

MEASURING SUCCESS

MONITORING NATURAL AND NATURE-BASED SHORELINE FEATURES IN NEW YORK STATE

FINAL REPORT

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1. PROJECT OVERVIEW

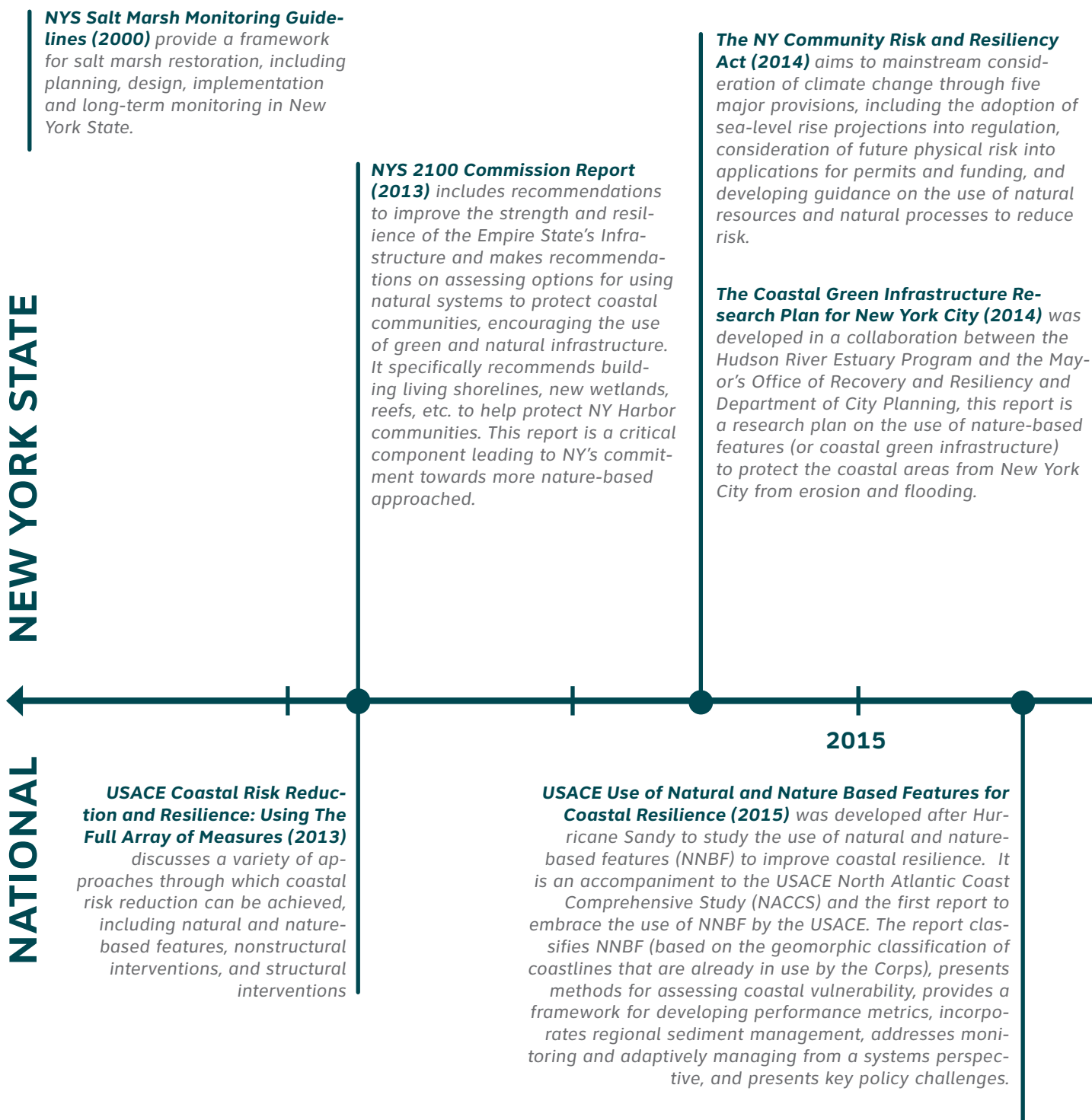
Measuring Success - Monitoring Natural and Nature-based Shoreline Features in New York State is a two-year initiative, sponsored by the NYS Department of State (DOS), with funds from the National Oceanic and Atmospheric Administration (NOAA), and NYS Energy Research and Development Authority (NYSERDA) to develop a coherent shoreline monitoring framework for shoreline features across New York State. The final monitoring framework includes a matrix summarizing (1) performance parameters, (2) indicators for monitoring performance relative to those parameters, (3) monitoring protocols to collect data to track those indicators, and (4) a database structure to make data easily available for reports and trend analysis. The project process also initiated the development of an informal network of shoreline managers and other stakeholders to adopt and use the monitoring framework in the future. The input of these local, regional and agency stakeholders across the state was critical to the framework's usability and helped locate pilot sites and partners across the state's coastal areas.

This monitoring framework brings together a literature review, technical expert working groups, regional stakeholder and advisory council input, and experience from pilot field data collection. Over the course of the project, the team deliberately gathered this input to generate informed guidance about what and how to monitor shorelines. However, it should be recognized that this framework represents a work-in-progress, particularly in regards to the field protocols developed to collect data. These protocols were developed in response to stakeholder input on indicators important to monitor and evaluate, and the resources likely available to those who would be collecting data. The protocols were then piloted in the field through one round of pilot monitoring at shoreline sites in the summer of 2019. Broad lessons learned from the process of developing the protocols and this pilot monitoring are summarized in this report, but fully incorporating the findings from pilot monitoring as well as feedback from project stakeholders on the protocols and their application in the pilot is beyond the scope of this effort. This feedback as well as repeated application of the protocols and decisions regarding how and who will host any data collected are all factors that will influence the further evolution of the protocols and monitoring framework. It is anticipated that DOS, in collaboration with partners, will continue to make refinements and improvements to the framework and protocols through future efforts.

Ultimately, the desired outcome of this project (and subsequent related efforts) is the consistent use of this monitoring framework and data collection protocols across the state's coastal regions (Hudson River Estuary, New York-New Jersey Harbor, Long Island, and the Great Lakes region) to enable the collection of comparable data through monitoring of nature-based and other shoreline management features. The resulting data will support the evaluation of how shoreline features provide resilience services of hazard mitigation, ecosystem function, and socio-economic outcomes. The framework will also provide the foundation for future decision-support tools and analysis, serving to inform more consistent and effective decision-making in the design and management of our shorelines.

PLANNING & POLICY CONTEXT

This effort builds on a great deal of past work defining types of shoreline features, designing multi-function shorelines, and monitoring different shorelines. The documents identified below have been especially influential in informing this work, including setting the policies, priorities, and research agenda that led to this effort. A more complete list of resources and references are included in Appendix F: Summary of Documents Reviewed.



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.

NYC Parks Salt Marsh Restoration Guidelines (2018) 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.

2018

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.

PROJECT BACKGROUND

WHY A MONITORING FRAMEWORK?

The demand to balance shoreline management strategies for competing coastal uses has been a nationally recognized policy goal since the passage of the Federal Coastal Zone Management Act in 1972. More recently, Hurricanes Irene, Lee and Sandy have spurred widespread interest in the use of natural and nature-based shoreline features (NNBF) as alternatives to conventional (typically hardened shoreline) approaches to coastal hazard mitigation in New York State. These nature-based shoreline features are thought to provide some or similar hazard mitigation benefits (from erosion, wave attack, and flooding) as hard structural features (HSF) do, while limiting the negative impacts on shoreline processes, habitats, or communities that these traditional approaches may have. Additionally, NNBFs are thought to provide ecological and social benefits not accrued through HSF.

Since 2013, a number of city, state, and federal guidance and planning documents have encouraged the use of NNBFs (see the timeline on the following page and Appendix F for summaries). In response to these calls, experimentation with new and hybridized techniques – such as living shorelines – has begun to proliferate in New York. Widespread adoption of NNBFs remains limited despite this growing trend in pilots and experimentation. This is in part due to a lack of data on how such shoreline features perform relative to goals for providing risk reduction, ecosystem services, or other services that decision-makers are interested in. Prior to this framework, there was no state-wide system to evaluate the relative performance of different shoreline features. As a result, there is currently limited data available on their actual (versus modeled) performance, and any existing data is difficult to compare because it has not been collected through consistent protocols.

To address this gap this project aims to develop a coherent state-wide monitoring framework. This is a “framework” rather than just a monitoring guide because it relates data outputs from the protocols to specific indicators prioritized by stakeholders. It isn’t just about collecting consistent and comparable data but data that can enable stakeholders to evaluate the selected indicators. Thus, while the main output of this effort is the monitoring protocols themselves, the framework can provide the foundation for future decision-support tools and analyses, serving to inform more consistent decision-making around the design and management of our shorelines.

PROJECT GOAL

The overall goal of this project is to develop a coherent framework for shoreline monitoring that will guide data collection to inform more consistent and effective shoreline management decisions in New York State, particularly as it relates to NNBF.

SPECIFIC PROJECT OBJECTIVES:

The project objectives center around three key areas:

1. Identify key performance and resiliency benefits of NNBF through a stakeholder-driven process.
2. Develop standardized protocols to generate better comparative data across the diverse shorelines of New York State.
3. Help decision makers determine which benefits are realized at shoreline sites.

THE FRAMEWORK ...

Aspires to

- Build on and contribute to ongoing work by existing shoreline managers.
- Build on and contribute to, where possible, long-term data sets focused on socio-ecological conditions.
- Provide protocols for data collection that are applicable or adaptable to the broad range of shoreline conditions found across New York States coastal environments such that comparable data can be collected across different shoreline conditions and geographic locations.

Does NOT aspire to

- Be exhaustive with respect to the data collected and services it aims to monitor.
- Be shoreline type-specific or create separate performance goals, parameters, and indicators for each individual type of shoreline feature.
- Provide monitoring guidance for inland riverine systems, streams, or stormwater management features.
- Prioritize the monitoring of one type of shoreline over another (Natural v. Nature-based v. Hard structural v. ecologically enhanced hard structural).

WHO IS THIS MONITORING FRAMEWORK FOR?

The primary audience for this framework are the public and private sector shoreline managers in NYS, which we define as anyone involved in the construction or management of New York's shorelines. The stakeholder-driven process for developing the framework gathered input from a wide network of shoreline managers and other stakeholders with varying degrees of expertise, capacity, and available resources. These stakeholders include government agencies, non-profit organizations (e.g. stewardship groups), academic institutions, environmental consultants, and private property owners. Thus, in developing this monitoring framework we sought feedback to make tools, language, templates, and protocols accessible and useful for the full range of potential user groups.

PROJECT DELIVERABLES & OUTCOMES

PROJECT DELIVERABLES:

The key deliverables, or near-term outputs, for the project are:

- With a multi-disciplinary team of technical experts, synthesize literature and existing monitoring programs to inform and develop a statewide Draft Monitoring Framework for assessing the performance of shoreline features related to ecological function, hazard mitigation, and socio-economic outcomes.
- Solicit feedback on the framework from stakeholders, particularly active shoreline managers, and develop monitoring partnerships through regional workshops in each of the four coastal regions (Long Island, New York Harbor, Hudson River and Great Lakes).
- Develop a database that can be used to produce basic reports and trend analysis.
- Test the framework at pilot sites through partnerships with local, state and federal agencies and other stewards.
- Within the scope of this effort, synthesize the ideas, concerns, and suggestions raised through the regional workshops, other stakeholder engagement, and the pilot monitoring to develop a Final Monitoring Framework.
- Document and share key findings with a community of stakeholders in New York and others nationwide to help public agencies, local communities, private consultants, and landowners identify where and how best to deploy the framework and protocols.

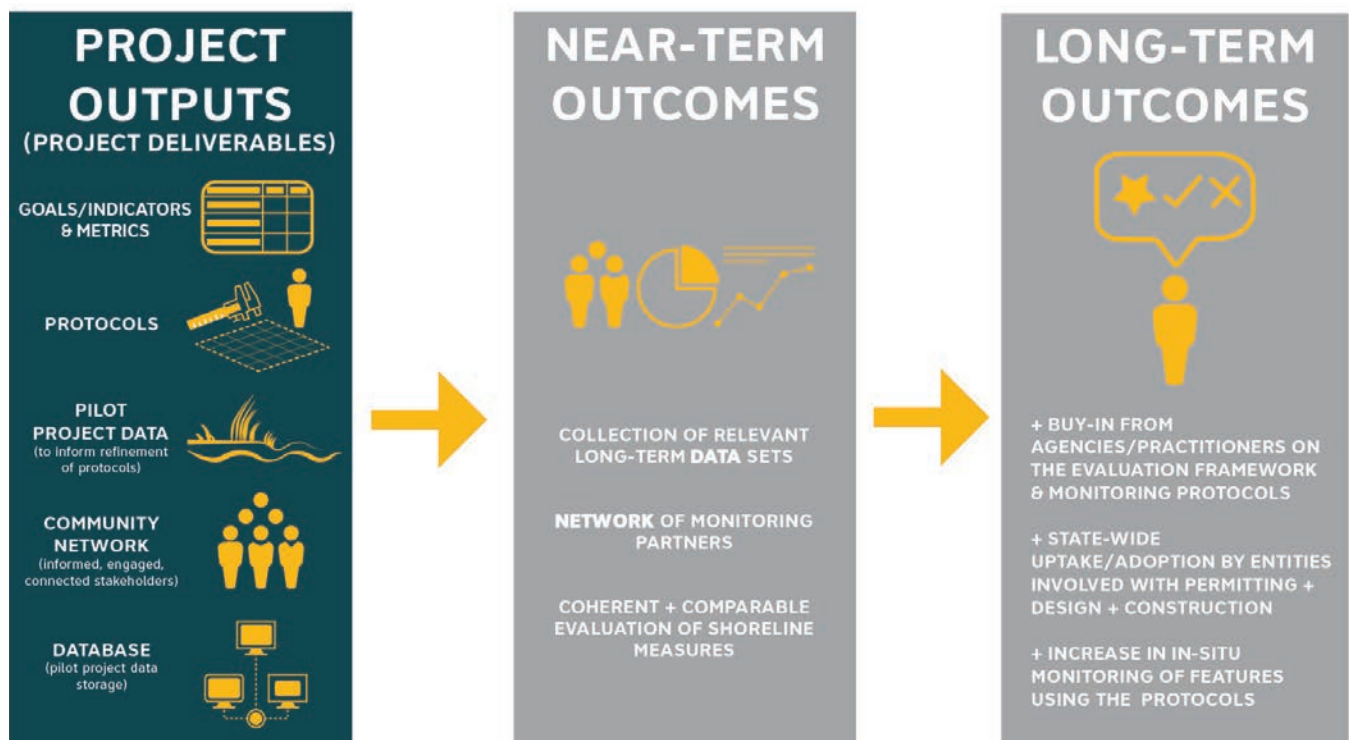
The figure on the following page specifies how our project process and products will build toward important outcomes for New York State. Each element of the project evaluation scheme is described further in the previous report sections. Because the project involves a collaborative process among diverse stakeholders, this evaluation scheme can help promote learning and adjustment over time by better pinpointing where improvements to processes and products can be made in future iterations of the monitoring framework, data collection, and decision support.

DESIRED LONG-TERM OUTCOMES:

We intend for shoreline managers and stewards across the state to adopt this framework to monitor field sites and share the resulting data with each other. Widespread application and testing of the framework will enable shoreline managers to generate robust and comparable data about different shoreline features across New York. We anticipate that data generated through this monitoring framework will be publicly accessible within a statewide database (see Appendix I). We also anticipate that analysis of such comparable data will allow managers, policymakers, and other decision-makers to better understand and evaluate not only the performance of the individual projects monitored, but the relative performance of different types of shoreline features.

CONTEXT

- + DECISION MAKERS SEE VALUE IN BETTER UNDERSTANDING HOW NATURAL AND NATURE-BASED FEATURES SUPPORT RESILIENCE AND ADAPTATION
- + SHORELINE MANAGERS NEED TO BETTER UNDERSTAND NATURAL AND NATURE-BASED FEATURES, COMPARED TO HARD STRUCTURAL FEATURES, TO SUPPORT RESILIENCE AND ADAPTATION
- + A COHERENT MONITORING FRAMEWORK WILL ENABLE FUTURE EVALUATION OF NNBFS AND HARD STRUCTURAL FEATURES BY GENERATING COMPARABLE DATA.



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 NNBFS

PROJECT TEAM

Measuring Success - Monitoring Natural and Nature-based Shoreline Features in New York State is a collaborative effort involving a diverse set of partners and stakeholders. Key team members and advisors include:

PROJECT SPONSORS

The NYS Department of State (DOS), with funding from the National Oceanic and Atmospheric Administration (NOAA) and NYS Energy Research and Development Authority (NYSERDA)

PROJECT CORE TEAM

Science and Resilience Institute at Jamaica Bay (lead) with NYS Department of Environmental Conservation, NYC Parks, Consensus Building Institute, US Forest Service, Brooklyn College, New York Sea Grant, New York-New Jersey Harbor Estuary Program, SCAPE Landscape Architecture, ARCADIS, New York State Water Resources Institute/Cornell University

COMMITTEES & WORKING GROUPS

Project Advisory Committee (PAC) and Agency Team:

Throughout the course of the project, members of the PAC advised the core team by providing feedback and input on the process, content, and products. The entire PAC consisted of 10 members, each with extensive professional expertise in the area of shoreline management. See Appendix G for a list of Project Advisory Committee members. The project also benefited from input from a team of advisors from state and federal agencies, including regulators and funders, who participated in two webinars convened by sponsors and the Core Team.

Technical Working Groups (TWG):

Technical Working Groups (TWG) assisted and guided the Core Team in the development, prioritization, and refinement of goals, parameters, indicators, and monitoring protocols for each of the resilience service areas. Each TWG was comprised of 5-10 members with expertise in their respective technical area; experience with developing or implementing monitoring in this area; and/or experience with the design, construction, or maintenance of NNBF. Participants were chosen based on their diversity of expertise and knowledge on existing literature and monitoring practices from around the state and include design practitioners, public agency representatives, and scientists. See Appendix G for a list of technical working group members and their affiliations.

PROJECT SCHEDULE:

Regional Working Groups (RWG):

Regional working groups were convened once in each of the four regions where shoreline monitoring would take place as part of this project: Hudson River, New York Harbor, Long Island, and the Great Lakes. In these one-day meetings, invited participants were asked to provide feedback on the draft monitoring framework with an eye towards: describing what monitoring makes sense in their region; identifying likely challenges to implementation and offering potential strategies for overcoming them; becoming a partner or helping to identify partners to pilot test monitoring; and joining the statewide network of practitioners, researchers, agencies, and non-profit organizations to support the project goal. RWG participants included shoreline property owners, permitting agencies, NGOs, researchers, community advocates, local governments, and educators. See Appendix G for a list of Regional Working Group leads and their affiliations. See Appendix C for a summary of notes from each Regional Working Group session.

Monitoring Teams / Partners:

Two monitoring teams and various regional partners tested out the draft framework along diverse shorelines in each region of NYS. In the New York City region, NYC Parks headed pilot data collection. In the remaining three regions, a team of four researchers (based out of the Research Foundation of CUNY) completed pilot monitoring in collaboration with local partners. In the process, data collectors worked together to refine protocols and provide feedback on the usability, etc. of the framework, particularly the monitoring protocols, based on that effort (see Chapter 3).

The monitoring framework was developed over the course of 2018 and 2019, with an initial draft framework reviewed by regional working groups in summer 2018. Technical Working Groups and the Core Project Team then used the regional working group input to revise the framework and develop protocols, which were tested over a single season (summer 2019) on selected shoreline sites in each of the four coastal regions of the State. A final framework was completed and made available for broader use in fall of 2019. It is anticipated that DOS, in collaboration with partners, will continue to make adjustments to the framework and protocols in response to user needs. Our hope is that the framework will be utilized by partners to allow for longer-term monitoring to provide more meaningful and useful information on shoreline sites and features statewide. For a more detailed Project Workplan, see Appendix J.



2. THE MONITORING FRAMEWORK AND ITS DEVELOPMENT

The monitoring framework is a part of a process of making adaptive decisions about New York State shorelines. The monitoring framework, the protocols for data collection, and the resulting data collected through them are part of an iterative decision-making process geared toward evaluating the relative performance of New York's diverse shorelines over time. The core output of this project is the set of data collection protocols that provide guidance for collecting consistent and comparable data about different shoreline features. However, this larger framework also maps these protocols back to specific indicators and performance parameters for shorelines, which stakeholders and technical experts have prioritized. Thus, the framework produces a roadmap for relating the data to be collected back to specific priority indicators and broader performance parameters for shorelines. It is beyond the scope of this project to develop specific scoring metrics or an evaluation tool. However, we hope that future efforts build on this work to include analysis, evaluation, and decision support to improve resilience and adaptation along our shorelines.

This chapter introduces the components and format of the framework including key terminology, the process of developing the framework, and an overview of the final framework. The final framework is summarized in a matrix included at the end of this chapter; a guidebook and worksheets for the associated data collection protocols are found in Appendix A. The draft framework matrices and preliminary protocols can be found in Appendix E.

WHAT ARE WE MONITORING?

The framework is intended to be applicable to all tidally influenced shorelines across the state of New York, as well as the non-tidally influenced Great Lakes. It may be applicable to some non-tidally influenced riverine systems as well (i.e. Niagara and St. Lawrence), but this is not the focus of the current effort. Additionally, it is not intended to address stormwater management strategies. The framework is intended to be applicable to the full spectrum of management options for such shorelines, including natural features, nature-based features, ecologically enhanced hard structural features and hard structural features. However, the emphasis and focus is on nature-based features due to the fact that there is not as much information about the performance of NNBF in New York State. The intent of the monitoring framework is to enable comparison of resilience services across the spectrum of features, in order to understand relative performance and allow for effective comparative assessment of shoreline management options. As such, it is important that the indicators be performance-driven rather than type-specific and that monitoring protocols be applicable to the various types of features.

TYPES OF SHORELINE FEATURES

Natural Features (NF) are created by physical, geological, biological, and chemical processes that evolve over time through the forces of nature. These include features like wetlands, floodplains, dunes, and barrier islands. Individual features are part of larger natural systems and are linked by natural processes 'Natural features' include:

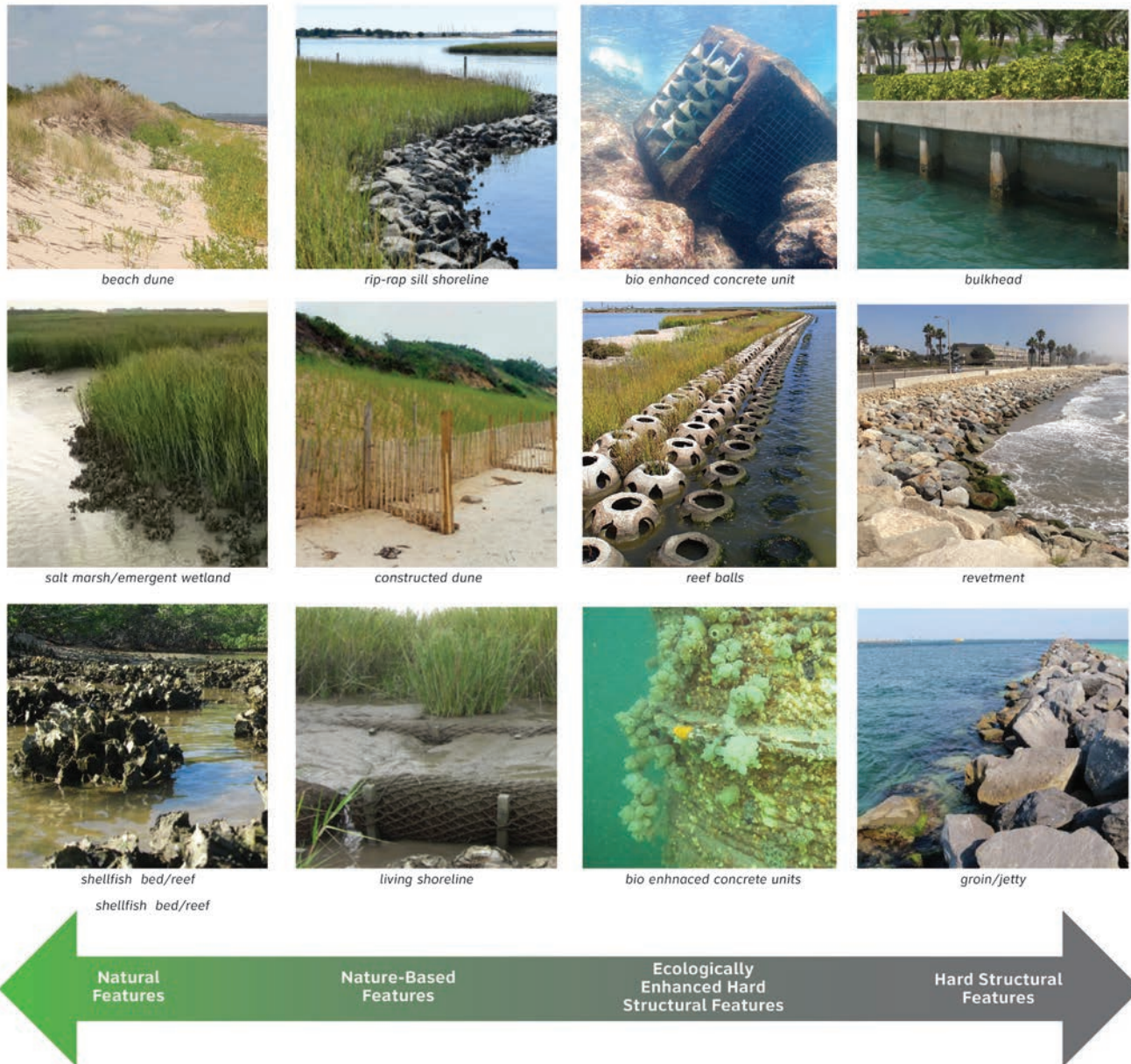
- (1) **Conserved Natural Features**, when existing natural systems/features are protected and managed to conserve the benefits they provide for future generations, or
- (2) **Restored Natural Features**, when natural features and processes that have been degraded or altered are re-established to enhance the natural

capacity of the feature while supporting the native ecological systems. (source: CRRRA)

Nature-Based Features (NBF), sometimes referred to as "living shorelines," are features that mimic natural features and processes and are designed to provide specific services, such as preventing erosion, reducing flood risk, increasing habitat or improving water quality. They typically incorporate or promote the growth of living materials and limit disturbance to existing habitat. Based on a number of factors, including site conditions, nature-based features may include hard structural components (e.g. stone, concrete). However, they use the minimum amount of structural components necessary to achieve project goals, while also realizing habitat and resilience benefits.

Hard Structural Features (HSF) are typically constructed of stone, pressure-treated wood, compacted earth, or hard human-made materials (concrete, metal, etc.) and designed to control or direct water and/or sediment movement. These features typically disrupt natural features and processes, and have limited or no living components. Some examples include levees, bulkheads, seawalls, revetments, dams, structural stream channels and stormwater conveyances. Hard structural features are not natural resilience features.

Ecologically-Enhanced Hard Structural Features (EEF) are features that would generally be categorized as hard structural features, but have been designed in a manner so that they provide or are designed to provide additional ecological or social benefits or reduce ecological or social impacts relative to traditional HSF. These features are largely used in heavily urbanized areas where environmental degradation, regulatory constraints, or critical infrastructure prohibit the use of natural or nature-based shoreline infrastructure. An example might be the integration or use of marine concrete technology to support enhanced biological activity on structures that traditionally would not support robust marine habitat (source: developed by project



Types of shoreline features include natural, nature-based, ecologically enhanced hard structural or traditional hard structural features.

team). See Appendix C: “Glossary of Terms and Shoreline Features Definitions” for a list and definitions of the shoreline features that the state wishes to be able to evaluate with this framework.

COMPONENTS OF THE FRAMEWORK

This section provides an overview of the monitoring framework organizational structure and key terminology. The monitoring framework matrices (see template on the opposite page) provide a “roadmap” for relating monitored data to a shoreline feature’s provision of resilience services.

The below figure outlines the project approach. blue-green highlights the specific goals of our project, while grey highlights future phases of informed, adaptive decision-making. The process of data collection, analysis, evaluation, and refinement of the framework based on those findings will continue beyond the life of the project.

A **resilience service** is the high-level grouping / categorization of the type of services and benefits that shoreline management features provide to communities and ecosystems. For this project, three resilience services have been identified: (1) Ecological function, which assesses a project’s contribution to ecosystem health; (2) Hazard Mitigation & Structural Integrity, which identifies how well a project mitigates risks associated with hazards and its ability to sustain that performance; and (3) Socio-Economic Outcomes, which captures the project’s associated services that may impact community resilience and well-being.

The framework identifies a set of prioritized performance parameters associated with each Resilience Service. A performance parameter is a factor that allows the evaluation of the relative effectiveness of a shoreline management feature in providing ecological function, hazard mitigation services or socio-economic benefits. Parameters have been developed for each resilience service area: 1) ecological function; 2) hazard mitigation & structural integrity; and 3) socio-economic outcomes. Performance parameters rather than “goals” have been called out in the matrix, as the project team has found that there is generally agreement on what is important and needs to be monitored (the parameter, e.g. biodiversity or erosion), but not always the particular value associated with it (the goal, e.g. increase biodiversity or decrease erosion).

For each parameter, the framework identifies one or more specific indicators. An indicator is a measurable or traceable attribute of a shoreline feature that can be used to evaluate progress toward

or achievement of a particular performance goal. For example, plant species richness and composition can be one indicator of biodiversity. Indicators should be expressed in values that can be measured or traced and can be qualitative as well as quantitative. We have chosen to use the term “indicator” rather than “metric” as these are not intended only as variables that one measures in isolation, but variables one measures as an indication of how the shoreline functions relative to a specified performance parameter.

The framework then matches each indicator with identified protocols for collecting data that would enable one to gather the information necessary to assess the identified indicators. A protocol describes the specifications for collecting, recording/reporting, and storing data related to the agreed upon indicators. Protocols may fall into different tiers of difficulty/cost, and thus, in some cases protocol variations have been identified in order to provide feasible monitoring guidance for shoreline monitors with differing levels of resources and expertise. In most cases, however, Technical Working Groups developed protocols geared towards the less difficult and less expensive options. It should be noted that individual protocols may inform multiple indicators and some indicators may require more than one protocol to generate the data needed to evaluate them, so a protocol may be repeated in multiple locations in the monitoring framework matrices.

The monitoring protocols themselves are the critical component of the monitoring framework, enabling consistent data collection and interpretation of indicators for evaluating the performance of shore-

line features. The protocols provided here should be considered works in progress, as they have only been tested through just one season of pilot monitoring. They have not yet been reviewed and vetted following this pilot application by all the various project stakeholders who provided input into their development. Once refined and vetted, consistent monitoring guidance will enable shoreline managers and other stakeholders to collect robust and comparable data about what was observed across different shoreline features around the state. With this foundation, future initiatives can provide recommendations or guidance on how the data should be analyzed and applied to evaluate the performance

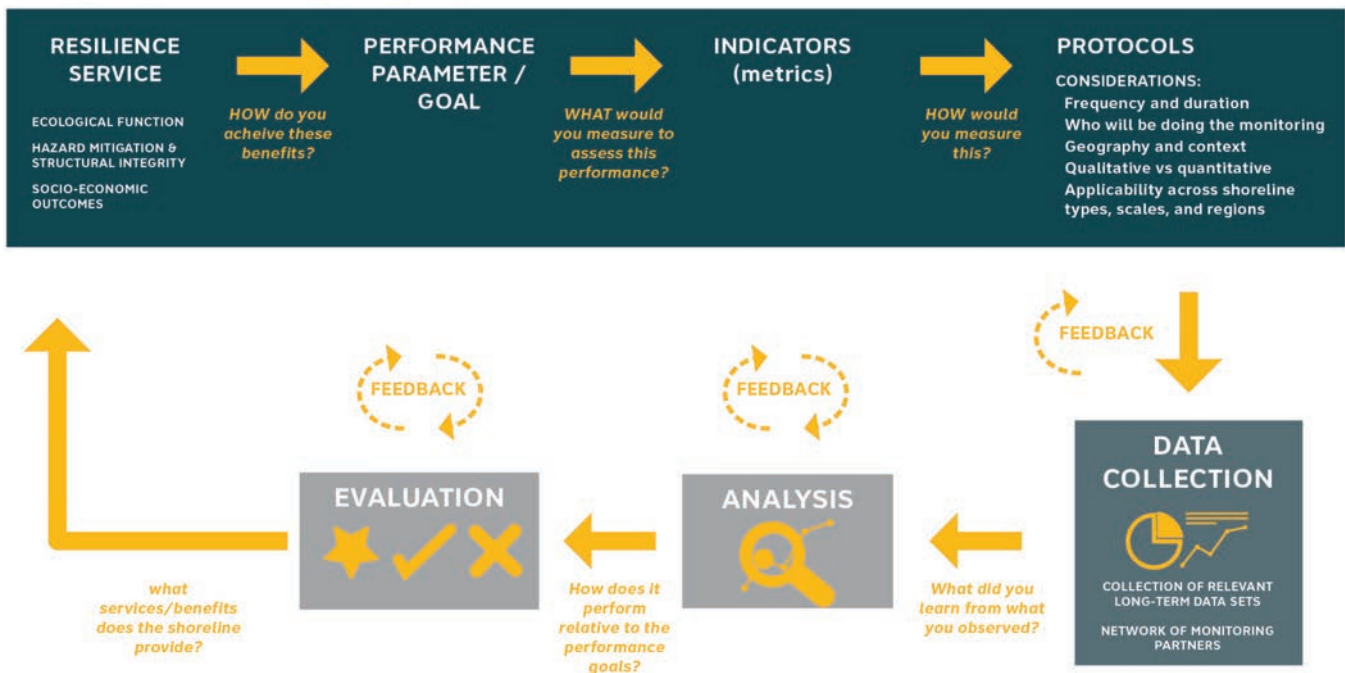
of individual projects as well as the relative performance of different types of shoreline features.

Note that the terms above are defined specifically for the purpose of this monitoring framework. We understand that there is no universal consensus around the definitions of these terms, and their use may vary by discipline, agency, organization, or other context. However, the project team felt that it was important to establish a common language and terminology for the project in order to enable robust communication and discussion among the Technical Working Groups, Regional Working Groups, and other project stakeholders.

INFORMING RESILIENT SHORELINE MANAGEMENT DECISIONS

MONITORING FRAMEWORK

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 indicators by which achievement of or progress towards these goals might be evaluated. This framework allows for the selection, development and prioritization of relevant monitoring protocols--agreed-upon methods for gathering comparable data about shoreline features .



FRAMEWORK MATRIX TEMPLATE

RESILIENCE SERVICE	PERFORMANCE PARAMETER	POTENTIAL PERFORMANCE GOAL STATEMENT	INDICATOR/METRIC	PROTOCOL
example resilience service	example performance parameter	example goal statement	indicator/metric A	protocol 1
			indicator/metric B	protocol 2
				protocol 3

HOW THE FRAMEWORK WAS DEVELOPED

EVOLUTION OF THE MONITORING FRAMEWORK

This section provides a brief overview of the process used to develop and refine the Framework in discussion with stakeholders and agency representatives. Subsequent sections provide more detail about the selection and prioritization of the indicators and development of the protocols.

BACKGROUND RESEARCH & DOCUMENT REVIEW

One of the first steps in framework development was to undertake an extensive document review to distill lessons and approaches from other monitoring efforts. The document review described the strengths and weaknesses of each of the programs, as well as their applicability to different shoreline strategies, geographic conditions, monitoring focus areas, and adaptive management approach. Recommended documents and plans were put into a comparative perspective to better understand differences and similarities. This process allowed the team to think through the benefits of developing a goal-oriented framework, the level of detail required for setting goals, and the need to reconcile and reflect different value sets during goal setting. It also allowed us to consider how to differentiate between core and conditional metrics on the basis of levels of effort (in terms of required skill, ease, and cost - monitoring aspects important to diverse prospective user groups. Finally, the review was instrumental in informing the initial set of performance parameters and metrics incorporated into the first draft monitoring framework. See Appendix F for a summary of documents reviewed.

KICKOFF MEETING / WORKSHOP

In-person pre-kick off meetings and webinars were held with the entire project team, sponsors and the Project Advisory Committee (PAC) to

ensure a shared understanding of project goals and approach. These early conversations focused on vetting and refining the overall project approach - from tasks, schedule, and deliverables, to consideration of the broader state policy context, expertise and past research on NNBF and monitoring parameters. These discussions also provided an opportunity to review, revise and come to agreement around terminology and organization for the monitoring framework.

Additionally, the project team and the PAC reviewed and modified the list of potential Technical Work Group members to ensure representation of all four coastal areas of the state, a range of experience with monitoring theory and practice, and mix of professional, academic and permitting experience.

ESTABLISHING THE FRAMEWORK STRUCTURE OR “ROADMAP” AND PROJECT TERMINOLOGY

Feedback from the PAC informed a series of revisions to the project approach and terminology, intended to foster not only more effective data collection protocols and processes, but also to gain support and uptake throughout the state from entities (agencies, practitioners, NGOs, etc) involved with permitting, design, construction and management of shorelines. These changes centered on the following:

- Emphasizing that this approach is meant to be evaluative, performance-driven, and geared toward learning. In addition to considering a diverse set of users, the monitoring framework is designed to enable users (when applied over time) to test a set of hypotheses about the performance of different shoreline measures in providing the various resilience services over time, rather than designing type-specific monitoring for every shoreline context.
- The concepts of parameter and metrics –

the original terminology used in the grant proposal – were nested into an evaluation framework or roadmap comprised of three resilience services (ecological performance, hazard mitigation & structural integrity, and socio economic outcomes), performance parameters, and indicators. This roadmap sets the stage for the types of data to be collected, the methods to use to collect that data, and how to analyze and evaluate it.

- Additionally, we aimed to align the terminology related to shoreline features with New York State’s Community Risk and Resiliency Act (CRRRA) draft guidance on natural resilience measures, using the terminology Natural Features, Nature-Based Features and Hard Structural Features to describe the spectrum of shoreline conditions. We also introduced the term Ecologically-Enhanced Hard Structural Features, based on conversations with staff at NYS Department of Environmental Conservation, to indicate those features that would generally be categorized as hard structural features, but have been designed in a manner that they provide or are intended to provide benefits or reduce impacts (environmental/ecological and/or social) relative to traditional hard structural features. See Appendix B for a list and definitions of shoreline feature types.

Over the course of the project, the Technical Working Groups adapted and revised content of the Monitoring Framework to reflect iterations of input from the Core Team, Regional Workshops, Permit Reviewers, and the Project Advisory Committee.

In the first phase, each Technical Working Group developed draft parameters and indicators drawing on the document review (Appendix F), their professional expertise, discussions, and a half-day workshop devoted to each resilience service area. The resulting Draft Monitoring Framework (Appendix E) consisted of a relatively broad list of parameters and indicators. TWGs also identified or developed sample protocols for some of the selected indicators.

These draft materials were presented to stakeholders across NYS in a series of regional workshops, and to federal, state, and local regulators and permit reviewers in two virtual meetings (described in the following sub-sections). Ultimately, those lists of indicators were refined based on TWG consideration of stakeholder feedback and reformatted into a Revised Matrix. After PAC Review, Core Team Review, and Pilot Data Collection, the Revised Matrix was refined into what is now the Final Matrix.

TECHNICAL WORK GROUPS

With this framework as a strawman pre-populated with draft parameters and metrics, we convened three Technical Work Groups (TWG), each focused on one of the three resilience service areas, with strong participation from the TWG members and the core team. The goal of these meetings was to have the TWGs develop a set of recommendations for the parameters, indicators (metrics) and draft list of protocols to be included in the draft framework, drawing on the expertise of the TWG members.

REGIONAL WORKSHOPS

During the summer of 2018, four regional workshops were held (one each in New York City, Hudson Valley, Long Island, and Great Lakes). Each of the Regional Working Group leads (as part of the Core Team) compiled lists of potential participants to invite and participate in the Regional workshops. Potential participants were assessed based on multiple criteria, with input from NYS Department of State (DOS), New York State Energy Research and Development Authority (NYSERDA), and the project team, including: (a) ability to provide meaningful feedback to the framework; (b) subject matter expertise related to the Resilience Service areas; (c) experience with shoreline management especially natural and nature-based features; and (d) experience in the region of interest.

A list of the attendee's affiliations are listed in Appendix G. Names of attendees were not included to preserve privacy and anonymity. Participants were invited to provide input into and rank the 'importance' of the draft performance parameters and indicators. The ranking exercise was supplemented by discussion of the results and consideration of the following questions:

- » Are the goals and assumptions reasonable and accurate? Are the definitions clear?

- » Are there other things that you want this group to consider?
- » Would you use this framework?
- » What are opportunities to get groups involved in data collection?
- » What are barriers? How do we overcome them?
- » Are there any potential monitoring sites in this region?

After hosting all four regional workshops, the Core Team and TWG members in attendance gathered and synthesized the rankings, comments, recommendations, and general discussion. Within each region, the team identified cross-cutting themes, key takeaways, high priorities, regional concerns, and written feedback. Regional takeaways were then combined into an overarching synthesis. This cross-cutting summary highlighted common concerns, issues and themes across the state.

Summaries of the Regional Workshop feedback can be found in Appendix C as (a) narrative summaries of all notes and (b) combined 'ranked' Matrix, showing which parameters and indicators that were prioritized by participants at each regional workshop, and overall.



Hudson regional workshop



New York Harbor regional workshop

PERMIT REVIEWER WORKSHOPS

The Core Team convened two virtual meetings with federal, state, and local permit staff in January of 2019. Invitees included staff from USACE, NYSDOS, NYSDEC central and regional offices, and municipal agencies involved in permitting. The purpose of those meetings was to collect information on the utility of the Framework from a permitting perspective, and to better understand how permitting agencies might play a role in facilitating the collection of critical data about shoreline features.

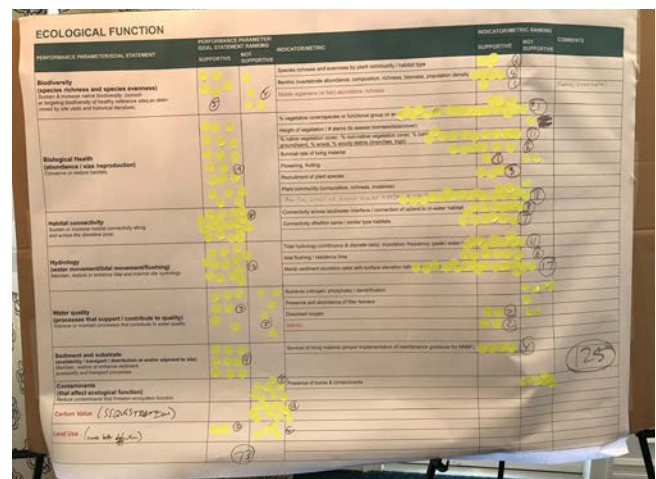
During the first meeting, feedback centered on the utility and feasibility of specific indicators most highly supported by attendees at Regional Workshops. Permit managers ranked indicators within each of the three Resilient Service Areas (Socio-economic Outcomes, Ecological Function, and Structural Integrity/Hazard Mitigation). Those rankings helped inform the final selection of indicators within the Framework. During the second call, Permit reviewers were asked to discuss their support for the most useful, feasible, or necessary approaches to support framework implementation. This discussion provided deeper insights about processes and programs that

may enable or constrain data collection on newly permitted shoreline features. See Permit Reviewer Meeting 1 and Meeting 2 notes for more detailed findings (Appendix D).

NOTE: These protocols and monitoring recommendations are not intended to supplant or replace monitoring required as part of permitting shoreline or in-water projects. Regulatory-required monitoring is typically undertaken for the purpose of assessing a projects' impact on a site relative to pre-project conditions, and thus the monitoring required is typically designed for very site-specific and issue-specific goals. Where it makes sense, alignment of the protocols recommended in the framework with protocols commonly used in post construction monitoring in the state is desired, as it may generate greater use of the protocols and result in the monitoring framework being applied at more sites. However, this monitoring framework is in no way intended to replace post construction monitoring plans required through permitting.



Great Lakes regional workshop



Long Island regional workshop

PROJECT ADVISORY COMMITTEE

The Project Advisory Committee provided feedback on all elements of the evolving Draft Monitoring Framework at key junctures throughout the project. This feedback—elicited through webinars, email, and content review—was documented and incorporated into the final Framework that was used for pilot data collection.

REVISING THE FRAMEWORK

Technical Working Groups reconvened to process stakeholder feedback and incorporate it into the final list of refined indicators. With the assistance of members of the core team and TWG members, TWG leads also drafted the monitoring protocols. This took place as a webinar with the Core Team to review synthesized feedback, a half-day workshop for each TWG to revise the lists of indicators and

protocols, and follow-up discussion and writing to develop the protocols. In many instances, protocols were adapted from existing monitoring methods, but new monitoring protocols were also developed where suitable published methods did not exist. The workbook of protocols developed is included in Appendix A.

PILOTING THE FRAMEWORK

Field teams brought draft protocols into the field at sites in each of the four regions to test out feasibility and applicability to different shoreline types. For more detail on the pilot monitoring effort, see Chapter 3. Preliminary feedback from this pilot monitoring are incorporated into the protocols in Appendix A as footnotes.

CONSIDERATIONS FOR INDICATOR SELECTION AND PROTOCOL DEVELOPMENT

The following are key considerations and recommendations that the Core Team and the Technical Working Groups incorporated into their screening and selection of performance parameters and indicators and in developing the monitoring protocols. These factors incorporate input and feedback from project stakeholder workshops that the Core Team and Technical Working Groups felt were critical to developing a framework that would be useful, effective, and able to be adopted by shoreline managers across the state.

WHY ARE WE MONITORING: DATA FOR ACTION V. DATA FOR UNDERSTANDING

This monitoring framework is intended to provide guidance on monitoring in order to inform action, be that policy creation, funding allocation, planning, design, or adaptive management – at the statewide level. While managers and practitioners generally agree that the reason to monitor shoreline features is to learn more about their performance, they can have very different objectives for this monitoring. Data collected may be used for research, comparative assessment to inform policy, planning and funding, or for generally, literacy and awareness building. In developing this framework, we were primarily interested in enabling comparative assessment to inform decision-making at the statewide level, but aspired to include indicators and protocols that could contribute all three where feasible.

We recognize that the objectives and purpose behind the desire to monitor and collect data can influence the prioritization of what is monitored and how it is analyzed. This framework attempts to balance the variety of goals of managers across the state, but in prioritizing indicators we kept in mind the intent of this monitoring framework to support comparative analysis of shoreline features to inform

policy, planning, funding, design, and management decisions.

RELEVANCE FOR COMPARATIVE EVALUATION: APPLICABILITY ACROSS SCALES AND SHORELINE TYPES

This monitoring framework prioritizes the ability to collect comparable data across different types of shorelines and over longer periods of time (e.g. 20 – 30 years) over granularity at any monitoring site. The intent and advantage of this approach is that we will be able to compare different kinds of shoreline types and circumstances to one another. This includes natural and nature-based features, as well as hardened shorelines and ecologically enhanced hardened shorelines. This recommendation stems from the goal of this effort to create a framework and protocols for monitoring that can generate comparative data upon which to evaluate the relative performance of shoreline types in order to inform policy, funding, and planning decisions regarding the selection, design or management of different shorelines.

It is understood that some parameters, indicators, and associated data will be more relevant to certain kinds of shoreline features than for others; however, in order to compare across sites, it is still necessary to collect that data for all sites. For example, we may not expect a traditional bulkhead to contribute to an increase in biodiversity, but this still needs to be measured in order to be compared with the biodiversity in a wetland or living shoreline.

The challenge for this effort was to select the most appropriate indicators, given the variety of shoreline types, environmental circumstances, and site-specific goals that different managers may have. We recognize that there may be tension or tradeoffs between the ability to generate data and analysis that has relevance for a single site or project versus

a broader understanding of relative performance that might inform policy.

As noted above, the priority in developing this framework was on the ability to generate data to support comparative analysis across shoreline types, locations, and scales. This is not to say that the monitoring framework was not informed by the needs and goals of shoreline design and management work around the state, but rather that, in prioritizing recommendations for what to monitor and how to analyze it, the emphasis was placed on indicators and associated monitoring protocols with greater potential to generate comparative data.

QUANTITATIVE V. QUALITATIVE INDICATORS / METRICS

This framework includes qualitative as well as quantitative metrics (indicators) and data collection protocols. Qualitative data and metrics are critical for addressing some of the biggest knowledge gaps in evaluating resilience services. Valuable information about shoreline features can come from both quantitative and qualitative data. We recognized the possible challenges in combining analysis of qualitative and quantitative data, but did not wish to exclude such potentially valuable information about shoreline performance merely because it could not be quantified. How to use and incorporate these different types of data continues to be an area for ongoing feedback and discussion.

GRANULARITY, COST, AND LEVEL OF EXPERTISE REQUIRED

In order to support broad applicability and adoption, this monitoring framework generally favors cost effective approaches that can be sustained over time as long as the data generated is reliable and has sufficient quality control. . We recognize that all protocols are not created equal in terms of the level of effort, staff expertise and training, financial investment or time that they entail to

implement. Monitoring protocols that would be cost prohibitive to most shoreline managers or difficult to implement with existing staff or other existing resources were generally viewed less favorably as they could limit uptake by shoreline managers and ultimately limit the generation of comparable data.

The ability to sustain the recommended monitoring over time was also a priority. Having consistent data on shoreline measures over time will be critical to understanding the performance of shoreline measures over time periods relevant to environmental and social contexts: Climate normals (i.e. expected climate) are defined over 30 years of observations, tidal epochs are measured over 19-year windows, and a typical mortgage is 15 to 30 years. The full benefits of natural and nature-based features might not be apparent over periods of time less than 10 years. For these reasons, we can define ‘robust’ data as that which can be analyzed longitudinally (over time). In order to gather such robust data, we need to be able to ensure that the same or similar data collection protocols can be sustained over that monitoring time period.

We recognize that level of effort and investment may have tradeoffs with data quality and managers will want to ensure sufficient data quality control over time. This was an important area for consideration and discussion as the monitoring protocols were developed and should be considered if they are further refined.

NUMBER OF INDICATORS AND PROTOCOLS INCLUDED

In order to enable broad use and application of the framework, the total number of indicators and protocols were limited to a number that was deemed to be manageable for data collection and evaluation by state shoreline managers, but comprehensive enough to derive conclusions about performance. There was significant discussion around how extensive a list of indicators and monitoring protocols for each resilience service was

appropriate. Monitoring protocols recommended in the framework aim to provide data comprehensive enough to assess the desired shoreline performance, but still be practical and feasible for a broad range of shoreline managers to implement. The intent of the framework is to recommend a prioritized set of indicators that will allow for the generation of comparable data across multiple shorelines and types of shorelines across the state and in different regions. We recognize that it may not be comprehensive for all project goals of all individual shoreline projects. This framework focuses on “statewide” goals, parameters, indicators and protocols; however, users may want to add their own project-specific protocols to gather additional data relevant to specific project or site goals.

PRIORITIES AND TRADE-OFFS IN PERFORMANCE

The framework identifies performance parameters rather than states specific performance goals; with the aim of supporting objective data collection about all types of shorelines to the degree possible. The framework includes indicators and performance parameters that make learning for the purpose of decision-making and adaptive management possible. The selected indicators and the associated protocols were prioritized largely by

their ability to inform known policy and management decisions related to shoreline management. However, while managers and practitioners involved in developing the framework were generally able to come to agreement on the areas of performance that needed to be better understood, they were not always in agreement on what was “positive” versus “negative” performance, in part because additional information (data from monitoring!) was required to understand the process in question and potential tradeoffs.

Through its application, this framework aims to inform future evaluation and policy and management decisions. We recognize that such future evaluation comes with potential challenges. For example, there may be various goals that cannot be achieved at the same time: optimizing the reduction of exposure to coastal flooding hazards may prevent the restoration of sediment accretion. When selecting the indicators to monitor for, it was critical that those involved in the process understood the possible trade-offs between these potential performance goals related to the performance parameters selected. In many cases, the trade-offs may not be known at this time, and data collection and analysis are necessary to establish and understand these possible conflicts and incompatibilities both empirically as well as theoretically.

INDICATOR SELECTION

*An **Indicator** is a measurable or traceable attribute of a shoreline feature that can be used to evaluate progress toward or achievement of a particular performance goal or along a performance parameter. Indicators should be expressed in values that can be measured or traced, and can be qualitative as well as quantitative. We have chosen to use the term “indicator” rather than “metric” as these are not intended only as variables that one measures in isolation, but variables one measures as an indication of how the shoreline functions relative to a specified performance parameter.*

This section provides background information and rationale from Technical Working Groups about why indicators were selected for the final framework. Indicators are described by resilience service area / Technical Working Group.

KEY CONCLUSIONS AND GUIDANCE FOR FINAL INDICATOR SELECTION

There was consensus among the project team and project stakeholders that the monitoring framework needed to be practical and implementable and to do that, it would not be able to be exhaustive. Thus, not every indicator introduced in the draft framework would be able to be included in the final framework. Based on the considerations described above and input from project stakeholders over the course of the project, the following guidelines were established for prioritizing and selecting the indicators that would be included in the final framework:

- Selected indicators may be quantitative or qualitative but must be measurable / traceable, and must be associated with specific monitoring protocol(s).
- While prioritizing indicators, it is absolutely critical to consider and incorporate input from the Regional Workshops and Permit Reviewer meetings.

- The number of indicators should be limited to 3-8 per resilience service. The number of indicators should be the minimum number of indicators that are sufficient to generate robust and comparable data on shoreline features.
- Be relevant and applicable to the priorities we heard from stakeholders. We should always keep in mind the goal to develop a monitoring framework that has a high likelihood of being used and adopted--if this sits on the shelf and isn't applied, then it isn't useful to anyone.

ECOLOGICAL FUNCTION INDICATORS

Key considerations

One of the most compelling features of natural and nature-based features (NNBF) is the ecological benefits that they can provide. These benefits range from increasing biodiversity and habitat at a site to providing connectivity to other sites. NNBF can facilitate hydrologic functions within and between coastal sites and can support processes that improve water quality. Much of this function is facilitated by maintenance of sediment formation and transport processes. The natural processes and ecological functions of shorelines are closely linked to their provision of other benefits, including hazard mitigation and social and economic benefits. Thus, the technical working groups (TWG) sought to coordinate across resilient service areas to capture benefits that may be highly complementary. In designing protocols, the TWG noted a high potential to adapt existing, low-cost, possibly citizen-based rapid assessment protocols for these ecological benefits.

Final List & Justification for Selection

Plant species cover, abundance, species richness and composition (including native versus exotic).

Living plant cover is fundamental to multiple ecological functions and performance parameters for natural and nature based features (NNBF) including biodiversity and water quality. Plant cover also plays a fundamental role in stabilizing substrates and protection of features from physical disturbances, both natural and anthropogenic. Native plants are preferred over exotic species for their ability to support native biodiversity. Thus, monitoring of plant species abundance, cover, richness, and composition can be an important indicator of biological health and biodiversity. Indicators including and related to vegetation cover, plant species richness, plant community composition and native versus invasive vegetation were all ranked highly at all regional workshops.

Sessile organisms presence, abundance, species richness, and composition:

Benthic organisms are a fundamental component of the biodiversity of coastal features and they play important roles in water quality and stabilization of substrates. Particularly for intertidal and subtidal areas of shoreline features and shoreline features with harder substrates, the presence, type, and distribution of sessile organisms can be an indicator of biologic activity, health, and biodiversity when vegetation or substrates to support vegetation may not be present. Native species are preferred over exotic species for their ability to support native biodiversity. Monitoring of benthic invertebrate abundance, composition, richness, biomass, and population density was ranked relatively highly across all regional workshops and particularly highly in the New York City workshop.

Habitat connectivity to adjacent areas, habitats, land uses in all directions.

Shorelines with viable habitats that are adjacent and connected to other habitats /features are likely to function better as they will be subject to less anthropogenic disturbance and migration of organisms and natural substrates will be facilitated. Conversely, the biological / ecological value of a

shoreline is increased if it can provide ecological support for adjacent natural areas and habitats. NNBF that are adjacent to other natural features are likely to function better as they will be subject to less anthropogenic disturbance and migration of organisms and natural substrates will be facilitated. Conversely, the value of NNBF is increased if they can provide ecological support for adjacent natural areas and habitats, particularly if they can connect one natural area or NNBF with another.

Visual evidence of hydrologic alteration.

Hydrology is fundamental to the structure, function and stability of coastal NNBF. Evidence of erosion and disruption of tidal and other water flows will be important for assessing the ability of features to support biodiversity and water quality functions.

Distribution and abundance of substrates including wrack, debris, concrete, etc.

The presence and stability of substrates is fundamental to the structure, function and stability of coastal NNBF. Sites with significant amounts of anthropogenic features and/or evidence of instability will have reduced ability to support biodiversity and water quality functions.

Additional Notes from the Ecosystem Function TWG

- We have not included “survival rate of living material” as an independent indicator / protocol as this is only evident from measurements of other factors (vegetation cover, species present, etc. including photos) over time. Thus long-term assessments may provide assessment of this variable. This type of analysis over time would also apply to “changes in habitat area,” another indicator that was not included.
- The indicator of hydrologic alteration that we have selected is simplified and limited

because we are assuming that basic tidal information will be recorded by the Hazard Mitigation protocols and (2) more detailed assessment would be more difficult (expensive, technically complex, time consuming) and not feasible or appropriate to the framework and protocols we are developing.

- Specific indicators for water quality are not included because these would be difficult (expensive, technically complex, time consuming) and not feasible or appropriate to the framework and protocols we are developing. More fundamentally these protocols are addressing relatively small features that cannot be expected to have a really significant effect on water quality.
- Specific indicators for biodiversity are not included but the protocols do call for detailed characterization of plant and sessile organisms; two important components of biodiversity. More detailed protocols are not included because these would be difficult (expensive, technically complex, time consuming) and not feasible or appropriate to the framework and protocols we are developing. More fundamentally these protocols are addressing relatively small features that cannot be expected to have a really significant effect on biodiversity.

HAZARD MITIGATION & STRUCTURAL INTEGRITY INDICATORS

Key considerations

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 effects 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 Hazard Mitigation and Structural Integrity group developed the evaluation roadmap to specifically address the following:

- 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 effects on people, property, and native ecosystems.
- In the evaluation of the coastal flooding hazards, a feature should be designed to reduce the exposure or vulnerability to coastal flooding that can have adverse effects 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 the context of natural coastal processes, as well as large storm events.

Final List & Justification for Selection

Change in Feature Position and/or Elevation.

Changes in the position or elevation of a shoreline feature indicate the response to external forcing. Reductions in elevation or seaward translations in position can indicate erosion whereas increases in elevation or landward translations could indicate

accretion. Features can be beaches, wetlands, oyster reefs, breakwaters, sills, bulkheads, revetments, etc and can be at or offset from the shoreline position. A common objective of shoreline projects in the state is that shoreline features maintain a functional elevation and position as per design and / or per natural shoreline processes.

Change in Shoreline Position (at Feature and / or Updrift / Downdrift)

The shoreline position is typically defined by a mean water level datum. Change in the shoreline position is an indicator of the performance of the shoreline to external forcing (waves, water levels, etc.). Maintaining the shoreline position or reducing shoreline erosion is a common performance objective of shoreline projects in the state. Change in the position of the shoreline updrift / downdrift of the project is equally important. Accretion at project features should minimize downdrift erosion.

Change in Wave Conditions

Shoreline processes are often driven by wave conditions. Shoreline erosion can occur when wave conditions exceed the natural threshold of the shoreline material / feature. Similarly, shoreline accretion can occur when wave conditions are reduced below the threshold of the shoreline material / feature. Shoreline projects in the state oftentimes impose a shoreline material / feature to reduce the wave conditions at an eroding shoreline. Therefore, quantifying the wave conditions and their changes by various shoreline materials / features is a critical indicator to understanding and designing shoreline projects.

Water Levels

Water levels are an important indicator to characterize the shoreline. For instance, shoreline position is often defined by a water level datum. Additionally, understanding the water level at the time of field data collection characterizes the time in the

tide cycle (high, low, slack) and / or the presence of storm conditions.

Visible Scour, Erosion, Escarpments, and/or Material Degradation

Observations of localized erosion, scour, escarpments, and / or material degradation are important indicators of the structural integrity of a feature. These observations could foreshadow a forthcoming structural failure of a feature and should continue to be monitored closely. If these observations are not present, it is an indicator that the shoreline feature is performing per design and / or per natural shoreline processes.

SOCIO-ECONOMIC OUTCOMES INDICATORS

Key considerations

Socio-Economic Outcomes captures the shoreline services that may impact community resilience and well-being. This can be difficult to define and may overlap with other areas, but essentially, this category is aimed at assessing if and how shoreline management features contribute to the neighborhood's or wider community's quality of life.

The socio-economic framework has been divided up into six primary categories in order to best capture the outcomes most directly tied to improving the environment as well as the health and well-being of the local community. Human health and safety is framed at the household – community level and designed to monitor the dynamics happening at that level. Property value and infrastructure is framed at the community-regional scale with the ability to compare and contrast with other areas throughout the state. Quality of life is how the feature might benefit or impact an individual, group, or community's comfort, happiness or general satisfaction in the vicinity of the project. Economic resilience and livelihoods speak to the special feature of the coast-

lines and how they uniquely impact the economic vitality of a region. Institutional knowledge and individual capacity are tied together as a lens to better understand local culture and capacity. Participation and stewardship is viewed as critically important for education and political engagement around these issues and areas.

Inclusion of socio-economic indicators in a framework to monitor natural and nature-based shoreline features is critical. Understanding how shoreline features impact the surrounding communities and their economies enables policy-makers and program managers to make accurate decisions that are inclusive, reflective and responsive to society. While socio-economic indicators may be relatively new in comparison to other modes of assessment used by environmental regulators, socio-economic assessment protocols have been used and refined in practice on a wide range of infrastructure projects for decades. Because there are many scalar, spatial and temporal aspects to social and economic impacts, the task of selecting the right set of indicators for shoreline assessments is complex. This task force decided to address this complexity by selecting only those indicators and protocols that would be relatively easy to implement and produce data that could be directly converted into 'actionable information' relevant to the sustainability and resilience of shoreline communities.

Final List & Justification for Selection

Environmental Justice Index

Using the definition provided by the EPA, environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The Socio Economic Technical Working Group also recognizes that certain demographic factors act as general indicators of a community's potential susceptibility to environmental factors, and that shoreline features

may have outcomes that pertain to these environmental factors. The goal of tracking EJ indicators is to ensure that communities experience the same degree of protection from environmental and health hazards, regardless of race and income.

The Socio-Economic Outcomes TWG determined that, with limited resources, the two demographic EJ indicators most relevant to shoreline features are (1) percent low income and (2) percent minority. The EPA recommends an additional six indicators (found here <https://www.epa.gov/ejscreen/overview-demographic-indicators-ejscreen>). However, in an effort to limit the number of socio-economic indicators, we narrowed it down to the two most relevant and informative.

The two demographic indicators serve another purpose: to better understand neighborhood trends over time as they may pertain to the existence of a shoreline feature. Stakeholders expressed an interest in 'green gentrification,' the process by which vulnerable residents are excluded and displaced from their communities as environmental improvement projects increase quality of life and property values. By tracking EJ Demographic indicators alongside quality of life and property (real estate) value index, we can obtain a record of the potential socio-economic outcomes of a nearby shoreline features.

Real Estate Value

The SE TWG hypothesizes that Real Estate Value will stay the same or increase in neighborhoods that are adequately protected from the impacts of coastal storms, flooding, and erosion; and that Real Estate Value will be further benefited by the existence of a shoreline feature that promotes recreational opportunity, stewardship, and aesthetic enjoyment.

The indicator and associated protocol is designed to evaluate what, if any, impacts investments in nature-based infrastructure projects have had on surrounding real estate values and will be applied across a

range of “treatment” sites. Since the effects of such an investment are likely long term, the data collection proposed here can reflect baseline conditions and relationships that can later be re-evaluated on an annual basis following project completion.

Business Index

The protocol is designed to evaluate what, if any, impacts investments in nature-based infrastructure projects will/have had on surrounding businesses and will be applied across a range of “treatment” sites. Since the effects of such an investment are likely long term, the data collection proposed here can reflect baseline conditions and relationships that can later be re-evaluated on an annual basis following project completion. The protocol proposes collection of a range of metrics that overall may give a sense of whether or not there has been an increase in business activity associated with the nature-based infrastructure project.

Neighborhood Perceptions (see Household Survey Protocol)

In Regional Workshops, the overall category of “Quality of Life,” was identified as important to consider but challenging to measure in the field. There was keen interest in knowing precisely how the shoreline impacts local community life. Specifically, participants were interested in knowing whether or not the shoreline and its particular feature had a negative or positive impact on the community.

The SE Technical Working Group acted upon this feedback and sought to create measures to assess quality of life, risk perception and neighborhood satisfaction. Quality of life, risk perception, and neighborhood satisfaction are measured quickly and easily through established survey methods. Literature reviews demonstrate the importance of measuring these factors as it relates to social resilience and social trust. The SE Technical Working Group felt that representation from social and economic expertise was not as strong as represen-

tation for other RSAs, therefore, results may have been skewed towards indicators perceived as more quantitative and/or familiar. The group decided to measure ‘Neighborhood Perceptions’ as a combination of Neighborhood Satisfaction (1 household survey question), Quality of Life (2 household survey questions), and Risk Perception (series of options in 1 household survey question).

Recreation and Cultural Shoreline Use (See Shoreline Social Assessment Protocol)

It is clear that recreation and tourism are of critical value to shoreline communities. As a result, there was great interest in understanding and assessing the potential impact of educational opportunities along the shoreline. There was also great concern that shorelines are accessible to all and that different stakeholder groups were able to interact with the shoreline areas. This social assessment seeks to understand shoreline use and social meaning through systematic site observations and interviews with local site users. We focus on individual perceptions of the shoreline and examine the social meanings of these spaces. We find that many of the ecosystem services produced by the interaction between people and the shoreline include social cohesion and space for personal reflection alongside critical ecological impacts and functions. The intent here is to capture the enduring patterns of why, how, when, and where urban residents engage with the shoreline.

ADDITIONAL PROJECT INFORMATION

In addition to information specific to the three resilience services the framework is monitoring for, it will be important to also gather key metadata regarding the scale, context, cost, and maintenance of the individual shorelines being monitored. This information is important to contextualize the scope of certain interventions and better enable comparison across different shoreline features or feature types. In some cases, this information may also be

quantitative data. For example, maintenance costs of NNBF tend to decrease over time, whereas it tends to increase over time for hardened structures.

PROTOCOL DEVELOPMENT

A Protocol describes the specifications for collecting, reporting, storing, and processing data that enables consistent interpretation of indicators for evaluating the performance of shoreline management features. Protocols describe methods for field design, sampling design, and data management. Protocols may fall into different tiers/level of difficulty/cost, and thus, multiple protocols may be identified in order to provide usable monitoring guidance for shoreline managers / monitors with differing levels of resources and expertise

This section describes the process and rationale for the selection and development of the protocols included in the final framework.

KEY CONSIDERATIONS AND GUIDANCE FOR PROTOCOL DEVELOPMENT

The following guidelines were established for developing the protocols that would be included in the final framework based on the work of the project team and input from stakeholders over the course of the project.

- Draw on existing resources (existing protocols) where applicable including, but not limited to:
 - » Existing monitoring programs and protocols used by NY agencies and organizations.
 - » Suggestions made by the regional working groups.
 - » TWG member knowledge, experience, and networks.
- Pick protocols that are relatively low-cost, rapid, require minimal training, can be implemented with widely-available or low-cost equipment and materials.
 - » Consider the capacity of and resources available to groups who may be tasked with collecting data. In doing so, consider the feedback and guidance on this provided by partners at the Regional Workshops.
- If alternative methods can achieve the same results, tend towards the methods that would be simpler and less expensive.
- For each indicator, develop one relatively simple and inexpensive “base” protocol for collecting the necessary data.
 - » The base protocol should yield the necessary quality / robustness of data needed to be useful and used in all data collection.
 - » If TWGs want to develop additional protocols that supplement the base protocol (tiers, or different means & methods for generating the same data), (a) they should be clearly identified as an alternative to the base protocol, (b) the data generated should be consistent and comparable with data generated by the base protocols, and (c) additional resources required and considerations for choosing one protocol over the other should be clearly noted.
- Indicators and protocols must be applicable to the full diversity of shoreline sites and feature types.
 - » One monitoring protocol that is applicable to all shoreline feature types is preferred.
 - » This may require the development of variations or sub-protocols for different site types / conditions or feature types for some protocols.
 - » If / when this is the case, different variations must result in comparable data across the different feature types even if the data gathering methods differ from one shoreline feature type to another.
 - » As a rule, try to minimize the number of variations and general complexity of the protocols.
- Protocols must provide guidance regarding

the physical extent of the monitoring area.

- » Monitoring may be confined to the extents of the feature itself, an adjacent area / area of influence, or both depending on the indicator.
- » This may vary depending on the nature of the data collected, the intended use of the data, and the nature or context of the site or shoreline feature(s).
- » Protocols may need to include methods / guidance for determining the extent of the site or shoreline feature(s) being monitored and/or defining “adjacent areas” or “areas of influence”.
- » Coordination across resilience services (among TWGs) is necessary / required.
- Protocols may be associated with only one or multiple indicators. In some instances, an indicator may require the data from multiple protocols to be evaluated.

PRELIMINARY PROTOCOLS

The TWGs developed preliminary protocols to collect data that can be used to evaluate the selected indicators and ultimately the performance parameters. They include both desktop and field protocols and draw from existing, published protocols when possible, as well as best professional judgment. While many of the published protocols are based upon natural shorelines or NNBFs, the TWG attempted to develop protocols that were not specific to asset type (i.e., inclusive of both “grey” and “green” shoreline types). These preliminary protocols were used by field teams for the Pilot Monitoring.

The TWGs recognize 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 attendees at the regional workshops and other sources:

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, escarpments.

Modify existing protocols to better address regionally specific storm events or seasonality of monitoring

Customize existing protocols for tide level and boat wake.

While each TWG took a similar approach to identifying / developing their monitoring protocols, the subsections below highlight some unique aspects specific to each resilience Service Areas protocols or protocol development:

Ecosystem Function protocols

One of the most compelling features of NNBF is the ecological benefits that they can provide. These benefits range from increasing biodiversity and habitat at a site to providing connectivity to other sites. NNBF can facilitate hydrologic functions within and between coastal sites and can support processes that improve water quality. Much of this function is facilitated by maintenance of sediment formation and transport processes. The natural processes and ecological functions of shorelines are closely linked to their provision of other benefits, including hazard mitigation and social and economic benefits. Thus, the technical working groups sought to coordinate across resilient service areas to capture benefits that may be highly complementary. In designing protocols, the TWG noted a high potential to adapt existing, for low-cost, possibly citizen-based rapid assessment protocols for these ecological benefits.

Hazard Mitigation and Structural Integrity protocols

In the development of monitoring protocols for indicators related to Hazard Mitigation and Structural Integrity, both field and desktop methods were utilized. In most cases, the desktop components of the protocols serve to verify or supplement the field

data. This is especially critical when the field data is being collected by simple methods (water levels, wave data, etc.). Additionally, some of the field parameters being collected are conducive to desktop analysis methods (i.e. shoreline change). Therefore designing desktop protocols allows the data to be compared against other datasets which can be useful for temporal comparisons.

Socio-economic outcomes protocols

There are a range of protocols that include using publicly available datasets (i.e. property values, health indicators, employment stats). The mixed method data protocols (qualitative and quantitative) are bundled into survey, observation and informant interviews. These protocols will be used to assess outcomes and issues related to quality of life, waterfront engagement, stewardship and social cohesion. Social and site data were collected in order to understand how waterfront users value and engage with the water's edge. Primary means of under-

standing were direct observations of human actions, observations of signs of human use and assessment of language and narrative conveyed through on-site interviews.

REVISED PROTOCOLS

After the field monitoring, minor revisions were made to the protocols to incorporate some lessons learned from the pilot monitoring, present the monitoring protocol guidance in a way that was useful and implementable in the field, and include tips for implementation as well as recommendations for future modifications. Recommendations are included in the protocols as notes. The protocols with these modifications are the protocols included in Appendix A: Annotated protocols and worksheets (Protocols). A list and brief description of the protocols are included at the end of this chapter.

FINAL MONITORING FRAMEWORK MATRIX

Resilience Service Area	Performance Parameter	Indicators	Associated Protocols	
			field protocols	desktop protocols
Ecological Function	Biological Health & Biodiversity	Plant species cover, abundance, species richness and composition (including native versus exotic)	Plant species cover, abundance, species richness and composition (including native versus exotic) Establishing Sampling Scheme (including transect locations, etc.)	n/a
		Sessile organisms presence, abundance, (percent) cover, species richness, and composition	Sessile organisms presence, abundance, (percent) cover, species richness, and composition Establishing Monitoring Scheme (including transect locations, etc.)	n/a
		Distribution and abundance of substrates including wrack, debris, concrete, etc.	Distribution and abundance of substrates including wrack, debris, concrete, etc. Establishing Monitoring Scheme (including transect locations, etc.)	n/a
	Habitat Connectivity	Habitat connectivity to adjacent areas, habitats, land uses in all directions	Site and feature characterization	Site and feature characterization
	Hydrology	Visual evidence of hydrologic alteration	Site and feature characterization <i>Site photolog (to be developed in future)</i>	Site and feature characterization
Hazard mitigation and Structural Integrity	Shoreline and topographic change	Change in Feature Position and Elevation	Feature Elevation Feature Aerial Dimension Erosion Measurements and Feature Displacement	Feature definition, location and aerial dimension Shoreline location, intertidal zone definition, and shoreline change
		Change in Shoreline Position (at Feature and/or Updrift / Downdrift)	Feature Aerial Dimension	Shoreline location, intertidal zone definition, and shoreline change
	Coastal Flooding	Change in Wave Conditions	Wave Height and Period Measurement	n/a
		Water Levels	Water Levels and Coastal Flooding	Water Levels and Coastal Flooding
	Structural Integrity	Change in Feature Position and Elevation	Feature Elevation Feature Areal Dimension Erosion Measurements and Feature Displacement Establishing Monitoring Scheme (including transect locations, etc.)	Feature definition, location and areal dimension Shoreline location, intertidal zone definition, and shoreline change
		Visible Scour, Erosion, Escarpments, and/or Material Degradation	Erosion Measurements and Asset Displacement <i>Site photolog (to be developed in future)</i>	n/a
		Change in Vegetation, Shellfish, or Other Biomass of Structure	<i>See biological health and biodiversity protocols</i>	n/a
Socio Economic Indicators	Quality of Life	Household Perception of Risk, Neighborhood Satisfaction (general & as it relates to shoreline condition), and Quality of Life	Household Survey	n/a
	Recreation and Cultural Use	Observation and Telling of Recreation and Cultural Shoreline Use	Shoreline Social and Site Assessment	n/a
	Economic Development	Change in Real Estate Value	n/a	Assessing Real Estate Value Impacts Associated with Shoreline Conditions
		Business Activity Index	Business Activity Impacts Shoreline Social and Site Assessment	Assessing Business Activity Impacts Associated with Shoreline Conditions
		# Households and public facilities exposed to (or protected from) flooding or erosion	Household Survey	Damages to Households & Public Facilities (to be developed in future)
	Environmental Justice	Presence/Absence of Potential Environmental Justice Area	n/a	Environmental Justice Index
	Civic Engagement	# People Participating in Stewardship Related to Shoreline	Shoreline Social and Site Assessment	n/a

SUMMARY OF PROTOCOLS

The table below describes the final selected protocols and their outputs.

#	RESILIENCE SERVICE	PROTOCOL	TYPE	DESCRIPTION OF PROTOCOL	OUTPUTS	RELATED INDICATOR(S)
1	EF / HM&SI	Site and feature characterization (Site Questionnaire)	desktop and field	A protocol for determining the type of shoreline feature and describing its physical and biological context and adjacencies including: adjacent land uses, evidence of erosion, presence water intake or discharge pipes, vulnerable infrastructure, existing human uses, and fill/construction activity. The protocol draws on existing site information such as aerial imagery, prior surveys, as-built documents, or input from people with local knowledge of the site as well as field observations.	Database file containing responses to Worksheet 1A; data sources recorded in Worksheet 1B; A single point file be used for identifying the approximate location of the feature on a regional or state map; A polygon file defining the boundary of the site; A polygon file defining the boundaries of individual features within the site (only if the site consists of multiple shoreline feature types); A preliminary site baseplan saved as a map file (filetype will vary based on software being used) and an image file or .pdf	All
2	EF / HM&SI	Feature definition, location and aerial dimension (desktop)	desktop	A protocol describing desktop analysis that uses existing remote sensed data (aerial imagery, LiDAR, etc.) to identify the “type” of site/feature for monitoring and establish the approximate location and extents of the monitoring site/feature prior to field monitoring.	GIS shapefiles (.shp, a database table with associated coordinates) for the following: A single point file identifying the approximate location of the feature on a regional or state map. A polygon file defining the boundary of the site, and A polygon file defining the boundaries of individual features within the site (only if the site consists of multiple shoreline feature types).	All
3	EF / HM&SI	Feature Aerial Dimension (field)	field	A simple field assessment to map the areal dimension of the feature, and track changes from the documented baseline conditions.	GPS points transferred as either a text file or GIS shape file describing elevations and the geographical extent of the feature.	Change in Feature Position and Elevation
4	EF / HM&SI	Shoreline location, intertidal zone definition, and shoreline change	desktop	A desktop analysis protocol to evaluate shoreline position using LiDAR or aerial imagery. If a time series of LiDAR or aerial imagery is available allows for the development of shoreline change over time.	GIS shapefile (.shp, database table with associated coordinates) for the following: A polyline file identifying the approximate location of the high water line (mean high water (MHW) on the site,. A polyline file identifying the approximate location of the low water line (mean low water (MLW) on the site, and A polygon file defining the approximate boundaries of the intertidal zone on the site.	Change in Shoreline Position
5	EF / HM&SI	Establishing Monitoring Scheme (including transect locations, etc.)	field with desktop pre-visit prep	A protocol for establishing the monitoring scheme layout, including transect locations and “assessment points” for all field protocols utilizing fixed locations on the site for monitoring. This protocol is a prerequisite to undertaking any of the other Ecological Function (EF) or Hazard Mitigation & Structural Integrity (HM&SI) protocols as monitoring locations rely on the transects and assessment points set up by this protocol.	GPS points transferred as either a text file or GIS shape file describing the end points of the transects and sampling points with associated database (text, excell, access, etc.) containing both text and numeric content describing the sampling set-up including “Segment Descriptions,” “Control Points (CP) and Assessment Points (AP),” and “Points of Interest.” scaled drawing of the site (site base plan) including location of monitoring transects and points.	Most EF and HM&SI
6	HM&SI	Feature Elevation	field	A field data collection protocol for identifying the feature elevation and evaluating feature elevation change by mapping elevational profiles along permanent transects associated with the feature as well as adjacent reference location(s).	Elevation data points transferred from GPS (or survey equipment) as either a text file and/or excel spreadsheet and/or GIS shape file.	Change in Feature Position and Elevation
7	HM&SI	Erosion Measurements and Feature Displacement	field	A simple field measurement protocol for evaluating the overall structural stability of the feature, and the degree to which the feature is abating shoreline erosion.	Elevation data points transferred from GPS (or survey equipment) as either a text file and/or excel spreadsheet and/or GIS shape file.	Visible Scour, Erosion, Escarpments, and/or Material Degradation
8	HM&SI	Wave Height and Period Measurement	field	A field protocol for measuring wave height and period caused by wind-driven conditions during routine or storm events with two alternative measurement methods: (1) An intensive protocol for making detailed wave measurements using acoustic or pressure-based wave measuring equipment that requires significant monitoring budget and technical expertise, and (2) a simpler method requiring observing and manually recording wave height and period.	Wave heights reported as significant wave height and wave periods reported as peak wave period or spectral wave period that accounts for multiple incoming frequencies, i.e. T m-1,0. Format may vary by data supplier, but should be exported as a text file or spreadsheet (text, excel spreadsheet or microsoft access database, etc.).	Change in Wave Conditions
9	HM&SI	Water Levels and Coastal Flooding	field + desktop	A simple field assessment of water levels, waves, and wave runoff at / around shoreline features. Complimented with the collection of desktop data intended to validate or support the field data.	Spreadsheet, text, or database file including measurements for water levels, wave height and period, and if available, wind speed.	Water Levels; Change in Wave Conditions

SUMMARY OF PROTOCOLS CONT.

#	RESILIENCE SERVICE	PROTOCOL	TYPE	DESCRIPTION OF PROTOCOL	OUTPUTS	RELATED INDICATOR(S)
10	EF	Distribution and Abundance of Substrates	field	A protocol for investigates the distribution and abundance of different sub- strates including wrack, debris, concrete, etc. within identified assessment areas. Substrate refers to the ground surface and any non-living material on the ground.	Worksheet responses saved in a database format that can be read in Microsoft Access or Excel (number, text, percent). Worksheet documents: % cover by substrate; presence / absence of wrack, woody debris, and inter- tidal & subtidal vegetation; and slope. A photograph of each quadrat (AP).	Distribution and abundance of substrates including wrack, debris, concrete, etc.
11	EF	Plant Species Cover, Abun- dance, Species Richness and Composition	field	A field protocol for documenting the cover, abundance, species richness and composition (including native versus invasive/exotic plant species). It requires plant identification skills.	Worksheet responses saved in a database format that can be read in Microsoft Access or Excel (number, text, percent). Worksheet documents: species richness, % cover, presence / absence of invasives, and dominant species.	Plant species cover, abundance, species richness and composition (including native versus exotic)
12	EF	Sessile Organisms Presence, Abundance, (Percent) Cover, Species Richness, and Com- position	field	A field protocol for documenting the presence, abundance, richness and composition of sessile organisms/benthic fauna. Requires identification skills.	Worksheet responses saved in a database format that can be read in Microsoft Access or Excel (number, text, percent). Worksheet documents: % cover, % encrusting cover, species richness, # of solitary organisms, species richness, native & invasive species, and observe mobile organisms. A photograph of each quadrat (AP).	Sessile organisms presence, abundance, (percent) cover, species richness, and composition.
13	SEO	Assessing Business Activ- ity Impacts Associated With Shoreline Conditions	desktop	A protocol designed to gather data on business activity surrounding a shoreline area and evaluate what, if any, impacts shoreline type, including investments in nature-based infrastructure projects, will/have had on sur- rounding businesses.	Data on local patronage of businesses (within Household Survey). Alterna- tively, count of foot traffic and/or business parking lot counts.	Business Index
14	SEO	Assessing Real Estate Value Impacts Associated With Shoreline Conditions	desktop	A protocol designed to gather data on real estate value in neighborhoods adjacent to a shoreline and evaluate what, if any, impacts shoreline feature type, including investments in nature-based infrastructure projects, have had on surrounding real estate values.	Real estate transaction data within a delineated neighborhood, real prop- erty characteristics data, and neighborhood characteristics data, all related to distance to the shoreline feature.	Real Estate Value
15	SEO	Environmental Justice Index	desktop	A protocol to determine whether the neighborhood around the shoreline intervention can be considered a potential environmental justice area (yes/ no), and why (because of income / race / or both).	Database file containing text describing if area is potential environmental justice area (yes/no) and why (income/race/both).	Environmental Justice
16	SEO	Household Survey Protocol	field	A survey that addresses the following indicators for socio-economic out- comes: Neighborhood Satisfaction (Quantitative), Risk Perception (Quanti- tative), Quality of Life (Quantitative & Qualitative), Households impacted by flooding (Quantitative & Qualitative), and Attitudes toward NNBF (Quanta- tive & Qualitative).	Database file containing survey responses containing both numeric and text responses. Quality of life: 5 point likert scale & qualitative. Neighbor- hood satisfaction: 10 point scale. Risk perception: 4 point scale. Attitudes toward shoreline project: 5 point scale & qualitative.	Neighborhood Satisfaction (Quantitative), Risk Per- ception (Quantitative), Quality of Life (Quantitative & Qualitative), Households impacted by flooding (Quantitative & Qualitative), Attitudes toward NNBF (Quantitative & Qualitative).
17	SEO	Shoreline Social and Site Assessment Protocol	field	A rapid social site assessment that includes human observation counts, signs of human use and randomized interviews with site users. This data is collected by using worksheets for (1) Interviews and (2) Direct Human Observation/Signs of Human Use.	Database file containing coded survey responses and qualitative (text) responses, and quantitative counts of human observation.	Neighborhood Perceptions; Recreation and Cul- tural Shoreline Use
TO BE DEVELOPED IN FUTURE						
	shared: Monitoring Set-up	Site Photolog / photos from fixed locations	field	Photo point monitoring consists of repeat photography of an area of interest over a period of time and is effective for documenting visual changes occurring at a fixed point through time.		Multiple
	SEO / HM&SI	Damages to Households & Public Infrastructure	desktop	An analysis of the potential damages to property inland of the shoreline were a particular storm event(s) to occur.		Property Damage & Cost of Recovery

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3. APPLYING THE FRAMEWORK: PILOT MONITORING

In June 2019, Technical Working Group (TWG) leads handed off the revised monitoring matrix to field researchers for pilot testing. Regional leads, with support from the Core Team, selected pilot sites out of the list of sites gathered through regional workshops, permit staff, and PAC engagement. The goal was to select four sites per region, to accurately represent the diverse types of shoreline regions throughout the state. Pilot sites were chosen to include at least one hardened structure, one NBF, and one natural shoreline feature in each region.

The NYC Parks Department (Novem Auyeung and Chris Haight, Core Team Members) led data collection within the NYC Harbor area. For pilot monitoring in Long Island, Hudson River, and the Great Lakes, SRIJB hired a team of three research assistants so that one person managed data collection for each resilience service area (Ecological Function: Katharhy G. Hazard Mitigation and Structural Integrity: Dylan Corbett; Socio-Economic Outcomes: Lindsey. Strehlau-Howay), accompanied by a field coordinator (Kathryn Graziano, Core Team Project Coordinator). Throughout pilot monitoring, TWG members continued to provide guidance on protocol implementation.

The two main goals of the pilot phase were to:

- 1) implement the draft monitoring protocols in the field to establish baseline data for each site, and
- 2) make recommendations on the usability of the monitoring protocols themselves based on experience from the field.

The monitoring team collected data from a total of 16 shoreline features between June and August 2019, and through the process gained understanding of how the protocols could be best implemented

at the different regions and shoreline types. Transects and site maps were established at each site to guide data collection for ecological function, hazard mitigation, and socio-economic outcomes for each shoreline feature. Throughout the pilot phase, the monitoring team collected pictures and detailed notes from each site about how the protocols functioned in the field. They documented lessons learned throughout the process and presented those to the core team as recommendations for future edits to the protocols. Each site came with unique challenges that the monitoring team had to navigate and adapt to in the field. That experience was critical in improving the clarity of monitoring protocols, and the recommendations (see Chapter 4 and footnotes in Appendix A) aim to further enhance the usability and utility of the protocols and the monitoring framework as a whole.

The following section profiles the sites where pilot monitoring was undertaken in the summer of 2019 and describes the monitoring that took place at each. The table below summarizes the monitoring sites. See Appendix G for a list of project team members involved in monitoring.

Region	Site Name	Feature Type	Approx. Size S: < 0.5 acres M >0.5 and < 3 acres L: >3 acres	Data Collection Team
Hudson River	1. Coxsackie Boat Launch	Hard Structure	Small	SRIJB, NYSDOS (C. Fraioli, T. Legere)
	2. Coxsackie Wetland & Living Shoreline	Natural Feature & Nature-Based Feature	Small	SRIJB, NYSDOS (C. Fraioli, T. Legere)
	3. Peekskill Municipal Park	Nature-Based Feature	Small	SRIJB
	4. Foundry Dock, Cold Spring	Nature-Based Feature	Medium	SRIJB, Hudson Estuary Program (I. Stinnette)
NYC	1. Randall's Island Bronx Kill	Nature-based feature	Small	NYC Parks, SRIJB, Randall's Island Park Alliance
	2. Randall's Island Living Shoreline	Nature-based feature	Small	NYC Parks, Randall's Island Alliance
	3. Bayswater	Restored Natural Feature	Small	NYC Parks
	4. Harlem River Park Esplanade	Hard Structure	Small	NYC Parks
Long Island	1 & 2. Widow's Hole Living Shoreline	Natural Feature & Nature-Based Feature (in water and shoreline)	Small	SRIJB, NY Sea Grant (K. Fallon)
	3. Shorefront Park / Patchogue Village	Hard Structure	Medium	SRIJB, NY Sea Grant (K. Fallon)
	4. Cedar Beach Creek. Southold Cornell Cooperative Extension facility / Suffolk County Marine Environmental Learning Center	Nature-based & restored natural feature	Small	SRIJB, NY Sea Grant (K. Fallon)
Great Lakes	1. Port Bay Barrier - West	Hard Structure	Medium	SRIJB
	2. Port Bay Barrier - East	Natural & Nature Based Features	Medium	SRIJB
	3. Sterling Nature Center	Natural Feature	Medium/Large	SRIJB, NYSDOS (C. Fraioli, T. Legere)
	4. Sodus Point Beach Park	Hard Structure	Small	SRIJB

COLD SPRING FOUNDRY PARK

COLD SPRING, NY | HUDSON VALLEY

NATURE-BASED SHORELINE FEATURE



Aerial of the Cold Spring Foundry Park site depicting shoreline features and monitoring activity.



SRIJB field member assessing transect placement along shoreline.



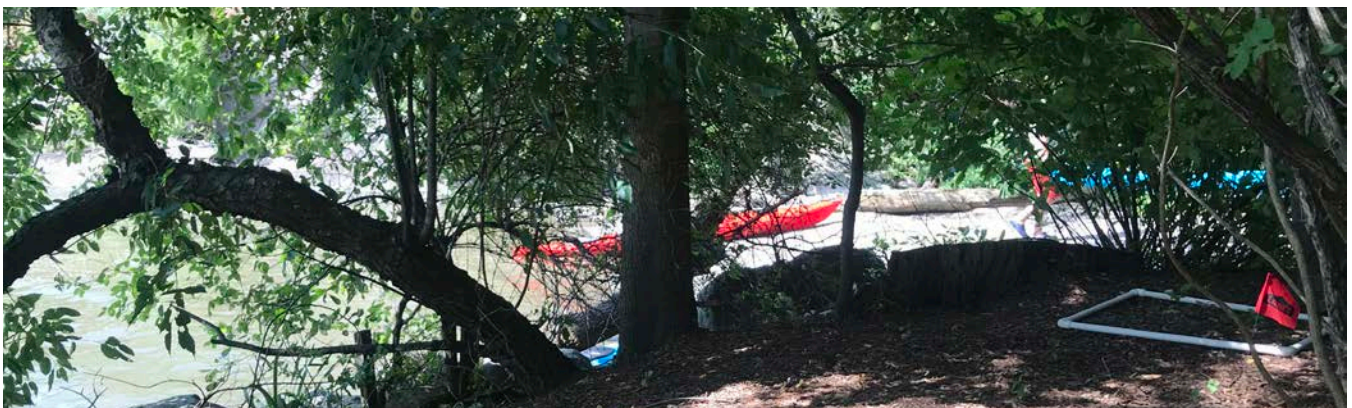
Remnants of old railroad being exposed at low tide.

SITE DESCRIPTION

Cold Spring Foundry Park is a public park on the Hudson River, sharing a parking lot with the Cold Spring Metro North train station located across the street. The Constitution Marsh Sanctuary is to the south of the site, and downtown Cold Spring is approximately 0.2 miles to the north. The park is approximately 0.7 acres in size and includes a living shoreline, dense shoreline vegetation, public boat launch, public restroom (port-a-potty), walking path, manicured green space, a few small accessible shorelines, and two platforms with benches. Signs at the shorefront prohibit swimming. A local kayaking business conducts rentals and group launches from the boat launch. The site was formerly the location of the West Point Foundry with a railroad and pier for transporting goods out to the ships in the Hudson River. Remnants of the railroad can still be seen along mean low water. The site was acquired by Scenic Hudson in 1996, and has since been preserved for its history and natural beauty, while also maintained for public use. The neighborhood near the site mainly extends north and east, as the Hudson River lies to the west and the West Point Foundry Preserve and Constitution Marsh are to the south.

MONITORING PERFORMED

The SRIJB team piloted all of the protocols at this site, except thunderstorms forced some to be cut short. Six transects were established throughout the site with six upland control points and two assessment points for each transect. The second assessment point for each transect was marked at the mean low water line. Social assessments were performed for the site as a whole, including documenting signs of human use and interviewing people using the park. One zone was used for this site due to lack of time, and no prior visit was made to establish differences in usage. The park was small in size, and there was fluid movement of persons throughout. This single zone extended from the entrance of the park to the shoreline and included all monitored areas of the living shoreline. Household surveys were completed within half of the business radius (.39km), while prioritizing pre-selected clusters nearest to the site. Ecological assessments were performed at each assessment point, and elevation surveying was also conducted for each transect. No wave action was observed at the site and no structure to collect water levels against existed.



Inland assessment point with quadrat alongside boat launch area.



Kayaks being launched for a group tour at the boat launch.

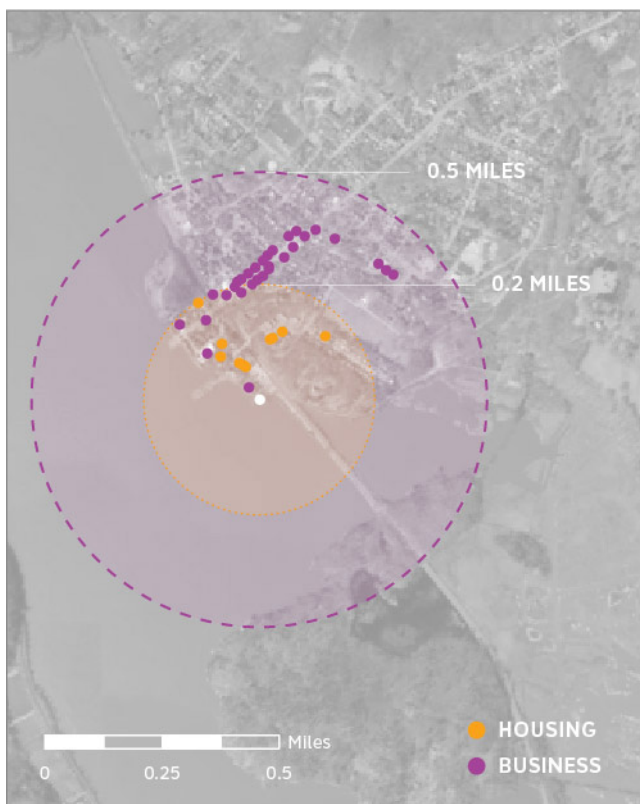
TAKE-AWAYS

Piloting the protocols in this semi-wooded peninsula-shaped park was challenging because it was difficult to set up transects and assessment points that were accessible and representative of the area. The shoreline was broken up into several different alternating segments of living shoreline areas, and rocky beach areas, plus the boat launch. However, there was significant erosion throughout the park which made the segments difficult to distinguish. Additionally, line of sight was frequently obstructed at this site during elevation surveying due to vegetation. More time would have been especially helpful in documenting and measuring the erosion. To adapt to this time restraint, the monitoring team took

lots of pictures and marked out the erosion with the GPS, rather than measuring out each area and estimating areas. When working at small sites with lots of different segments, its importance to budget extra time to delineate the site, despite the small site area. Household surveys were also challenging in this area, since there were not many homes immediately in the vicinity of the park. Natural and man-made features like the train station were common at many of the sites and seen as areas that could potentially influence a household in addition to the intended feature. Adding markers in the socioeconomic maps to identify these would help a team prepare for the field and could be added to the survey as a question ranking its level of influence when speaking with a homeowner.



Aerial of the Cold Springs site depicting social assessment zones.



Aerial of the Cold Springs site depicting businesses, households, and associated inventory radii.

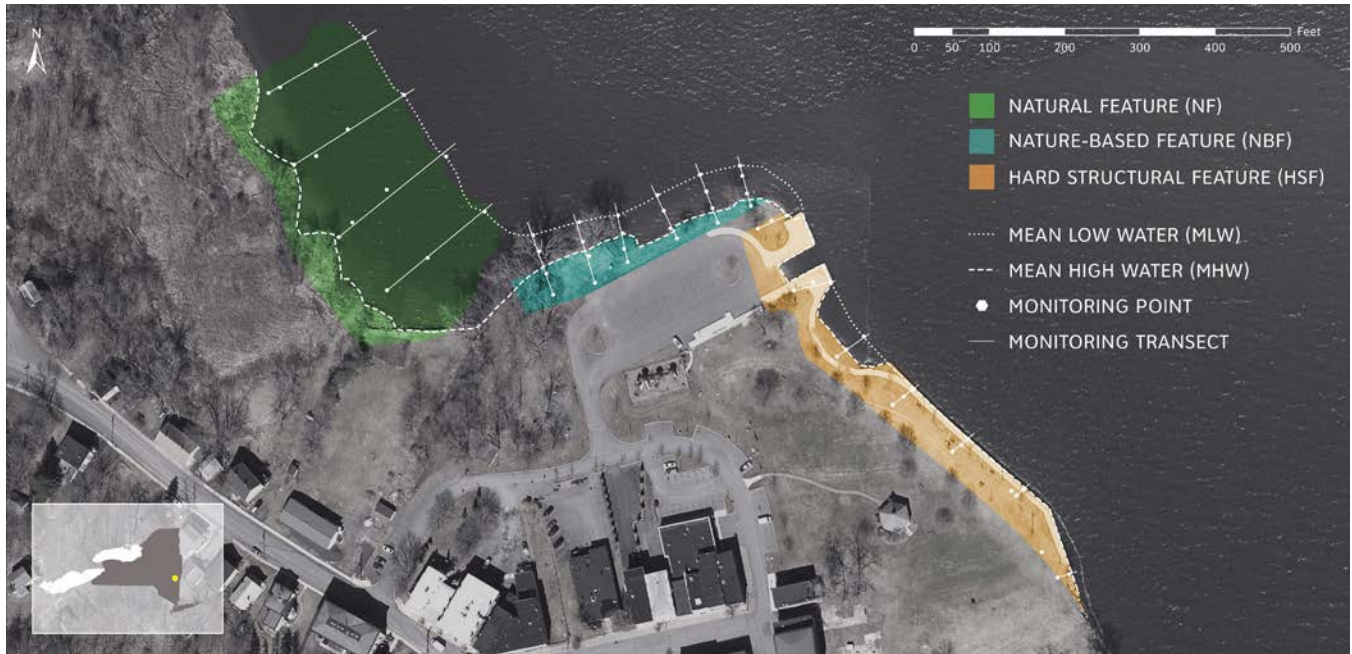


Sun-drenched rocky beach segment of the living shoreline.

COXSACKIE BOAT LAUNCH

COXSACKIE, NY | HUDSON VALLEY

NATURAL SHORELINE, NATURAL-BASED FEATURE, AND HARDENED STRUCTURE



Aerial of the Cocksackie Boat Launch site depicting shoreline features and monitoring activity.



Floating dock and kayak launch seen at the south end of bulkhead.



Sunken boat and vegetation revealed within the living shoreline at low tide.

SITE DESCRIPTION

The Cocksackie site is a public park with a boat launch in the middle of Cocksackie, NY along the Hudson River. A bulkhead with a boat launch makes up the eastern extent of the park adjacent to a living shoreline restoration project immediately north of the launch. There is a break in the bulkhead just south of the boat launch and includes a small beach. People have been seen to use it for kayaks as well as shore play with kids and dogs. The living shoreline segment of the site began construction in February 2012 as part of the NOAA Habitat Blueprint Project. It was regraded, terraced with boulders, and replanted with native bulrush, pickerelweed, dogwood and button bush. Sycamore trees were planted in the upland adjacent to the parking lot (NOAA). It is now densely vegetated and stable, and includes an old wooden boat that was sunk in the mud in the intertidal zones as part of the restoration area. At high tide, most of this area is hidden under water. A natural shoreline to the north of the park is comprised of an intertidal wetland along the river. The entire park is approximately 7 acres in size and is frequently used by the public for recreational activities such as fishing, boating, picnics, concerts, and markets. A playground, basketball court, and gazebo are also located on the grounds. Access to the boat launch, restoration site, and other park areas is fluid with people often moving between sections and sharing the same parking lot. The wetland to the north of the park has no public access and is abutted by private property upland to the east. The surrounding neighborhood begins just past the small downtown area next to the park with some homes lining the river while others are located on higher elevation inland.

MONITORING PERFORMED

The Cocksackie site contains three connected 'features': HSF (bulkhead and boat launch), NBF (living shoreline) and natural feature (wetland). To differentiate, the SRIJBteam divided the site by these three

features and established transects through each for comparison. Four transects were set up through the northern wetland segment that included four upland control points and three assessment points along each transect. The control points for the wetland were marked on trees and other semi-permanent vegetation, due to lack of access to the private property upland of the wetland. Six transects were set up through the living shoreline segment with six upland control points for each transect and three assessment points along each transect. Seven transects were set up through the bulkhead segment with seven upland control points and two assessment points along each transect. All assessment points were placed in areas representative of the segment starting with the upland control points and ending along mean low water (i.e. the upland grass, intertidal vegetation, and muddy mean low water level, etc.). The team was able to pilot all of the protocols at each segment of the site, however certain protocols were shared amongst the three segments due to the close proximity and connected nature of the site. Social assessments were performed for the site as a whole using one social zone, since there was no prior visit to establish differences in the area. In addition, it was impossible to distinguish distinct zones, because the boat ramp and restoration area shared the same upland area (parking lot), and the restoration site was inaccessible to the public, especially at high tide. The length of the monitored site extended the length of the park, so it seemed natural to establish one zone as people move fluidly throughout. Human use assessment was not conducted in the wetland segment due to not having access to the private land. Household surveys were conducted on foot through the neighborhood located within roughly one-fourth of the business radius (1.23km). The neighborhood within the radius was split into three 'sections,' where clusters of homes were pre-selected for sampling. Only two of the three neighborhood sections were visited due to worsening weather conditions. These were used for all features located at Cocksackie since the business and household radius was the same for all. Ecological assessments were per-

formed at each assessment point to measure plant cover and species richness multiple invasive species were observed within the restoring living shoreline segment. Elevation surveying was also conducted for each transect, except for the wetland segment due to thunderstorms. Little to no wave action was observed at the site except for boat wakes from passing ships. Boat wake size and run-up was documented along the beach area next to the boat launch. Site maps were generated of the area to show coordinates for control points and assessment points along transects, as well as reference points around the site, erosion, plant cover, and elevations. Monitoring was conducted over three days. A separate site map was created to show zone borders, the first 30 businesses near the site, and households selected in the field for surveys.

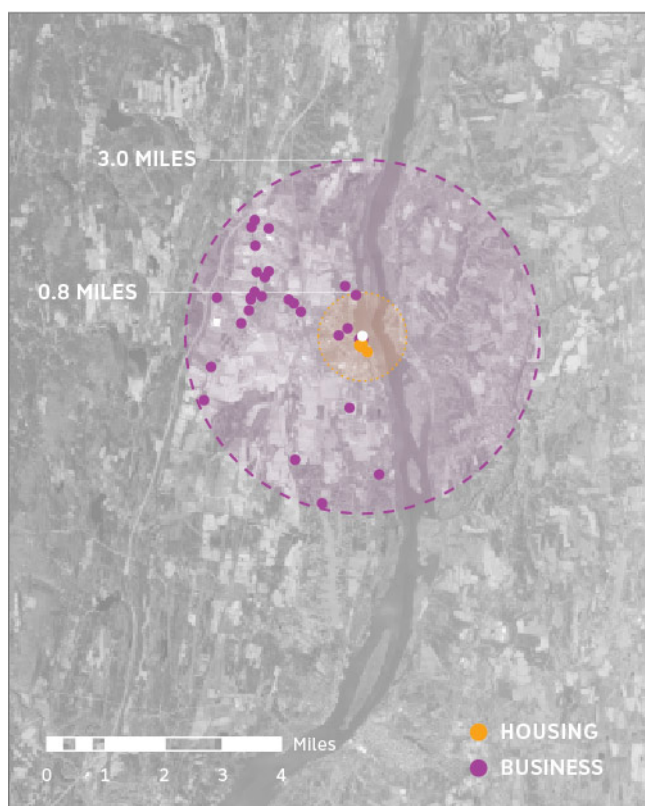
TAKE-AWAYS

Takeaways from the Cocksackie site included a better understanding of how to space out assessment points at each transect, and how to adapt the protocols to an inland river shoreline environment. The team found it useful to only establish assessment points throughout each transect that accurately represented the lateral extent of the site. This assured that each assessment point was unique to its transect, but similar to its adjacent assessment points. This made them easier to compare across the site and more efficient to set up and monitor. Defining this site was difficult initially because each segment combined is about 465 meters of shoreline, but accurately segmenting it and having multiple

days on site made it feasible. For the social assessment protocols, the site proved equally as difficult when distinguishing social zones. This once again stresses the importance of pre-site visits and exact knowledge of, or maps illustrating, the selected sites. Teams could then draw and adapt these while in the field to reflect observations. Size and usage of the shoreline feature should also be considered when establishing zones such as bulkheads, which can run hundreds of feet in length and have various uses throughout. The biggest takeaway from this site was how to adapt the protocols to a river shoreline feature. Overall, the protocols and metrics were equally well-suited to monitor a river shoreline, but there were different focus areas for collecting data along a river. For example, boat wakes in the Hudson River play a larger role than wind-driven waves in erosion and deterioration of these shorelines, so collecting boat wake data along the Hudson River is more critical for monitoring than wind driven wave data and could possibly have greater implications for shoreline management in the future. If possible, collecting more boat wake data would be useful for sites along the Hudson River. Piloting the socio-economic protocols for a feature on private land prompted unique takeaways. The social site assessment protocol was adapted from a NYC parks assessment, and is therefore geared towards human use of publicly accessible, recreational land. For a wetland bordered by private property, human use is likely to be significantly less than on public land. If 'human use' is a measure of shoreline success, it is worth re-considering the design of this protocol or interpretation of associated data gathered.



Aerial of the Cocksackie Boat Launch site depicting social assessment zones.



Aerial of the Cocksackie Boat Launch site depicting businesses, households, and associated inventory radii.



Behind the field crew, wetlands span the length of the shoreline.

PEEKSKILL MUNICIPAL PARK

PEEKSKILL, NY | HUDSON VALLEY

NATURE-BASED SHORELINE FEATURE



Aerial of the Peekskill Municipal Park site depicting shoreline features and monitoring activity.



A mixture of rocks, driftwood, and debris form the west side shore of the NBF.

SITE DESCRIPTION

Peekskill Municipal Park is a large public park along the Hudson River right next to the Metro North train station, and about .65 miles from downtown Peekskill. The train tracks and station transect the park and surrounding neighborhood. The portion of the park chosen for pilot monitoring is also known as Riverfront Green South and extends from the boat launch to the gazebo, which is about 200 meters long and is located adjacent to the train station parking. This area is comprised of an upland walking path next to the parking lot, followed by grass and then shoreline vegetation and finally a rock revetment along the intertidal zone. There is a crescent shaped beach in the north end of this area adjacent to the dock which kayakers were seen using to launch boats. The community and tourists frequently use the area for recreation such as walking, picnics, fishing, boating, and events. A boat tour business operates in a small shed and dock beyond the gazebo. The walking path extends beyond the site in both directions running south past a marina and north through a manicured park containing art sculptures, an open field, playground, and bathroom facilities. Peekskill's Southern Waterfront Park and Trail Master Plan was enacted in 2009 and included shoreline restoration along the Riverfront Green South segment of the park which restored the revetment and vegetation along the shoreline.

MONITORING PERFORMED

The SRIJB team was able to pilot all of the protocols throughout the site. Five transects were established with five upland control points and three assessment points along each transect. One transect ran through the crescent beach area and the other four ran through the grass, shoreline vegetation, and rock revetment ending at mean low water. The social assessment was performed for the site as a whole, including documenting signs of human use

and interviewing people using the park. This site had the highest concentration of people observed, and most were seen using the walking path in the park. Household surveys were completed the day after and were shortened due to worsening weather conditions. Pre-selected locations were bypassed for closer alternatives to help compensate for the weather. Ecological assessments were performed at each assessment point to measure plant cover and species richness. Elevation surveying was also conducted for each transect. No wave action was observed at the site but the water level data were taken from the boat dock north of the beach.

TAKE-AWAYS

A major take away from this site was that the monitoring protocols are able to distinguish between NNBF that are frequently maintained and ones that are left alone. Data collected from the ecological function protocols, along with pictures and site documentation, can paint a picture of how the feature stands up over time with differing approaches to maintenance. The shoreline along the segment of the park had undergone some restoration work in 2009 as part of the Peekskill Southern Waterfront Park and Trail Master Plan. While the shoreline and park were in great shape with little or no signs of erosion, it was obvious that many invasive plants had moved into the vegetation above the rock revetment. Since the restoration work in this area seems to be accomplishing its goal of hazard mitigation for the park, there may be no need to eradicate invasive species along the shoreline except for ecological and aesthetic concerns, if any. It could be useful in future monitoring efforts to track maintenance costs of NNBF as it relates to invasive plant species to decide how to cost effectively maintain a project area. Site stewards' tolerance for invasive species in the project area may have an impact on maintenance costs, but the protocols are capable of providing the data to make these decisions. If the



Kayak launches were observed at this rocky beach abutting the NBF.

spread of invasive plants is a concern for the surrounding ecosystem, then increased maintenance to keep invasive plants at bay might be required after completion of the project. However, the same

invasive plants may also play a critical role in hazard and erosion mitigation along the shoreline, while also decreasing maintenance costs.



Aerial of the Peekskill Municipal Park site depicting social assessment zones.



Aerial of the Peekskill Municipal Park site depicting businesses, households, and associated inventory radii.



Popular walking path running the length of the vibrant living shoreline.

WIDOW'S HOLE

GREENPORT, NY | LONG ISLAND

NATURAL SHORELINE, NATURE-BASED SHORELINE FEATURE



Aerial of the Widow's Hole site depicting shoreline features and monitoring activity.



Sandy beach and dune grass stretching towards a group of distant condos.



Natural occurring spartina lines a rocky shoreline north of the restored dune.

SITE DESCRIPTION

Widow's Hole Preserve is a 2.31-acre plot and restoration site with 0.64 acres of undeveloped beachfront along Greenport Harbor, located less than one mile from downtown Greenport. The preserve is owned by the Peconic Land Trust for restoration purposes. Access to this privately-owned site is technically restricted, as indicated by signage, in an effort to minimize disturbance to the restored ecological system. In August 2019, there were no physical barriers to access, and people were seen freely using the beach area. Currently the shoreline feature of the site consists of a rebuilt sandy dune with *Leymus mollis* plantings, followed by a sandy beach, and then a plot of replanted *Spartina* spp. in the intertidal zone. A more natural shoreline with thick vegetation is to the south of the restored dune. A private oyster farm operates in the cove immediately to the north. Immediately behind the beach area is a thin strip of dense trees and plants followed by an open grassy area ending at the road and informal parking area. The site faces the Peconic Bay and is generally sheltered from wave action, except for boat wake from the frequent passage of ferry boats to and from Shelter Island. The surrounding neighborhood begins immediately outside of the site and extends west and north with residents being both full-time and part-time during the summer.

MONITORING PERFORMED

The SRIJB team implemented every field protocol for ecological function, hazard mitigation, and socioeconomic outcomes at Widow's Hole. The shoreline features were delineated, five transects were established across the beach, and fifteen assessment points were marked out. Five control points were established upland of the dune at the top of each transect. The site was not uniform and included the nature-based restoration and an adjacent natural shoreline, so the team established transects across both segments to get a representative snapshot of both segments at the shoreline. Quadrat survey-

ing methods were used to assess shoreline ecology such as plant species cover, species richness, and presence of sessile organisms. Elevations were surveyed at all control points and assessment points. Wave data were collected from the bay, and erosional areas were delineated. The social assessment was also performed over two days. One social zone was established for the site due to time, the area's small size, and no prior visits occurring to determine separation of use. This zone extended from the borders of the oyster farm, around the shoreline including the beach area at the sides of the restoration section, and the inland grassy area. Household surveys were conducted by means of walking and driving through the neighborhood, locating pre-selected houses within the radius of the 30 closest businesses (1.08km) as well as selecting alternative options since some locations turned out to be businesses or posted no trespassing signs. Site maps were generated to show coordinates for control points and assessment points along transects, as well as reference points around the site, erosion, plant cover, and elevations. A second site map was created to show zone borders, the first 30 businesses near the site, and households selected in the field for surveys.

TAKE-AWAYS

This was the first shoreline monitored by the SRIJB team. The most critical takeaways from this site were learning how to efficiently delineate boundaries and implement protocols in a short window of time. This site was larger in person than was inferred through aerial imagery, so it was critical to limit the monitoring to predefined shoreline features; in this case, the natural/restored feature and nature-based feature. It is critical to complete pre-site protocols for every site visit before going into the field, so that time on-site can be used efficiently. Pre-site visits to establish social zones are also essential in being able to correctly judge a site's unique differences before going into the field to collect data. If repeat visits are possible,



Kayaks lay strewn over the rocky beach area, a popular informal storage area for locals.

more time could be spent delineating the site with more detailed segments and focusing on additional assessment points to capture the range of substrates and species along the beach.

Shoreline monitoring for hazard mitigation and ecological function provided useful data and the protocols were feasible to perform at this site. Widow's Hole was also ideal for carrying out the socio-economic outcome protocols due to its proximity to downtown Greenport and the surrounding residential neighborhood. At this site, the households were randomly pre-selected within a 1.08 km radius, which made it time-consuming to reach

the identified households. Additionally, some of the houses selected ended up being closer in proximity to a different shoreline, making it more challenging to deduce the 'influence' of a bounded shoreline feature. Based on this experience, the team recommended shrinking the household survey radius. This adjustment was tested out and continuously refined in subsequent sites. Overall, the team felt confident that these protocols were useful for data collection and feasible to perform at Widow's Hole given the site's size and density of the surrounding area.



Aerial of the Widow's Hole site depicting social assessment zones.



Aerial of the Widow's Hole site depicting businesses, households, and associated inventory radii.

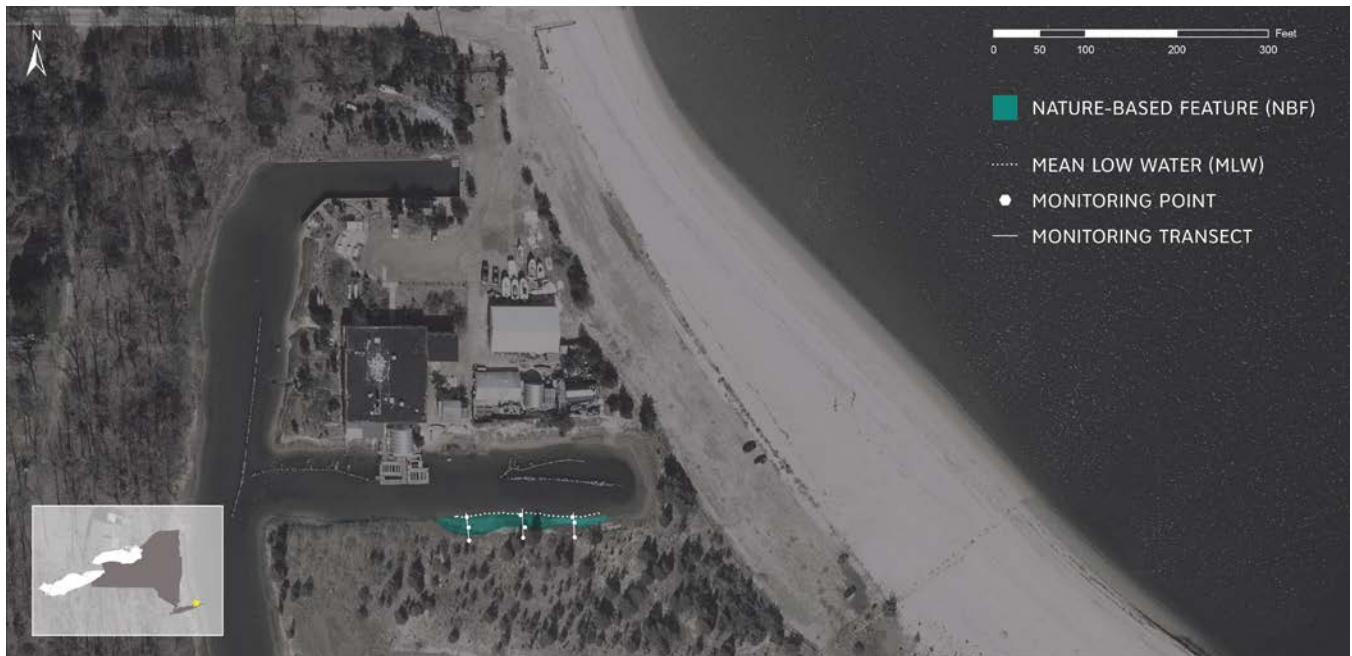


Upland dune restoration area sloping gradually towards the shore with young *Leymus mollis* plantings..

CEDAR BEACH CREEK

SOUTHOLD, NY | LONG ISLAND

NATURE-BASED SHORELINE FEATURE



Aerial of the Cedar Beach Creek site depicting shoreline features and monitoring activity.



Multiple restoration projects in progress at the creek.

SITE DESCRIPTION

Cedar Beach Creek is a dredged tidal inlet behind the Cornell Cooperative Extension (CCE) facility on Cedar Beach in Southold that is comprised of approximately 90 feet of living shoreline demonstrations. There are five planned experimental plots of living shoreline options that will include intermittent patches of planted *Spartina alterniflora* and oyster shell bags for spawning ribbed mussels. At the time of monitoring, only three of the five proposed demonstration plots had been installed. The purpose of this site is to provide physical examples of living shoreline techniques that could be used as an alternative to full-scale bulkheads. The land that CCE sits on was originally created to build condos; however, this never came to fruition. There is a public beach on the other side of the dune that includes a boat launch area and sandy beach frequently used for fishing. A bird nesting preservation area is also roped off further down the beach. The CCE facility is open to the public and operates educational programs and various marine research projects. A small informal path, sometimes used by the public, leads from the beach parking lot to the facility's tidal inlet. The surrounding neighborhood is made up of full-time as well as seasonal residents.

MONITORING ACTIVITIES

The SRIJB team implemented every field protocol for ecological function, hazard mitigation, and socioeconomic outcomes. The shoreline feature was delineated, bounded by the edges of the existing demonstration plots. Three transects were established across the shoreline, each with one upland control point and two down-gradient assessment points. Each assessment point was used for quadrat surveying methods to assess shoreline ecology such as plant species cover, species richness, and presence of sessile organisms. Elevations were surveyed at all control points and assessment points. The site was fairly uniform but did include three different experimental plots of replanted *Spartina* and oyster

shell bags. The team established transects across all three segments to get a representative snapshot of the shoreline. The social assessment was also performed. This site was split into two distinct social zones (see protocol for social zone details), the CCE facility and the shoreline on the outside of the dune, since a vegetative barrier and difference in usage was apparent. Household surveys were conducted by means of walking and driving through the neighborhood located within one-fourth of the business radius (1.37km, see protocol or lessons learned for further explanation), locating pre-selected houses as well as alternative options since certain locations were inaccessible. Selection of homes was limited to a Google Maps exercise of randomly selecting homes in neighborhoods within the radius. Site maps were generated to show coordinates for control points and assessment points along transects, plant cover, and elevations. Only one reference point was established on the CCE dock due to lack of permanent structures around the site, and wave action was observed to be flat. A separate site map was created to show zone borders, the first 30 businesses near the site, and households selected in the field for surveys.

TAKEAWAYS

Cedar Beach Creek was the quickest site the monitoring team worked on due to its small size, location, and easily differentiated segments along the water. There was no wave action in the inlet, so wave data were noted to be zero. Elevation surveying was also fairly rapid due to the small work area and lack of benchmarks. Elevations were taken relative to mean low water, which has been previously established by CCE. Additionally, social zone one (CCE facility) was on private property, so signs of human use were limited. A majority of the social assessment data was collected from zone two (shoreline) on the other side of the dune that faces the bay, as that was the public area to the beach. Establishing more social zones here would further distinguish the activity and specific use in



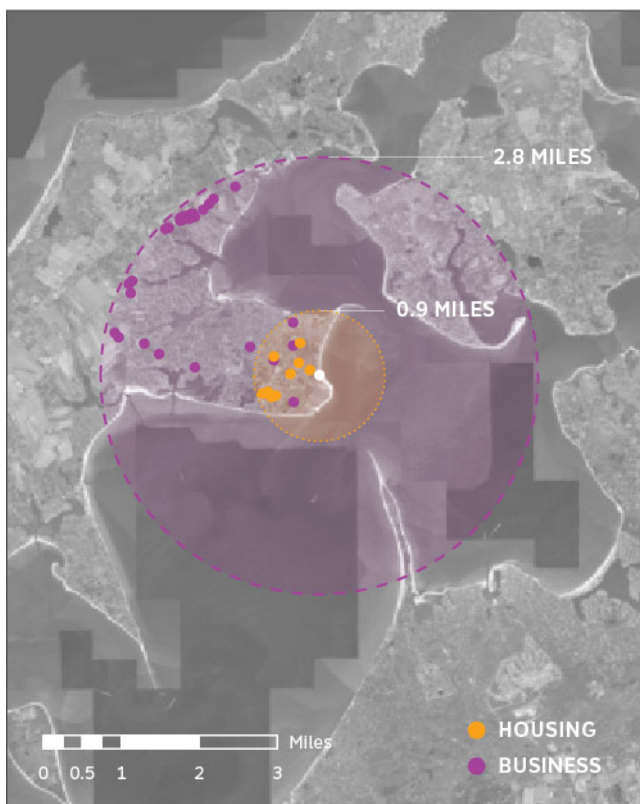
CCE's oyster and spartina building and stations.

each zone, which could be resolved with a pre-site visit. The social assessment could also be planned for different days and times of the week to account for temporal variation in human activity. Household surveys were challenging to complete at this site. Unforeseen barriers such as gates, no trespassing signs, and vacant vacation homes were encountered, so randomly pre-selected households needed to be adapted to in the field. Taking into account spatial distance, time of day, and day of the week may increase the likelihood of connecting with people in their homes. The metrics and protocols were applicable to the site and provided critical information, but specific instructions should accom-

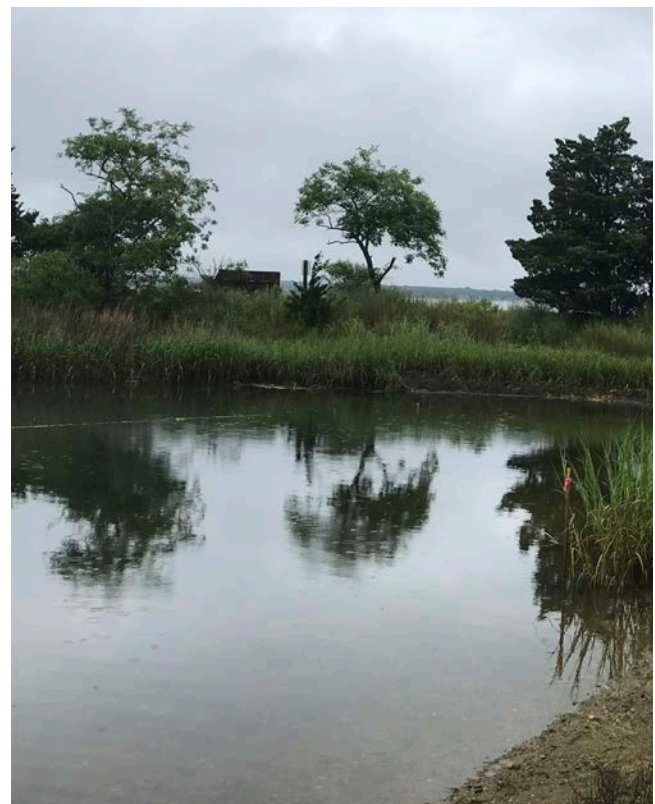
pany protocols about how to adapt in the field to fit the specific needs of the site and shoreline feature. This site provides a good example of a case in which a protocol is designed to measure something that is absent from the site: in this case, the indicator is wave action; in other sites, it could be sessile organisms, erosional features, etc. A wave reading of '0' is still critical site information that can be captured by following directions for implementation of the protocol. This does not reflect a data gap or an inapplicable metric for the site, but rather neutral data that still relays critical information about the dynamics of the shoreline.



Aerial of the Cedar Creek Beach site depicting social assessment zones.



Aerial of the Cedar Beach Creek site depicting business-, households, and associated inventory radii.

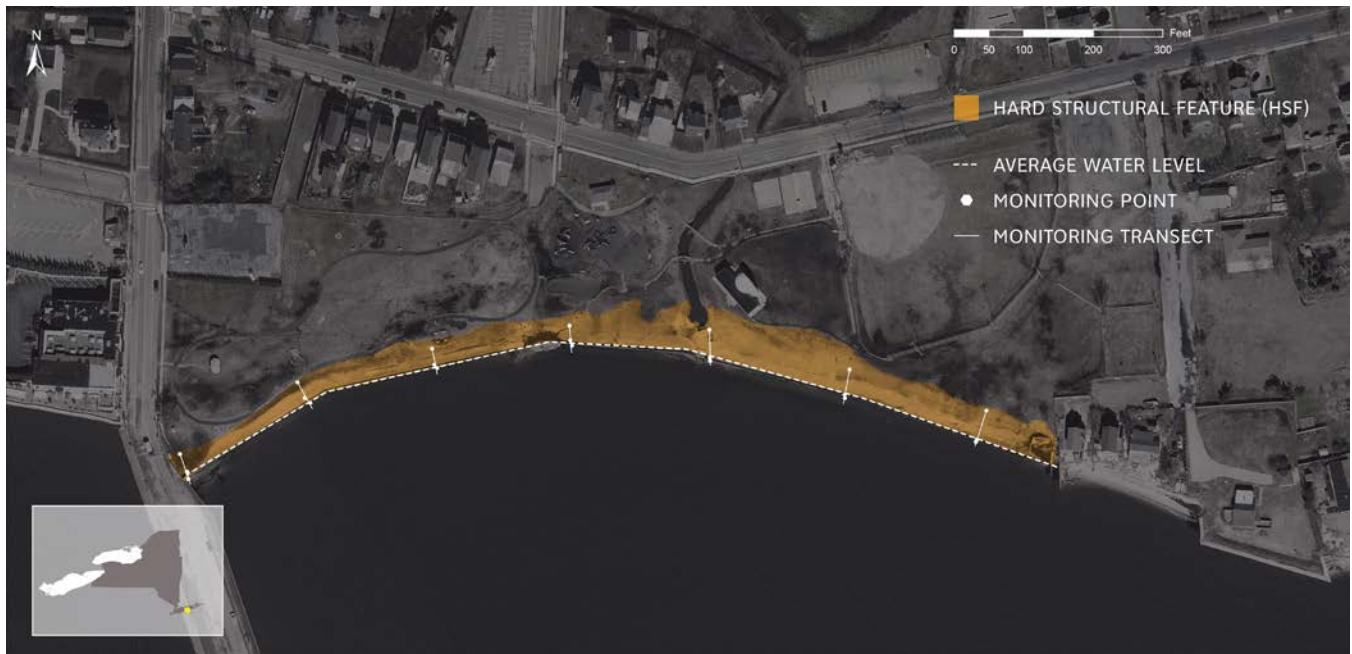


Example of the thick vegetation bordering the beach, dune and open grassy area.

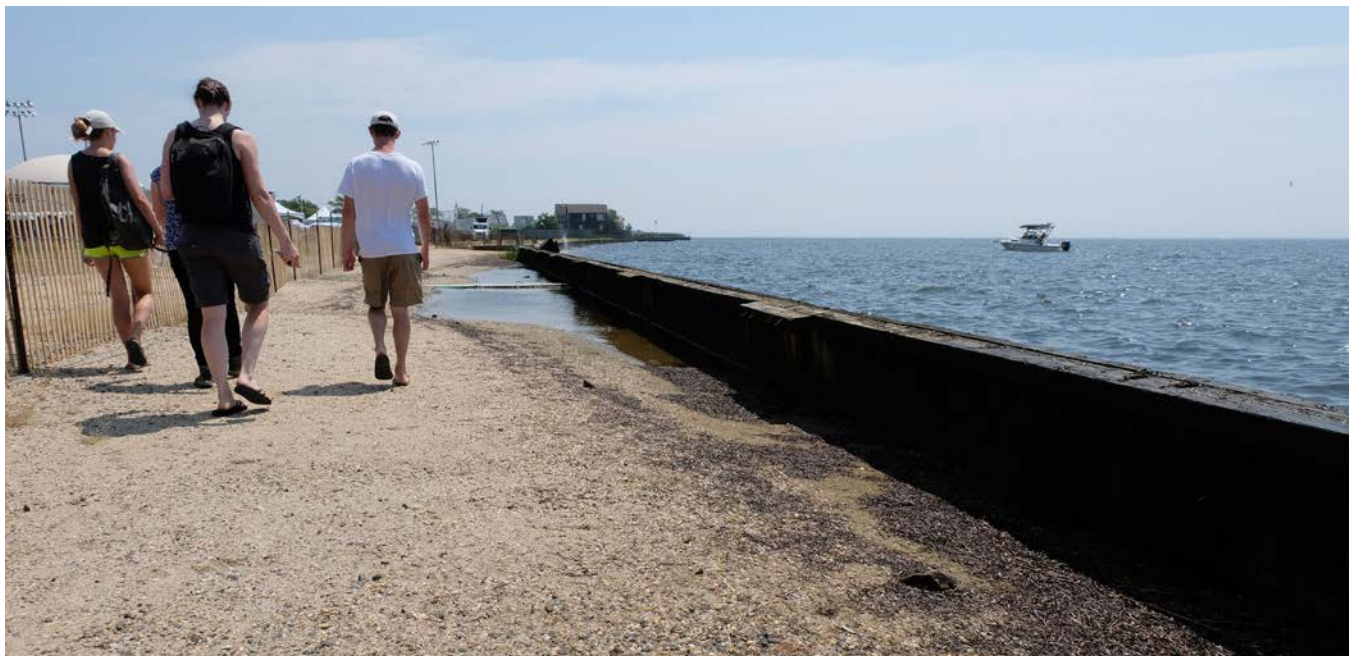
PATCHOGUE SHOREFRONT PARK

PATCHOGUE, NY | LONG ISLAND

HARDENED STRUCTURAL FEATURE



Aerial of the Patchogue Shorefront Park site depicting shoreline features and monitoring activity.



SRIJB field crew scouting the park's accessible beach and bulkhead.

SITE DESCRIPTION

Patchogue Shorefront Park is a public park along the shore of the Great South Bay and 1.1 miles south from downtown Patchogue. The park is approximately .25 miles long and adjacent to Mascot Dock and Marina at the end of South Ocean Ave. The area is frequented by residents and tourists for fishing, boating and outdoor activities in the park, which includes a playground, baseball fields, and open green space. The southern border along the water is comprised of a failing bulkhead that was damaged from storm surge, leading to tidal flooding along the south end of the park. At the eastern end of the bulkhead is a vacant lot that is not lined by the bulkhead and has direct access to the water. A few houses line the shore east of this area. The park also hosts a large music festival and other events throughout the summer months. To the north of the park is Rider Avenue Park, which consists of a softball field, baseball fields, basketball courts, and portions of Little Creek. The surrounding neighborhood envelops the park areas and consists of full-time and part-time residents.

site, including documenting signs of human use and interviewing people using the shoreline assessment protocol. This site was assessed as one social zone due to time constraints, no prior visits to determine separation of use, and event set-up limiting access to the area. The zone extended the length of the bulkhead and incorporates the upland areas including the playground and fields where event set-up was being done. The team returned a second day to conduct household surveys around the neighborhood. Household surveys were conducted by means of walking and driving through the neighborhood located within roughly half of the business radius (.8km). The team began surveys in pre-selected clusters, but needed to add new clusters since certain locations were inaccessible or difficult to get to due to event related road closures. Site maps were generated of the area to show coordinates for control points and assessment points along transects, as well as reference points around the site, erosion, plant cover, and elevations. A separate site map was created to show zone borders, the first 30 businesses near the site, and households selected in the field for surveys.

MONITORING PERFORMED

At the time of the site visit, the park was host to the Great South Bay Music Festival. The SRIJB team arrived on the eve of the event in order to access the park and run through all the protocols before the event began. The team was able to establish six transects each with two assessment points and one upland control point. Because of time limitations, and due to the length and uniformity of the site, the team decided to place transects 200ft. apart, despite the protocol calling for a transect every 100ft. Several reference points through the area were marked out for surveying. The second assessment point on each transect was placed right along the bulkhead to include the bulkhead itself and any sessile organisms that may be inhabiting it. All the protocols were piloted at this site during the first day. Social assessments were also performed for the

TAKE-AWAYS

The biggest takeaway at this site was the importance of planning ahead to navigate site access challenges and unanticipated events that affect shoreline use. It was not feasible to establish a permanent wave or tide gauges on site, but the team was able to rely on data from the Great South Bay NOAA Buoy. Due to the music festival, the team's time on site was limited. The music festival also impeded household surveys and social assessments. The team experienced very low response rates for the household survey protocol. The event also affected accessibility to other potential zones for social assessment. This experience highlighted the importance of completing the social protocols as written (three visits: morning, evening, weekend), to capture variation in use. The music festival clearly drew visitors and presumably business to the town.



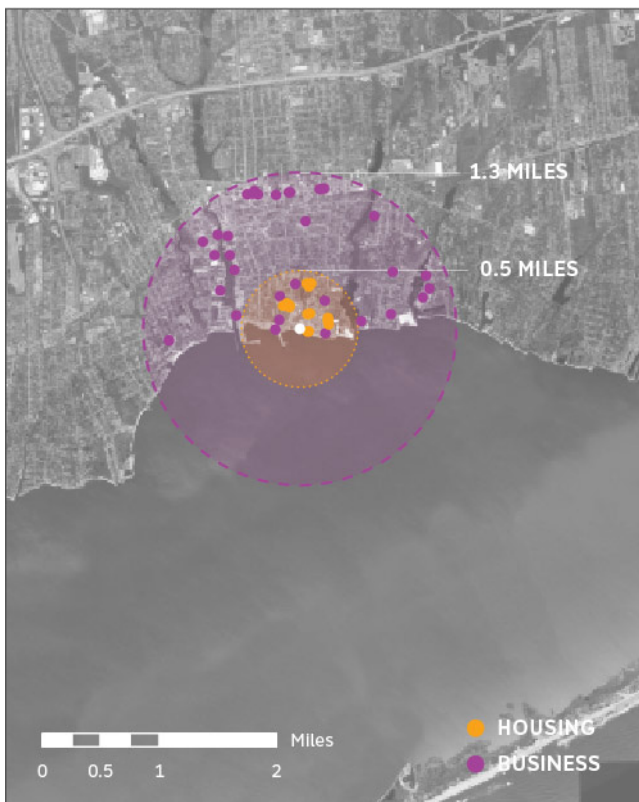
East end of bulkhead spanning west towards Marina.

With enough interviews, the business data gathered from the 'simple' version of the existing protocol (a question about business visits within the site assessment interview) would provide a basic assessment of whether visitors to the site, for the festival or otherwise, are also patronizing local businesses. Future users will have to determine how many data

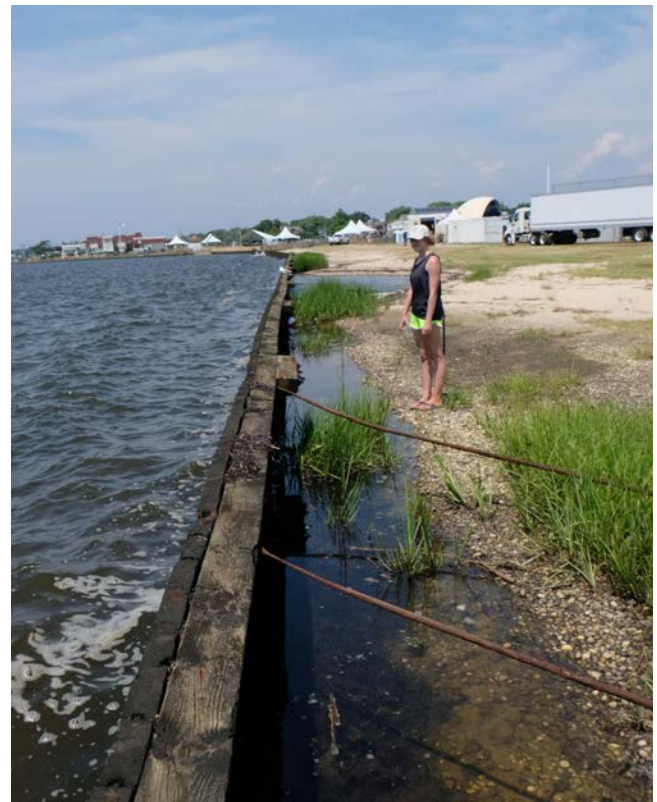
points are sufficient for a robust picture of business influence. Overall, the team was able to complete protocols despite challenges posed by the festival, primarily because parks are easier to monitor than more natural shorelines due to the lack of biodiversity and obstacles along the shore.



Aerial of the Patchogue Shorefront Park site depicting social assessment zones.



Aerial of the Patchogue Shorefront Park site depicting businesses, households, and associated inventory radii.

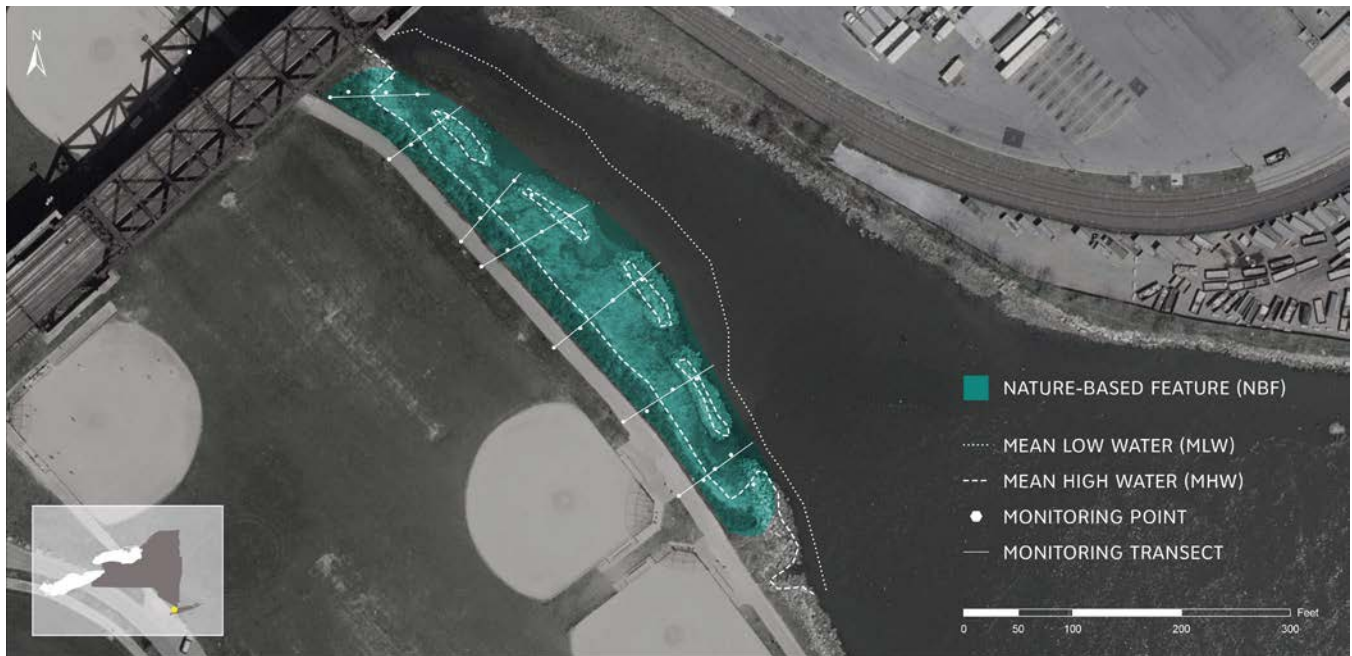


Water accruing behind one of the damaged sections of the bulkhead.

BRONX KILL

RANDALL'S ISLAND, NYC | NY/NJ HARBOR

NATURE-BASED SHORELINE FEATURE



Aerial of the Bronx Kill site depicting shoreline features and monitoring activity.



Lawn and ball field to the south of the shoreline feature.



Incoming tide at the Bronx Kill, with New York Post offices to the northeast.

SITE DESCRIPTION

The Bronx Kill shoreline feature is a one-acre scrub shrub and salt marsh restoration behind a rock sill on the northern shore of Randall's Island in New York City. The site is located on the Bronx Kill, which connects the East River to the southern section of the Harlem River and separates Randall's Island from the Bronx. The site was formerly a degraded riprap shoreline with a small section of lawn and ball-fields. The site was restored in 2008 by NYC Parks and consists of five rock sill islands with five openings from the Bronx Kill into the salt marsh, which is dominated by *Spartina alterniflora*. The sloped upland edge of the site is dominated by woody shrubs including *Iva frutescens* and *Baccharis halimifolia*. The rock sill and salt marsh are inundated by salt water twice daily to the toe of the scrub-shrub upland transitional edge. The site is fenced off on the south side adjacent to the recreational area, open on the north side to the Bronx Kill, and located across from a parking lot and commercial zone in the Bronx. The surrounding shoreline includes riprap to the east and a railroad bridge, pedestrian bridge to the Bronx, and natural areas to the west. The site is monitored and maintained by the Natural Areas' staff of the Randall's Island Park Alliance (RIPA).

MONITORING PERFORMED

NYC Parks worked in partnership with RIPA staff to implement the pre-site assessment, ecological function, structural integrity and hazard mitigation, and socio-economic protocols. The site was considered one segment as the shoreline feature was uniform. The site had seven profile lines, which were determined by the location of control points (lamp posts) along the pedestrian pathway south of the site. An assessment point was evaluated in three habitats along each profile line: scrub-shrub, salt marsh, and rock sill. Elevation was recorded along each profile line using a Real-time Kinematic GPS system with centimeter level vertical and horizontal accuracy. The elevation profiles extended from the inside

edge of the southern fence to the farthest extent that could be safely reached into the Bronx Kill and the bottom of the rock sill. The social assessment was performed in zones consisting of natural areas, recreational ballfields, and commercial areas. A business inventory map was created for the site. Data were collected across three non-consecutive days.

TAKE-AWAYS

This was the first site where most of the monitoring protocols (i.e., ecological function and elevation) were piloted by NYC Parks and the SRIJB team. This first day illustrated the need to thoroughly review the protocols and create a more streamlined set of worksheets to be used in the field. Thus, NYC Parks developed a two-page field worksheet that included all metrics for ecological function, shared it with the rest of the field staff, and used it at all NYC pilot monitoring sites. The main implementation take-aways were that it was beneficial to have assistance from a local group, such as RIPA, as the staff were familiar with the site, and with five people implementing the protocol at once, the team was able to collect ecological function data and elevation profiles simultaneously, which expedited the field work. Working with RIPA also illustrated that a team of people unfamiliar with the protocols can be trained to implement them in a short period of time as long as there is at least one person who is familiar with the protocols to give a brief introduction and explanation. General monitoring takeaways include the importance of timing monitoring with low tide and clear weather. The initial monitoring took place on a high tide, and it was raining, which limited the team's ability to collect data.

The site appears to be in good condition with robust vegetation in both the scrub-shrub and salt marsh habitats, mussels were present in the salt marsh, and the rock sill did not show any major signs of degradation. The social assessment indicated that the area around the site was used recreationally and



Restored salt marsh and rock sill at the Bronx Kill, looking west.

as a passthrough area mostly by RIPA staff, bikers, and joggers. The team also interviewed one person who was birding and frequently visited the salt marsh to view shorebirds and waterfowl, and people were observed digging holes and possibly harvesting mollusks along the mudflats below the rock sill in the Bronx Kill waterway at low tide. Businesses in

the area were typically manufacturing or shipping and distribution centers. This site is an example of a successful nature-based feature that benefits from active maintenance and monitoring by RIPA.



Restored salt marsh and rock at the Bronx Kill, looking east.



Aerial of the Bronx Kill site depicting businesses and inventory radius.



Restored salt marsh and shrub scrub separating ballfield.

RANDALL'S ISLAND LIVING SHORELINE

RANDALL'S ISLAND, NYC | NY/NJ HARBOR

NATURE-BASED SHORELINE FEATURE



Aerial of the Randall's Island site depicting shoreline features and monitoring activity.



A mix of intentionally planted and volunteer plants established around a tide pool, looking west.

SITE DESCRIPTION

Randall's Island Living Shoreline is a 1.8-acre nature-based feature on the northeastern shoreline of Randall's Island, south of the RFK Bridge on the Harlem River. The site was previously an unpaved parking lot and storage yard with contaminated soils and a degraded sea wall. The site was reconstructed in 2018 with a restored sea wall that includes small intertidal zones planted with *Spartina alterniflora* and live stakes of woody wetland species including *Salix nigra*. The intertidal zone also includes manufactured tide pools. Above the sea wall, there is a woody shrub transitional zone dominated by *Salix nigra*, *Salix discolor*, and *Baccharis halimifolia*. The restored upland area includes a woody zones dominated by *Populus deltoides*, and grasslands. Grasses and trees were planted in the most contaminated zones to phytoremediate the soils. There is a wood-chip pedestrian path that runs along the feature between the shrub transitional zone and the upland, and a picnic area is located in the center of the site with mature *Morus alba*, public grills, and picnic tables. The site is surrounded by pathways and landscaped greenspace to the east, the RFK Bridge and the NYPD Harbor Unit to the north, and a ferry terminal, sea wall, and festival grounds adjacent to Icahn Stadium to the south.

MONITORING PERFORMED

NYC Parks worked with RIPA staff to implement the pre-site assessment, ecological function, structural integrity and hazard mitigation, and socio-economic protocols. The feature had to be mapped with a GPS unit prior to being able to complete the pre-site assessment because an aerial image showing the recent restoration was not available. The site was considered one segment as the shoreline was uniform. The site had 7 profile lines which were determined by the location of control points (lamp posts) along the pedestrian pathway east of the site. An assessment point was evaluated in each of the three habitats along each profile lines (upland woody/

grassland zone, shrub zone, and sea wall/intertidal zone). An elevation profile was recorded along each profile line using a Real-time Kinematic GPS system with centimeter level vertical and horizontal accuracy. The elevation profiles extended from the lamppost control points to the waterward edge of the sea wall or intertidal zone. The social assessment was performed in zones consisting of pathways and passive recreational areas, picnic area, and roadways. A business inventory map was created for the site. Data were collected across three non-consecutive days.

TAKE-AWAYS

Similar to the previous site, assistance from a local group (i.e., RIPA) was beneficial as the staff were familiar with the site and having five people expedited the field work. A majority of the site was outside the intertidal zone; however, the shrub zone was also planted with wetland species, which will make the shoreline and vegetation resilient to higher levels of flooding over time. This site also illustrated that the protocols can be implemented in sites with limited intertidal zones and more upland and shrub dominated areas. The tide pools on the sea wall all contained water, some algae, and limited evidence of invertebrate life. This is likely due to some tide pools being located at higher elevations and not receiving regular inundation from tides, the early stage of restoration, and potential poor water quality in the Harlem River. In the intertidal zone, the live stakes and *Spartina alterniflora* plugs were generally not successful; however, there were some portions of the intertidal zone where they survived. The site is mostly used as a passthrough area for people who work on Randall's Island, tourists, festival attendees, joggers, and bikers. The picnic area is also actively used, mostly by people who work on Randall's Island. Businesses near the site were typically commercial including a mix of large retail stores and small businesses, delis, and restaurants. These data will serve as a baseline for this site, and this site will benefit from active monitoring

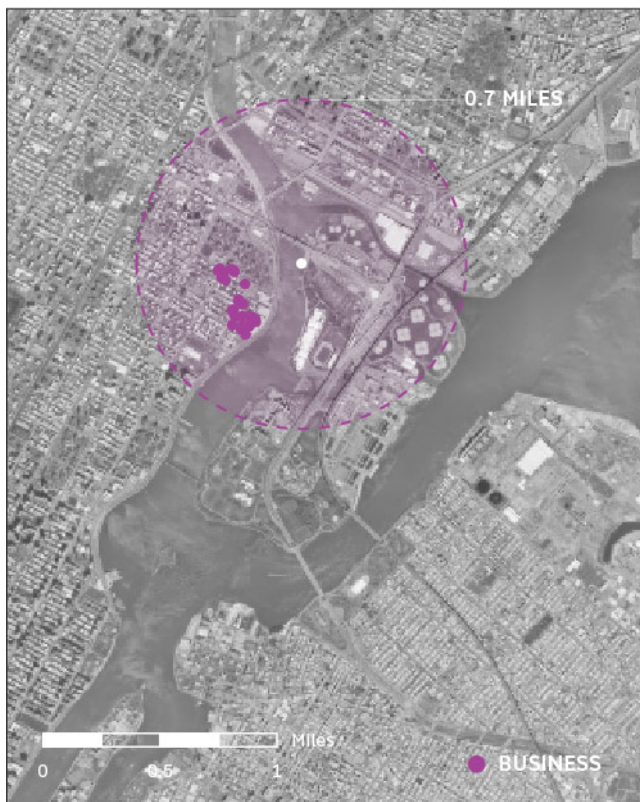
and maintenance by RIPA who are already addressing issues with erosion, plant die off, and invasive plants.



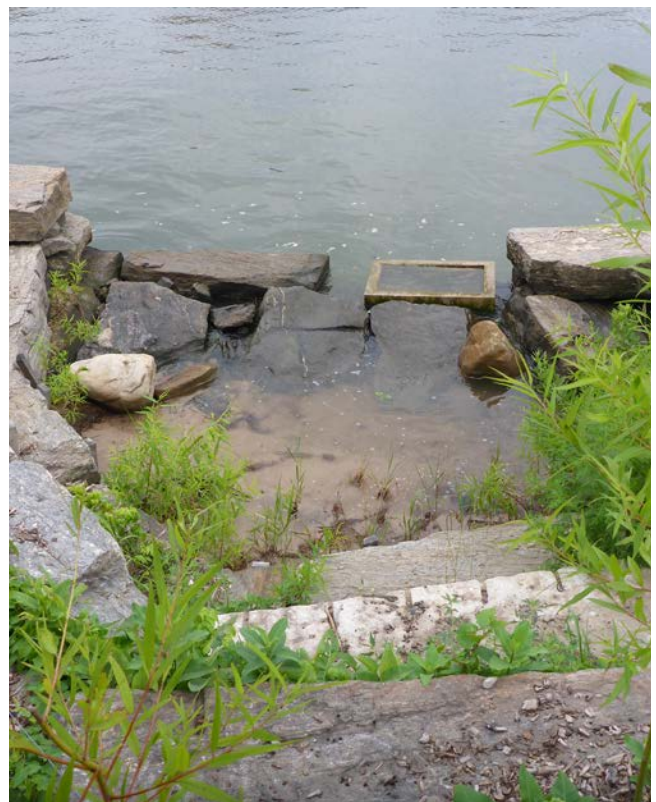
Restored scrub shrub upland planting and woodchip path, looking north.



Boundary between restored grassland, scrub shrub and upland plantings adjacent to the Robert F. Kennedy Bridge.



Aerial of the Randall's Island Living Shoreline site depicting businesses and inventory radius.

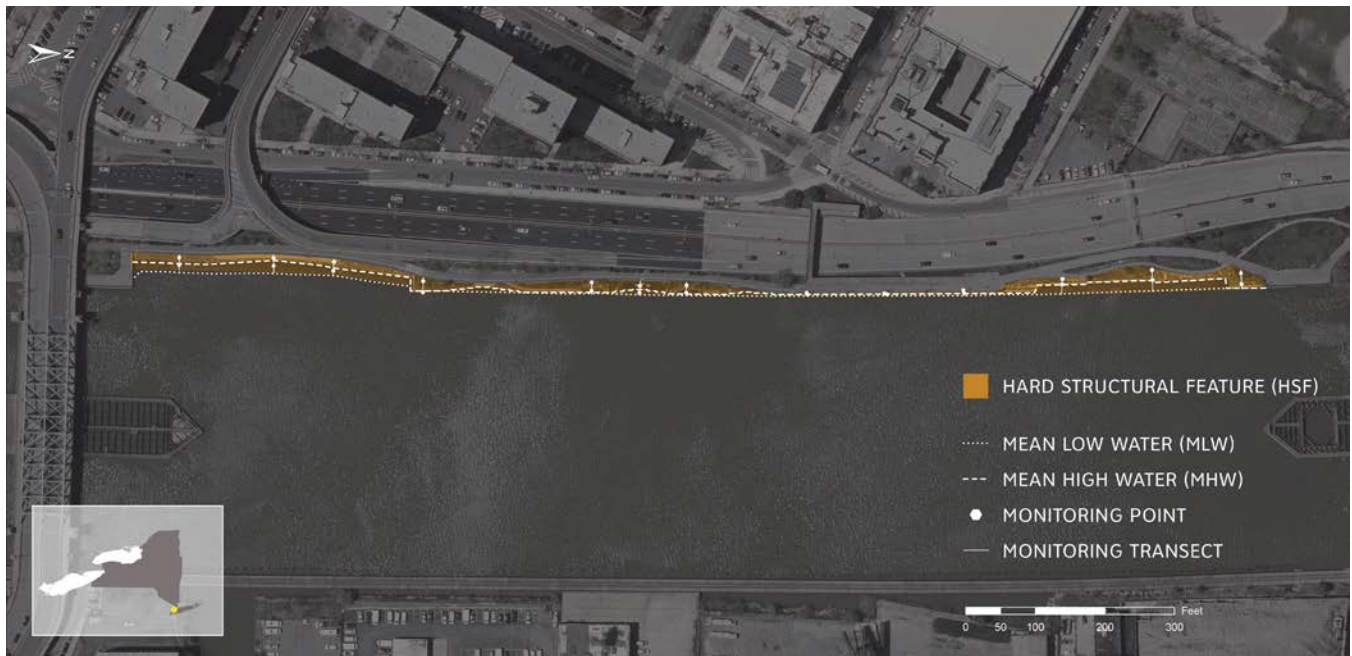


A tide pool at high tide.

HARLEM RIVER PARK

MANHATTAN, NYC | NY/NJ HARBOR

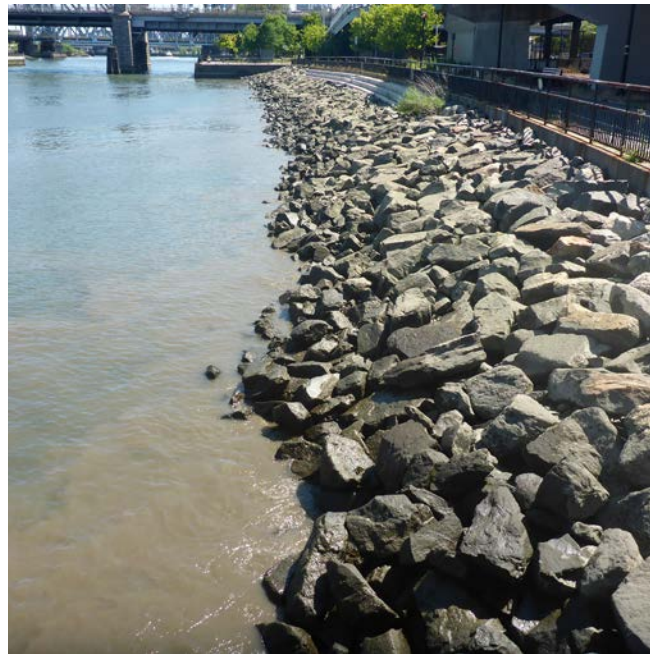
HARD STRUCTURAL FEATURE



Aerial of the Harlem River Park site depicting shoreline features and monitoring activity.



Looking north: Hard structural features along the shoreline composed of cement baskets filled with rip rap.



Hard rip rap shoreline at Harlem River Park, looking south.

SITE DESCRIPTION

Harlem River Park is a 0.7-acre hard shoreline on the western edge of the Harlem River between the Madison Avenue Bridge and 145th Street Bridge. The site was previously a smaller shoreline park with degraded sheet piling. The site was reconstructed in 2009 using experimental shoreline feature types including concrete baskets full of riprap, gabion baskets filled with rock and shells and planted with *Spartina alterniflora* plugs, terraced planting and tide pools, and a riprap edge. Vegetated areas include *Spartina patens* and *Baccharis halimifolia* as well as maintained grassy lawns and areas of vines and invasive plants. There is a bicycle path and pedestrian walkway that extends along the entire length of the feature, which is dotted with various murals and other forms of art. The site is adjacent to Harlem River Drive to the west, the Harlem River and the Bronx to the east, the 145th Street Bridge and a hardened shoreline to the north, and the Madison Avenue Bridge and a continuation of Harlem River park along a sheet piled shoreline to the south.

MONITORING PERFORMED

NYC Parks implemented the pre-site assessment, ecological function, structural integrity and hazard mitigation, and socio-economic protocols. The site was divided into four segments: 1) concrete baskets with riprap, 2) sheet piling, 3) gabion baskets with vegetation and tide pools, and 4) riprap. The site had 13 profile lines, which were determined by the location of control points (lamp posts) along the pedestrian pathway west of the site. An assessment point was evaluated in each of the habitats present within each segment along each profile line (shrub zone, tide pool, riprap, and hard edge). Elevation was recorded along each profile line using a Real-time Kinematic GPS system with centimeter level vertical and horizontal accuracy. The elevation profiles extended from the lampost control points to the waterward edge of the feature within each

segment. The social assessment was performed in zones consisting of pathways and passive recreational areas and an adjacent recreation park. A business inventory map was created for the site. Data were collected across three non-consecutive days.

TAKE-AWAYS

Ecological function and profile elevation data were collected by one person over two days and the social assessment was performed by two people in one day, indicating that these protocols can be applied even with limited personnel and resources. The walls of the shoreline feature were not safely or easily accessible without a boat; however, looking over the edge of railing or adjacent overlooks, as well as using Google Street view (with images from the Circle Line Cruise on the Harlem River) were sufficient to assess the feature. This site illustrated that the protocols can be implemented on hard structures. The concrete baskets with riprap, sheet pilings, gabion baskets, and riprap segments were not vegetated or colonized by sessile invertebrates. The original *Spartina alterniflora* plugs in the gabion baskets did not survive. The terraced vegetated areas had robust vegetation; however, the tide pools did not show any evidence of invertebrate or plant life, and one tide pool did not contain water. The site is used as a passive recreational area with people sitting on benches or walking along the pedestrian path as well as an active recreational area with people biking, jogging, and fishing. The site is not well connected to the adjacent recreational park north-east of the site, with no connection to the bike path or walkway clearly marked on the adjacent pedestrian bridge. The pathways and seating areas are well maintained; however, the green spaces along the feature would benefit with more maintenance as they were overgrown and contained litter. NYC Parks has a strong presence at the site as staff working along the shoreline park were observed on each visit. The site also had several educational signs discussing how the site was

designed experimentally. Businesses at the site were typically commercial including vehicle and equipment rental centers, parking garages, restaurants, and delis.



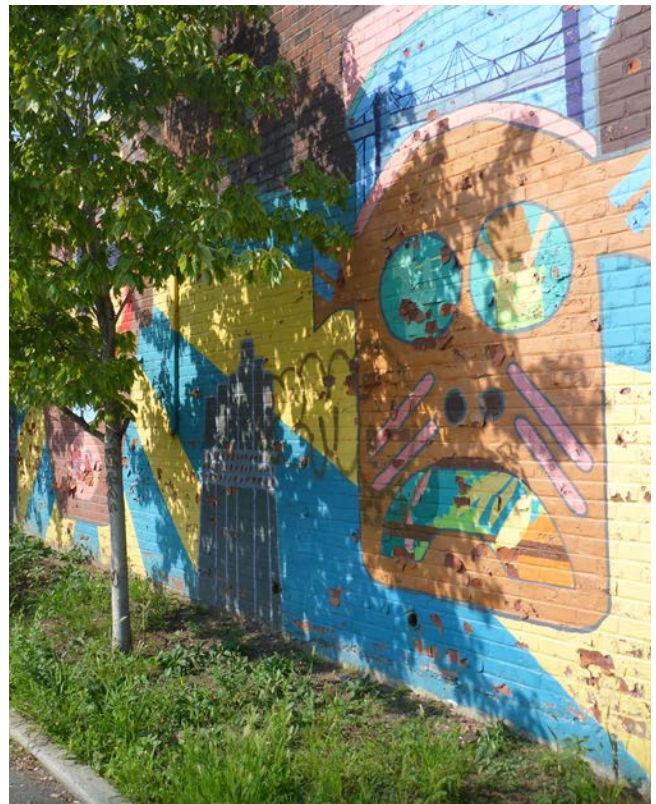
Looking south: Restored, terraced scrub shrub and tide pool atop gabion baskets lining the shoreline.



One of the two access points to the park: the 138th St pedestrian bridge.



Aerial of the Harlem River Park site depicting businesses and inventory radius.



One of the many murals along the park.

BAYSWATER

QUEENS, NYC | NY/NJ HARBOR

NATURAL SHORELINE FEATURE



Aerial of the Bayswater site depicting shoreline features and monitoring activity.



Looking east: Restored salt marsh adjacent to existing salt marsh and herbivory fencing.



Existing salt marsh and outfall at Bayswater, looking north toward Jamaica Bay.

SITE DESCRIPTION

Bayswater is a 1.5-acre salt marsh restoration on the south side of Bayswater Park in Jamaica Bay on the Rockaway Peninsula. The site was previously a degraded shoreline with remnant salt marsh adjacent to fill with large pieces of concrete and extensive areas of *Phragmites australis*. The site was restored in 2018 by the Natural Areas Conservancy and NYC Parks, including preservation of the existing salt marsh, excavation of large debris, removal of *Phragmites australis*, and planting of native *Spartina alterniflora*, *Spartina patens*, *Distichlis spicata*, and shrubs. A majority of the site is in the intertidal zone with the low marsh areas inundated twice daily by the tide and the high marsh inundated several times a month on higher monthly spring tides. The site is adjacent to a residential area along Norton Avenue to the south, a commercial area along Beach Channel Drive to the east, salt marsh to the west, and passive and recreational areas in Bayswater Park to the north.

function, profile elevation structural integrity and hazard mitigation, and socio-economic protocols. The site was considered one segment as the shoreline was uniform. The site had 7 profile lines which were determined based on the location of existing monitoring plots established by NYC Parks for regulatory environmental compliance monitoring purposes. An assessment point was evaluated in each of the three habitats along each profile lines (restored high marsh, restored low marsh, and existing low marsh). An elevation profile was recorded along each profile line using a Real-time Kinematic GPS system with centimeter level vertical and horizontal accuracy. The elevation profiles extended from the upland edge of the high marsh to below the existing low marsh. The social assessment was performed in zones consistent with the previous social assessment conducted by the USDA Forest Service in 2014 in natural areas and recreational ball fields and courts. Data were collected across three non-consecutive days.

MONITORING PERFORMED

NYC Parks, in collaboration with Billion Oyster Project, completed the pre-site assessment, ecological

TAKE-AWAYS

Collaboration with the Billion Oyster Project was a great way to expose other local restoration practitioners to the protocols and receive feedback on



Elevated goose fencing protects the restored salt marsh from herbivory while allowing park visitors and staff to walk through.



Kayak and canoe launching area.

the protocols. The Billion Oyster Project suggested including their oyster monitoring protocol, which consists of walking the length of the shoreline and counting any oysters observed at the site. It was also beneficial to leverage existing monitoring designs created by NYC Parks; it also shows that these protocols are consistent with existing monitoring protocols and study designs. The site was recently planted in July and monitored in August, and the native plant plugs were doing well and showed evidence of growth. Herbivory fencing was constructed at the site to protect the plants from geese and other herbivores. Due to local use of the site as a passthrough area, the fencing was opened and an informal path was created along the length of the feature. The flagged string connecting the herbivory stakes were constructed so that they were

tall enough to allow people to walk underneath, this was a beneficial difference compared to other restoration sites where the string is lower, and monitoring staff are required to duck underneath string as they move through the site. There were some areas where *Phragmites australis* and some other upland invasive vegetation was beginning to grow. The site is primarily used for fishing and boating, and as a passthrough by local residents to access the recreational areas on the north side of Bayswater Park. Business in the area were typically commercial including supermarkets, gas stations, and restaurants. This site will benefit from active maintenance and continued monitoring by NYC Parks.



Restored and existing salt marsh and herbivory fences at Bayswater, looking west.



Aerial of the Bayswater site depicting businesses and inventory radius.



Improved fish ruler near southwestern edge of the shoreline feature.

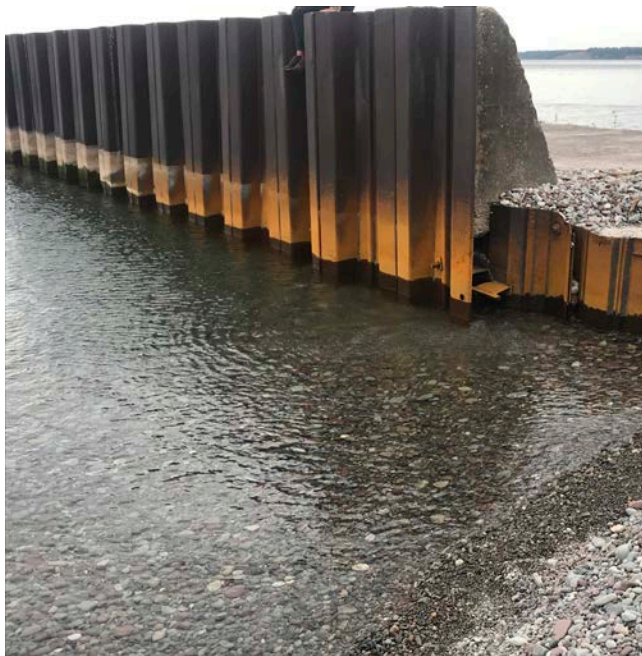
PORT BAY BARRIER - WEST

WOLCOTT, NY | GREAT LAKES

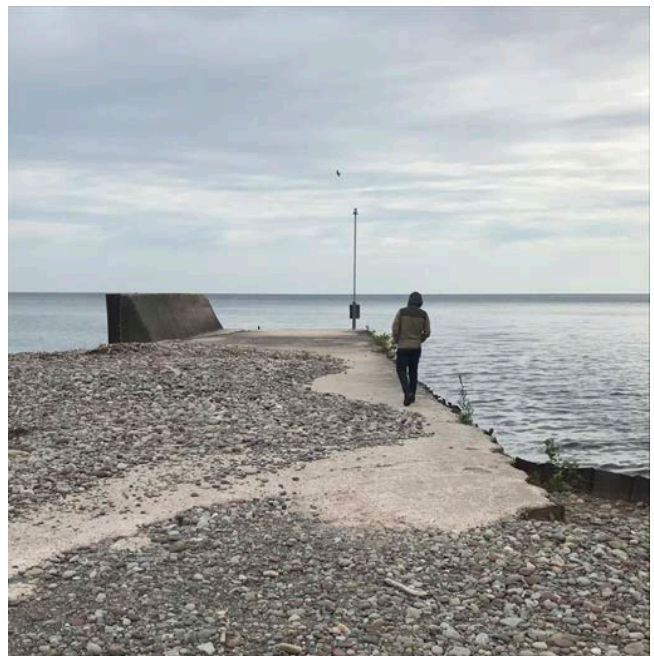
HARDENED STRUCTURAL FEATURE



Aerial of the Port Bay West site depicting shoreline features and monitoring activity.



High west side steel wall of hardened structure .



Bulkhead jutting northward into Lake Ontario.

SITE DESCRIPTION

Port Bay Barrier West is a publicly accessible area that extends out between Lake Ontario and Port Bay. The selected hardened structure, a small concrete break wall, lies at the northeastern end of the site and a bulkhead lines the inner edge of an inlet that intersects the western and eastern barriers of Port Bay. Boaters were seen using this pathway to move between the two water bodies. Upland of the bulkhead consisted of grass and a few trees, with a gravel parking lot, while the north side of the site was a rock beach with uniform pebbles and rounded stones. Immediately to the left of the break wall is a natural rocky beach. This shoreline extends west towards a wooded area that lines the site's main road. The southern, bay-facing shoreline includes a handicap parking lot, a floating boat ramp and tree-lined edges. The water levels at this location were much higher than normal, and people on site stated that warmer days and lower water levels, make the site very popular for water sports and recreation. The neighborhood starts down the road from the site lining Port Bay and extends inland, but primarily south along the bay.

MONITORING PERFORMED

Three transects were established at the site, each with an upland control point followed by two assessment points. The second assessment point was located along the bulkhead. Quadrat surveying methods were used to assess shoreline ecology such as plant species cover, species richness, and presence of sessile organisms, all of which was minimal because the park was mostly grass with a concrete bulkhead along the channel. Elevations were surveyed at all control points and assessment points. No erosion or structural damage was observed along the bulkhead, and wave action was flat on the lake in front of the feature. The social assessment was performed for the site as a whole, including documenting signs of human use and interviewing people using the park. One zone ran

from the lakeshore to the bay side shore including areas between. As assessments were completed, differences in the zone became noticeable and were thus reflected in field data collection by creating subzones within the assessment counts to later separate upon data entry if needed. Both Port Bay sites (east and west barriers) were monitored in one day with household surveys to be done at the end of completing both sites. West Port Bay was monitored first and then East Port Bay, where surveys were successfully administered. However, household surveys were not completed on the east side due to lack of time in the day to drive back and complete the protocol.

TAKE-AWAYS

The Port Bay West site was fairly small and lacked biodiversity, which made it easy to pilot the monitoring protocols. The northeast corner of the site was just a concrete pier, which did not appear to provide habitat for any sessile organisms. Ecological assessments were very quick for this reason, however quadrats surveying methods are still likely the best way to capture ecological data along a pier. Collecting elevations at each point was also quick because there was little vegetation to block the line of site, and it was all mostly flat. Water level data were collected along the pier, and were provided by the NYSDOS prior to the monitoring team visiting the site, and also inferred using the desktop protocols for collecting coastal flooding data with the NOAA Lake Level Viewer site. This site was the only site in this pilot region with a hardened structure that allowed for measuring the water level at the feature. Finally due to the poor weather, fewer people were observed using the park area than the team had expected. Most public use of the area on the day of the visit consisted of a few fishermen and some dog walkers, although warmer summer days most likely bring large crowds to this site for swimming, fishing and boating. It would have also been useful to spend more time researching benchmarks on this peninsula for surveying, since there were

very few structures in the area to serve this purpose. The pier almost certainly has been surveyed at some point in the past, but the monitoring team

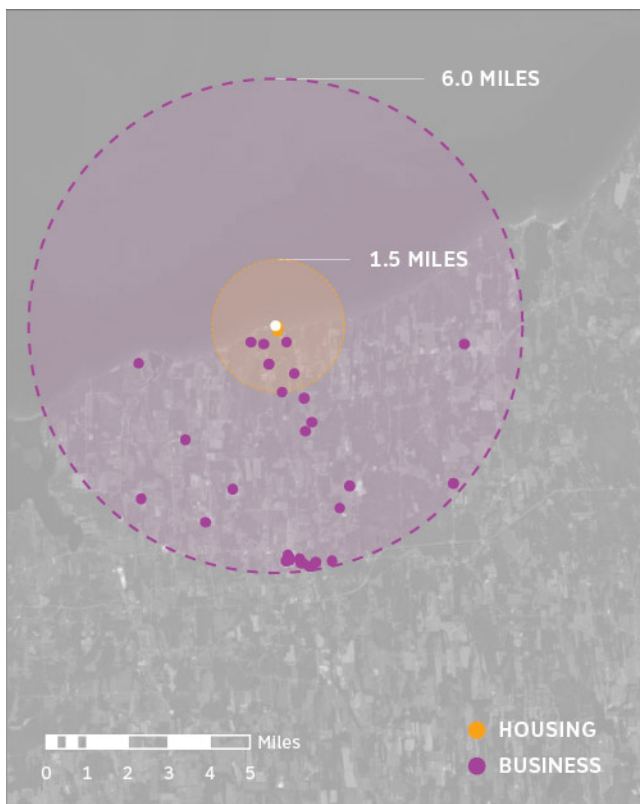
was unable to find any public record of this or other possible benchmarks in the area.



Inside edge of structure, lining the Lake Ontario and Port Bay inlet.



Aerial of the Port Bay Barrier - West site depicting social assessment zones.



Aerial of the Port Bay Barrier site depicting businesses, households, and associated inventory radii.

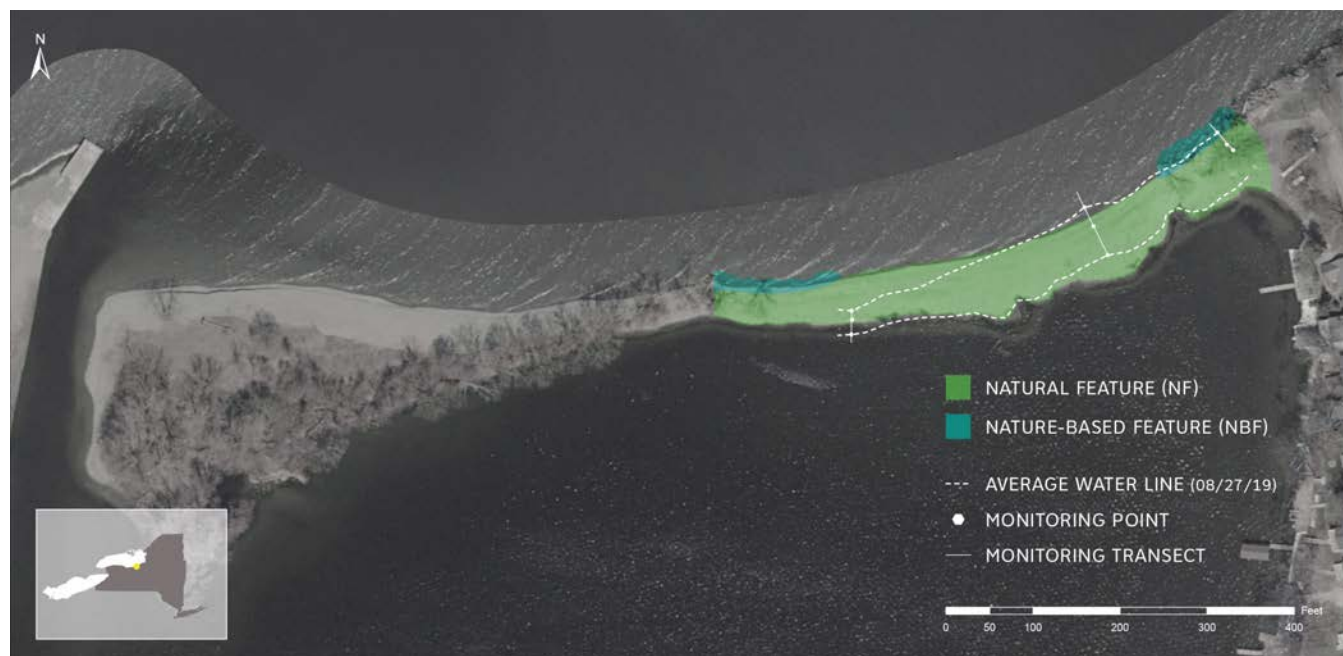


Rocky shore and elevated vegetation west of the bulkhead.

PORT BAY BARRIER - EAST

WOLCOTT, NY | GREAT LAKES

NATURAL SHORELINE & NATURE-BASED SHORELINE FEATURE



Aerial of the Port Bay East site depicting shoreline features and monitoring activity.



Lowest portion of rocky barrier separating Lake Ontario and Port Bay.



Fallen trees, possibly from recent storms, seen on lake-side shore of sandbar.

SITE DESCRIPTION

Port Bay Barrier – East is the eastern barrier of the channel between Lake Ontario and Port Bay. It is an almost hidden public area at the end of a road and across from a house. Private property signs, grass, a private boat ramp, and a homemade break wall made out of rocks and trees, also line the entrance. An informal trail leads between these down to a naturally rocky shoreline peninsula/breakwater. This shoreline extends throughout the entire site, opening up after the private areas and sloping downward towards the middle of the site. Both ends of the site are higher in elevation and contain riparian trees (*Salix* spp.) and herbaceous invasive plants. The center of the barrier is slender and free of vegetation, but has a few downed trees covered in grapevines leading towards the far end. The lake-side nature-based features are located towards the entrance including three tractor tires and about six short wood posts at the middle of the barrier. The tractor tires are now halfway submerged in rocks and water, but were initially placed in concrete by a private homeowner to stand vertically out of the water. The wood posts were put in two years ago and according to a nearby homeowner, were added in hope to break waves as they were reported to do in Louisiana. Only one man and his two dogs were seen using the area. The neighborhood starts immediately outside of the site lining Port Bay and extends inland with higher elevation, but primarily runs south along the bay.

MONITORING PERFORMED

Three transects were established across the peninsula, with only one control point at a cluster of trees at the eastern end of the site. There were no other permanent structures or plants along the site. Each transect had 3 assessment points that captured the entire width of the peninsula. Quadrat surveying methods were used to assess shoreline ecology such as plant species cover, species richness, and

presence of sessile organisms. Elevations were surveyed at all control points and assessment points. Wave data was collected from the bay side of the site, and erosion was documented across the entire peninsula. Water levels were provided by the NYS-DOS and also inferred using the NOAA Lake Level Viewer site. The social assessment was performed for the site as a whole, including documenting signs of human use and interviewing people using the park. One zone ran from the lakeshore to the bay side shore including areas between extending to both ends of the barrier. Household surveys were completed within one fourth of the business radius (2.41km) and most of the homeowners in this area were noticed outside and approached outside of their houses.

TAKE-AWAYS

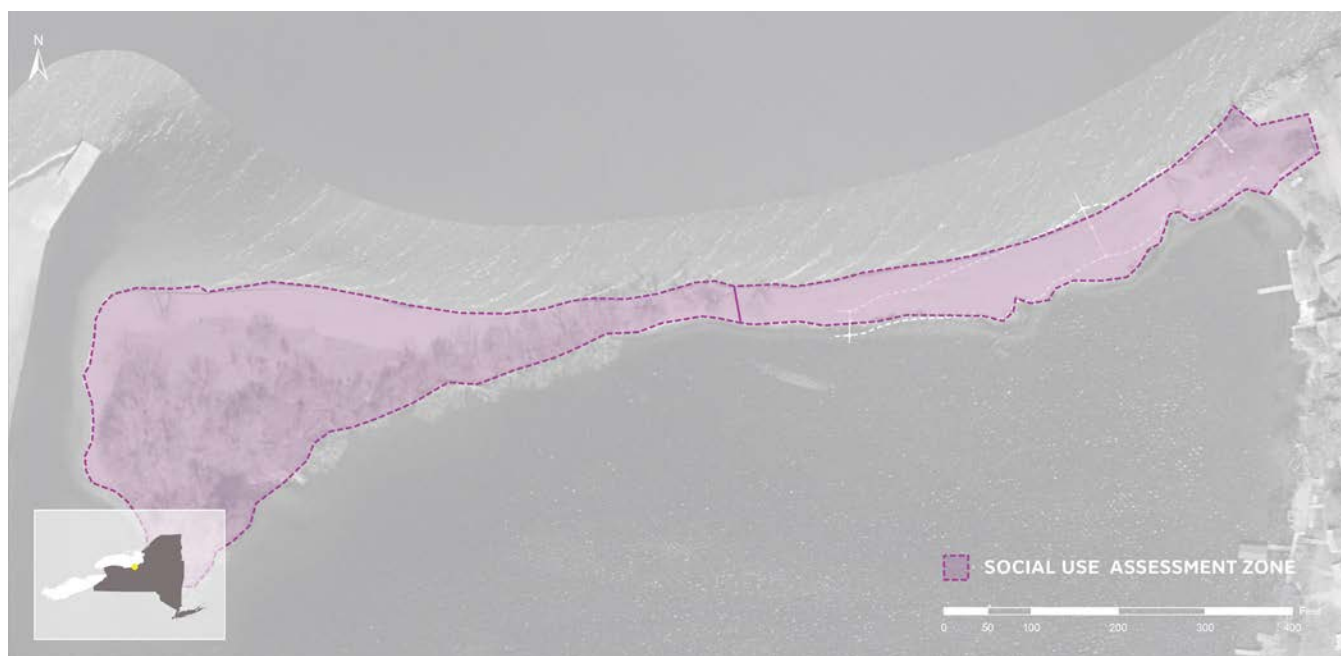
The Port Bay east site was fairly small and uniform but not as simple to delineate due to the lack of permanent structures and erosion along the entire shoreline. This site is an example of a failing NNBF, possibly due to lack of maintenance, design failures, or the high water levels and wave action in Lake Ontario this year. State policy for maintaining the water level in Lake Ontario is complex and involves many stakeholders. Precipitation is a major driver of water levels in the lakes, but policy developed through the International Joint Committee; the Lake Ontario - St. Lawrence River Plan 2014, also plays a role. More can be read on this topic at www.ijc.org. Elevated water levels in the lake combined with regular wave action caused the lake to breach into the bay at this site thereby increasing erosion along the shoreline of the bay and of private properties. Monitoring of this shoreline site may provide important information regarding the successes and failures of the shoreline feature, and inform decisions about future restoration work, and aid policy by providing standardized information about the impacts of erosion on communities around Lake Ontario. Concerning household surveys, choosing houses with people

visually at home significantly increased the number of surveys completed and this approach would be

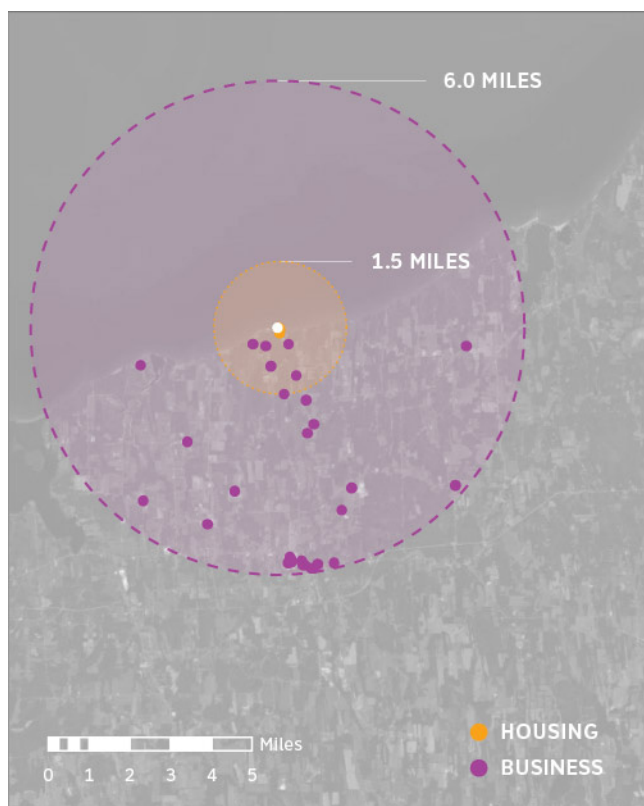
suggested to use in the field as long as personal boundaries are respected.



Width of barrier showing both bay (left) and lake (right) shores.



Aerial of the Port Bay Barrier - East site depicting social assessment zones.



Aerial of the Port Bay Barrier site depicting businesses, households, and associated inventory radii.



Vegetation along lake shoreline.

SODUS BAY

SODUS POINT, NY | GREAT LAKES

NATURE-BASED SHORELINE FEATURE



Aerial of the Sodus Bay site depicting shoreline features and monitoring activity.



A closed Sodus bayside beach hidden and unrecognizable under high water.



Rocks form the nature based feature along a street edge where personal piers once stood.

SITE DESCRIPTION

The selected monitoring site at Sodus Bay is a thin man-made rock revetment lining Sodus Bay shore. A thin grass area dotted with park benches runs the length of the feature, with a road and then houses immediately behind it. The feature extends from a marina down to a small crescent shaped public beach, which is mostly underwater. The road leads past the feature into a large parking lot, lined by a sheriff's office, public boat ramp, and Coast Guard office. North of the Coast Guard office is an east facing grassy picnic area and then a long thin break wall jutting north into Lake Ontario with a light-

house at the end. People were seen fishing and bird watching in these areas. West of the break wall is Sodus Point Beach Park (lake-side) and more houses that line the west side of the parking lot. The monitored site once had private docks lining it; however, these were removed by the city for possible aesthetic and liability purposes, as mentioned by a homeowner. The immediate neighborhood is sandwiched between the lake and bay shores, with houses on small lots owned by full-time residents, seasonal residents, and renters.



Benches and flowers now line the thin upland grass section.

MONITORING PERFORMED

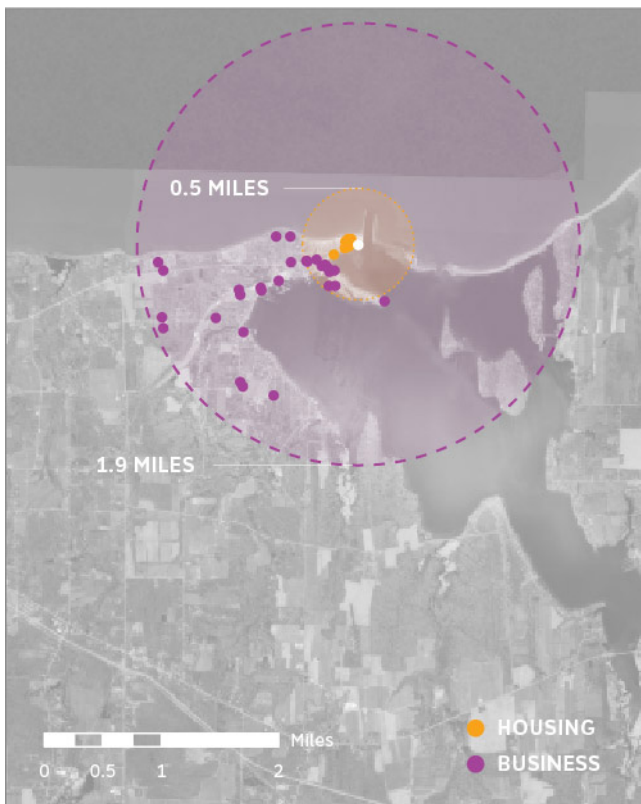
Four transects were established across the site, each with an upland control point followed by two assessment points. The second assessment point was located along the water on the rock revetment. Quadrat surveying methods were used to assess shoreline ecology, all of which was minimal because the site was mostly grass with a rock revetment along the bay. Elevations were surveyed at all control points and assessment points. Wave action was not observed in the bay, and erosion was documented across the whole site at the interface of the rock revetment and the grass. Erosion in this area was mostly due to unseasonably high water levels in the lake that combined with normal wave action eroding the soil and grass along the road. The social assessment was performed for the site as a whole, including documenting signs of human use and interviewing people using the park. One zone was used for this site, running from the lakeshore to the bayside shore including areas between. As assessments were completed, differences in the zone became noticeable and were thus reflected in field data collection by creating subzones within the assessment counts to later separate upon data entry if needed. Household surveys were completed by means of walking through the neighborhood located within less than the business radius (.76km) and locating sections to conduct surveys with ideal households being near to the site.

TAKE-AWAYS

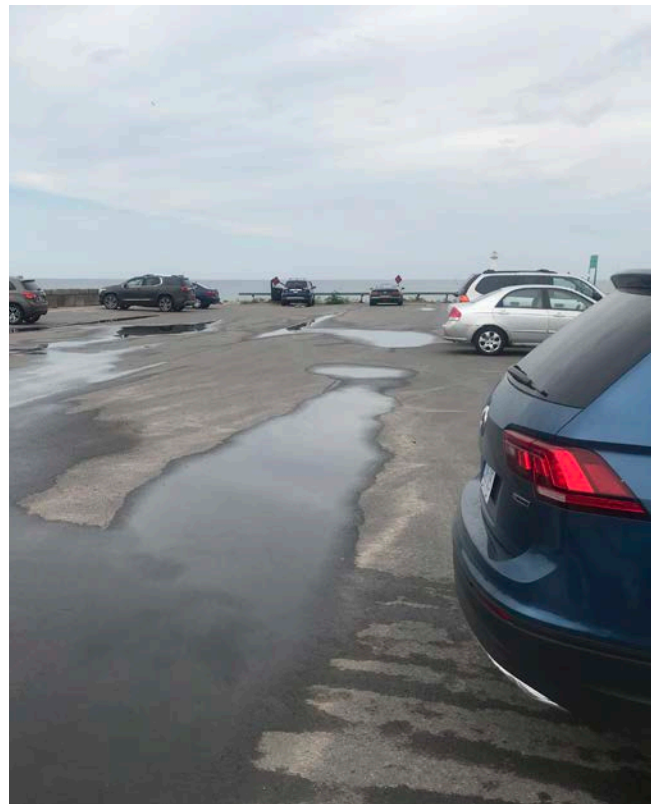
The Sodus Point area was primarily a low lying area with summer homes and a public park and beach. The rock revetment and grass area along the bay-side of the road made for easy access and efficient field work. There was minimal biodiversity along this public area, and it was flat and unobstructed. This shoreline feature also had direct implications for flooding to the homes just behind it on the other side of the road. This site was an ideal pilot site for these reasons. Homeowners were generally willing to speak to the monitoring team for the social assessment protocols as they had a number of concerns about flooding in their homes and neighborhood. The survey was able to successfully capture the physical damage of flooding for one household (only one surveyed house had damage). The homeowner additionally spoke to the financial and emotional damage they suffered from the flooding, which is not quantified in the survey and should be considered when evaluating the quality of life and housing affordability risk. There was significant erosion of the shoreline and grassy area between the road and rock revetment so it will be critical to document this and monitor the change in erosion of this area over time as challenges with maintaining the water levels in Lake Ontario are worked out at the policy level.



Aerial of the Sodus Bay site depicting social assessment zones.



Aerial of the Sodus Bay site depicting businesses, households, and associated inventory radii.



Pooling water seen in the parking lot that borders access to all shores.

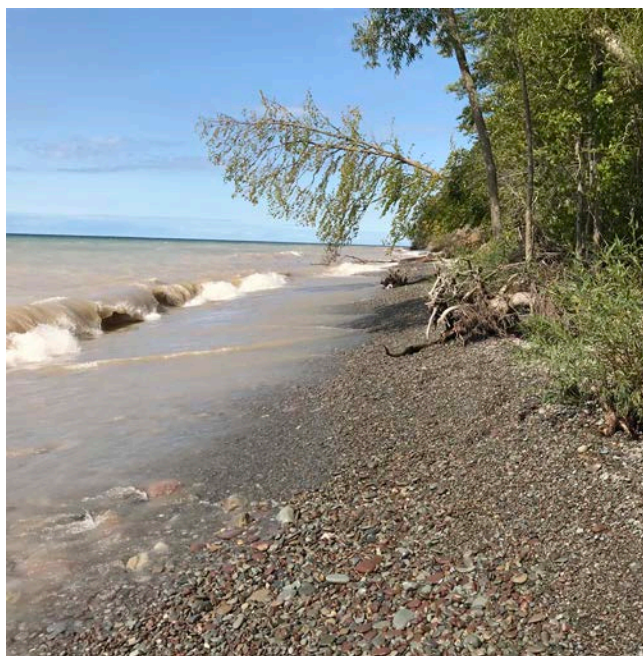
STERLING NATURE CENTER

STERLING, NY | GREAT LAKES

NATURAL SHORELINE



Aerial of the Sterling Nature Center site depicting shoreline features and monitoring activity.



Rough waves at Lake Ontario shorefront.



Upland area nearest the trail that led up and out towards the Center's parking lot.

SITE DESCRIPTION

The Sterling Nature Center is a 1,400-acre preserve with access to Lake Ontario shorefront. Beaver wetlands, heron rookery, vernal pools, meadows, creeks, woods, glacier formed bluffs, and 2-miles of accessible shoreline are included in the preserve. A canoe launch into Sterling Creek and an interpretive center also exist on the grounds. Many vistas and observation decks line the trails that run throughout the area. A wooded hiking trail leads down to the lake and, due to high water levels, a smaller than normal rocky shoreline. McIntyres Bluffs is located south of the site and can be seen from the lake front area. Shorelines terminate inland at a tree line glacial and bluff that were both factored in when considering transects. Visitors all use one central parking lot and no immediate neighborhood exists next to the center, as houses are spread out or are located on farmland in this area.

MONITORING PERFORMED

The SRIJB team was able to complete most protocols, but did have some difficulty in establishing survey measurements since no structures with known elevations were present. All survey elevations were relative to the staircase at the entrance to the beach area. High waves were also a factor in setting up protocols, as shoreline access was shortened and debris limited areas to the south. Significant wave data was documented from the beach, but the water level data was provided by the NYSDOS and from the NOAA Lake Level Viewer. Four transects were established along the beach starting at the trail area heading north with three assessment points per transect. One control point was marked out at the trailhead stairs due to lack of permanent structures and erosion along the shoreline. Quadrat surveying methods were used to assess shoreline ecology such as plant species cover, species richness, and presence of sessile organisms. The social assessment was performed for the site as a whole, including documenting signs of human use and

interviewing people using the park. One zone was used for this site which along the shoreline from the trail entrance and headed north until debris obstructed the pathway. Household surveys were not completed for this site. Being able to locate and visit enough houses would be possible if done on its own day. Mailing a brochure or sending a survey via email to households in the area could be used as an alternative.

TAKE-AWAYS

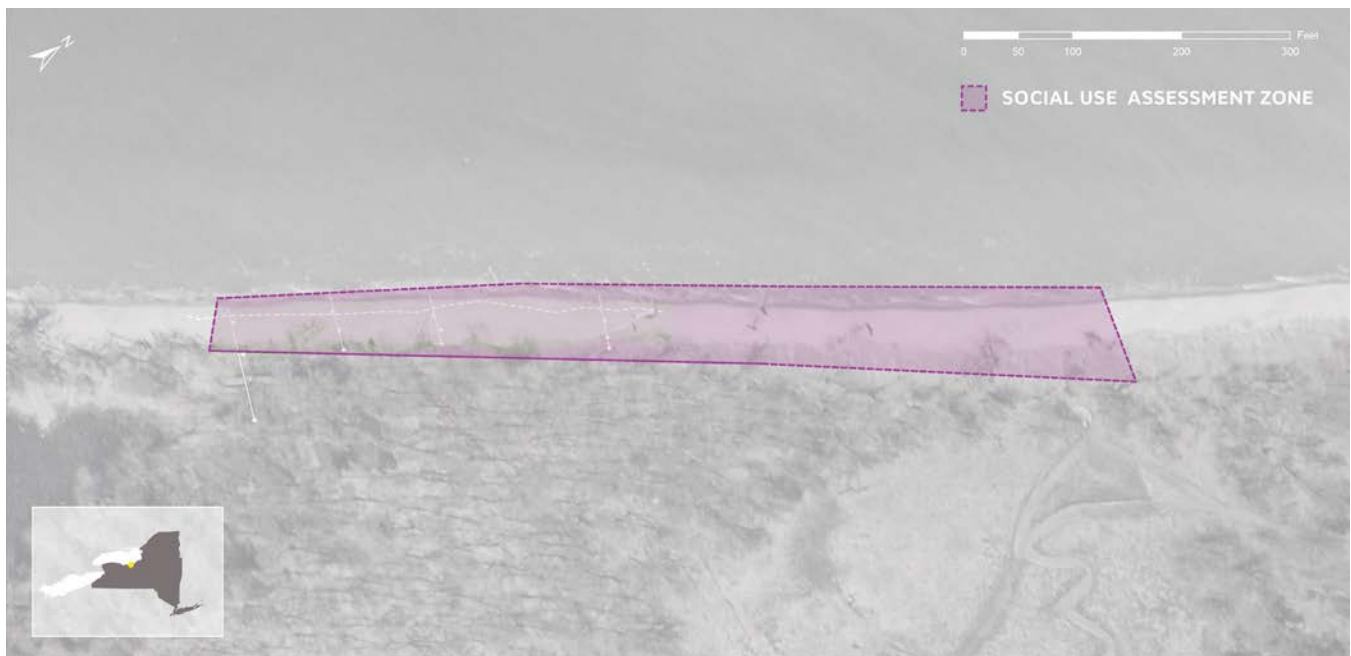
This site had experienced severe erosion along the shoreline and the bluffs possibly from elevated lake levels combined with seasonal wave action. There were many downed trees and the bluff was visibly unstable in several areas above the beach. This made measuring erosional areas especially critical; however, it was difficult to do in a semi-remote area with no permanent structures for reference. The team documented and measured the erosion as best as possible in the field, but assessing shoreline change through the desktop protocol may be most useful for this remote shoreline. This site was also the only site with a large bluff and dense woodland area. It would be interesting to include in the ecological function protocols, the monitoring of bird species and change in bird habitat along the bluff and tree canopy, as it relates to erosion of the bluff. This could be addressed in assessing habitat connectivity with the pre-site visit protocols in the future. Regardless, all other ecological function protocols were extremely beneficial at this site. Assessments of substrates within the quadrats also provided useful data since the bluff was comprised of glacial till and the beach was comprised of rounded, uniform rocks and pebbles, which all has implications for erosion of the shoreline. This site would be very difficult to monitor during the winter months, due to the exposure and distance from the parking lot. Ice can also form along the shores of the lake and make a site like this inaccessible. Additionally, the medium pebble sizes and lack of significant tidal changes at this beach might make it difficult to

identify ice scour along the shoreline because these pebbles are easily manipulated by wave action. Significant wave action also made gathering data at

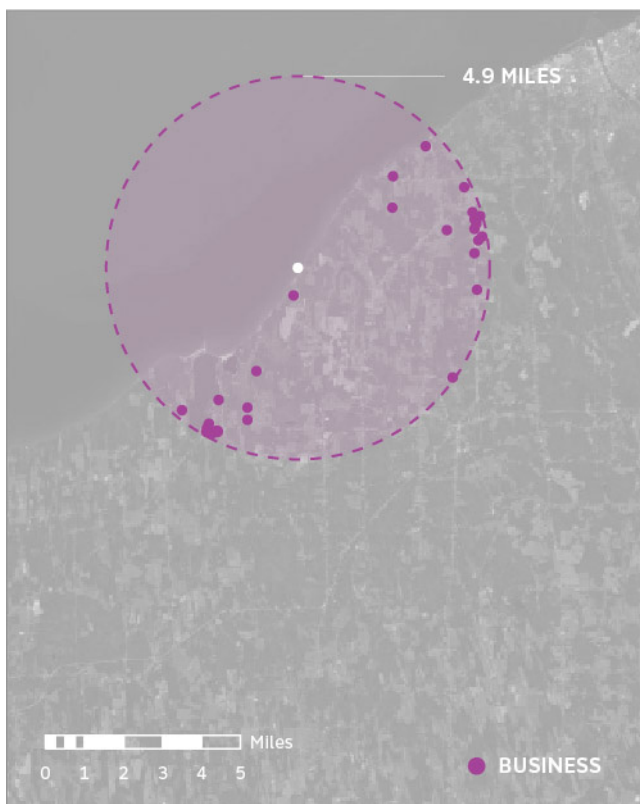
downgradient assessment point along the water line challenging.



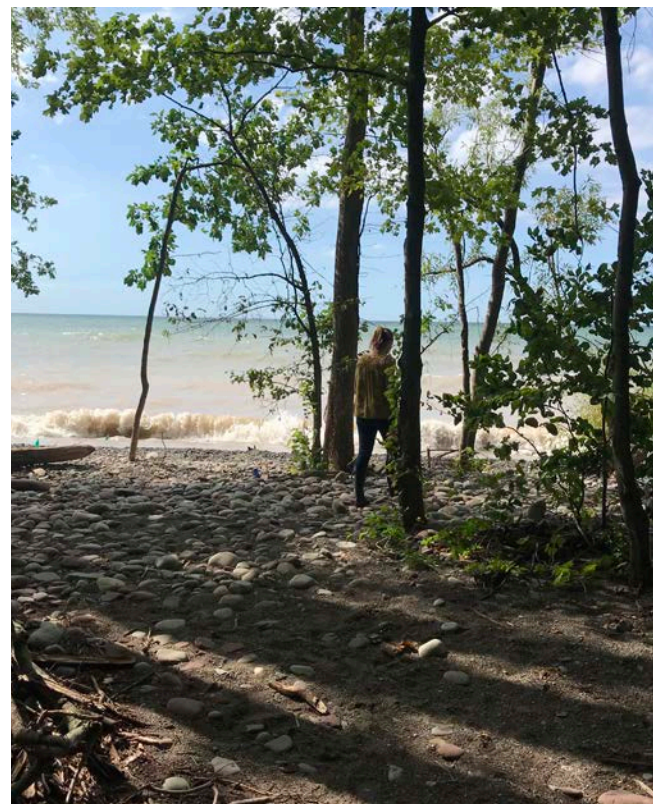
Fallen trees, debris and high water made accessibility difficult along the shore.



Aerial of the Sterling Nature Center site depicting social assessment zones.



Aerial of the Sterling Nature Center site depicting businesses and inventory radius.



Waves crash in the background as SRIJB crew assess the site.



4. STRATEGIES FOR CONTINUED FRAMEWORK DEVELOPMENT AND IMPLEMENTATION

Throughout the course of framework development, stakeholder engagement, and pilot monitoring, the Core Team gathered key ‘lessons learned’ and recommendations for the next steps of framework refinement, dissemination, and implementation.

Department of State (DOS) anticipates, in collaboration with partners, to make refinements and improvements to the framework and protocols over time. DOS supports continued monitoring of natural, nature-based and hard structure features across New York State. Data gathered through monitoring over time will provide the State with improved information to encourage the use of NNBF where appropriate. DOS also anticipates pursuing opportunities for third parties to monitor projects to support robust data collection, and incorporate the framework into publicly sponsored projects across the state.

In light of anticipated support to improve and disseminate the framework, this section is a summary of insights from the project team, to guide further framework development and implementation.

STRATEGIES FOR FRAMEWORK DEVELOPMENT

The current framework (matrix and protocols) reflects a tremendous effort from regional stakeholders, TWGs, PAC, and the core project team, but there are still improvements to be made. Protocols were piloted for one summer, and based on that effort, the field teams (NYC Parks and CUNY research assistants) provided suggestions for specific protocol revision and refinement, highlighted in Appendix A. We intend that practitioners in future phases will be able to rely on these recommendations to continue improving the protocols, picking up where the current project team left off. Before the protocols are widely implemented, we recommend additional testing and refinement. For instance, further testing across multiple seasons would help highlight weaknesses and gaps in the protocols' utility in the context of seasonal variability. There is opportunity to critically re-assess the utility of all indicators and feasibility of protocols from the perspective of users, furthering the dialogue between technical experts and groups who will be deploying the framework.

In the following sections, we provide high level recommendations for resolving challenges that span multiple protocols.

Defining feature boundaries was one of the most challenging parts of data collection.

The protocols provide guidance on how to define the boundaries of shoreline features. However, for some sites, the monitoring team found it difficult to delineate the extent of the shoreline feature to be monitored. For example, in Port Bay, Lake Ontario, it was difficult to identify the edges of an installed shoreline feature that was older and failing, and submerged by accreting sands and raised lake water level. Some shorelines are long and relatively uniform with no clear end, such as the natural beach shoreline at Sterling Nature Preserve. To address this, we recommend gathering as much historical information about the site, and recent aerial photos when available, before beginning field work. Histori-

cal context (e.g., original plans of a restoration project) can help to define site boundaries and set up representative transects that capture the full extent of the feature. If historical information is unavailable or insufficient, try to establish monitoring locations along the fullest length as is reasonable between the uncertain feature endpoints given available time and resources. If it is not possible to monitor the full extent of the feature, pick a representative section that is manageable given the time and resources available, ideally with clear control points, so that the same segment is consistently measured year after year. Keep in mind that the amount of time it will take to finish a monitoring visit is a direct function of the number of assessment points rather than the extent of the shoreline feature. Thus, a small site with closely spaced transects can take as much time as a large one with transects that are spread out. More detailed guidance for setting up monitoring transects can be found in the attached field protocols (Appendix A).

Indicators of social and economic outcomes add rich context and critical depth to shoreline assessment, but this type of data collection and analysis comes with unique challenges.

The field protocols for social and economic outcomes include a visual assessment of human use, surveys of visitors to the site, and door-to-door household surveys; the desktop protocols include a business inventory, real estate value estimate, and determining whether the site is within a Potential Environmental Justice Area as defined by the New York State Department of Environmental Conservation (see NYS DEC Commissioner Policy 29). It is difficult to separate broader social and/or economic changes in the vicinity of shoreline features from potential effects of a specific shoreline feature. For example, multiple socio-economic parameters (e.g., environmental justice index, business activity index) are influenced by larger social, economic, and political decisions, so it would be challenging to attribute the extent to which changes in those parameters are

due to the specific shoreline feature(s). Furthermore, the socio-economic protocols span a wide range of disciplines (e.g., sociology, geography, economics) and methodologies (e.g., field observations, one-on-one interviews, GIS analysis) and some protocols were originally designed for different purposes (e.g., to assess the use and value of public open space, to assess overall community resilience). Therefore, the time and expertise needed to refine these protocols before they could be deployed in the field was much greater than what was needed for the ecological function and structural integrity/hazard mitigation protocols. Pilot testing offered further insights into the utility and feasibility of the current protocols, detailed in Appendix A. These recommendations, along with the rationale for socio-economic indicator selection presented in Chapter 2, should be referred to for future improvements.

Defining neighborhood boundaries for the socio-economic indicators proved challenging, but was better clarified with each field visit.

The neighborhood boundaries for socio-economic protocols were mostly undefined in the draft framework deployed during pilot testing. Technical working groups deliberated on how to delineate a “neighborhood” in the context of our socio-economic indicators, and how to distinguish potential socio-economic signals from ‘noise.’ In general, it was observed that larger sample areas made it more difficult to link household or neighborhood characteristics to the impact of the specific shoreline feature being observed. For example, a 0.5 mile radius was drawn around the feature to define the household sample area. In Greenport, Long Island, a house within 0.5 miles of the feature was still closer to other shorelines not associated with the pilot sites. In neighborhoods surrounded by water (located on peninsulas or islets), it is particularly difficult to link neighborhood-scale socio-economic indicators to just a small section of the nearby shorelines. Conversely, in more sparsely populated neighborhoods, a short sampling radius was limiting. For example, in

the less-dense residential areas around Lake Ontario, a standard radius of 0.5 miles would capture very few of the businesses potentially affected by shoreline conditions.

With these challenges in mind, the field teams, in communication with technical working group members, used experiences during pilot testing to better define boundary radii for the “Household Survey” and “Business Activity” protocols. We sought to balance the size of the defined area of feature influence with site-to-site variation in housing and business density. Instead of using a standard distance, the team created a radius around each feature by counting the 30 closest businesses (radially outward from the feature). To create consistent site boundaries, household surveys were first conducted within the same radius of the closest 30 businesses. However, in the field, the area defined by the first 30 businesses often exceeded what we would consider the surrounding “neighborhood.” In these cases, the household survey radius was delineated as a fraction of the business radius (usually one half, or even one quarter in highly dense neighborhoods of NYC). While the protocol specifies sampling at least 15% of total houses within the ‘neighborhood,’ we limited sampling to 10 households per site. This part of the protocol also needs refinement, particularly in neighborhoods with apartment complexes.

The unresolved questions regarding these issues are: (1) should the boundary for household surveys match the boundary for business activity assessment?, (2) should the radius around a feature be consistent across all sites, regardless of housing and business density?, (3) how will the data be analyzed, and how will sampling approach affect that analysis?, and (4) how should apartment complexes be accounted for in the sampling?

STRATEGIES FOR DATA COLLECTION

With an efficient team, it is possible to collect all field protocols for one site in a single day, though single site visits pose limitations.

The pilot monitoring in Long Island, Hudson Valley, and the Great Lakes was conducted by four-person teams provided with basic training in the protocols. Dividing the tasks amongst the team members makes it possible to collect the ecological function and hazard mitigation/structural integrity field data, plus a single social assessment, in one day. For example, one person can set up transects and log points in GPS while two people perform the ecological and structural integrity / hazard mitigation assessment, and one person executes the social site assessment. As the monitoring team becomes more familiar with protocols, data collection becomes quicker. Including a greater number of species (plant and sessile), and/or a greater number of assessment points will add to the amount of field time necessary. If the trip is not properly planned around the timing of low tide, high water levels can prevent finishing in one day. A single day of rapid assessment, however, will not account for daily variability of human use or the full spectrum of site visitors. It also will not account for changes in wave dynamics across different scenarios depending on wind, storm surge, boat traffic, and other factors. For this reason, in accordance with the protocols, we recommend revisiting the same site multiple times during each season if time and resources allow.

Establishing partnerships can help facilitate access to public and private lands.

During pilot monitoring, the monitoring team did not encounter issues accessing public lands to implement the protocols. However, prior to beginning field data collection, we recommend communicating with the entity that has jurisdiction over the public land about necessary permits and/or permissions. For shorelines where access is controlled by local site stewards or landowners, it was critical

to have our local partners provide an introduction and facilitate new partnerships with the site owners and managers. In addition, following up with entities after site visits proved to be helpful in affirming findings, and critical for maintaining relationships that would minimize obstacles to further data collection. For example, in order to confirm some of the signs of use we observed, we reached out to partners who visit the site more regularly and had a more comprehensive understanding of how the feature was being used by the community.

Newly permitted projects may offer an opportunity to work with willing landowners.

Managers and permit staff that participated in 'Permit Reviewers' engagement webinars (see Appendix G) were not comfortable suggesting that landowners voluntarily collect data within the structure of a permitting process, and were opposed to making data collection a permit condition. Plus, private landowners are not likely to have the resources or expertise necessary to do data collection independently. Nonetheless, private landowners could potentially support efforts to monitor and assess shoreline features by allowing third party access to their property. Initiating this discussion early in the permitting process could allow for pre-construction data to be collected, and thus strengthen the overall post-construction assessment. This approach was not utilized during pilot testing, but we recommend exploring how the permit process could facilitate building relationships with landowners that might be interested in supporting monitoring on their property.

The Core Team recommends continuing to work with federal, state and local permit staff to determine how landowners could be recruited to enable monitoring access through the existing permitting process.

After piloting the monitoring protocols in NY Harbor, Long Island,

Hudson Valley, and the Great Lakes, the protocols were found to be universally applicable to all regions.

The Project Team was tasked to determine if the monitoring protocols produced comparable data across shoreline types and regions, or if different protocols are required for different shoreline types or regions. In other words, is it desirable, feasible, or even possible to create a single set of protocols for gathering data related to a given indicator, or does a given indicator need multiple context-specific protocols (protocols specific to a particular shoreline type, aquatic condition, habitat type, etc.). During pilot testing, the field teams found that protocols were applicable across all regions provided that the boundary of the feature encompasses all of its critical parts, including inshore reefs, if relevant. The most challenging and pervasive difference across regions was population density, which affects housing and business density. As discussed above, this may require modification of the boundary delineation for household surveys and business activity.

Until data from pilot monitoring are analyzed, it is not possible to tell whether the data collected illuminates significant differences between individual sites and regions. For example, due to abnormally high water levels in spring and summer of 2019, the Great Lakes (Lake Ontario) sites were experiencing drastic physical and social impacts from flooding, erosion, and loss of property and assets. During this particular season, the level of evident social and physical impact observed at Lake Ontario was unmatched by any of the other regions. Whether or not the outputs from pilot data collection corroborate the dissimilar impacts observed in the field will help gauge how well the indicators capture the 'story' of each site.

STRATEGIES FOR CONTINUED FRAMEWORK IMPLEMENTATION

The ideal team of data collectors are shoreline managers or local stewards with capacity to monitor for multiple years in a row.

Local stewards or shoreline managers in collaboration with state and local agencies, non-governmental organizations, or academic institutions are likely to have the strongest capacity for data collection over multiple years. This is ideal because these groups will have a sustained investment in their site(s), can more easily form lasting local partnerships, likely have access to the necessary equipment, and can build institutional knowledge of their site(s) over the course of multiple seasons and years. College classes, graduate programs, and annual internship programs could provide opportunities for institutionalizing data collection with the protocols, particularly since specific sites could be visited over multiple years. The value of the data-set increases when many sites are sampled over many years. Thus, when resources are available, it is preferable to spread out monitoring effort over time, rather than expend all the resources on detailed monitoring for just one season. Private firms can also provide monitoring capacity, provided funding exists and those firms commit to consult with local stewards.

Training will be a critical component of long-term sustainability and quality control.

Protocols are intentionally designed to be relatively simple. However, some skills such as plant identification, elevation surveying, and interviewing require substantial experience or expertise. The necessary training is likely found within many NGOs and universities, but not necessarily within the whole range of groups that may carry out monitoring. For data collection teams that lack the necessary social and biophysical science training, it would be ideal to provide training specific to the protocols. Therefore,

a system of regular framework training and/or mentorship should be developed to maximize framework adoption, ensure sustained data quality and help build the capacity of local stewards to manage their data collection.

Identifying sources of Funding for monitoring

Requiring or incentivizing monitoring after new shoreline projects are completed is one potential mechanism for funding framework implementation. However, as mentioned earlier, permitting agencies expressed concerns over the State's ability to make this monitoring a mandatory permit requirement. Among stakeholders, there was relatively high support for implementing a monitoring program funded by the State. As the framework is taken up by more partners, it may become easier to garner funding to continue and expand its use. Investment in using the framework will be more attractive if it is adaptable to the needs of users and funders.

The sustainability of the Framework likely depends on assigning responsibility for Coordinating training, demonstrations, database management, quality control, troubleshooting, and adaptive improvements to a single organization.

As training is a critical component of framework sustainability, it is equally important to establish a single organization to serve as the central point of contact to answer questions about framework implementation as well as to coordinate training. This organization would also be responsible for managing the database and checking inputted data to ensure quality control. While DOS anticipates acting as a central point of contact in the near-term, particularly as it relates to answering questions and making updates to the framework, it may make sense to have different entities take lead on various future efforts, such as training and database man-

agement/expansion. These efforts will need to be coordinated to ensure consistency moving forward. Furthermore, the framework can (and should) be adaptive in response to lessons learned as different end users implement it. Incorporating lessons learned into indicators, protocols, and the database will further enhance its sustainability by allowing the framework to adapt to the needs of users.

DATA ANALYSIS AND OUTPUTS

The primary goals of this project were to identify monitoring parameters and indicators, develop a monitoring matrix, create a publicly accessible database, and establish a network of partners to assist with framework implementation and refinement. Data analysis is a separate yet critical next step, which will detail how the data will be interpreted and utilized.

The intention over time is that data collected using the framework will be entered into a publicly accessible central database. A first version of the database has been created using Microsoft Access and is populated with data from the 16 pilot sites. The database contains quantitative and qualitative data collected using the desktop and field protocols, metadata on spatial datasets that can be linked in future versions of the database, forms for inputting data, and basic queries for averaging and summing certain metrics if applicable.

In the future, designating a responsible organization will be necessary to establish a plan for improved data analysis, and to manage the database, data storage, and reporting. The desired data analy-

sis, outputs, and automatic reports created by the database should reflect the original rationale for indicator selection. Database developers need to understand what parameters the data were intended to measure, the rationale for these decisions, and the variations in how the same data were collected across different sites. Standardized reporting mechanisms may eventually include a high level synthesis of each site. Ultimately, data analysis is intended to provide reports that support decision-making in shoreline management and implementation in New York State.

Special considerations must be made for social-economic data, to ensure that all partners use proper protocols to protect the anonymity and welfare of any people or businesses interviewed or surveyed in the process. Before any socio-economic data is used for research culminating in presentation, thesis, publication, dissertation, or any dissemination, users must consult with the Institutional Review Board standards and requirements of their respective institutions. For more information, refer to <https://researchservices.cornell.edu/offices/IRB>.

CONTINUING STAKEHOLDER ENGAGEMENT

Consensus and confidence in the monitoring framework was established by soliciting feedback from stakeholders through regional workshops in each of the four coastal regions.

Gathering the ideas, concerns, and suggestions of stakeholders in each of the regions was important to refine and finalize parameters, indicators, and protocols that were relevant to the shorelines of the four regions. Additionally, engaging with stakeholders during this process allowed us to develop and foster strong relationships, establish the credibility, legitimacy and relevance of the process, and identify potential monitoring partners.

Inclusivity and representation were enhanced by hosting the workshops in each of the regions, providing workshop accessibility and a place-based context for attendees. Workshop invitees represented a broad range of interests, opinions, expertise, and relationship with shorelines. Invitees included scientific and engineering experts from research institutions and the consulting community, as well as key stakeholders representing implementing agencies, project consulting teams, land owners/managers, and community organizations.

Although workshops were well-designed to capture all voices present at the meetings, not all invitees were able to participate, for example, tribal communities and private property owners. Multiple workshops at different times and locations may be a way to gather additional voices in the future. Success of any framework depends upon all parties with interest and control of shorelines be engaged and supportive of the activity.

Overall, participants that attended the workshops viewed the framework and the overall project highly.

Participants would use the framework if the following criteria were met:

- funding is provided,
- the framework is simple and easy to use,
- implementation is inexpensive
- the framework is sustainable for long-term use, and
- the framework considers site-specific goals.

These criteria were foundational in the development of protocols for the final framework. Appendix C contains a summary of the feedback gathered from the workshops, including common themes across all four regions as well as differences of concerns and issues, feedback on each of the resilience service areas, and strategies to overcome potential challenges.

Stakeholder engagement is essential for successful framework deployment. Future efforts could consider conducting follow-up surveys with stakeholders not represented at meetings. For example, in Long Island, workshop participants noted that not enough property owners were present at the workshop; in the Hudson, the MetroNorth Railroad, situated along the eastern coastline of the river, was not present. Following up with stakeholders could encourage new opportunities for monitoring partnerships. Furthermore, we would like to better connect to those who attended the workshop, as well as relevant stakeholders to partake in the monitoring process at respective sites.



APPENDICES

Appendix A. Annotated Protocols and Worksheets
(available via request to OPD@dos.ny.gov, use subject line MONITORING)

The following are available for download at
dos.ny.gov/statewide-shoreline-monitoring-framework

Appendix B. Glossary of Key Terms and Feature Definitions

Appendix C. Summary of Regional Workshops

Appendix D. Summary of Permit Reviewer Meetings

Appendix E. Draft Monitoring Framework Matrices and Preliminary Protocols

Appendix F. Bibliography of Documents Reviewed

Appendix G. Project Core Team and Working Group Membership

Appendix H. Project Workplan and Schedule