

### Indicator (or metric)

A measurable or traceable attribute of a shoreline feature that can be used to evaluate progress toward or achievement of a particular performance goal.

### Protocol

The specifications for collecting, reporting, storing, and processing data.
## Preliminary list of potential monitoring protocols

HAZARD MITIGATION & STRUCTURAL INTEGRITY PRELIMINARY PROTOCOL LIST

<table>
<thead>
<tr>
<th>#</th>
<th>Protocol Name</th>
<th>Existing Available Protocol?</th>
<th>Status</th>
<th>Type</th>
<th>Expertise Required</th>
<th>Cost/Level of Effort</th>
<th>Source</th>
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<td>1</td>
<td>Asset Aerial Dimension</td>
<td>Y</td>
<td>Draft Included</td>
<td>Field</td>
<td>Medium</td>
<td>Medium</td>
<td>Boston Port Install - NYCDPR, Oyster Monitoring Guidelines*</td>
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<td>Wave Measurement</td>
<td>N</td>
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<td>TBD</td>
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<td>Boat Wake monitoring - NYCDPR</td>
<td>Y</td>
<td>Recommended existing protocol</td>
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<td>Tide Level monitoring - NYCDPR</td>
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<td>Asset Negotiation, Shellsfish, or Other Biomass</td>
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<td>Medium</td>
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</table>

*May not apply to all regions

A draft list for consideration and discussion; suggestions welcomed and desired!
EXAMPLE PROTOCOL: ASSET AERIAL DIMENSION

Summary Information:
- Protocol name / shorthand: Asset Aerial Dimension
- Related resilience service category: Hazard Mitigation

Associated Parameter: Topographic change / structural integrity


Descriptive/quantitative: Quantitative

Data output / data format: Elevations and geographical extent, typically exported to excel spreadsheet as well as Geographic Information System (GIS)

Protocol type (easy, medium, hard): Medium

Description of monitoring methods / field protocols:
This protocol involves the data collection relative to mapping the aerial dimension of the asset. In terms of hazard mitigation, the measure of aerial dimensions of an asset is critical to estimating the amount of reduced area (if measure taken), disturbance caused to the shoreline, as well as the quality of intended services provided to the shoreline over time. The aerial dimensions of an asset is necessary in evaluating the following metrics:

- Change in shoreline position; sea level rise adaptability
- Change in horizontal position of asset
- Loss or gain of sediment supply/drift
- Local scour, visible erosion, encroachments
- Grey material degradation

At a negative low tide (if applicable), the perimeter of the asset footprint should be mapped using a mapping/survey grade Global Positioning System (GPS) with post-processing capabilities. Collection of as many data points as possible is recommended and could be facilitated through continuous measurements within GPS. The larger the data set of data points, the more accurately the perimeter of the asset can be delineated. Temporary place markers (i.e., wood stakes or PVC pipe) can be placed along the asset perimeter for reference in subsequent surveying events. Photographs should be taken along perimeter to provide reference to site conditions. Data forms to be developed by a project at a minimum should include the following base information:

- Observers
- Site location
- Survey date and time
- Time at (or closest to) tidal period (i.e., low tide, high tide)

Requirements (equipment, training, etc.):
This protocol does require use of a mapping/survey grade Global Positioning System (GPS) with post-processing capabilities. These can be rented on a daily or weekly basis from multiple vendors throughout New York. Alternatively, a standard handheld GPS could be used. Data collection with the GPS will require definition of at least the following settings:

- Frequency: Point – 1 second; Polyline – 1 second
- Minimum positions per point observation – 10 positions
- PDOP mask – A PDOP threshold of 6 is necessary to achieve sub-meter accuracy
- Coordinate system – project specific
- Real-time settings: In order to guarantee the ability to post-process, real-time data correction should always be set to NO.

Data points should be transferred from GPS into mapping software (e.g., ArcGIS) or civil engineering software (e.g., AutoCAD, Microstation). Transfer of data and post-processing should be performed with GPS-specific software (e.g., Trimble TerraSync), and typically is supplied by GPS rental company. Monitoring frequency should occur immediately after construction (ideally, baseline) and then annually. Additional surveys are recommended after events that could alter shoreline position (e.g., hurricanes). Seasonal monitoring may also be needed in October and April to account for changes in weather/wind patterns, seasonality of the beach profile, and seasonal above ground biomass changes.

Data QA/QC procedures:
An engineer or scientist with background in mapping should review the dataset to verify the data set is consistent with existing project mapping, and that the geographic points makes sense based upon site observations. Publicly available aerial photography can also be utilized to confirm mapping.

Data format and management requirements:
Data sets will be transferred from GPS at either a text file, or ESRI shape file. Text files which can be quite large would then be converted or projected into an appropriate mapping program (i.e., ArcGIS). It is assumed that data is collected in the appropriate coordinate system and does not need to be converted at a later date. Management of data is best done through appropriate definitions of metadata. Metadata describe geographic information system (GIS) reference. In the same way a card in a library's card catalog describes a book. It then supports sharing of files and data.

Data analysis protocols:
Data points should be transferred from GPS into mapping software (e.g., ArcGIS, ESRI, Redlands, CA). Post-processing should be completed consistent with mapping software protocols. Mapping software should allow mapping of the geographical extent of the asset overlain on a base map (i.e., topography, aerial photography). This can provide comparisons to as-built conditions or previous monitoring events. In addition, the mapping software can facilitate calculation of the aerial extent reported in square feet or acres.
### TASKS + SCHEDULE

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<th>TASK</th>
<th>2017</th>
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<th>2018</th>
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<th>2019</th>
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<td>Organize Project Advisory Committee</td>
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<td>Hold Kickoff Meeting with PAC</td>
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<td>Conduct Background Research</td>
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<td>Develop Draft Monitoring Framework with TWGs</td>
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- **Completed**: Grey
- **Meeting**: X
- **Future Workshop**: W
- **Major Deliverable**: D
CONTACT

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