National Park Service
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Natural Resource Stewardship and Science

Integrated Coastal Climate Change Vulnerability Assessment

Fire Island National Seashore

Natural Resource Report NPS/FIIS/NRR—2020/2156

ON THE COVER
Photograph of the Fire Island Light and associated buildings.
Photograph courtesy of the National Park Service

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Contents

Contents (continued)

Page

Contents (continued)

Figures

Figures (continued)

Tables

Page

Tables (continued)

Page

Tables (continued)

Page

Appendices

Executive Summary

A climate change vulnerability assessment, which integrated issues across natural resources, cultural resources, and facility assets, was conducted between November 2017 and March 2018 for Fire Island National Seashore (NS). This was a rapid assessment using existing data and expert knowledge through a series of three workshops to assess resource or asset specific vulnerability across three time frames—2020, 2050, and 2100—and the risk to the park's goals. The methods were based on an assessment that was piloted for Colonial National Historical Park (Ricci et al. 2019a) and were refined through this process and are described in Ricci et al. (2019b). Climate stressors used in the vulnerability assessment included sea level rise, storm surge, flooding, erosion, precipitation and temperature changes, drought and ground water change. One limitation of this study is that the sea level rise scenarios used (Caffrey, 2015) are substantially lower than what is currently being used by New York State and other local partners; it's likely the projections assigned to time frames may occur significantly earlier. This assessment is a method to combine these three resource types parkwide and to seek areas of integration that could increase the depth of understanding of the issues. The assessment broadly covers all of the resources in Fire Island NS, excluding the residential communities. While it was beyond the scope of this assessment to evaluate non-park resources in the 17 residential communities interspersed among the federal lands of Fire Island NS, members of the communities were invited to participate in the process and the connected resources and goals between the park and the communities is reflected in the discussions and results. The term communities in this report refers to these 17 residential communities; other communities which are also important, such as those on Long Island, are considered within partners.

The results of the assessment are presented for each of the workgroups: cultural resources, natural resources, and facility assets. It is important to recognize, however, that vulnerability and adaptive capacity across these different resource types can interact or conflict and are better considered in aggregate where they overlap in geography. Three key focal areas were selected for integrated discussion based on areas where there were combinations of high priority resource types: Fire Island Light Station complex, Island Change on the Bayside, and the William Floyd Estate. Figure 1 indicates locations of these focal areas, highlights locations of other park resources and areas discussed and includes results from the vulnerability scores in the 2050 timeframe for all resources with geographic data.

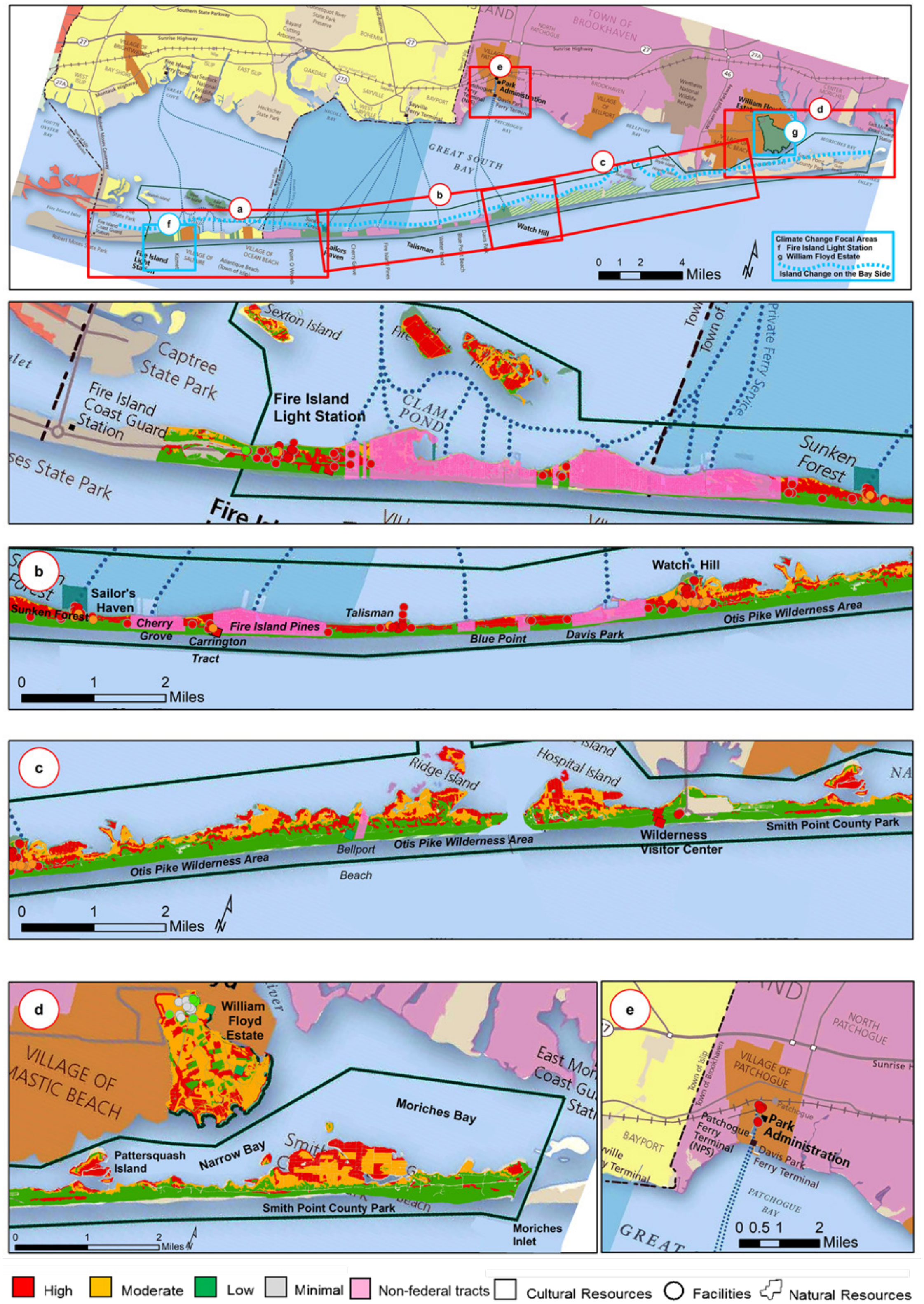

Figure 1. Map of vulnerability scores of all assessed resources with geographic info based on climate projections for 2050 at Fire Island National Seashore, New York. Top panel indicates where subsequent sections a) through e) are in relation to overview and where focal areas are located.

Fire Island Light Station

In the near-term, natural resources in the Light Station area have low to moderate vulnerability, though that changes by 2050 for some resources. Elevation and current condition drive vulnerability of facility assets. The Lighthouse and Keeper's Quarters nearby have moderate vulnerability mostly due to the condition of the structures. From a facilities assets perspective, the Light Station has a high adaptive capacity due to the strong local interest to maintain the cultural resources and roadway that provides emergency services to communities. The annex housing building, boat house, oil house, and store house are below base flood elevation and therefore highly vulnerable. Cultural resources in this area are mostly highly vulnerable. Most of the changes occur for archaeological resources (e.g. rubble and artifact scatter) which were moderate in 2020 and change to highly vulnerable by 2050 due to changes in erosion and groundwater. From a natural resources standpoint, the beaches and foredune ecosystems by the Light Station have high adaptive capacity, but the adaptation actions likely to protect other resources will interfere with that intrinsic adaptive capacity.

Recommendations for this focal area include reconsidering the assumption that Burma Road would be maintained as it currently functions due to its role for both emergency access and for associated utilities. The question was raised of how many times would Burma Road have to be breached before leaving a breach open becomes a real possibility? Options such as increasing bayside water transportation for emergency response were discussed. Road planning should be done more holistically, through park efforts with communities—with an acknowledgement that eventually it will no longer be feasible to maintain this road. This planning should include water and electricity, as they have been maintained below the Burma Road.

To address the vulnerability of this focal area, a planning process for developing long-term site management plans is recommended, specifically for the Coast Guard Annex and Light Station tract. Building on lighthouse repair planning already underway, this plan would balance resource protection and visitor safety and access for decisions such as when and where to move the boat house. There are co-benefits between Facilities and Cultural Resources in planning for adaptation together.

Island Change on the Bayside

The combined issues of bayside sediment transport and how it interacts with resources, infrastructure and communities were categorized as a focal area termed *Island Change on the Bayside*. In many places, the bayside beaches are eroding faster than the oceanside beaches which is impacting infrastructure (Nordstrom and Jackson 2005; Psuty et al. 2017). The bayside issues surrounding sediment supply and erosion are complex. Recurring common concerns include the sediment starved system, erosion impacting the built environment, and infrastructure in the communities that limits sediment mobility. The bayside challenges are also connected to the oceanside beaches because, one factor in the bayside sediment limitation is the fact that cross-island sediment transport, such as through overwash and breaches, has been limited by human interventions.

Recommendations for this focal area include incorporating system-wide sediment transport and geomorphology into any localized management decisions for the bayside system. One example is the proximity between Sailors Haven and the Sunken Forest, a globally rare habitat, which presents potential conflicts between what we can do to protect different resources. The marina is an important public access point, but it exacerbates erosion. The option of replacing the marina with a pier may be worth further study. It would need to be evaluated based on how much time this major infrastructure and access change could benefit the maritime holly forest. Talisman is an example of an area where a marina was replaced with a pier; while the series of cuspid headlands there are geomorphically more stable, marine access goals there have had to change. Mooring buoys are another alternative to the marina, but potential impacts to the seagrass need to be planned for in siting and designing moorings. Summertime fetch makes mooring buoys less appealing to boaters.

Discussions of creating marsh to function as wave barriers need to consider the wave and sediment environment of where a marsh would be viable. Feeder beaches are a shorter term management option to address sediment disruption due to bulkheads and marinas that climate change may increase the need for. Such efforts to add nature based protection seaward of the island to protect infrastructure were discussed as a medium term option, but the long term imperative is retreat. The park staff should consider options for replacing vulnerable facilities, such as the maintenance shop, with mobile facilities, such as a barge that could be removed in storm season.

A long term way the bayside system can supplement its sediment budget is to allow a breach to persist, which would allow overwash to make its way to the bayside. Planning for at what time and under what conditions this is an acceptable option (beyond the Hurricane Sandy example of the breach in the Otis Pike High Dunes Wilderness) need to consider impacts to the back bay communities and involve New York State Department of Environmental Conservation (NYSDEC), Suffolk County, US Army Corps of Engineers (USACE) and local communities.

William Floyd Estate

The William Floyd Estate landscape has been in flux for the 300 years since William Floyd’s time there; it is continuing to change and will be substantially different in 100 years. The high vulnerability resources in the near term are low lying habitats and roads that are part of the cultural landscape. By 2050 more of the upland resources and assets increase to moderate and high vulnerability. Among the climate impacts of greatest concern to the William Floyd Estate, strong winds and stronger storms, such as Nor’easters and hurricanes, will cause damage to structures and the landscape.

Rising groundwater is presently affecting basement flooding in Estate structures. Sea level rise will change the types of plants that can survive in the lower Estate landscape and impact cultural landscape features such as ditches, ponds and roads. The ongoing marsh loss increases exposure of other habitats to salt water intrusion and erosion. Since the ponds are contaminated, it is an increasing concern that the sediment within them could contaminate the surrounding areas and the Great South Bay, with four out of five ponds expected to be inundated from sea level rise by 2050. There will be co-benefits between the cultural landscape and salt marshes and dependent species in planning for adaptation of this low lying system together.

Facilities at the William Floyd Estate have mostly high adaptive capacity, while natural and cultural resources range from low to high adaptive capacity. There is a strong commitment by the Park to protect these facilities as well as enduring public interest and support that will help in future funding of needed adaptations. There is the expectation that upland resources on the William Floyd Estate, including historical structures can be protected with technical interventions.

A key challenge for coastal features and shore landscapes within the Estate focuses on how to manage and interpret the changes that are expected. It is important to let the public know what used to be there, how the family used and modified the landscape over time, and how the property will continue to change in the face of ongoing and anticipated impacts from climate change.

It is recommended that the park investigate the proper compliance necessary for actions associated with potentially contaminated materials. There is an urgent need to study the remediation of the coastal ponds, which are contaminated with chemicals including DDT (Sprenger et al. 1988), given the projections of sea level rise and likely impacts of future storms in order that potential breaches of the ponds do not release contaminants to Great South Bay.

Cultural Resources

Cultural resources are already being impacted by ongoing erosion and sea level rise. Structures and landscape features on Fire Island are more vulnerable than those situated on the mainland at the William Floyd Estate. The landscapes, sites, and structures are already changing on Fire Island NS; a priority now needs to be using these changes to illustrate and share the climate change story.

Recommendations include being proactive in planning efforts and have plans in place for cultural resources if or when the island breaches in locations with cultural resources. Additionally there is a need to document what is highly vulnerable with low adaptive capacity; and then to recover and archive artifacts as museum space and budgets allow.

Natural Resources

Of the natural resources evaluated, there was a spread between 5 high vulnerability, 9 moderate and 10 low for the current time frame. By 2050 three transition from moderate to high and one from low to moderate; one more transition from low to moderate happens by 2100. Those resources identified as most vulnerable are: salt marshes, maritime forests, and freshwater systems. More dynamic systems (e.g. oceanside beaches and dunes, bayside beaches) are generally considered low to moderate vulnerability, but some geographical areas (not identified in this process) will have higher vulnerability when adjacent to infrastructure or cultural resources, wherein additional management actions would be required to sustain the ecosystem services they provide. Figure 1 show how much ocean side resources are lower vulnerability than bayside, which is counter-intuitive. The dynamic beach and dune system is formed through responding to storm events and is resilient to dynamic forces; this will help it as climate changes. Whereas systems such as maritime holly forest take centuries to establish, and are going to be more sensitive to changes both on short and long time scales.

The high vulnerability and significance of the Sunken Forest and the maritime holly forest more generally, make it a high priority for working through questions of how long we can protect it, and when ultimately will we have to reconsider goals. The management actions available have trade-offs with infrastructure, including the infrastructure that provides visitor access and interpretive value. Other stressors such as groundwater change are being monitored, but have limited management options. This issue was identified as an opportunity to observe, study, and educate visitors about climate change impacts to natural resources.

There is a need to include geomorphic dynamism to advise the facilities and cultural resources program areas to help further understand and guide action. The data layers and assumptions going into this assessment are static and can't explain the complex coastal processes, though the discussion of each resource attempted to capture it.

Vulnerability and adaptive capacity of species were assessed primarily based on each species' habitat. For piping plovers (*Charadrius melodus*) and seabeach amaranth (*Amaranthus pumilus*), non-climate stressors are a dominant threat and need to be considered, along with the tradeoffs of managing climate and non-climate stressors.

When incorporating adaptive capacity, most resources fall within the two opposite quadrants categorized by Quick Wins (low vulnerability and high adaptive capacity) or High Concern – Reconsider Goals (high vulnerability and low adaptive capacity).

Facility Assets

Most facility assets are moderately to highly vulnerable (82%) to climate change due to the topography of most of the park on a low lying barrier island, with the exception of facility assets at the William Floyd Estate. These assets have a combined current replacement value over $155M (from the NPS facilities database). Of the 153 facility assets assessed, there were 22 structural assets that increased their vulnerability over the three time frames, with the majority occurring by 2050. There were no changes in the vulnerability of transportation assets over time. Areas of concern for Facilities include the Fire Island Light Station, marina associated infrastructure, park headquarters facilities in Patchogue, and emergency access to the island for the park and communities. Park headquarters facilities in Patchogue are highly vulnerable which is a concern as it also serves as one of the primary launching sites for emergency access to the island after severe storm events. Recommendations include coordinate with local government on how to integrate climate projections into long-range infrastructure plans and how to balance the NPS's resources to maintain systems that significantly service the neighboring communities (roads, marinas, water and power lines). Fully develop the decision points that add in the lag time, unique to Facilities and transportation sector, between initiating planning and when the funding is provided to stay ahead of the changes in climate.

In summary for the overall park resources, these results highlight many high vulnerability resources in the near term, and even more by mid-century, only some of which will have effective adaptation options. A limited number of resources changed vulnerability across the three time frames, with most changes between moderate to high vulnerability between 2020 and 2050. This is likely due to a combination of many of the resources that are sensitive to climate change are already highly vulnerable and the conservative sea level rise projections used in this assessment. Based on the results there are actions which can be taken now, as well as planning that needs to happen for long term changes that mean park management goals will need to change. A core principle of this assessment was to ensure that the process and results lead to follow-up actions. Often that involves incorporating the finding into other planning and management activities, such as the Capital Investment Strategy, a Resource Stewardship Strategy, Hurricane Preparedness Planning and compliance. The detailed information captured in this assessment, including which stressors most affect vulnerability by each resource can be used on their own for work planning in each program area as well as park-wide prioritization. In addition, there was the recognition that it needs to be part of collaboration efforts with partners and communities. A key research need identified was for a comprehensive and dynamic sediment transport model, that builds on previous research, and can be applied to management needs of how natural sediment processes interact with infrastructure.

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List of Acronyms

AC	Adaptive capacity
API	Asset Priority Index
ASMIS	Archeological Sites Management Information System*
CLI	Cultural Landscape Inventory*
CRIS	Cultural Resources Inventory System
DOI	Department of Interior
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIIS	Fire Island National Seashore
FILPS	Fire Island Lighthouse Preservation Society
FIMI	Fire Island to Moriches Inlet stabilization project
FIMP	Fire Island to Montauk Point reformulation study
FMSS	Facilities Management Software System
HML	High, moderate, low
IPCC	Intergovernmental Panel on Climate Change
LGBTQ	Lesbian, Gay, Bisexual, Transgender, and Questioning
LiDAR	Light Detecting and Ranging
LSC	List of Classified Structures*
NOAA	National Atmospheric and Oceanic Administration
NPS	National Park Service
NRCA	Natural Resource Condition Assessment
NS	National Seashore
NYSDEC	New York State Department of Environmental Conservation
POSE	Adaptive capacity categories: physical, organizational, social, economic
RCP	Representative Concentration Pathway
SLAMM	Sea Level Affecting Marshes Model
SLOSH	Sea, Lake, and Overland Surges from Hurricanes
SLR	Sea level rise
SOP	Sustainable Operations Program

USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
WCU	Western Carolina University

*Note that while ASMIS, LCI and LCS were the system in use during the assessment and thus referred to in this report, the NPS has incorporated those systems into the new Cultural Resources Inventory System (CRIS).

Introduction

As a low lying coastal site with most resources on a dynamic barrier island, Fire Island National Seashore (NS) faces serious issues now and will likely increase in the coming decades due to climate change. As part of adaptation planning, Fire Island NS partnered with the National Park Service (NPS) Northeast Region (now Interior Region 1) and the Coastal Resources Center at the University of Rhode Island (URI) to undertake this vulnerability assessment to understand integrated vulnerability across three program areas—natural resources, cultural resources, and facilities assets. This effort was a test of transferability of a method previously piloted at Colonial National Historical Park (Ricci et al. 2019a), built on other NPS efforts focused on individual resource types, to develop a framework that can be applied at other parks using existing data, modeling, and qualitative expert judgments. A separate methods report (Ricci et al. 2019b) provides the details of the methods used in this assessment.

Fire Island NS lies on the south shore of Long Island, New York, and includes the barrier island, headquarters facilities in Patchogue and the historic William Floyd Estate adjacent to the Village of Mastic Beach (Figure 1). Fire Island was selected for this assessment based on the need for vulnerability information across the three program areas and staff commitment to using the results to inform climate adaptation This differs from the pilot vulnerability assessment (Ricci et al. 2019a) in that natural resource issues and data availability pushed the limits of the methods, as opposed to cultural resources for Colonial National Historical Park, in addition to refining the method based on what was learned in the pilot.

Purpose of the Assessment

An integrated climate change vulnerability assessment was conducted to gain a deeper understanding of how the park is vulnerable and to identify key linkages among the program areas of natural resources, cultural resources and facility assets. Fire Island NS is the second in the NPS system to test and refine an integrated vulnerability assessment for a coastal park targeting these three program areas, based primarily on the effective use of available information.

The goals of the assessment were to help park managers identify and choose adaptation actions for priority vulnerable resources and assets, justify actions, and pursue funding to implement adaptation actions. Managers will also be able to determine investment priorities for resources that are highly vulnerable but have low adaptive capacity. This report is intended to both support parkwide planning efforts and to be a useful tool for each program area to use for its own purposes.

At the conclusion of this pilot project, the expectation was that park staff would be able to:

- identify the time series of changes likely to occur across the park in the time frames of 2020, 2050, and 2100,
- explain the major linkages across the natural resources, cultural resources, and facility assets,
- identify the co-benefits across these three program areas for potential action,
- provide recommendations on actions that can be taken to keep adaptation options available.

The vulnerability assessment relied primarily on existing data, local knowledge, and subject matter expertise. Many existing science products contributed to the feasibility of applying the methodology, though the challenges of working across different resources and spatial and temporal scales in a relatively rapid process meant that a variety of valuable data was not able to be included (McElroy et al. 2009; Gonzalez, 2018; Caffrey, 2018). The process combined this best practicable science and tools with qualitative expert judgment captured through the workshops.

The assessment broadly covers the entire park area, excluding the resources specific to the residential communities set within the island, with further attention to focal areas for integrated discussion. Participants from the communities took part in the workshop, and the results will be relevant to future discussions with them. It was beyond the scope of this effort to assess resources specific to the communities. Each workgroup selected which resources and assets to include differently; details can be found in the accompanying methods document (Ricci et al. 2019b).

Setting overall priorities for adaptation within Fire Island NS will require taking the vulnerability of its natural resources, cultural resources, and facility assets into account. The vulnerability scoring should assist each program area when setting planning priorities or targeting funding sources and for park-wide planning where there are opportunities and trade-offs among resources.

Climate change impacts, such as sea level rise, on cultural and natural resources as well as infrastructure are addressed in the Fire Island NS General Management Plan update signed in 2016, and concerns about coastal flooding, storm and hurricane impacts, and salt water intrusion were recognized (NPS, 2016b). Climate change impacts have become specific concerns in light of increased frequency and intensity of storm events impacting park and adjacent infrastructure, changing natural resource features and wildlife habitats, and causing loss of or damage to sensitive cultural resources. Hurricane Sandy impacted Fire Island NS in multiple ways, with the breach in the Otis Pike Wilderness Area the most visible. Important contributions to this assessment were learned in the development of the Wilderness Breach Management Plan, including the recovery and the ensuing research and monitoring phases (NPS, 2018).

The three different resource types required different indicators of exposure, sensitivity, and adaptive capacity, and methods are discussed in more detail in each program area section below, as well as in the methods report (Ricci et al. 2019b). For natural resources, each stressor for exposure was subsequently assessed for corresponding sensitivity, for each resource. For cultural resources, the method tailors sensitivity indicators to each cultural resource type: archeological resources, cultural landscapes, ethnographic resources, museum collections, and buildings & structures. Assessment of cultural resources incorporates information such as archeological condition assessments and threats included in the Archeological Sites Information Management System (ASMIS), Cultural Landscape Reports from the Cultural Landscape Inventory (CLI), and historic structures information from the List of Classified Structures (LCS). Note that all of these databases have now been replaced by CRIS, but since they were the source at the time of the workshop, they will continue to be referenced as such in the report. Links were made to a museum program risk assessment for collections facilities by the NPS Park Museum Management Program (De Young et al. 2015). Facilities methods development was greatly enhanced by the coordination with the NPS's Sustainable Operations

Program (SOP) to incorporate the methods derived from the Coastal Hazards & Climate Change Asset Vulnerability Assessment Protocol (NPS, 2016a) and its implementation concurrent with this project (Tormey et al. 2018).

Context of Integrated Studies in NPS

Since park management decisions are often interdisciplinary across program areas, an integrated approach to assessing resource vulnerability is needed. Clear and well-tested methods for doing this are still being developed through this study and others. Examples of this approach completed to date include a review of existing vulnerability assessments for coastal parks in the northeast region and a handbook by NPS for coastal adaptation strategies (Ricci et al. 2017; Beavers et al. 2016). The work at Fire Island NS was a further development of methods for integrating cultural resources, natural resources and facilities assets, following the pilot at Colonial National Historical Park (Ricci et al. 2019a). Previous assessments have integrated cultural and natural resources (Amberg et al. 2012).

The idea for developing a relatively rapid assessment method was to use the best practicable science and capture existing knowledge into a system that could be iteratively updated as new information becomes available. To gather expert judgement, a broad team of experts was assembled, which included park, regional, and Washington office NPS staff, long term partners such as local government and academic research collaborators from the Stony Brook University and Rutgers University, partner agencies such as the US Geological Society (USGS), and the non-profit organizations The Nature Conservancy and Seatuck Environmental Association. The vulnerability assessment set out from the beginning to engage all three program areas of the park both in information gathering and the workshop process by creating workgroups to prepare for and help lead the three assessment workshops. These provided opportunities for each program area to advance the assessment as well as for the entire group to listen, engage, and reflect on aspects of the assessment in plenary and mixed group exercises.

It should be noted that the three program areas have different communication practices, such as level of description included in a report. Thus this report includes differing levels of descriptive detail, in order that it can be a useful document for each program area to use on its own, as well as for the integrated vulnerability discussion.

Assessment Framework

Scanning the Conservation Horizon (Glick et al. 2011) has served as a guidance document for vulnerability assessments in many national parks and conservation areas. Glick et al. (2011) and much of the natural resource literature on vulnerability and the Intergovernmental Panel on Climate Change (IPCC) has come to a consensus definition that vulnerability is a combination of exposure, sensitivity, and adaptive capacity. Though for the NPS and its focus not only on natural resources but also non-living resources and assets, there have been recognition that a different framework for addressing adaptive capacity is needed. This is due to the different definitions of adaptive capacity across resource types (Smit et al. 2000). Within the NPS, methods to define vulnerability for Facilities and non-living Cultural Resources recommend not including adaptive capacity within vulnerability, and instead defining vulnerability as the combination of exposure and sensitivity (NPS, 2016a; Rockman et al. 2016). This assessment tested the previously developed (Ricci et al. 2019a) experimental approach of defining adaptive capacity of a resource more broadly than in other frameworks, and including extrinsic factors that ultimately express the capacity of resource and asset managers to manage vulnerability. Key factors include non-living physical, social, organizational, and economic capacities. Since these factors are not inherent to the resource, we chose to assess adaptive capacity separately from vulnerability, even for natural resources. This was a test of the vulnerability score based solely on sensitivity and exposure, without modifications from adaptive capacity. While workshop participants found this method functional, the review of the methods (Ricci et al. 2019b) subsequent to the workshops recommends future efforts may need to differentiate the intrinsic component of adaptive capacity for natural resources so it can reduce vulnerability, from the management adaptive capacity components which are communicated separately.

Vulnerability is the degree to which a resource, asset or process is susceptible to adverse effects of climate change, including climate variability and extremes. Figure 2 provides an overview of how vulnerability and adaptive capacity were determined. Exposure is the magnitude of change in climate and other stressors that a resource, asset, or process has already or may experience in the future. Exposure was calculated using climate projections in 2050, and 2100 for a range of climate stressors, based on the Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway (RCP) 8.5 where available, depending on the stressor. While assessing multiple plausible scenarios is best practice, a single scenario was all that was practicable to assess so many resources over multiple time frames. A climate stressor is a condition, event or trend related to climate variability and change that can exacerbate hazards. Sensitivity is the degree to which a resource, asset, or process is or could be affected, either adversely or beneficially, by climate variability or change. Adaptive capacity was assessed separately and used as a tool to bridge the vulnerability assessment and future adaptation planning processes.

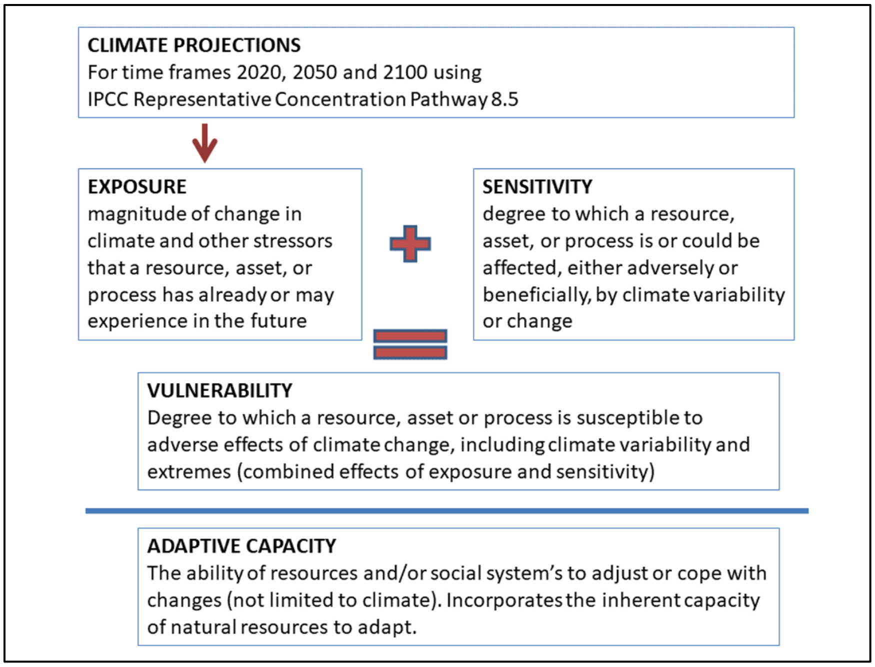

Figure 2. Overview of the climate change assessment framework adapted for integrated vulnerability assessments.

Details of the exposure and sensitivity methods are further explained in the accompanying Methods report though additional explanation about adaptive capacity is provided here (Ricci et al. 2019b). To estimate adaptive capacity, each workgroup carried out an analysis using a simple framework that divided the concept into four key types of capacities—Physical, Organizational, Social, and Economic (POSE) (adapted from Bruneau et al. 2003). Every resource/asset received an adaptive capacity score, except for facility assets that were not exposed and thus did not receive an adaptive capacity score.

Physical capacity refers to the physical properties of systems, including the ability to resist damage and loss of function or to evolve into a new desired functional state. Physical properties include natural characteristics (e.g. wetlands that can vertically accrete or migrate upland) and infrastructure (vehicles, boats, gear, facilities). The method distinguishes between two following aspects of physical adaptive capacity:

> **Intrinsic**, sometimes referred to as natural adaptive capacity, is the ability of the species or habitat to resist climate impacts or re-establish itself in a changed environment. For natural resources, intrinsic adaptive capacity is usually considered a component of vulnerability (Glick et al. 2011). The natural resources workgroup considered including it in vulnerability, but it was decided to keep separate for consistency with other workgroups. For natural systems within the park, the assessment of sensitivity to climate impacts includes some consideration of short-term response; the adaptive capacity analysis takes a longer-term perspective.

Technology/Infrastructure refers to the availability of engineered or technical means to resist impact or to aid in migration, re-establishment or creation of similar habitat or the availability of infrastructure needed to adapt (vehicles, boats, gear, facilities), such as to move a resource.

Organizational Capacity relates to the organizations and institutions that manage the physical components of the systems. This domain encompasses measures of organizational capacity, planning, training, leadership, experience and information management that improve organizational performance and problem solving. This includes factors such as legal mandates or prohibitions and the need for conflict resolution among competing priorities.

Social Capacity considers the degree of public interest and support for adaptation actions, potential conflicts with neighboring land uses, and competing values of maintaining the cultural landscape versus allowing ecological processes to proceed. NPS sites often contribute to a community's sense of place and the local economy, and community members frequently develop strong interests in the preservation of the resources. These can influence the NPS's willingness to act even when they have the authority to do so. Non-local communities interested in the asset should also be considered as they could be influential in the ability to act.

Economic Capacity is the financial cost and accessibility to resources of implementing climate adaptation measures or the loss caused from damage due to climate impacts. For example, shore protection structures may provide temporary protection but are expensive, while allowing wetlands to migrate as impacts occur would be low cost. Protecting visitor centers and historic structures is also a significant economic activity which includes maintenance and recovery from hazard events. The NPS can also utilize partner funding so the discussion should include all sources of likely funding.

To guide the scoring of adaptive capacity within each of the POSE categories, relevant factors were identified to focus discussion; which and how many of these were considered varied by resource (Table 1).

Table 1. Examples of factors that could be considered within each of the four Physical, Organizational, Social, and Economic (POSE) capacity categories adapted for integrated vulnerability assessments.

Physical	Organizational	Social	Economic
• Natural-intrinsic ○ Health ○ Abundance ○ Protection ○ Sensitivity to current impacts • Infrastructure ○ Transportation (boats/vehicles) ○ Facilities ○ Shoreline structures ○ Monitoring protocols ○ Technology	• Laws/Authority • Coordination • Agreements (formal and informal) • Plans • Implementation • Enforcement Staffing – number of staff (term vs seasonal) and training • Transparency • Accountability • Meets multiple goals (across NPS program areas) • Number of viable management options (don't select them, just recognize the variety available) • Willingness to take effective action • Willingness to take timely action	• Significance (across a variety of sectors/communities) • Cohesion • Community organizations and associations • Trust • Diversity of livelihoods, culture and language • Awareness • Conflicts • Equity (gender, financial) • Perceptions • Culture • Values and attitudes • Champions (leaders that support effort) • National interests • Constituencies dedicated to an asset	• Base funding • Competitive funding • Congressional line items • Emergency funding • Administrative system to disburse finances in timely fashion • Likely scale of economic resources required to do a variety of actions

Since this assessment separated adaptive capacity from the vulnerability formula, we developed a graphic to show the relationship between the two for each resource/asset evaluated. This is displayed through a matrix of vulnerability vs adaptive capacity for focal areas or resources/asset groupings. The following four general concepts were assigned to each quadrant of the matrix that captures the general context based on the vulnerability and adaptive capacity scores:

- **Monitor for Change:** For low-vulnerability and low-adaptive capacity situations the term "monitor for change" was applied with the assumption that while these resources appear to be low priority for now, the situation can change.
- **Quick Wins:** For low-vulnerability and high-adaptive capacity situations the term "quick wins" was applied with the assumption that these resources may provide opportunities to begin adaptations using existing capacity.
- **Serious but Actionable:** For high-vulnerability and high-adaptive capacity situations the term "serious but actionable" was applied with the assumption that these resources are a priority due to their vulnerability and there is existing capacity to address them individually or preferably in an integrated way with similar resources.

- **High Concern – Reconsider Goals:** For high-vulnerability and low-adaptive capacity situations the term "reconsider goals" was applied with the assumption that there isn't sufficient existing capacity to address these highly-vulnerable resources and there is the chance that NPS goals will not be met should the vulnerabilities turn into impacts over time. In such circumstances, more realistic and achievable goals should be drafted.

Going forward, Fire Island NS would benefit from integrating adaptation planning into existing planning processes. An example exercise introduced Decision Points and corresponding Adaptation Pathways to explore how vulnerability assessment results can be applied towards adaptation planning (Haasnoot et al. 2013; Barnett et al. 2014). Mixed workgroups were asked to identify decision points for a focal area and consider the likely park management decisions that need to be made as part of routine management as the climate change scenarios unfold. An example was to determine at what threshold the Burma Road should no longer be maintained at a level that could support vehicle traffic, and instead be replaced by boat or beach access. Decision Points attempted to place qualitative thresholds for acceptable vulnerability where action would be highly advantageous.

The workgroups then were asked to brainstorm a menu of potential adaptation options associated with a decision point. Each option was assessed for how long it might be effective based on climate change projections. The idea was to develop Adaptation Pathways indicative of options available without further analysis and stakeholder engagement and are not a prescriptive plan for action. Challenges arose related to the utility of the exercise without tailoring it to a stakeholder process that actively engaged the communities. Since adaptation planning was beyond the scope of this vulnerability assessment, only limited time was allocated to this exercise to explore their applicability to Fire Island NS. Given the challenges exploring adaptation pathways in a theoretical discussion with the limited time available, the vulnerability assessment workshop may not include these exercises in the future. Parks are encouraged to link the vulnerability results to future planning process with specific management decisions.

These range of discussions during the three workshops served as a way to integrate ideas, concepts, concerns, and priorities across program areas. As in most cases, the process and discourse itself was of significant value.

Assessment Process

The assessment process consisted of background work carried out mainly by URI staff and the detailed study of facilities conducted by Western Carolina University (WCU) under their SOP work (NPS, 2016a). Experts were organized into three workgroups—Natural Resources, Cultural Resources, and Facilities. Conference calls occurred before and in between three onsite workshops aimed at eliciting qualitative judgments, capturing staff knowledge, and testing efficient approaches for use by park staff. Workgroups at each onsite workshop were tasked with integrating and prioritizing across all park resources. This vulnerability assessment report was prepared after the third workshop.

In advance of each workshop, workgroups were provided background information and orientations to be able to maximize the efficiency of each face-to-face activity. Each workgroup held one or more preparatory conference calls between the workshops.

The general flow and objective of workgroup activities is listed below:

Project Launch Conference Call: The project was introduced to Fire Island NS staff via conference call/webinar held on September 20, 2017.

Workshop #1 was held on November 15–16, 2017 at the Fire Island NS Patchogue Ferry Terminal. The objectives were to:

- Learn and advise on the methods for conducting a rapid integrated climate change vulnerability assessment,
- Share expert analysis on the exposure and sensitivity of Fire Island NS's natural and cultural resources and facility assets,
- Reveal key linkages across the Natural Resources, Cultural Resources, and Facilities program areas to understand the co-dependence of resources and assets at and their implications for achieving management goals.

Workshop #2 was held at the Fire Island NS Patchogue Ferry Terminal January 30–31, 2018. The objectives were to:

- Review the vulnerability of key assets/resources for three time frames.
- Select indicators for adaptive capacity and begin to assign scores.
- Select focal areas and examine in depth key linkages across the natural, cultural and facilities program areas in a select focal area to understand the co-dependence of assets/resources at Fire Island NS to achieve management goals/objectives
- Set out the goals and process for the final workshop and report preparation.

Workshop #3 was held at the Fire Island NS Patchogue Ferry Terminal on March 29–30, 2018. The objectives of the final workshop were to:

- Review the final scores for vulnerability and adaptive capacity.
- Share the results with local government and community representatives.
- Reveal key linkages across the natural, cultural and facilities program areas in select focal areas to understand the co-dependence of assets/resources at Fire Island NS to achieve management goals/objectives—with a focus on linkages to neighboring communities.
- Identify recommendations and next steps on how to use the results—such as further data needs and adaptation planning.
- Evaluate the assessment process to inform the next iteration at a different site.

Full details of the method are available in the methods report (Ricci et al. 2019b).

Climate Projections

Key climate stressors on resources and assets were identified by the workgroups. The stressors focused on priority issues, given the limited scope of the assessment. Stressors included by multiple workgroups were: sea level rise, flooding/storm surge, erosion, changes in temperature, changes in precipitation, and changes in groundwater. Other stressors by just one workgroup included changes in wind, humidity and fire. For this assessment, non-climate stressors (e,g. cesspools and septic systems were not included unless they interacted with climate stressors (e.g. water quality components of hypoxia and harmful algal blooms (HAB) that are intensified by warming).

The assessment looked at observed climate change trends and future projections. Three time frames, 2020, 2050, and 2100 were identified and used throughout the assessment. The 2020 time frame identifies existing vulnerabilities and recognizes the park is currently seeing impacts. The mid-century projection should be incorporated into the long-term planning horizon of some current and planned projects. The end-of-century projection recognizes our responsibility to preserve resources for future generations. It should be noted that we used the best data practicable to NPS at the time which centered around 2090, for the 2100 scenario used. Building on the principle of using existing data and knowledge where feasible, the team coordinated with other ongoing studies in Fire Island NS especially coordinating with the Facilities' SOP/WCU protocol (NPS, 2016a; Tormey et al. 2018). Coordinating with this effort that uses consistent data for all parks meant that we committed to using Caffrey (2015) sea level rise scenarios (2050, 2100) were selected for our exposure level to be consistent with SOP/WCU protocol (NPS, 2016a) and comparable to other parks using the same methods for projections (Caffrey et al. 2018). Of the multiple scenarios in Caffrey (2015), RCP 8.5 was chosen for consistency with SOP/WCU protocol with the benefit that as the highest scenario, it is closer to the other local sources.

To localize sea level rise projections, local data was accessed from the Montauk, NY tide gauge. Discussions that set these scenarios in the context of other scenarios included additional data from 1) the Sea Level Change Curve Calculator showing the US Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA) projections (USACE, 2017) and 2) New York's ClimAID report (2015), which is used by the NYDEC (Horton, et al. 2014). By way of comparison, the NOAA scenarios range from 0.15 feet to 1.54 feet by 2050 so the scenario of 0.85 feet is low but not implausible. For 2100, the range is between 1.31 feet and 7.23 feet, so the scenario of 2.51 feet misses the upper range of risk. A discussion of the implications of using these sea level rise rates significantly lower than other projections being used locally is included in the next section under Caveats. Workshop participants strongly objected to aligning these sea level rise projections with the time frames used. Discussion included communicating it without the time frames, but for the report purposes, we are continuing to use the method (Ricci et al. 2019).

In the case of temperature, precipitation and wind, the project partnered with the Department of Interior (DOI) Northeast Climate Adaptation Science Center (NECASC) to develop baselines and projected changes. For temperature and precipitation, several metrics were analyzed (Table 2) (see Appendix A for details) to determine which are expected to fall outside of the range of historical variability for each future time frame. While the projections were downscaled to the Seashore, the spatial resolution on the projections was insufficient to determine any spatial differences within the park. To make it more useable for the workshop, Table 3 of exposure was developed with key metrics, with a presence of exposure for each time frame.

Table 2a. Climate Projections for Temperature at Fire Island National Seashore, New York.*

Baseline (1996–2015)	**2020**		**2050**		**2100**		
Mean Annual Temp	**Mean Annual Temp**	**Hot days (>90°F)**	**Mean Annual Temp**	**Hot days (>90°F)**	**Mean Annual Temp**	**Hot days (>90°F)**	**Notes**
51–55°F	n/a	n/a	+x°F	+15 days	+2–10°F	+x days	• Warming impacts many other aspects of climate Warming is projected to continue, rising 6–10°F by the end of the century. Fastest warming is in Summer • Freeze-free Period +25 days (2050)

* Based on methods developed for Acadia National Park and adapted for Fire Island NS by A. Bryan, Climate Postdoctoral Fellow, USGS, DOI Northeast Climate Adaptation Science Center. n/a = not available.

Table 2b. Climate Projections for Precipitation at Fire Island National Seashore, New York.*

Baseline (1996–2015)	**2020**		**2050**			**2100**		
Mean Annual Height	**Mean Annual Height**	**Days exceeding 1”**	**Dry spell length**	**Days exceeding 1”**	**Days exceeding 4”**	**Mean Annual Height**	**Days exceeding 2”**	**Notes**
46–51”	n/a	n/a	+1 day	+20%	+65–80%	n/a	n/a	• Precipitation has increased slightly, but weak compared to temperature, and not outside of the normal range of natural variability • Precipitation increases are expected annually, though strongest in the winter, potential drying in the summer with continued intensifying extremes

* Based on methods Acadia National Park and adapted for Colonial NHP by A. Bryan, Climate Postdoctoral Fellow, USGS, DOI Northeast Climate Adaptation Science Center. n/a = not available.

Table 3. Climate projections* across three time frames at Fire Island National Seashore, New York.

Stressor	Metric	Exposure**		
		2020	2050	2090/2100
Temperature	Mean annual temperature	Yes	Yes	Yes
	Daily highs	Yes	Yes	Yes
	Daily lows	Yes	Yes	Yes
	Hot days (> 95°F)	Yes	Yes	Yes
	Cold nights (< 32°F)	No	Yes	Yes
	Warm spells (3+ days of > 95°F)	No	Yes	Yes
	Cold spells (3+ days of <32°F)	No	Maybe	Yes
Precipitation	Mean annual total	No	No	No
	Days exceeding 2" precipitation	No	No	No
	Dry spell length (3+ days w/ no precipitation)	No	No	No
	Wet spells (3+ days w/ precipitation.)	No	No	No
Bio	Growing season length***	No	Yes	Yes

* Climate projections are based on methods Acadia National Park and adapted for FIIS by A. Bryan, Climate Postdoctoral Fellow, USGS, DOI Northeast Climate Adaptation Science Center.

** Defined as whether "yes" or not "no" the 20-year mean, centered on the year (2020, 2050, or 2090), is greater than the historical (1950–2005) mean plus one standard deviation. The final column, centered around 2090 model results, is the best available information at the time. For purposes of consistency with other projections, we refer to this as the 2100 or end-of-century projection. "Maybe" indicates exposure according to the "major change" scenario but not according to the "least change" scenario, suggesting that exposure depends on future greenhouse gas emissions and other sources of uncertainty.

*** Defined as the number of days between the last spring freeze and the first fall freeze, where a "freeze" occurs when the daily low drops below 32°F.

The following current data sources for storm surge and flooding were selected; the NOAA Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model for category 3 hurricane, Federal Emergency Management Agency (FEMA) flood zones, and combined sea level rise and storm surge scenarios using the Advanced Circulation and Storm Surge (ADCIRC) model (Bradley et al. 2018). Groundwater change models were (Misut and Dressler, in press). Note that a category 3 hurricane was chosen based on one category higher than previously experienced, after Caffrey et al. (2018).

Caveats

This assessment uses the Caffrey (2015) projections for sea level rise to have internal consistency with the implementation of the Facilities' SOP/WCU protocol (NPS, 2016a; Tormey et al. 2018). These are conservative when compared to NOAA's current modeling and what other local partners are using (NOAA 2017; USACE 2016/2017; Horton et al. 2014). One reason for the difference is that the Caffrey (2015) projections are not relative sea level rise and thus do not include subsidence, which is a substantial component for the area. Another is that they are based on the IPCC (2013) models and were becoming dated by the time of the workshop as new research on ice sheet melting was coming out. It is valuable to recognize that the projections assigned to timeframes may occur significantly earlier. There is a need to revisit the assessment periodically to incorporate the best available science. In the future, it is recommended that this process use more locally consistent, and often higher, projections.

Models of projected change were only available for sea level rise, storm surge with sea level rise (Caffrey et al. 2018), groundwater (Misut and Dressler, in press), temperature, and precipitation (as described in Table 3). Erosion and flood zones were based on current conditions rather than projections, because models for how these stressors change with sea level rise or increased heavy precipitation are not available. Erosion as a stressor is a simplification that misses the complexity of the challenges of sediment supply, disruption of sediment pathways and displacement of geomorphic features.

This assessment of Fire Island NS is based on a rapid assessment using existing information, but a more detailed analysis may be needed for particular resources or assets. The SLOSH and FEMA models do not include sea level rise or the potential for increased frequency of storms in the future. This limitation, paired with the low sea level rise projections, and high current vulnerability, explains why much of the exposure does not change between time frames for facility assets. However, ADCIRC models were available for Fire Island NS, which do show the combined effects of sea level rise and storm surge (Bradley et al. 2018). These informed the natural resources discussion, but were not used by the facilities workgroup. Since the sea level rise scenarios were different in this model from Bradley et al. (2018), we chose the closest one to the time frame being considered.

The results of the assessment are presented in the following sections highlighting the three key focal areas selected through the workshops—Fire Island Light Station complex, Island Change on the Bayside, and the William Floyd Estate. This is followed by more in-depth analysis for each of the workgroups: cultural resources, natural resources, and facility assets. The general organization for each section is to describe the value and importance of the resources, present the overall vulnerability and the adaptive capacity, and finally offer recommendations for next steps or management actions. The body of the report has summary tables and examples of outputs for the Natural Resources, Cultural Resources and Facilities program areas (sometimes referred to as divisions, hereafter referred to as "program areas"). The full dataset for all of the resources and supporting materials are located in the appendices.

Focal Areas for Integration

The three workgroups compared their vulnerability analysis results to identify focal areas for integration that would benefit from coordinated planning and action. This was in addition to the scoring of all park resources/assets in their respective databases. The focal areas chosen for integrated discussion are Fire Island Light Station complex, Island Change on the Bayside and the William Floyd Estate (Figure 1). These focal areas share common features such as low-lying coastal segments and contain priority resources related to the mandate of the park. By being identified in the enabling legislation, these cultural and natural resources receive the highest priority preservation and protection. However, they differ in how climate change impacts will play out over time and the options available for management responses. By acting together, the program areas see opportunities for reducing vulnerability and/or redefining management objectives to provide clarity for joint action and combine resources to increase the likelihood of timely, efficient and effective action.

Fire Island Light Station

Description of Resource and Value

On the western side of Fire Island is an assortment of structures and facilities that comprise the Fire Island Light Station and surrounding cultural landscape. Since 1826 there has been a series of maritime navigation and communication activities and thus creating a rich cultural heritage.

The centerpiece of the area is the current Fire Island Lighthouse—built in 1858 at 168 feet tall and fitted with a First Order Fresnel Lens (FILPS, 2019). The lighthouse was the first sight of land for many European immigrants and an important landmark for ships coming into New York Harbor. The United States Coast Guard managed the lighthouse between 1939 and 1973 upon which the lighthouse and the surrounding 82 acres were transferred to the Fire Island NS in 1979.

In 1984 the lighthouse was placed on the National Register of Historic Places and in 1986 the lighthouse was restored to its 1939 condition and reinstated as an official aid to navigation. In 1996 the Fire Island National Lighthouse Preservation Society (FILPS) which led the restoration fundraising effort took over maintenance and operation of the lighthouse and Keeper's Quarters/Visitor Center, through an agreement with the NPS. There have been several assessments for how to maintain the lighthouse and at least one major resurfacing intervention. However, the exterior surface of the lighthouse and the foundation continue to be a major area of concern. As major investments are planned for a new, long-term fix, there is a need to take climate change into account with these new repairs.

The Light Station represents a rich mosaic of cultural resources and a landscape to interpret the maritime history of the island. In addition to the current lighthouse are the artifacts from the first lighthouse, over ten other associated structures and supportive transportation infrastructure. One key asset in this area is Burma Road which serves an important access role, including for emergency vehicles, for the rest of the island, and the associated utilities which run below it.

In partnership with the FILPS, the public has access to tours and interpretive walks. All of these resources are set within a mix of natural resources that are continually changing and with the slow long-term littoral drift the Light Station which was at the end of the island when it was built, is now almost five miles east of the western inlet (NPS, 2015a). The dominant natural resource types in the lighthouse district are the foredune and swale, with some surrounding pockets of maritime forest and high salt marsh. The ability of the foredune to migrate landward has been limited in this area by efforts to maintain the Burma Road in place, such as minimizing the frequency of overwash via the construction of a planned berm as part of Fire Island to Moriches Inlet (FIMI) project.

Vulnerability

In the near-term, natural resources in the Light Station area have low to moderate vulnerability though that changes by 2050 for some resources in the middle of the island (Figure 3). The methods for scoring vulnerability, as shown in Figure 3, are described in below sections for Cultural Resources (marked by squares in Figure 3), Natural Resources (marked by polygons in Figure 3) and Facility Assets (marked by circles in Figure 3), specific to methods for each program area and in more detail in Ricci et al. (2019b). The primary vegetation types in this area are swale, foredune and beaches—all of which are scored as low vulnerability based on a parkwide assessment assuming natural processes such as overwash are able to respond to sea level rise and storms. Most of the structures are located in and around swale habitat. Protecting these structures in place will have impacts on the swale, as well as the ability of the foredune to migrate landward. Yet the foredune plays an important role in protecting the structures. Bayside beaches, high salt marsh, freshwater ecosystems, and maritime forest have moderate vulnerability in the near-term though the latter two increase to high vulnerability by 2050.

Facility assets have mixed vulnerability in the Light Station driven by a combination of elevation and condition of the structures. The Fresnel lens building which is above base flood elevation in the center of the island and in good condition has low sensitivity which makes it stand out as one of the few assets that have low vulnerability. However, the Lighthouse and Keeper's Quarters nearby have moderate vulnerability mostly due to the condition of the structures. Structures in high vulnerability due to lower elevation and below base flood elevation include the annex housing building and the houses—boat, oil, and store.

The Light Station also serves as an emergency access route for the western side of the island and associated communities. Burma Road is a priority roadway that must be continually cleared after storm overwash from the dunes. The key interaction between natural resources and facilities is the maintenance of the roads after storm events when sand piles up on the roadway. Over time the challenge is increasing to keep the road surface at current elevation while the dune transgression bordering the road increases the elevation of surrounding landforms.

Cultural resources are mostly highly vulnerable with the archeological resources of rubble and artifact scatter changing from moderate to highly vulnerable by 2050. Archeological sites on the island are of special concern as these sites are threatened by erosion and dispersal from rising sea levels, as well as changes in groundwater, both changing depth to groundwater and saltwater intrusion. Archeological sites on the island are also at risk from wind and wave action and the potential storm surge.

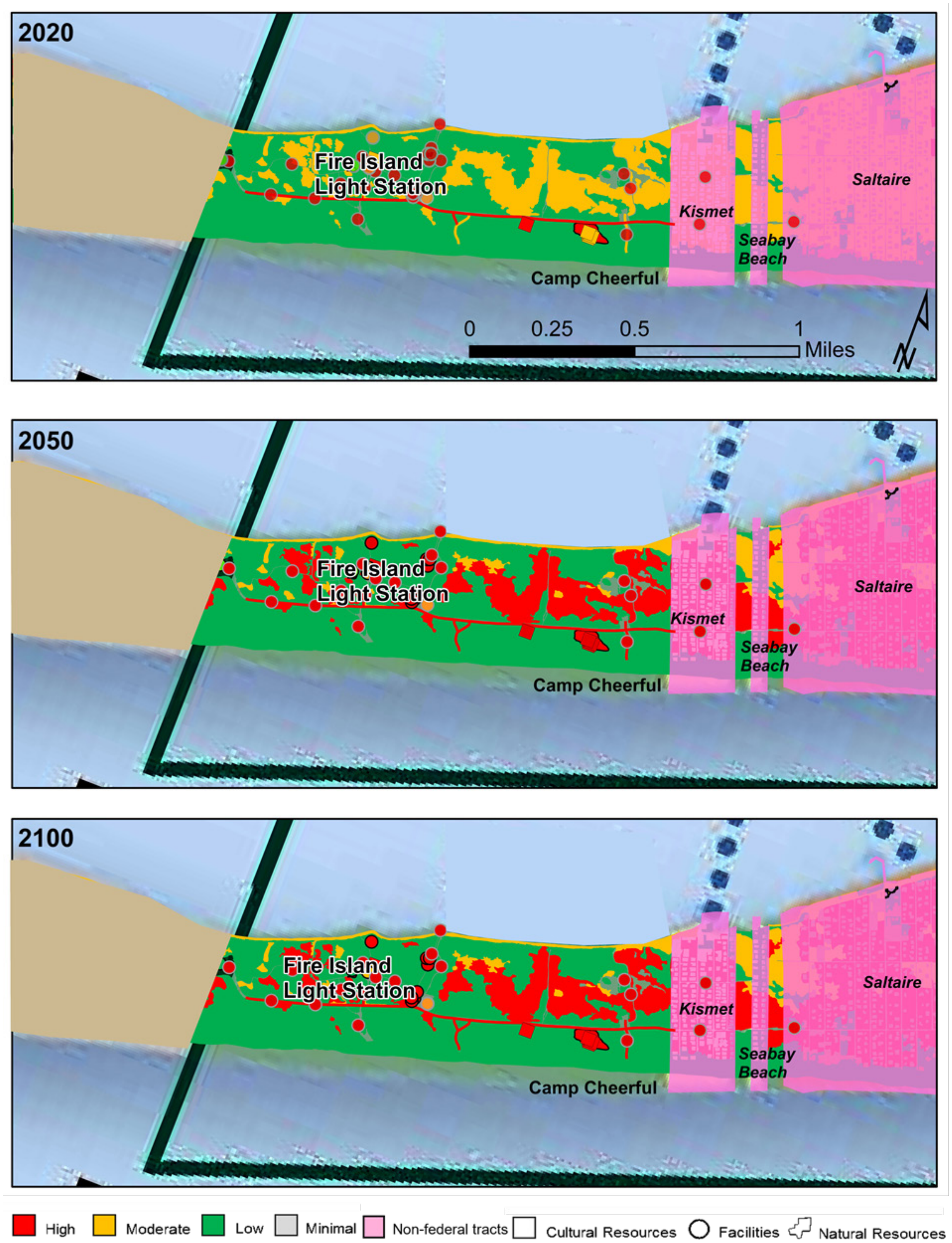

Figure 3. Vulnerability scores for facility assets, cultural, and natural resources over three time frames for Fire Island Lighthouse Complex, New York.

Cultural resources workgroup rated a couple of resources differently than facilities—the Keeper's Quarters as highly vulnerable while facilities scored it as moderate and Power House foundation as high vs the Lens Building, which is in the same location, as low. This is likely due to facilities focusing on the base flood elevation of the main structure. Cultural resources values involve integrity and historical value information, as well as design aesthetic.

Adaptive Capacity

From the overall perspective of the POSE framework, physical options are available, the organization is capable and committed to implementing them, and there is social support that could lead to funding to carry out an adaptation strategy. For facilities assets, the Light Station has a high adaptive capacity due to the strong local interest to maintain the cultural resources and roadway that would offer emergency services to communities. Although the technological requirements to maintain and protect the lighthouse is well understood, the expense of these projects may affect their practicability.

From a natural resources standpoint, the beaches and foredune ecosystems by the Light Station have high adaptive capacity, but the adaptation actions likely to protect other resources will interfere with that intrinsic adaptive capacity. The freshwater ecosystems and maritime forest have lower level of intrinsic adaptive capacity because as the island narrows, they are the first to be squeezed with nowhere to migrate and maritime forest adapts on much longer time scales. The organizational component of adaptive capacity is moderate to high for most habitats, but the economic component is low, with mixed results for the social component.

The cultural resources at Fire Island Light Station have a moderate to high adaptive capacity. The one exception are the archeological resources including the 1827 lighthouse foundation. While they can be excavated for their protection, this solution removes the resources from the landscape and from their original context. The removal of archeological resources then requires management through museum collections. Historical structures including the Lighthouse, Keeper's Quarters and Annex Building all have moderate adaptive capacity due to the public interest in these resources. Because these resources would lose their cultural context and sense of place, moving them would be the last option to consider.

Stewards of the Fire Island Light Station have been coping with the impacts of storms, erosion and accelerating sea level rise for more than a century. The island geography and low elevation which makes it so vulnerable has also shown great adaptability. The area likely has a lower risk to a breach due to the ample sediment supply for this portion of the island and thus the health of the dune system (Leatherman and Allen, 1985; Hapke et al. 2010).

Relationship of Vulnerability to Adaptive Capacity

The assessment team prepared a matrix comparing the vulnerability and adaptive capacity of the Light Station (Figure 4). Each resource type has a unique dynamic between its vulnerability and adaptive capacity. In a number of cases a deeper understanding of this interplay is required. A majority of resources are in the Serious But Actionable quadrant—high vulnerability and high adaptive capacity. This is due to the straightforward nature of maintaining and adapting structures in a dynamic coastal ecosystem. The resources in the High Concern – Review Goals quadrant due to lower adaptive capacity are the maritime forest, 1827 lighthouse foundation and the cultural landscape spatial organization. The park should review the long-term goals and strategies for these in relation to the other resources and the focal area to find opportunities for joint action.

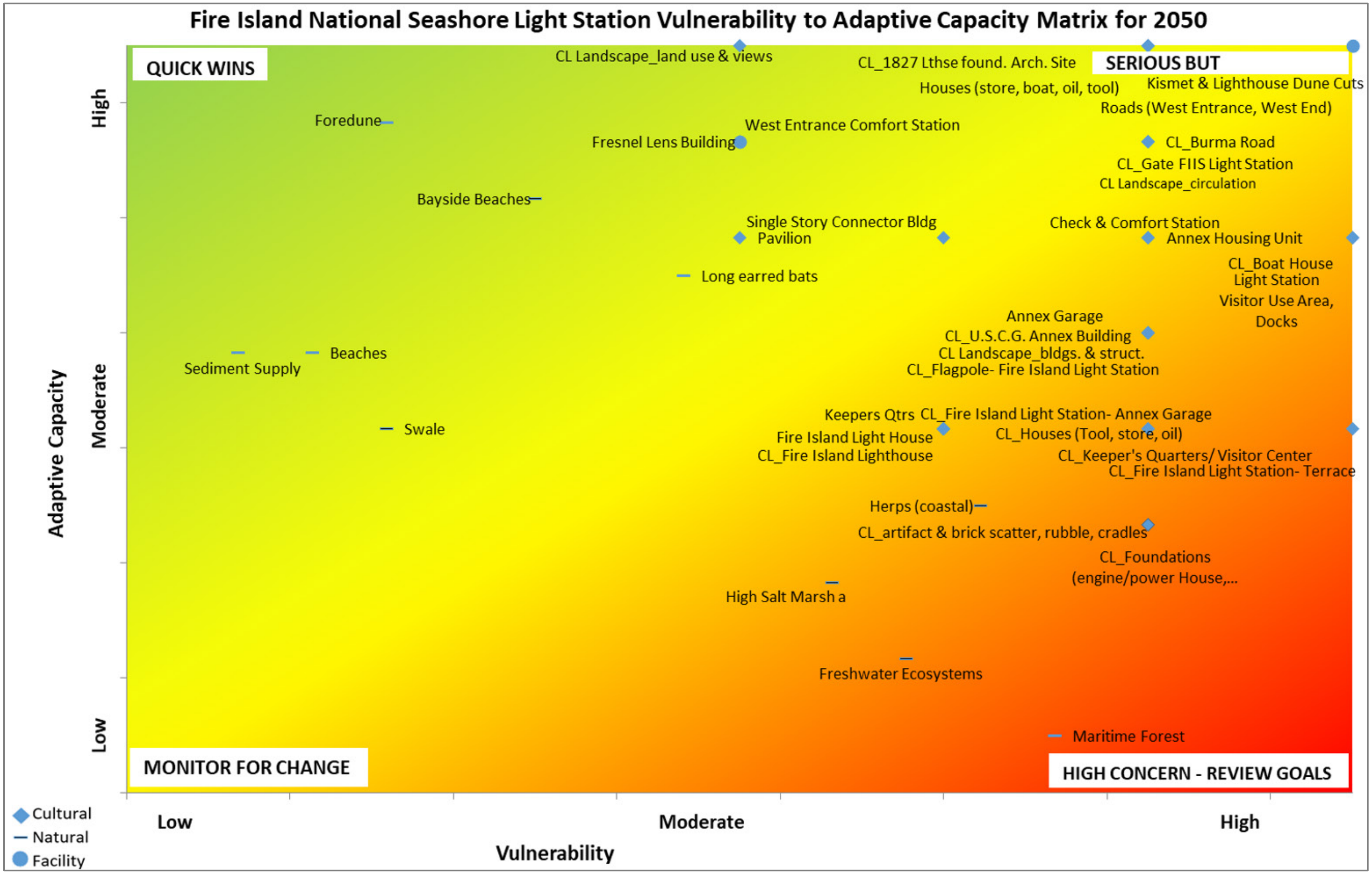

Figure 4. Relationship of vulnerability to adaptive capacity for Fire Island National Seashore Light Station, New York. CL is cultural landscape.

Recommendations

Recommendations for addressing climate change vulnerability in the Light Station are primarily management needs, supported by coordination needs.

- The assumption that Burma Road would be maintained as it currently functions, due to its role both for emergency access and for associated utilities will at some point need to be reconsidered. The question was raised of how many times would it have to be breached before leaving it open becomes a real possibility? Breach contingency planning would involve coordination with USACE, NYSDEC and affected communities (USACE, 2016; NPS, 2018). Options such as increasing bayside water transportation for emergency response were discussed.
- Investments in lighthouse repair, including the planned skim/surface coat, should incorporate climate information, and the long term vulnerability considerations. Long term, visitor safety and access, including whether the lighthouse remains open to climb will be part of the investment strategy.
- The current management plan is to re-nourish the Light Station tract dune without planting grasses to allow for piping plover habitat and seabeach amaranth. A monitoring program should be maintained to learn how well it works as sea level rise, storm strength and frequency increase.
- Prioritize long-term site management plans, specifically for the Coast Guard Annex and Light Station tract. This plan would determine when and where to move boat house.
- Road planning should be done more holistically, through park efforts with communities—with an acknowledgement that eventually it will no longer be feasible to maintain roads. Examples may be through driving regulations, Burma Road Working Group, and the right of way discussions with the utility providers. This planning should include water and electricity as they are integrated.

Island Change on the Bayside

Description of Resource and Value

In many places, the bayside beaches are eroding faster than the oceanside beaches (Nordstrom and Jackson, 2005; Psuty et al. 2017). The bayside shoreline is comprised of narrow beaches fronting salt marsh, maritime forest and freshwater ecosystems. The orientation and characteristic of the bay shore are inherited from past episodic additions of sediment delivered from the ocean side by inlets, storm-wave overwash and dune migration. Efforts to protect homes on the ocean side by constructing and stabilizing dunes have reduced sediment inputs across the island, eliminating the major sediment inputs to the bay shore. Bulkheads constructed to protect bayside marinas and buildings prevent the erosion of bluffs that would provide sediment inputs to the beach, and these structures trap sediment that would move alongshore under natural conditions. These limitations to input of new sediment contribute to bayside erosion. The net longshore sediment transport is east to west. The marinas at Watch Hill and Sailors Haven create substantial interruptions to sediment delivery alongshore. Areas within the marinas require periodic dredging. Reuse of material dredged from the marinas to create feeder beaches to supplement littoral transport is a potential management option (Nordstrom et al.

2016), but the gains are only a temporary fix to the larger issue of ongoing erosion exacerbated by sea level rise associated with climate change. The nearshore bayside resources of seagrass (*Ruppia maritima*, widgeongrass) and clam beds are part of this system because accretion, erosion and nourishment processes affect their vulnerability. There are also issues with disposal of contaminated dredge sediment from Watch Hill Marina. The challenges associated with bayside erosion are not limited to local disruptions at bulkheads and marinas. Erosion occurs along undeveloped segments of the bay shore as well because of actions taken on the ocean side.

While discussions tried to narrow down to a specific bayside focal area, and some could be taken as examples, it was important to recognize the system as a whole. Particular stretches that were identified for the discussion were Talisman to Point O' Woods and Point O'Woods to Cherry Grove.

The FIMI stabilization project was part of the larger context for the discussion, but since projects were in development, the specifics were beyond the scope of the assessment. The placement by the USACE of large volumes of sand within the communities, and thus within the larger Fire Island sediment transport system has the potential to serve as a source of additional sediment input to the bayside, but it has not been designed to do so. Discussions were informed by the FIMI process and future work will need to be coordinated with full understanding of long term change.

Vulnerability

The natural resources were scored based on the entirety of the habitat and initially without considering localized impacts, and even so bayside beaches are moderate vulnerability for all time frames and salt marshes (both high and low) are high vulnerability for all time frames (Figure 5). The methods for scoring vulnerability, as shown in Figure 5, are described in below sections for Cultural Resources (marked by squares in Figure 5), Natural Resources (marked by polygons in Figure 5) and Facility Assets (marked by circles in Figure 5), specific to methods for each program area and in more detail in Ricci et al. (2019b). Near Sailors Haven, there are clear examples of bayside erosion affecting the maritime holly forest of the Sunken Forest (moderate vulnerability changing to high by 2050), along with needs to reroute the trails to access it. Similarly, there are localized places where freshwater ecosystems (also moderate vulnerability changing to high by 2050) may have even higher vulnerability currently due to bayside sediment disruption and associated groundwater change causing saltwater intrusion. Nearshore areas of seagrass and clam beds (low and moderate vulnerability) can also be affected by disruptions in sediment processes, either indirectly through light availability or directly through impacts of management actions such as dredging or sediment placement. The marina facilities that sit along the bayside and play a role in the sediment transport disruptions are all moderate for the 2020 time frame then change to high vulnerability by 2050.

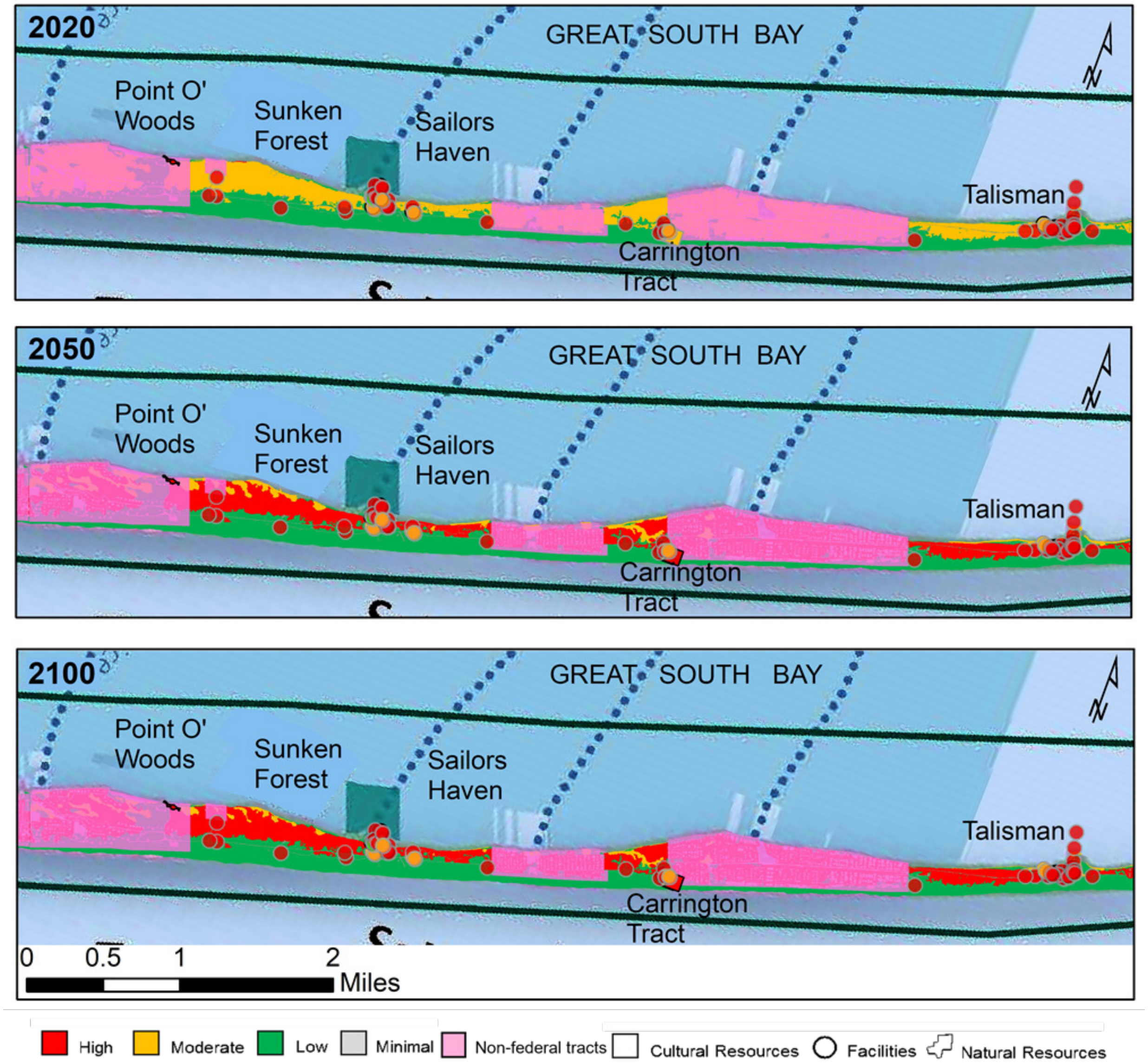

Figure 5. Vulnerability of Island Change on the Bayside from Point O'Woods to Talisman for Fire Island National Seashore, New York in 2020, 2050, and 2100.

Other factors related to the vulnerability of the marinas is that they may be vulnerable to a breach in those locations. The marinas have associated driving cuts (cross island routes for over sand vehicles) to the oceanside, and overwashes tend to follow the driving cuts. If a breach were to occur along one of these overwash channels, the bayside water is deep so there is potential to expand into a wide breach. There would likely be a push to close a breach if one occurred in the area of a marina. If there was an overwash event that made the area more vulnerable to a future breach, any push to build a berm to prevent a future breach needs to understand how that affects the long term adaptive capacity of the system. Places that have maintained artificially high berms in an effort to prevent a breach end up stopping the benefits of the overwash that in the naturally functioning system would add elevation to the landward side of the barrier island (Schupp, 2013).

As sea level rise exacerbates bayside erosion, it also draws the groundwater closer to the surface and the bayside (Raphael, 2014). These factors working together are already contributing to impacts to the Sunken Forest. While sections of the boardwalk to access the Sunken Forest have been relocated, the erosion is accelerating, and there are limitations on retreat in order to not impact the maritime holly forest further. The shallower depth to groundwater as well as saltwater intrusion can cause vegetation die-off, vegetation which would otherwise protect against erosion.

Adaptive Capacity

The adaptive capacity of bayside beaches was categorized as high, in particular due to high physical-technology and organizational components of the POSE framework—there are existing adaptation options that have been tested with existing infrastructure and authority that could be implemented here. Note that there is high uncertainty associated with the intrinsic adaptive capacity of the bayside beaches, as well as the other resources which contribute to the geomorphic system, particularly in relation to how they interact with the infrastructure. There is the potential for geomorphic processes to play a large role in adaptation if allowed. The other bayside natural resources all had low adaptive capacity. The facilities assets in the bayside areas were primarily high adaptive capacity with a few that were moderate.

Relationship of Vulnerability to Adaptive Capacity

For the resources on the bayside, comparing vulnerability to adaptive capacity (Figure 6), most of the resources fall in the Serious But Actionable quadrant, with a few natural resources in the Quick Wins and a mix of cultural and natural resources in the High Concern – Reconsider Goals quadrant. Those natural resources in High Concern are likely even higher vulnerability considering the potential impacts of actions that may be taken to protect the facilities. Given the high vulnerability and high adaptive capacity of so many of the facilities assets in the Serious But Actionable quadrant, there will be important adaptation planning opportunities that need to incorporate the larger natural resource questions in order to be successful. Doing management actions piecemeal for only one marina or community boundary will mean solutions will only be temporary, and yet will have downdrift consequences.

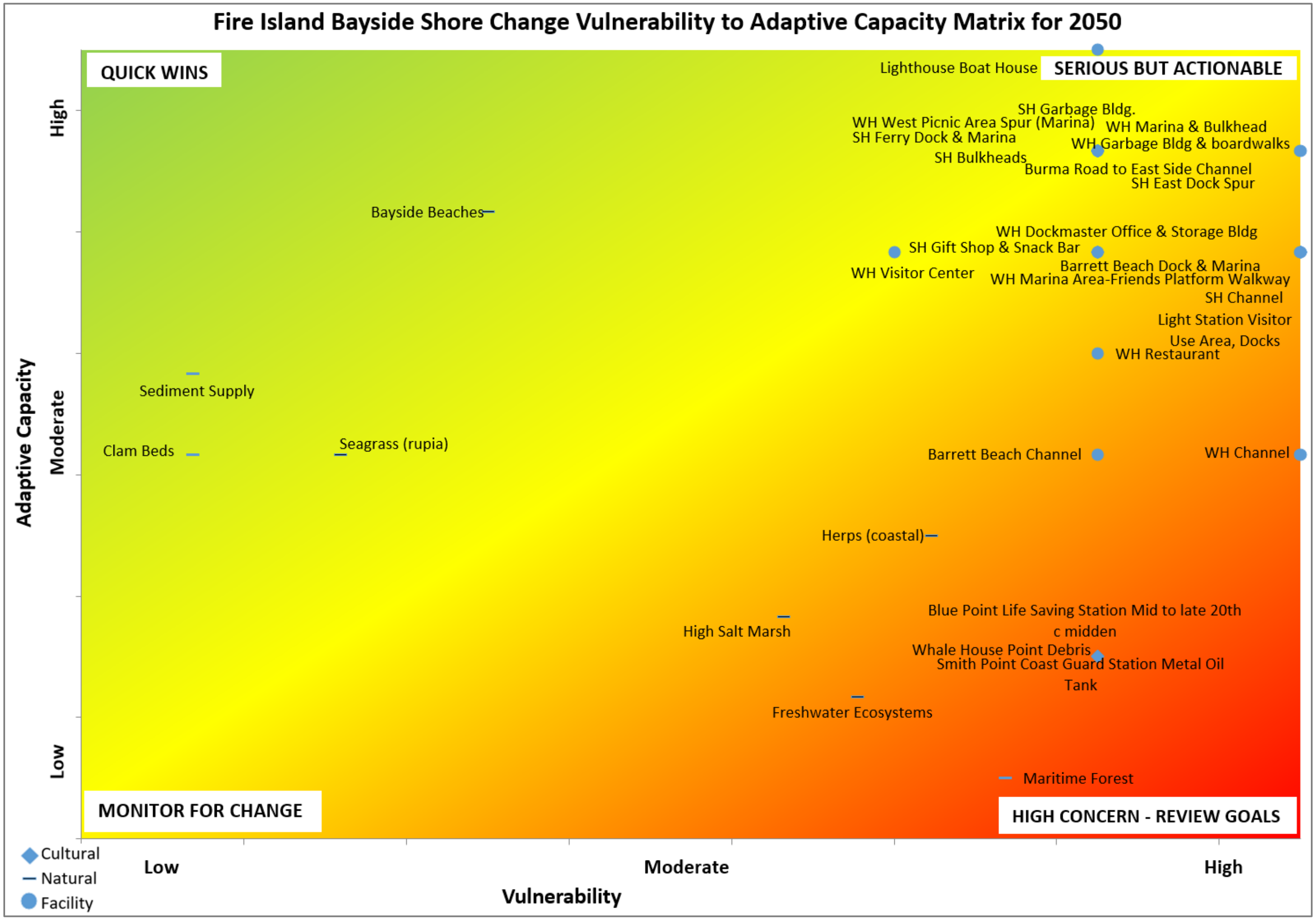

Figure 6. Relationship of vulnerability to adaptive capacity for Island Change on the Bayside at Fire Island National Seashore, New York.

Recommendations

The discussion of the interacting vulnerability and adaptation options of different resources in that the actions to protect some may be maladaptation for others raised more questions than recommendations. These recommendations are mostly based on future planning needs, informed by science needs, and capture some of the questions raised in discussion.

- Incorporate system-wide sediment transport and geomorphology into any localized management decisions for the bayside system.
- Plan for and continue studying feeder beaches. Feeder beaches are a shorter term management option for sediment disruption due to bulkheads and marinas that climate change may increase the need for and frequency needed. Expectation for the bayside system based on the Sailors Haven study (Nordstrom et al. 2016) is that they would need to be resupplied every 4–5 years. There are questions of scale on effectiveness of feeder beaches. A long term sediment source would be a problem because local sources from what is being directed away from the marina out of the channel and could be available for dredging are insufficient.
- Evaluate options for nature based solutions as wave barriers. Discussions of creating marsh to function as wave barriers need to consider the wave and sediment environment of where a marsh would be viable. Efforts to add protection seaward of the island to protect infrastructure would be going against the direction of sea level rise, where the long term imperative will be toward retreat. Sediment nourishment projects that mimic ocean to bayside sediment transport may be considered as a part of future FIMI planning. There is a need to coordinate FIMI project planning and implementation with long term adaptation goals; their role in the larger sediment transport system may reduce pressure on some downdrift areas, but may also introduce conflicting expectations. FIMI projects are important context for park management options. FIMI projects to protect homes may be on a scale that will affect the park natural processes in the adjacent areas (e.g. east side of Point O'Woods).
- Plan for changes at Sailors Haven. The proximity between Sailors Haven and the Sunken Forest, a globally rare habitat, presents potential conflicts between what we can do to protect different resources. The marina is an important public access point, but it also exacerbates erosion. The option of replacing the marina with a pier was discussed, and may be worth further study. It would need to be evaluated based on how much time it could benefit the maritime holly forest. An initial estimate is that by removing the marina and adding sediment, it might add 1–2 decades to the functioning of the maritime holly forest raises important questions for such trade-offs. Talisman is an example of an area where a marina was pulled and replaced with a pier; while the series of cuspid headlands there a geomorphically more stable, marine access goals there have had to change.
- Consider longer term options for replacing facility functions: these could include replacing the maintenance shop or housing from on island vulnerable locations to mobile facilities such as on a barge that could be removed in storm season. Consider alternatives to the marina (e.g. mooring buoys, but potential impacts to the seagrass need to be planned for in siting and designing moorings). Summertime fetch (the distance traveled across open water by wind) makes mooring buoys less appealing to boaters.

- Allow a breach to persist, and allow overwash to make its way to the bayside: this is a long term way the bayside system can maintain its sediment budget.
- Lead conversations about preparing for change with the communities and partners. As the park considers more creative adaptation options, regulatory agencies will also need to consider more creative options, especially within the communities. While some actions will be reactive to storms, preparation for change will need to be proactive.

William Floyd Estate

Description of Resource and Value

Continuously owned and occupied by the Floyd Family from 1720 to 1976, the 613-acre William Floyd Estate was the home of General William Floyd, a signer of the Declaration of Independence. The family's multigenerational tenure on the property not only tells their story but also reflects the dynamic social, economic, and political changes that took place over time on Long Island and throughout the nation. It is located in the midst of a densely developed residential neighborhood in the village of Mastic Beach. The Estate has 27 buildings and structures to be preserved, including Old Mastic House that needs to be stabilized. The Estate's major landscape features serve as a cultural resource for tracing 300 years of management and changing use, currently a mixed habitat complex of fields, forest, wetlands and marshes.

The Estate has a shoreline on Great South Bay that does not have seawalls or other shoreline protection structures. Current management issues include protecting native animals and plant species, management of white tailed deer population, southern pine beetle and non-native invasive plants, challenge of tick populations posing health risk to visitors, and presence of mosquitoes with the potential for spreading West Nile Virus or Eastern Equine Encephalitis in and near the Estate. Man-made ponds—one freshwater, the others brackish—were created for waterfowl hunting by members of the Floyd family. The man-made ponds are one acre or less in size and are fed by the exposed groundwater aquifer and direct rainfall. Some ponds are contaminated by agricultural chemicals including DDT (Dichlorodiphenyltrichloroethane) (Sprenger et al. 1988). The tidal wetlands are cut extensively by mosquito ditches.

Vulnerability

Much of the William Floyd Estate landscape has been in flux for 300 years now, it is continuing to change and will be substantially different in 100 years. Cultural resources (Figure 7 and shown with all resources in Figure 8) show how the high vulnerability resources for 2020 include low lying habitats and a couple of roads. The methods for scoring vulnerability, as shown in Figure 8, are described in below sections for Cultural Resources (marked by squares but also Figure 7 indicates roads and trails that are part of cultural landscape), Natural Resources (marked by polygons in Figure 8) and Facility Assets (marked by circles in Figure 8), specific to methods for each program area and in more detail in Ricci et al. (2019b). Note that for this area, few Cultural Resources change vulnerability between time frames so there is little difference between the panels in Figure 7. By 2050 more of the upland resources and assets are expected to shift to moderate and high vulnerability (Figure 8).

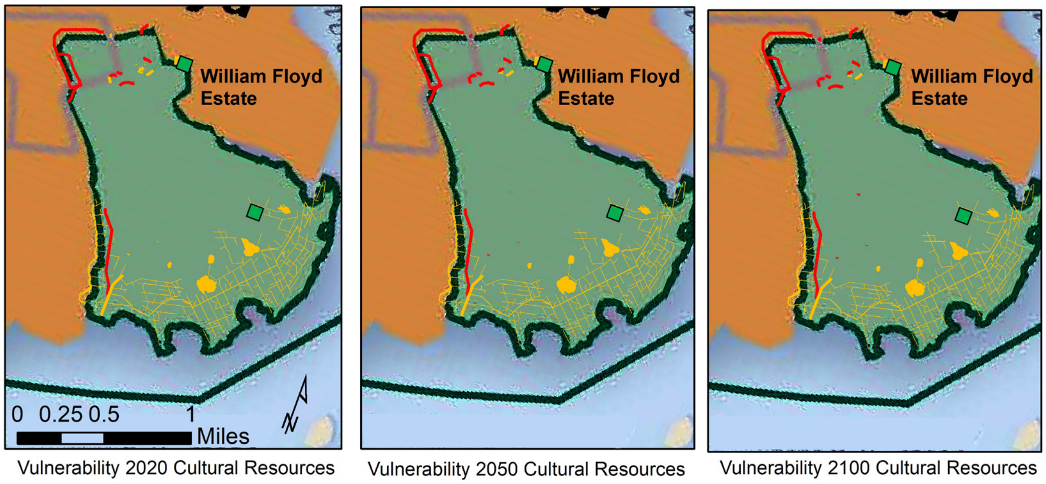

Figure 7. Vulnerability of cultural resources in 2020, 2050, and 2100 at the William Floyd Estate, Fire Island National Seashore, New York.

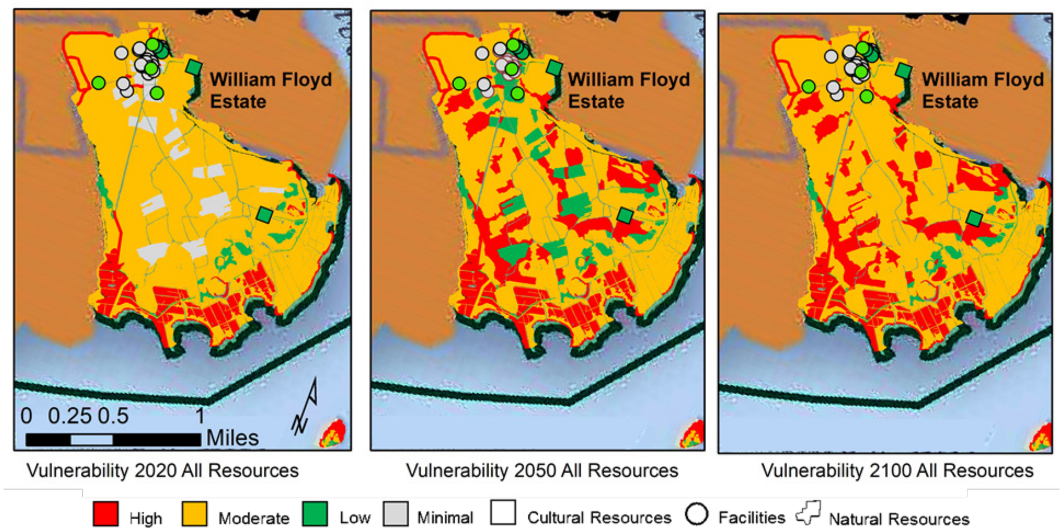

Figure 8. Vulnerability of all resources in 2020, 2050, and 2100 at the William Floyd Estate, Fire Island National Seashore, New York.

In the historic period the Estate changed dramatically from forest to almost entirely cultivated fields, then eventually back to forest during the hunting retreat period, leading to the mixed landscape that is seen now. Present conditions are being driven by sea level rise and the migration of the marsh to the uplands of the Estate, which is inundating shoreline landscape features. Salt tolerant species are increasingly present. The forests themselves are changing and deer population increases have had an important impact on the Estate. Although there is ongoing pressure to keep the fields open, maintaining them is becoming harder as woody vegetation persistently overtakes open areas. The landscape changes are taking place over an armature of a cultural landscape, the record of which is still present in the land itself. Features related to historic engineered structures and the cultural landscape include the ditches, the dikes, the roads, the ditch and berm system, the ponds, the fields.

Climate related changes are affecting all of these physical records of the use of this land, the organization of this land, all the way back to William Floyd's time.

Among the climate impacts of greatest concern to the William Floyd Estate, strong winds and stronger storms such as Nor'easters and hurricanes will cause damage to structures and the landscape. Rising groundwater, potentially in conjunction with increased heavy precipitation events, is presently affecting basement flooding in Estate structures. Sea level rise will change the types of plants that can survive in the lower Estate landscape and impact cultural landscape features such as ditches, ponds and roads. The ongoing marsh recession increases exposure of other habitats to salt water intrusion and erosion. Sediment washout from ponds is an increasing concern due to potential contamination from pesticides such as DDT, with four out of five ponds expected to be inundated from sea level rise by 2050.

A major die-off of pitch pine is underway due to southern pine beetle. Another ongoing threat to the Estate is from fire including wildfires and arson. Prolonged dry periods are expected to exacerbate this concern. In summary, the William Floyd Estate faces the prospect of losing areas of the 300-year footprint of use of the estate, and the story of the landscape.

Adaptive Capacity

Facilities at the William Floyd Estate have mostly high adaptive capacity, while natural and cultural resources range from low to high adaptive capacity. There is a strong commitment by the Park to protect these facilities as well as enduring public interest and support that will help in future funding of needed adaptations. Most of the cultural resources with low adaptive capacity were minimal or low in all four components. The natural resources that were evaluated specific to the William Floyd Estate (long eared bats, mixed hardwood forest, open fields) were lower adaptive capacity more from the organization, social and economic components, though long eared bats were high for organizational and economic components. The transportation assets were either high across all components or were scored moderate because a mix of high physical and organizational but low social and economic.

Relationship of Vulnerability to Adaptive Capacity

Looking at vulnerability versus adaptive capacity for the combined resources of the William Floyd Estate, most of the resources fall within the Serious But Actionable quadrant of moderate to high vulnerability and moderate to high adaptive capacity (Figure 9). These are mostly cultural resources, and some of the associated natural resources that are important elements of the cultural landscape. Most of the facilities assets fall in the Quick Wins quadrant of low vulnerability and high adaptive capacity, which may be a good place to start given the expected progression over time of vulnerability. There are important resources that fall in the High Concern-Review Goals quadrant of high vulnerability and low adaptive capacity. Reviewing the goals for these resources may help identify needs for documenting and planning for how they fit with the larger interpretive goals.

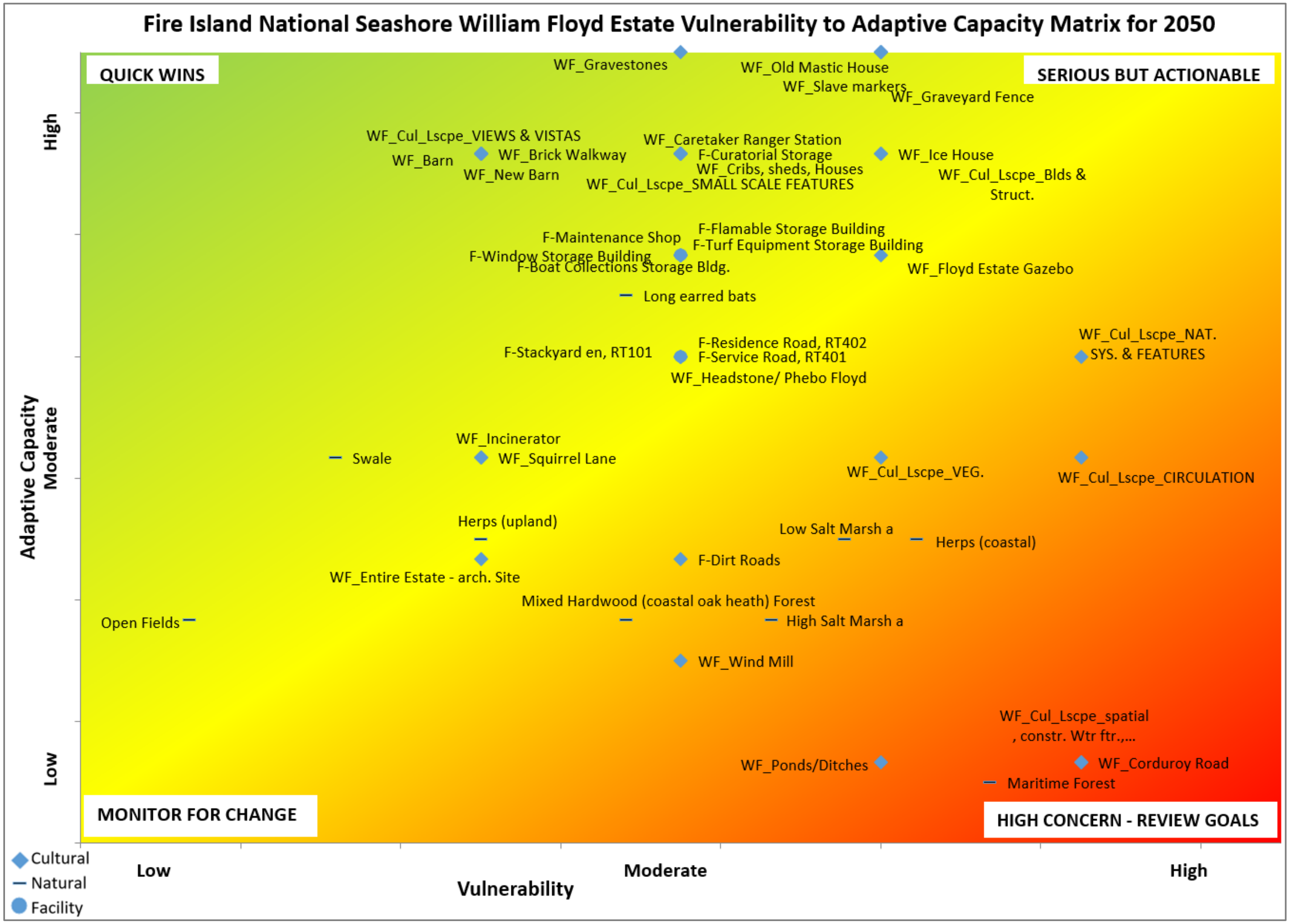

Figure 9. Relationship of vulnerability to adaptive capacity for 2100 for the William Floyd Estate, Fire Island National Seashore, New York.

Recommendations

- The key inflection point for the Estate is already at hand. Fortunately, a Cultural Landscapes Report is to be completed in 2020. It will contain non-binding treatment recommendations for the Estate and other park historical and cultural resources and fill an important management need to set out the resources present in the Estate landscape and how it fits together as a whole.
- Improve access to the Estate grounds and resources. Improving the Estate's role in interpreting landscape and climate change requires making them visible, and improving access in the near term. This could involve repairing the dike systems, board walk construction, and other means of access that enhance landscape visibility.
- Define what a "healthy forest" means in the context of the Estate. Building on the deer management plan (NPS, 2015b), the park needs to clarify what a healthy forest is comprised of as these ecosystems migrate across the land (Fisichelli et al. 2015). This includes addressing invasive plant species, the impact of deer, the southern pine beetle and the dynamics of the hydrology of the Estate. This is primarily a science need since a better understanding has to precede identifying more specifically how to get there.
- Track and interpret shoreline and near-shore resource changes to visitors. The Estate's shoreline is presently one of the few remaining unhardened segments of the northern coast of Great South Bay and adjacent embayments. It is also possibly gaining new habitats such as shellfish beds. The existing modifications to the coastal strip including the five ponds, the extensive berm and ditch system are the locus of marsh migration to new areas within the estate. The presence and growth of Phragmites is an indicator of this ongoing change and can be viewed as "marsh in escrow", that is, the future location of salt and brackish marsh as sea level rises.
- Investigate the proper compliance necessary for actions associated with potentially contaminated materials in the coastal ponds. The fear is that the ponds will all be breached with higher scenarios of sea level rise, combined with inundation from storms and heavy rainfall. This would undermine previous thinking that the best course would be to leave the ponds undisturbed, since they could be subject to increased velocity of water flow and resuspension of potentially contaminated sediments. For the ponds, no physical landscape action is required right now.
- In regards to interpretation, expanded documentation of the landscape is more urgent than ever as the Estate has changed. Engineered historic cultural landscape features such as the Corduroy Road are already disappearing. Good documentation of all highly vulnerable resources is needed so that the full story of the past and the future of the Estate can be told. Features such as the ponds, windmill, and linden tree may not be visible to the public in the future, but proper documentation will enable options to continue to tell their story. There is a science need to show history of the shoreline change, for example by comparing old and new maps, along with shoreline change data.

Integration of Scoring across Program Areas

This assessment focused on the integration across three major program areas—Cultural Resources, Natural Resources and Facilities. Integration was achieved using a variety of techniques. First, the three workgroups shared their analysis and scoring throughout the process so they could understand how each workgroup assessed the exposure and sensitivity of the resources. Second, interactive workshop sessions for each focal area allowed the group to go deeper in the analysis of how exposure and sensitivity will play out and interact with other associated resources for a place. Finally, as the workgroups scored their respective resources they noted those which overlapped with another workgroup due to shared responsibility or direct dependence. For instance, historic buildings received scores from the Cultural Resources and Facilities workgroups which enabled a discussion and review for discrepancies as to how vulnerable that resource is from those two perspectives or sets of stressors. Details of the process, techniques and stressors for each workgroup can be found in the methods guide (Ricci et al. 2019b) and the latter chapters for each group in this report. Integration occurred for all of the resources in the park at a basic level, though the Focal Areas chapter highlighted how integration occurred for three areas of shared interest amongst the three workgroups.

Cultural Resources

Key Messages

At Fire Island NS, the cultural landscapes, historic features, and archeological sites, that comprise the park, as well as the neighboring communities are already being impacted by ongoing erosion and sea level rise, which are both affected by climate change. Landscapes and structures on Fire Island are the most vulnerable compared with sites on the mainland of New York (Figure 1). And the landscapes, sites, and structures are already changing on Fire Island NS; a priority now needs to be using these changes to illustrate and share the climate change story.

Vulnerability

The two components of vulnerability in this study are exposure and sensitivity. In order to address exposure and sensitivity, the Cultural Resources Workgroup divided resources into seven geographical areas:

- Blue Point Life-Saving Station
- Camp Cheerful
- Carrington House tract
- Fire Island Light Station complex
- Smith Point Light Station complex
- Whale House Point
- William Floyd Estate

Within each of these areas, the Cultural Resources Workgroup used a comprehensive park list of cultural resources. Cultural landscapes were identified using the CLI, archeological resources using the ASMIS, and historic structures using the LCS. From this list, park and regional staff used their professional expertise and judgment to determine a list of priority resources. Through this process, staff focused on selecting all of the structures with historical characteristics rather than modern infrastructure as these structures were captured in the simultaneous Facilities Workgroup's assessment and grouped individual structures (e.g. flagpoles) by site. The Cultural Resources Workgroup determined that the impacts of stressors such as storm surge may be minimal on an individual structure, but damage to the site and surrounding area may impact the ability to use that structure, making the vulnerability of the site a more informative assessment.

Once a list of resources was developed, the Cultural Resources Workgroup assessed the exposure and sensitivity of each resource to eight separate stressors of climate change. These eight stressors are:

- Breach
- Erosion
- Sea Level Rise
- Water Table
- Storm Surge

- Precipitation Events
- Fire
- Wind

The exposure and sensitivity of each resource to these eight factors were assessed in two ways. For sites that had specific geographic locations, exposure to these factors was determined by data overlays in a GIS map. For resources without identified or with a broad geographic footprint, a binary Yes/No response for exposure to each stressor within each geographical area was provided by subject matter experts. For sensitivity, the Cultural Resources Workgroup used a scale from 1–4 to represent sensitivity of each resource. In this system, a score of ‘4’ meant the resource warranted significant concern given the sensitivity to the climate stressor and corresponded with the qualitative score of high sensitivity. A score of ‘3’ for moderate and a score of ‘2’ for low. A score of ‘1’ indicated that the resource did not warrant additional concern beyond the normal level of care and maintenance. Each of the five types of cultural resources (archeological sites, historic structures, cultural landscapes, museum collections and ethnographic resources) had different considerations for exposure and sensitivity, discussed below. Vulnerability was calculated by normalizing (through binning) the raw exposure and sensitivity scores and then adding them together. They were binned first since sensitivity had a larger scoring range than exposure. The results of the cultural resources vulnerability are shown in Figure 10 with details shown for select areas in Figure 11. The exposure, sensitivity and vulnerability scores by each stressor for each time frame are shown in Appendix B.

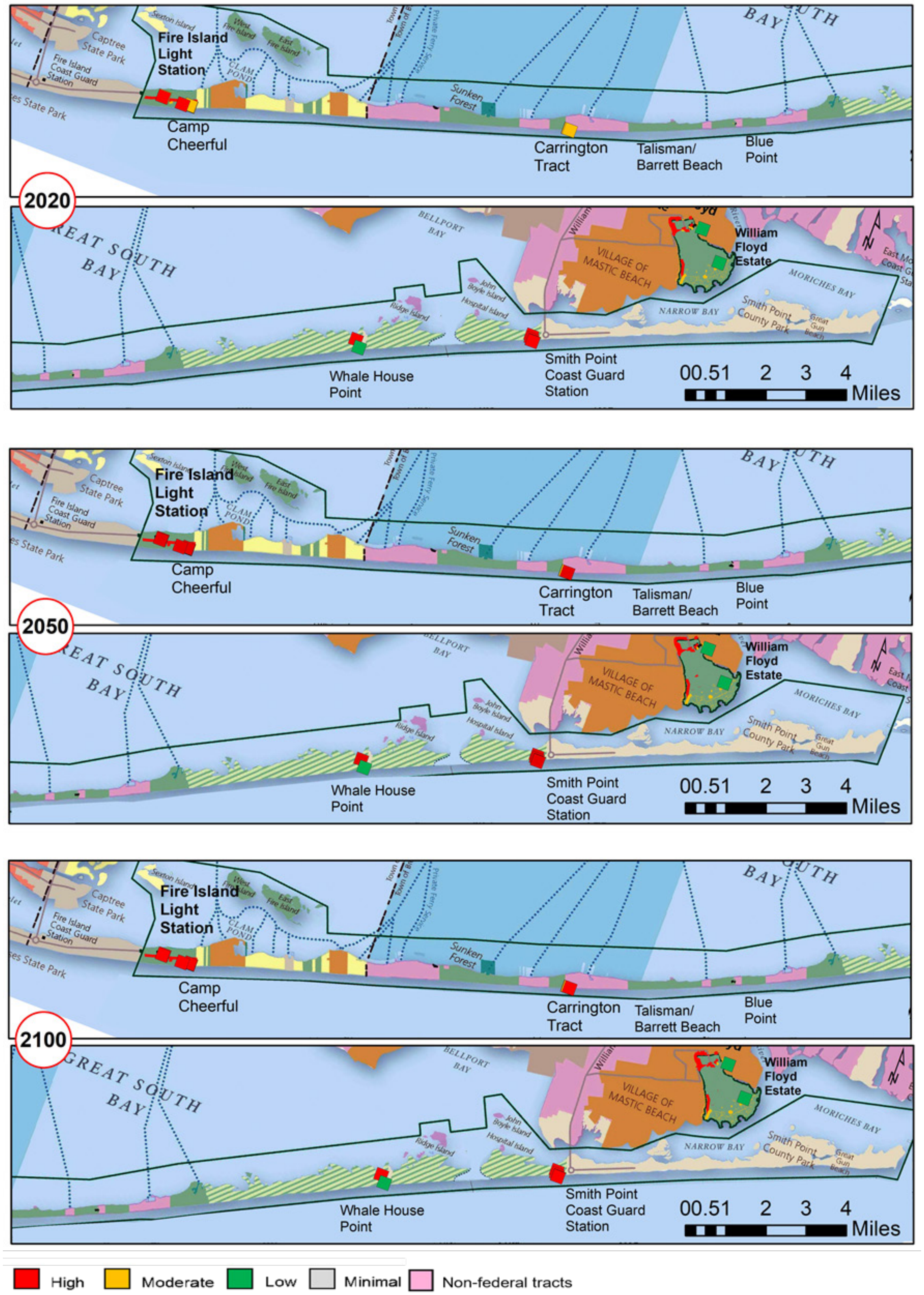

Figure 10. Vulnerability of cultural resources in 2020, 2050, and 2100 at Fire Island National Seashore, New York.

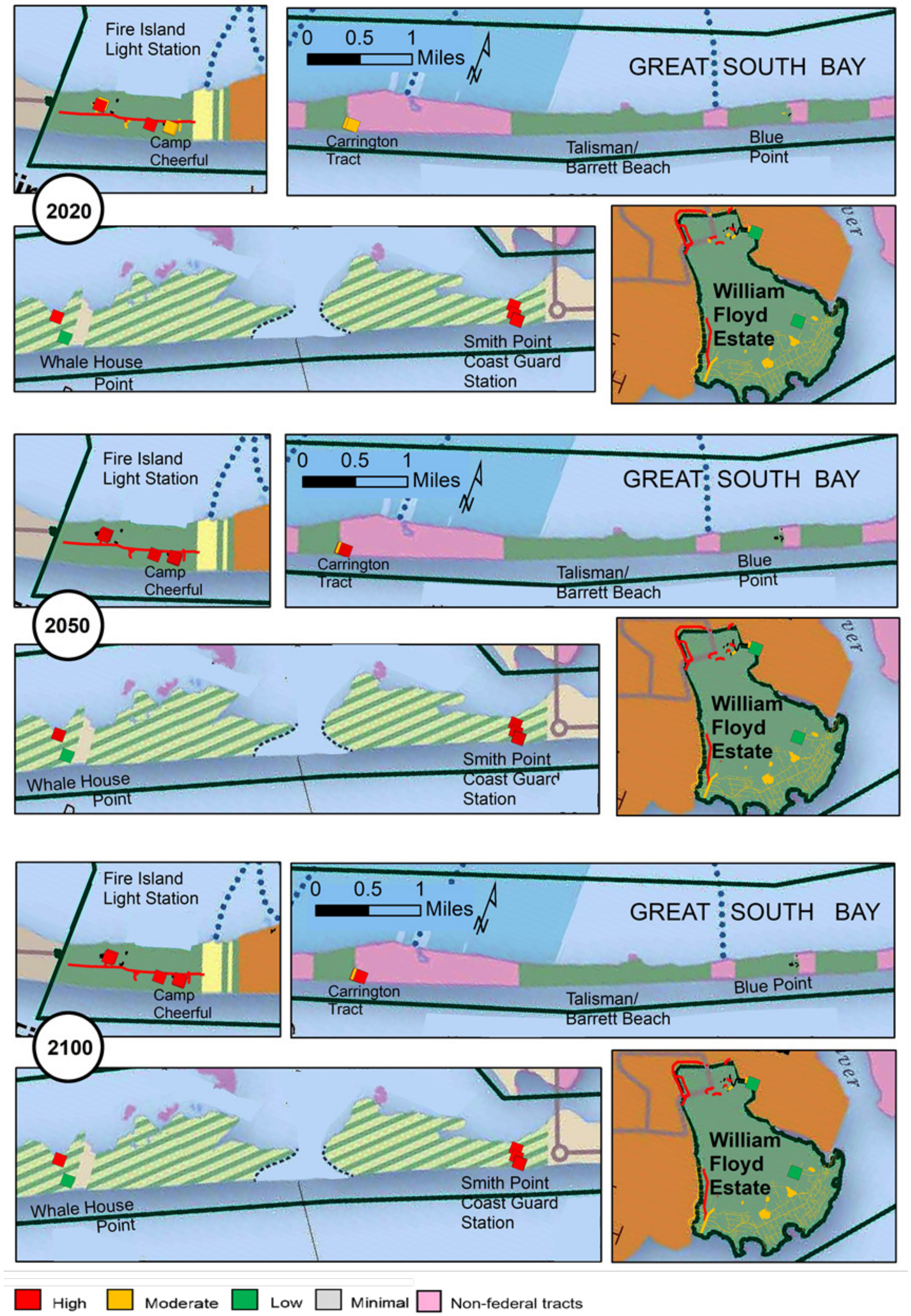

Figure 11. Vulnerability of cultural resources in specific areas in 2020, 2050, and 2100 at Fire Island National Seashore, New York.

Archeological Sites
The archeological resources of Fire Island NS are being impacted by ongoing erosion and sea level rise amongst other factors. For additional information on potential impacts of various climate stressors see Morgan et al. (2016). The combination of erosion and sea level rise can damage sites, disperse artifacts, and make sites inaccessible for staff and visitors. The ongoing erosion on both the Great South Bay and Atlantic Ocean-facing sides of Fire Island has already impacted or destroyed archeological resources. In addition to these climate change factors, sudden, storm-driven events such as surge or a breach of the island are challenging to predict and present a major risk to the integrity of archeological sites.

Historic Structures
The historical structures at Fire Island NS are primarily located on a barrier island and a breach of the island could damage or destroy many or all of the historic structures in an area. In addition to geographically-specific considerations such as storm surge and erosion on both the ocean and bayside, the difficulty in reaching the sites in a timely manner increases the fire hazard for historic structures on Fire Island. Historic buildings and associated outbuildings may suffer damages from increasing shear force or changing wind patterns due to both the direct impacts of the wind and from the potential for increased water or other damages if the roof or other portions of the building become dislodged. Rising groundwater levels and sea level rise may damage the foundations of structures, affecting both the historic and structural integrity. A potential adaptation option may include using beach nourishment to slow bayside erosion to extend the amount of time for decision-making about resource protection. While it was beyond the scope of the discussion, any sediment management adaptation strategies would benefit from coordination with FIMI stabilization planning.

Museum Collections
The Cultural Resource Workgroup's assessment of museum collections was informed by the 2015 report, *Risk Assessment for Fire Island National Seashore Museum Collections*. The scope of the museum collections risk assessment extended beyond climate change issues, into questions on topics such as collection security. However, the concerns surrounding fire and emergency response time, sea level rise, and storm surge in the risk assessment were also echoed by the Cultural Resources Workgroup for this assessment.

Concerns about the exposure and sensitivity of collections artifacts from Fire Island NS were two-fold. First, direct impacts of climate change may affect the foundation of buildings or increase the amount of electricity needed to maintain the temperature and humidity of the historic structures and buildings in the William Floyd Estate serving as storage facilities, both on a regular basis and during storms when power is lost. Second, any excavation and retrieval of artifacts conducted in the park as a climate change mitigation measure could increase the required museum storage space, leading to budgetary and management challenges.

The relative isolation of many sites at Fire Island NS or the lack of available fire equipment could affect response times should a fire occur. Museum collections stored on the island are at risk from sea level rise and storm surge. Museum collections stored at the William Floyd Estate may be damaged by changing temperature and humidity regimes if the existing climate control systems are unable to cope with changing climate regimes.

Cultural Landscapes

To assess the totality of factors that comprise cultural landscapes, the Cultural Resources Workgroup divided cultural landscapes into boundary, natural systems and features, spatial organization, land use, topography, vegetation, circulation, buildings and structures, views and vistas, small-scale features, and archeological sites. The sensitivity of these various features was determined through consultation with the two existing CLI reports: Fire Island Lighthouse (NPS, 2006a) and the William Floyd Estate. For cultural landscapes that have been identified, but not yet documented, sensitivity of the cultural landscape boundary was addressed using expert judgment. Not every potential cultural landscape in the park has a formal inventory. Because cultural landscapes include both natural and man-made features, the exposure and sensitivity vary greatly from built structures to natural features. In addition to the eight exposure and sensitivity indicators, cultural landscapes may change due to natural accretion along the shoreline. Accretion was not scored for the other resource types, but was incorporated into cultural landscapes scores.

Ethnographic Resources

Future efforts could benefit from tribal consultation, including reaching out to the Shinnecock, Unkechaug and Delaware tribes, to understand key sites, characteristics, and species of significance in Fire Island NS. Lesbian, Gay, Bisexual, Transgender, and Questioning (LGBTQ) communities are another key stakeholder group to reach out to for future inclusion of ethnographic resources.

Adaptive Capacity

Cultural resources represent a diverse collection of materials, structures and sites with diverse preservation requirements and limited adaptation strategies in the face of climate change. While natural resources may have intrinsic abilities to adapt to change, man-made sites and memorialized viewscapes may not have the same flexibility. NPS guidance recognizes that resource adaptation may include a range of options from loss to reconstruction. The ability of site managers and partners to aid in the protection of cultural resources from the impacts of climate change represents one type of adaptive capacity. The decision to handle adaptive capacity separately was informed by the work supporting the NPS Cultural Resources Climate Strategy (Rockman et al. 2016) though the method was developed at a pilot workshop prior to that publication (Ricci et al. 2019a). Table 4 shows key considerations for each type of cultural resource, in each of the five categories of adaptive capacity. The table also indicates categories and resource types for which the Cultural Resource assessment was advised by Natural Resources and Facilities adaptive capacity scores. Although the table below shows key considerations, the adaptive capacity of each priority site, structure and feature in this study was scored individually. Details of the adaptive capacity scores for cultural resources are in Appendix C.

Table 4. Cultural resource adaptive capacity (AC) guidelines used in methodology.

Resource Type	Physical AC: Intrinsic	Physical AC: Technological	Organizational AC	Social AC	Economic AC
Archeological Resources	Default value = Low Archeological resources have little or no ability to adapt without human intervention.	Maximum value = Moderate Excavation, etc. saves the story, but not the site and context.	Default value = Moderate Sites with potential for partnerships.	Minimum value = Moderate Well-known, or important sites may receive more support for adaptation.	Default value = Low Adaptation actions for archeological resources are very expensive.
Historic Structures	Default value = Low Historic structures have little or no ability to adapt without human intervention.	Historic structures may be protected through a combination of historic and modern preservation techniques. Interventions must consider preserving the historic integrity.	Organizational capacity may depend on historic preservation staff. Scores advised by facilities scores.	Structures with associated community groups may have higher adaptive capacity.	Structures with concession or adaptive reuse potential may have higher adaptive capacity.
Cultural Landscapes	Natural features may have intrinsic adaptive capacity. Scores advised by natural resource scores.	Varies by landscape feature.	Organizational capacity may depend on park and regional cultural landscape expertise.	Certain parts of the landscape may have advocacy groups while others do not.	Economic adaptive capacity of cultural landscapes may depend on integrated projects among NPS program areas.
Collections	Default value = Low Collections have little or no ability to adapt on their own.	Collections resources may already be protected in climate controlled facilities.	Organizational capacity to protect consolidated collections is generally high.	Social desire to protect consolidated collections is generally high.	Climate adaptations to collections buildings may be expensive.
Ethnographic Resources	Natural features may have intrinsic adaptive capacity. However, changes to natural features may impact the ethnographic use of the resource.	Varies by ethnographic resource type.	Ethnographic resources may not be well-documented, which may present organizational challenges.	Modern uses may conflict with historic ethnographic uses.	Varies by ethnographic resource type.

Overall, archeological sites had a low adaptive capacity due to the low intrinsic ability of the resource to adapt and the high expense of existing adaptation options. Certain historic structures with high significance such as the Fire Island Lighthouse Tower had a higher adaptive capacity due to the interest as well as previous and ongoing investment in restoration at the site. Additional potential adaptation options for the Light Station tract include armoring the area, pumping water back into the Bay, and working with the local communities to maintain emergency access to the area.

The various features that comprise cultural landscapes have different adaptive capacities. The natural features of landscapes may have some intrinsic ability to adapt; however, low-lying, constructed waterworks and other manicured landscapes may be negatively affected by changing climate. Features such as the topography and spatial organization of sites have low adaptive capacities, while the views and vistas and small-scale features associated with these sites have a high adaptive capacity. In order to score the adaptive capacity of cultural landscapes, we worked through individual features with varying adaptive capacities. However, for the sake of assessment usability, these various adaptive capacities are reported as an individual score in many places.

The Cultural Resources Workgroup found it challenging to determine the economic adaptive capacity of individual resources because while funding may be available, the use of economic resources on one site may mean they are no longer available for use at another site. Although each individual structure may be able to adapt, without understanding how much funding was set aside for other sites, it was very challenging to score this. Another challenge the workgroup faced associated with scoring adaptive capacity came in trying to separate sites that may be dependent on other structures for physical protection.

Relationship of Vulnerability to Adaptive Capacity

Comparing the vulnerability of cultural resources to adaptive capacity provides additional insights into the areas of concern and how they could be linked to other resources when considering actions (Figure 12). From a cultural landscape perspective, the Fire Island Light Station has high vulnerability and moderate adaptive capacity. Part of the adaptive capacity of the Light Station area will depend on the partnerships with local communities who desire to access their homes and thus advocating for long term maintenance of the Burma Road through the Light Station area. At the William Floyd Estate, many of the buildings have a high adaptive capacity because they can be moved and are of interest to visitors. The historic engineered structures, roads, trails, and the series of constructed ponds on estate grounds are key components of the story of how the Floyd family used the land and how land use has changed overtime. However, some of these components of the cultural landscape may have a lower adaptive capacity because they are dependent on their original location and cannot be moved or protected. There may be options for boardwalks or other construction to allow visitors ongoing access to the estate grounds.

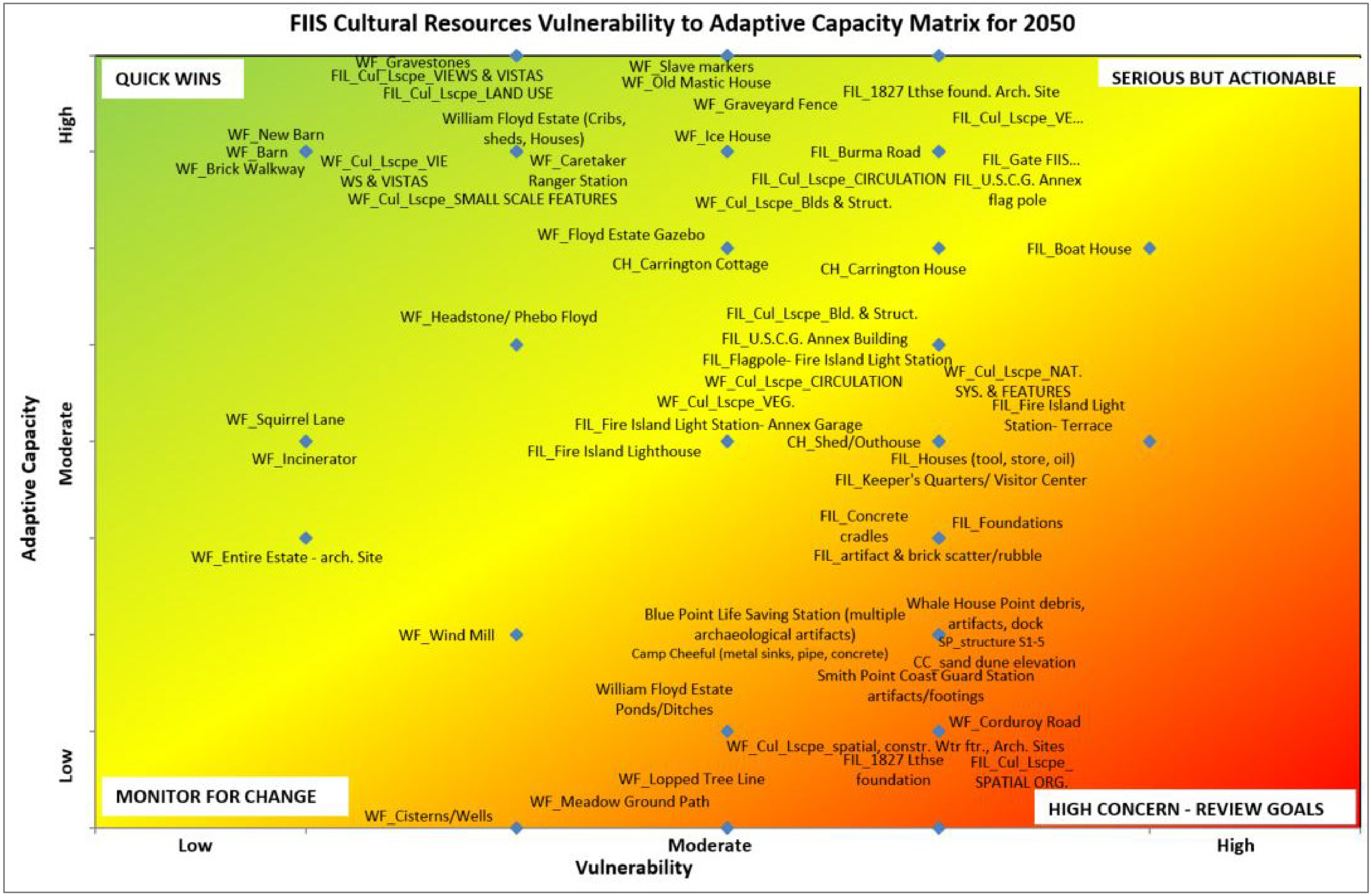

Figure 12. Comparison of vulnerability to adaptive capacity for cultural resources in 2050 at Fire Island National Seashore, New York.

Recommendations

- The Cultural Resources Workgroup observed that sites are already being lost to erosion and climate change factors. As such, the Workgroup's overall recommendation is that adaptation actions need to be implemented alongside ongoing planning processes. Recommendations from the workgroup at the conclusion of this process fall into two categories: planning and action. Through proactive planning the Cultural Resources group can apply for funding to document vulnerable resources.

The following action-oriented recommendations focus on developing collaborative plans with partner organizations:

- Document what will be lost, recover and archive limited artifacts as museum space and budgets allow.
- Continue to repair the lighthouse tower with the current funding and project support.
- Be proactive in planning efforts and have plans in place for cultural resources if or when the island breaches.

Natural Resources

Key Messages

The highest vulnerability resources identified are the salt marshes, maritime forest, freshwater ecosystems and coastal reptiles and amphibians (herps). While the dynamic nature of some habitats and landforms mean that in general, many natural resources are low or moderate vulnerability, the characteristics that enable them to respond to change are limited in areas where they intersect with infrastructure and cultural resources. In these places, the management actions to protect facilities and cultural resources is not likely to rely on natural functioning processes such as overwash to maintain sediment supply and thus localized vulnerability would increase.

While resources were scored individually, the dynamic nature of the barrier island system means that the vulnerability of resources is interrelated. Discussions made it clear how important a naturally functioning geomorphic system is to each resource, extending well beyond the beach and foredune. Part of this functioning is overwash and breach events. There are future thresholds that this method wasn't able to identify, where breaches, and the management responses to them will change geomorphic conditions and these estimates of vulnerability will no longer be applicable. It is important to note the tradeoffs between natural and cultural resources, where breaches are considered an important part of a naturally functioning geomorphic system for natural resources and are included as a stressor for cultural resources.

The Wilderness area was the example where many habitats are naturally functioning and their exposure or sensitivity to each stressor was most clearly evaluated. Outside the Wilderness area, where non-climate stressors, such as bulkheads or invasive species, were a major factor, isolating sensitivity to climate stressors was more complicated. This assessment was limited to resources on NPS property, so did not include the resources within the communities, and management actions within them, such as sediment management. However, the management actions that are taken by the communities affect the vulnerability and adaptive capacity of park resources. Regional sediment management efforts planned through the Fire Island to Montauk Point (FIMP) reformulation study and the FIMI stabilization project include management actions that are important context for adaptation planning (USACE, 2016; USACE, 2014). These projects have the potential to impact the long-term adaptive capacity of the barrier island, and the results of this analysis may need to be adjusted as those projects are implemented.

Vulnerability

The natural resources that were evaluated were a combination of habitats, species and other features such as water quality and sediment supply and are listed in Table 5. Habitats were chosen starting with those in the Natural Resource Condition Assessment (NRCA) (McElroy et al. 2009) and tried to combine the land cover classes from Klopfer et al. (2002) from which mapping was done; where classes were combined into a smaller number of habitat categories. Benthic habitats had limited mapping coverage from Lafrance Bartley et al. (2018). Resource categories were also informed by Inventory and Monitoring program climate change conceptual models (Stevens et al. 2010). Additional discussion differentiated geographically within some habitat types where vulnerability was expected to differ, such as separating the salt marsh islands from the rest of the salt marshes and identifying where only the occurrence at the William Floyd Estate was considered. Oceanside beaches (including overwash), are distinguished from bayside beaches. Many of the species chosen were due to threatened or endangered status. Sediment supply and groundwater were both identified as resources, that are distinguished from the related stressors of groundwater change or erosion. Those resources where geospatial data is available are mapped in Figure 13.

Figure 13 summarizes the main characteristics of the general habitat types in the park, based on combining vegetation categories of Klopfer et al. (2002), which were evaluated by the Natural Resources Workgroup.

Table 5. Summary of natural resources examined in the vulnerability assessment for Fire Island National Seashore, New York.

Natural Feature	Summary Characteristics (primarily from McElroy et al. (2009))
Seagrass (eelgrass)	Submerged aquatic vegetation beds dominated by eelgrass (*Zostera marina*), usually found in depths less than 8 m.
Seagrass (widgeongrass)	Submerged aquatic vegetation beds dominated by widgeongrass (*Ruppia maritima),* which is a smaller than eelgrass and usually found in depths less than 3 m.
Clam bed	Areas where either: (a) living clams, siphons, or siphon holes are the dominant surface feature, or; (b) clams dominate the faunal biomass. (CMECS)
High salt marsh	The marsh platform above mean high water. Dominant species is saltmeadow cordgrass (*Spartina patens*); “spikegrass (*Distichlis spicata*), black-grass (*Juncus gerardii*), and glassworts (*Salicornia* spp.) are also common”
Low salt marsh	Marsh “occurring at the seaward border of the high marsh, along the edges of saltwater tidal creeks, and along mosquito ditches that drain the high salt marsh”. Dominant species smooth cordgrass (*Spartina alterniflora*) is more salt tolerant.
High salt marsh (island)	Same species assemblage as the general high salt marsh habitat type, but specific to the islands in the Great South Bay
Low salt marsh (island)	Same species assemblage as the general low salt marsh habitat type, but specific to the islands in the Great South Bay
Beaches (including overwash)	The area between mean low water and the foredune, consistency primarily of unconsolidated sand. Mapped categories of vegetated sand, northern beach grass and open beach were split and those not in proximity to Great South Bay were included. Overwash dune grassland also included.
Bayside beaches	“Bayside beaches are small, usually measuring only a few meters from the tide line to the dune, and have relatively steep planar foreshores fronted by a broad, flat low tide terrace.” Mapped categories of vegetated sand, northern beach grass and open beach were split and those in proximity to Great South Bay were included.
Foredune	Barrier island landform between the beach and the swale. Mapped land cover type was northern beach grass dune.
Swale (backdune, maritime shrubland)	Barrier island landform behind the foredune. Mapped land cover types include Brackish Interdunal Swale, Northern Sandplain Grassland, Northern Dune Shrubland, Northern Salt Shrub, Maritime Vine Dune, Interdune Beachgrass-Beach Heather Mosaic, Beach Heather Dune.

Table 5 (continued). Summary of natural resources examined in the vulnerability assessment for Fire Island National Seashore, New York.

Natural Feature	Summary Characteristics (primarily from McElroy et al. (2009))
Maritime forest	Coastal wooded habitats found behind, and at higher elevation than, dunes. Mapped land cover types included Pitch Pine Dune Woodland, Japanese Black Pine Forest, Maritime Post Oak Forest, Pitch Pine-Oak Forest, Maritime Deciduous Scrub Forest. Also includes Coastal Oak-Heath Forest not on William Floyd Estate.
Maritime holly forest	The subset of the maritime forest that is the globally rare maritime holly forest which "is dominated by American holly (*Ilex opaca*) trees of up to 300 years in age with an average diameter at breast height (dbh) of 24 cm."
Mixed hardwood forest (William Floyd Estate)	Upland hardwood forest characterized by closed-canopy deciduous trees. Mapped land cover types include Coastal Oak-Heath Forest; do we also include Japanese Black Pine Forest, Maritime Post Oak Forest, or Pitch Pine-Oak Forest on Floyd Estate.
Open fields (William Floyd Estate)	Fields on the William Floyd Estate are kept open as part of the cultural landscape; these provide meadow type habitat.
Freshwater ecosystems	Surface freshwater system and associated ecosystems. Mapped land cover types include high bush blueberry shrub swamp, northern interdunal cranberry swale.
Piping plover	A federally listed threatened shorebird, *Charadrius melodus,* that nests on beaches and overwash.
Seabeach amaranth	An endangered plant species, *Amaranthus pumilus*, that prefers beaches, overwash areas and foredunes.
Colonial waterbirds	Seabird and wading bird species that congregate in colonies to nest and obtain all or most of their food (fish and aquatic invertebrates) from the water. They include a variety of birds such as gulls, terns, herons and egrets.
Long eared bats (William Floyd Estate)	Hibernating bat species known to roost at the William Floyd Estate. Includes federally listed threatened northern-long eared bat.
Herps (coastal)	Reptiles and amphibians found within coastal habitats.
Herps (upland)	The park distinguishes between reptiles and amphibians found within upland habitats at the William Floyd Estate, which include box turtles and black racers (snake). As with coastal herps these are not mapped.
Sediment supply	Sediment available in the transport system, both marine and aeolian
Water quality (estuary)	Water quality of the Great South Bay. Note this is different from the water quality stressors evaluated.
Groundwater	Subsurface system of freshwater stored in geologic formations. Note that this is different from the Changes in Groundwater stressor.

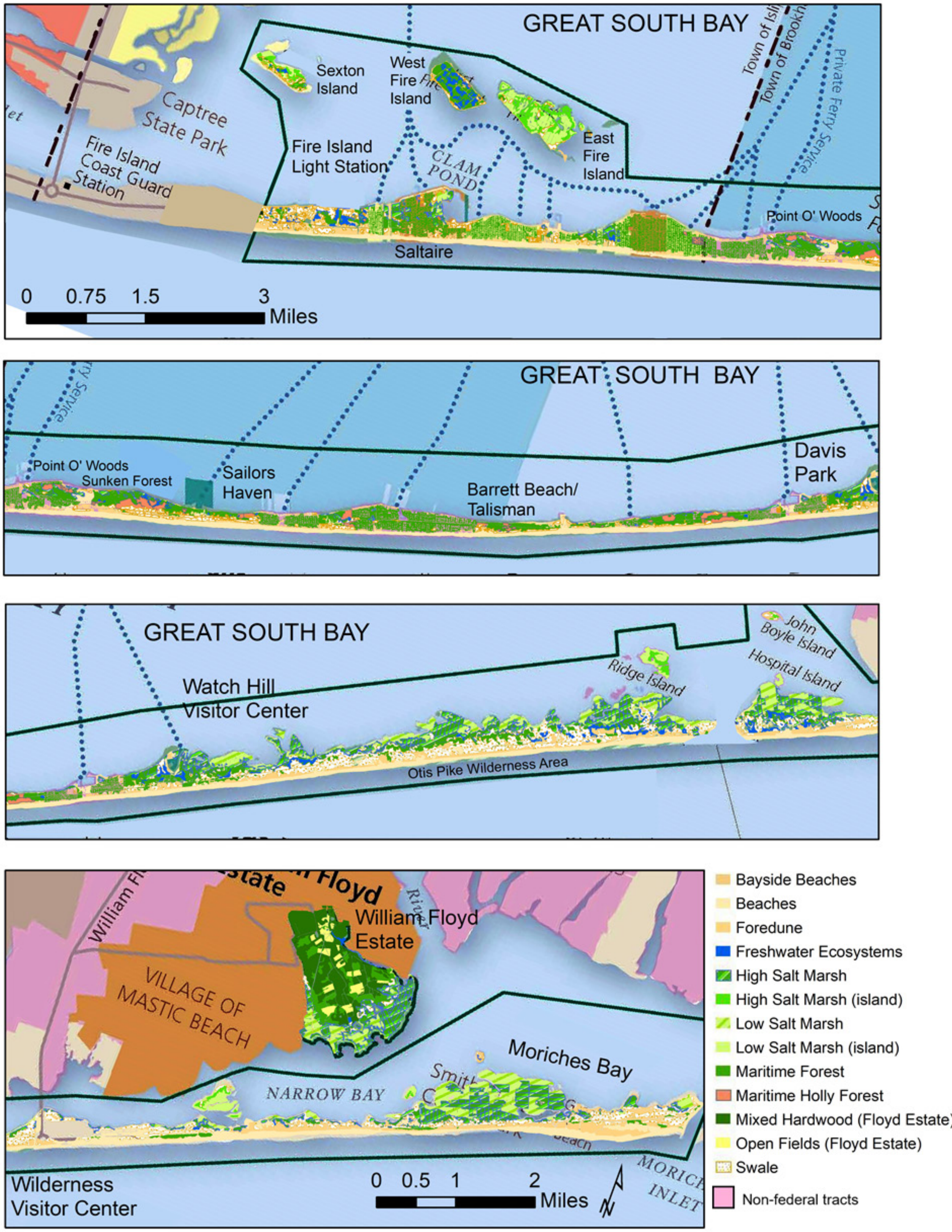

Figure 13. Land cover features, generalized by habitat types at Fire Island National Seashore, New York (Klopfer et al. (2002)).

Each resource was assessed based on exposure to seven climate change related stressors: sea level rise, groundwater change (depth to water, depth to saltwater-freshwater interface), severe storms and flooding, erosion, precipitation, temperature and water quality (pH, algal blooms and hypoxia, water temperature). Exposure is scored in a binary yes or no for each stressor for each time frame. Sensitivity is scored on a scale of Minimal or beneficial, Low, Moderate, High, and the reason or expected response noted for each stressor. Sensitivity does not change between time frames.

The exposure, sensitivity and vulnerability scores by each stressor for each time frame are shown in Appendix D. Five resources (four of which are marsh categories) are high exposure in all time frames. The two maritime forest resources go from moderate to high exposure by 2050. Five resources are moderate exposure in all three time frames and one more goes from low to moderate by 2050. Only open fields in 2020 was minimal exposure; that exposure increases to low in 2050 and moderate in 2100.

The high sensitivity resources are seagrass (eelgrass), water quality, all the salt marsh resources, maritime forest (both maritime holly and general), mixed hardwood forest, freshwater ecosystems, colonial waterbirds, herps (both coastal and upland), long eared bats, and groundwater.

Vulnerability is based on the combining scores of exposure and sensitivity of the resource by each climate stressor. The vulnerability to all the stressors is then combined for the total score. Each stressor was treated equally and not weighted differently, even though sea level rise might present a greater long-term impact for some resources. The combined vulnerability across all stressors then determines a resource's score (Minimal, Low, Moderate, High) for each time frame.

Vulnerability scores are shown in Table 6. Figure 14 shows a map of natural resources vulnerability for those resources with geospatial data. Finer details can be seen in Figure 15a-d for specific areas. All of the salt marsh categories of resource are high vulnerability for all three time frames, as are coastal herps. Oceanside habitats (beaches, foredune, swale) are low vulnerability and remain so over the three time frames. Many of the species scored with low vulnerability end up that way because they are closely dependent on their habitats, e.g. piping plovers are dependent on beach habitat, which is low vulnerability because it is not sensitive to sea level rise. Note that the low sensitivity of some of these habitats could be thought as partially related to what some would categorize as adaptive capacity, the beach will continue to exist, likely of a similar width and form, migrating landward in response to sea level rise. This was determined to be separate than the adaptive capacity framework used here, even the intrinsic component of adaptive capacity. Freshwater ecosystems, maritime forest and maritime holly forest go from moderate to high vulnerability by 2050. Eelgrass goes from low to moderate vulnerability by 2050. The one resource that changes over all time frames is the open fields of the William Floyd Estate, going from minimal to low to moderate vulnerability.

These simple scenarios are based on a 'bathtub model' analysis that represents sea level rise as a change in contour level of the shore. It does not incorporate the dynamic nature of habitat response to environmental changes nor the increased impact of storm surge as sea level rises. The discussions did include the dynamic nature of these landforms, and the sensitivity scores do consider future increased exposure. Since in this framework sensitivity is not allowed to change over time, for resources that are expected to have changing sensitivity to future exposure, the guidance was to assess for 2100.

Table 6. Natural resources vulnerability scores by time frame at Fire Island National Seashore, New York.

Resource	2020	2050	2100
Seagrass (eelgrass)	Low	Moderate	Moderate
Seagrass (widgeongrass)	Low	Low	Low
Clam bed	Low	Low	Low
High salt marsh	High	High	High
Low salt marsh	High	High	High
High salt marsh (island)	High	High	High
Low salt marsh (island)	High	High	High
Beaches (including overwash)	Low	Low	Low
Bayside beaches	Moderate	Moderate	Moderate
Foredune	Low	Low	Low
Swale (backdune, maritime shrubland)	Low	Low	Low
Maritime Forest	Moderate	High	High
Maritime holly forest	Moderate	High	High
Mixed hardwood forest (William Floyd Estate)	Moderate	Moderate	Moderate
Open fields (William Floyd Estate)	Minimal	Low	Moderate
Freshwater ecosystems	Moderate	High	High
Piping plover	Low	Low	Low
Seabeach amaranth	Low	Low	Low
Colonial waterbirds	Low	Low	Low
Long eared bats (William Floyd Estate)	Moderate	Moderate	Moderate
Herps (coastal)	High	High	High
Herps (upland)	Moderate	Moderate	Moderate
Sediment supply	Low	Low	Low
Water quality (estuary)	Moderate	Moderate	Moderate
Groundwater	Moderate	Moderate	Moderate

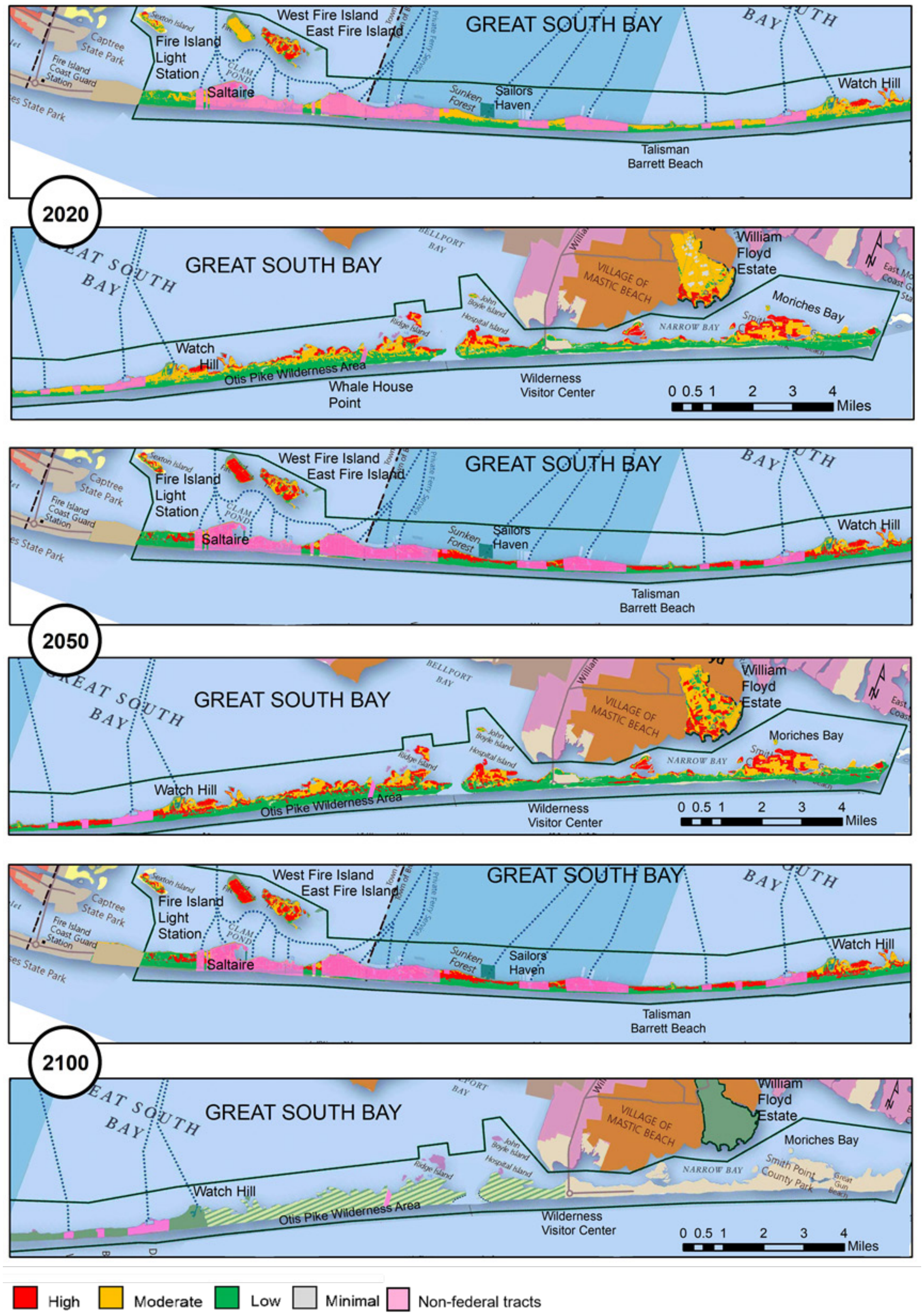

Figure 14. Vulnerability of natural resources in 2020, 2050 and 2100 at Fire Island National Seashore, New York.

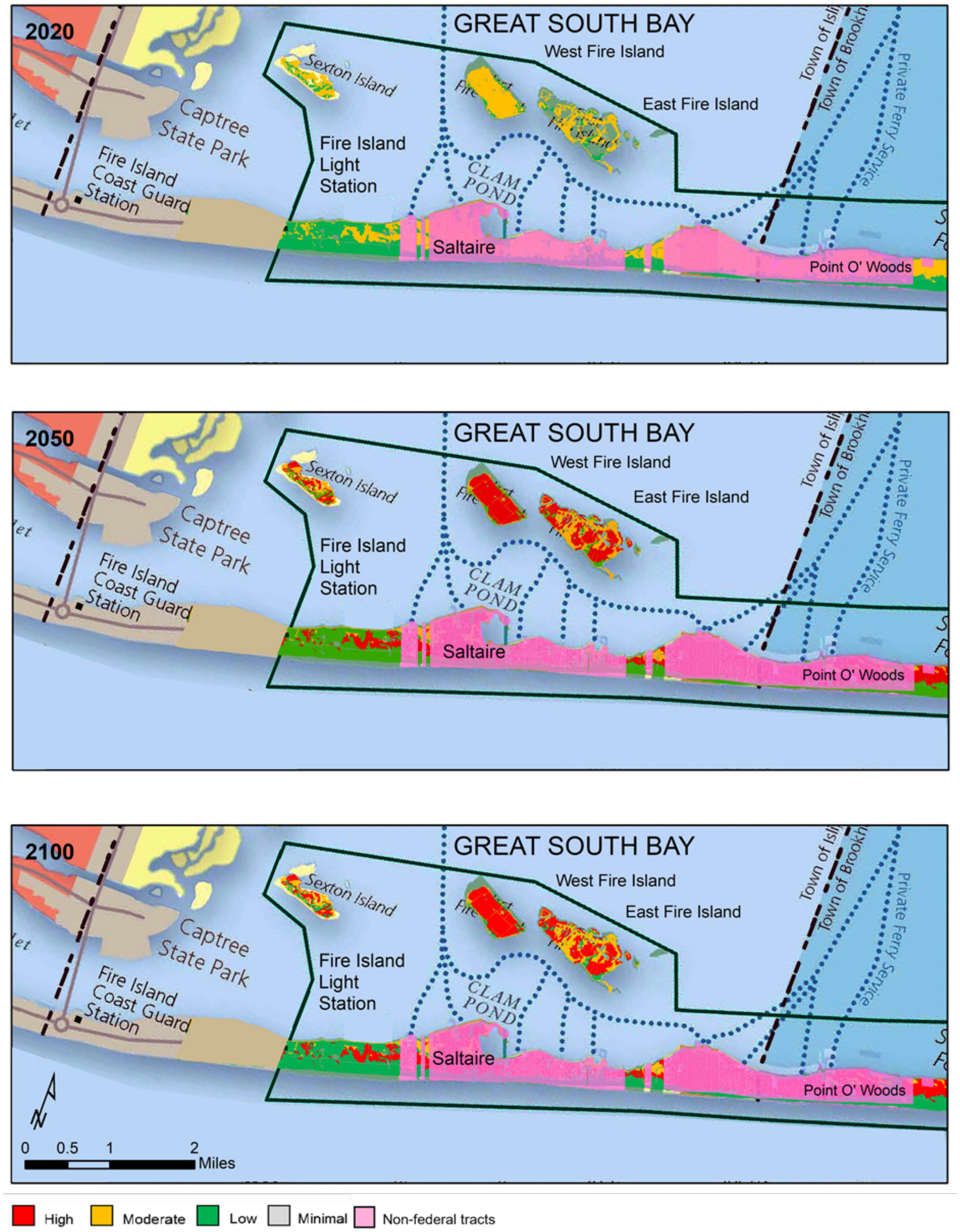

Figure 15a. Vulnerability of natural resources in select locations in 2020, 2050 and 2100 at Fire Island National Seashore, New York.

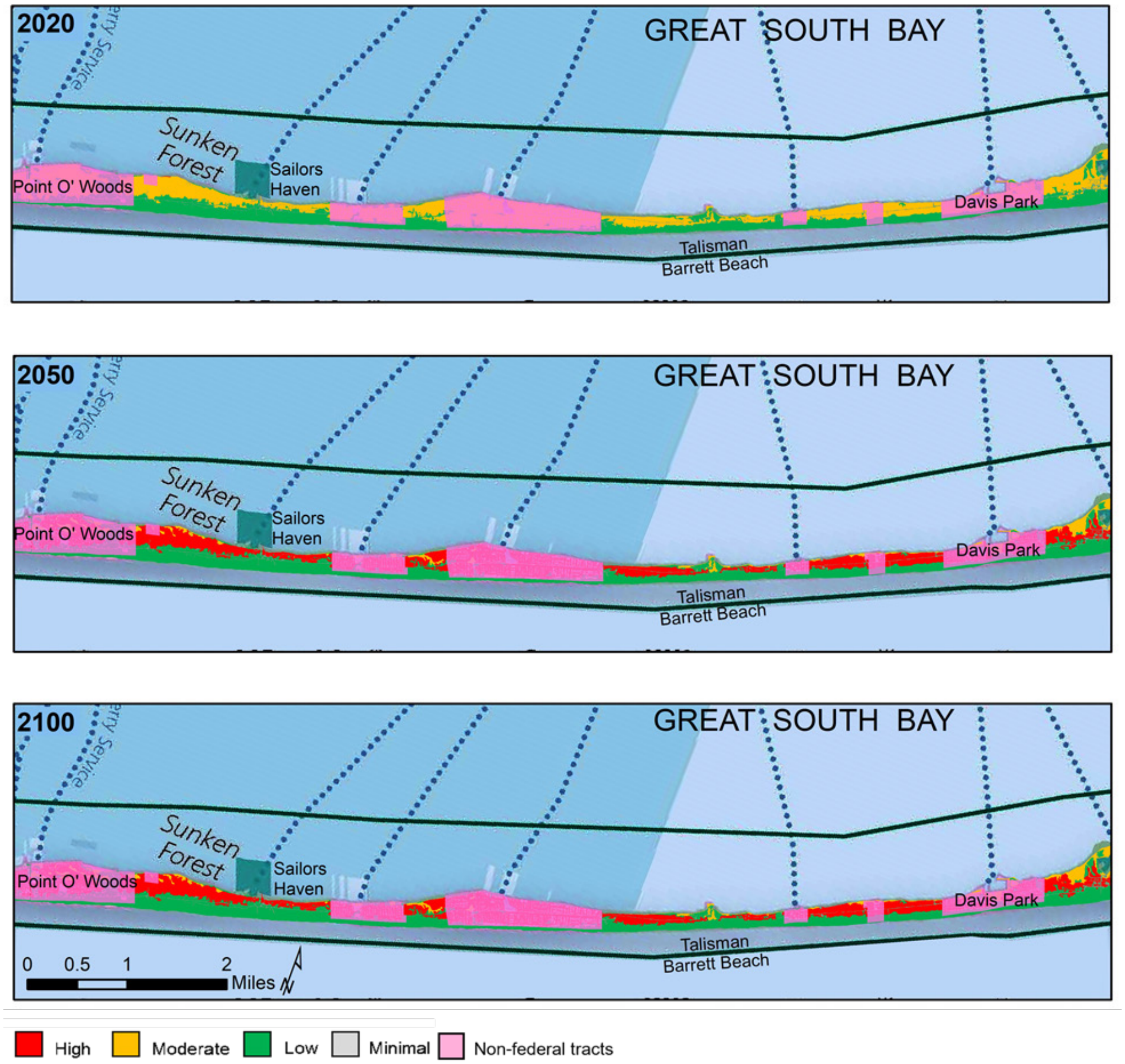

Figure 15b. Vulnerability of natural resources in select locations in 2020, 2050 and 2100 at Fire Island National Seashore, New York.

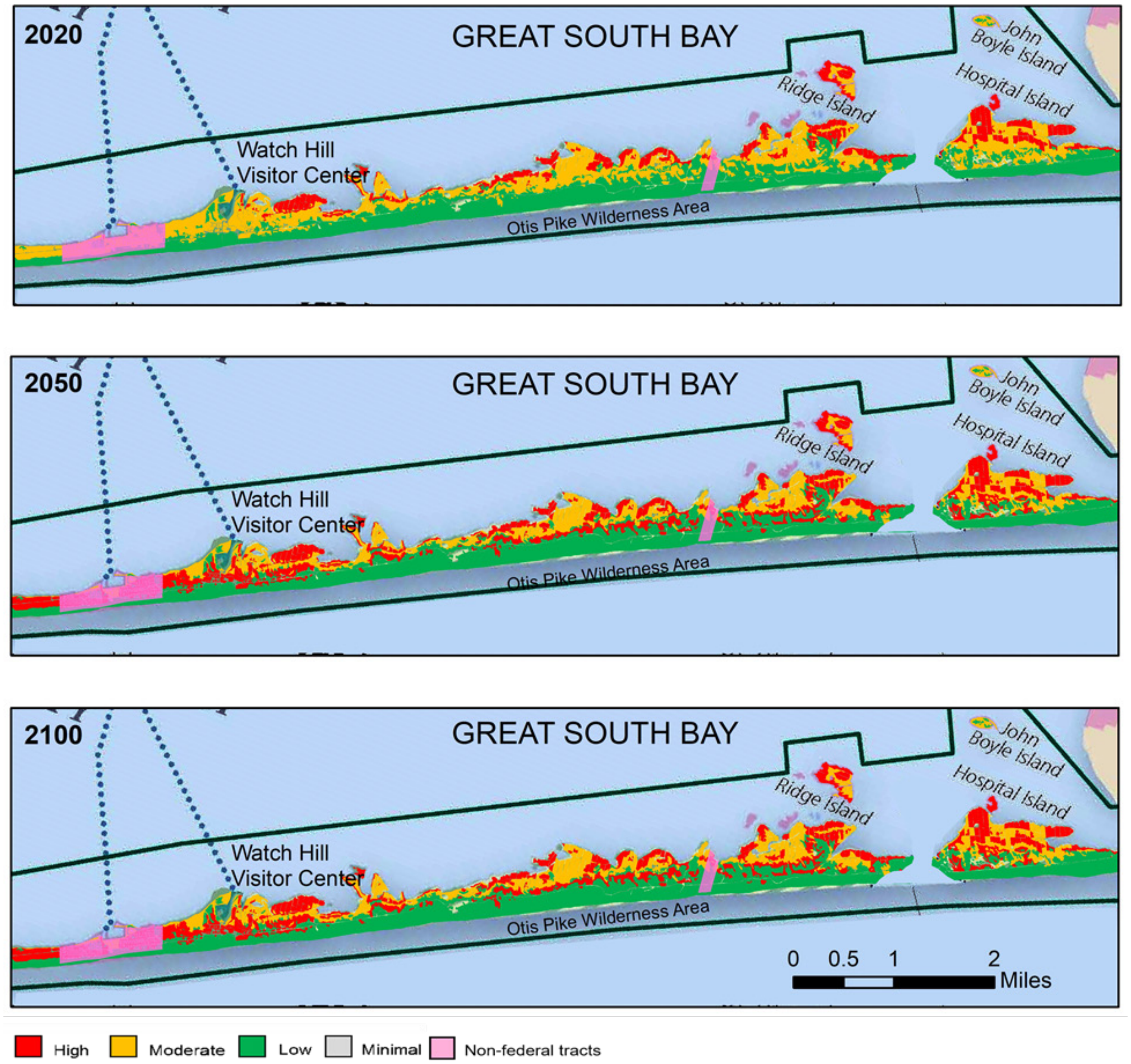

Figure 15c. Vulnerability of natural resources in select locations in 2020, 2050 and 2100 at Fire Island National Seashore, New York.

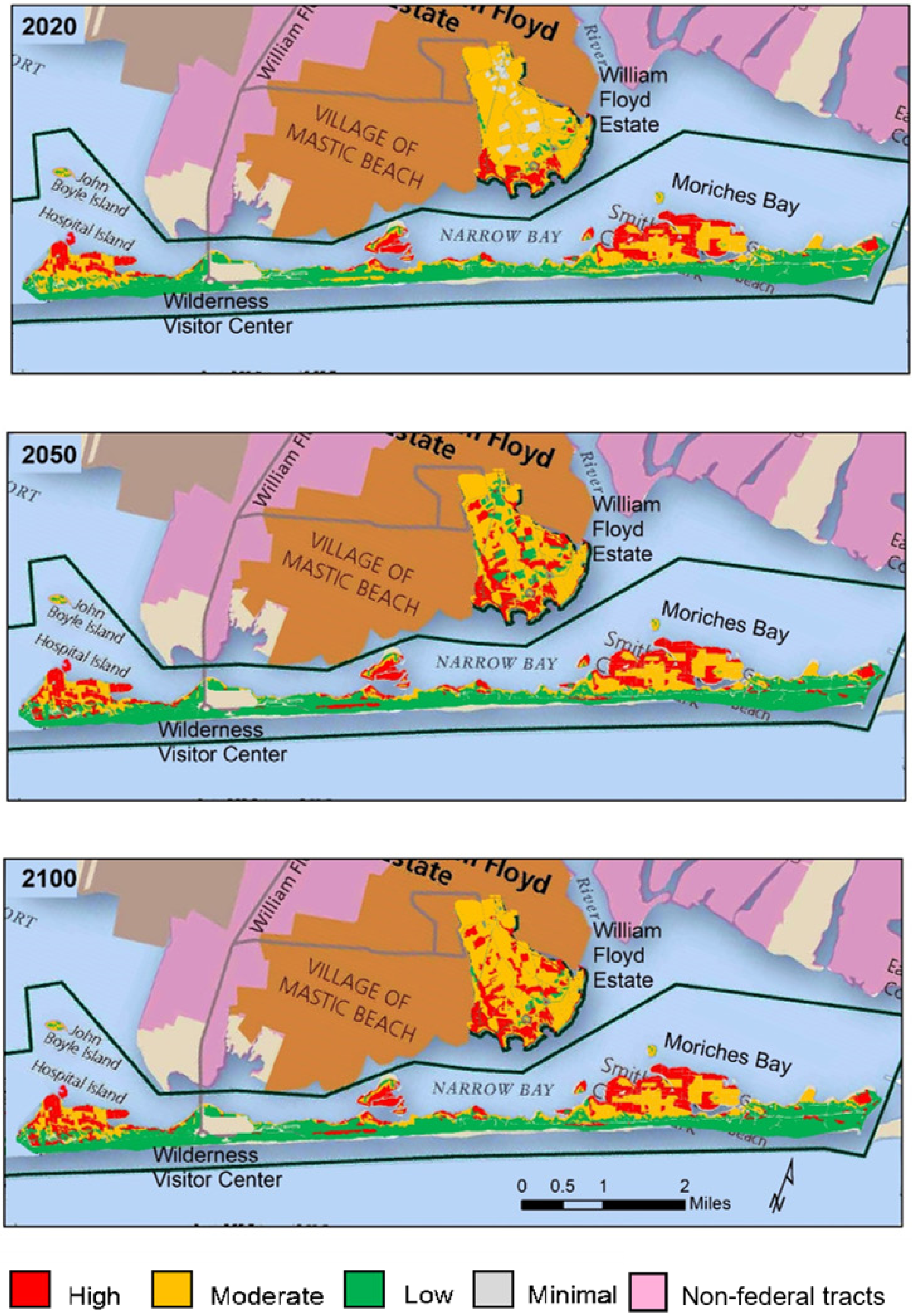

Figure 15d. Vulnerability of natural resources in select locations in 2020, 2050 and 2100 at Fire Island National Seashore, New York.

Adaptive Capacity

Natural resources differ from most other resources in adaptive capacity by having the intrinsic ability to adapt. Within the Physical category of the POSE framework, intrinsic adaptive capacity was captured separately from the physical-technology component under the physical category in case it was to be handled separately in future analysis (i.e. as the method was being developed, it was considered whether to include within vulnerability for natural resources). Details are in Appendix E. Table 7 shows adaptive capacity scores for natural resources. The majority of natural resources have low adaptive capacity, while only a few have high adaptive capacity.

Table 7. Adaptive capacity scores for natural resources at Fire Island National Seashore, New York.

Resource	Adaptive Capacity
Seagrass (eelgrass)	Low
Seagrass (widgeongrass)	Moderate
Clam bed	Moderate
High salt marsh	Low
Low salt marsh	Low
High salt marsh (island)	Low
Low salt marsh (island)	Low
Beaches (including overwash)	Moderate
Bayside beaches	High
Foredune	Low
Swale (backdune, maritime shrubland)	Moderate
Maritime forest	Low
Maritime holly forest	Low
Mixed hardwood forest (William Floyd Estate)	Low
Open fields (William Floyd Estate)	Low
Freshwater ecosystems	Low
Piping plover	High
Seabeach amaranth	High
Colonial waterbirds	Low
Long eared bats (William Floyd Estate)	Moderate
Herps (coastal)	Low
Herps (upland)	Low
Sediment supply	Moderate
Water quality (estuary)	Moderate
Groundwater	Low

Relationship of Vulnerability to Adaptive Capacity

Comparing Natural Resources vulnerability to adaptive capacity (Figure 16) shows that most of the resources fall within two opposite quadrants, the Quick Wins (low to moderate vulnerability and high adaptive capacity) or High Concern-Reconsider Goals quadrants (high vulnerability and low adaptive capacity). For the High Concern habitats, much discussion was focused on maritime holly forest and the maritime forest more generally, where there is recognition that we will have to reconsider goals. They are such high priority resources that the need to reconsider the goals for other resources including facilities that interact with them are part of the focal area discussion for Island Change on the Bayside. Between the other High Concern habitats, there was recognition that the island salt marshes are likely to be lost, but the role that the salt marshes on Fire Island play in protecting other resources may mean exploring new goals for these habitats. For the habitats that fall under Quick Wins (e.g. beaches, foredune and the species that depend on them), there are already a variety of management actions underway that may benefit from determining how climate adaptation can be incorporated into them.

Priority Natural Resources

The vulnerability scores for each habitat resource with available geospatial data are mapped for 2050 in Figure 14. Seeing vulnerability mapped shows how much ocean side resources are lower vulnerability than bayside, which is counter-intuitive. While it varies by resource, it shows how the dynamic beach and dune system is formed through responding to storm events and is resilient to dynamic forces; this will help it as climate changes. Whereas systems such as maritime holly forest take centuries to establish, and are going to be more sensitive to changes both on short and long time scales. It should be noted that while the residential communities were not included in this vulnerability assessment, the vegetation mapping data available covers the communities with an associated habitat type and so they are shown with a gray layer over them, but the associated vulnerability of the underlying parkwide habitats can be seen below. This does not represent an assessment at all related to the community characteristics.

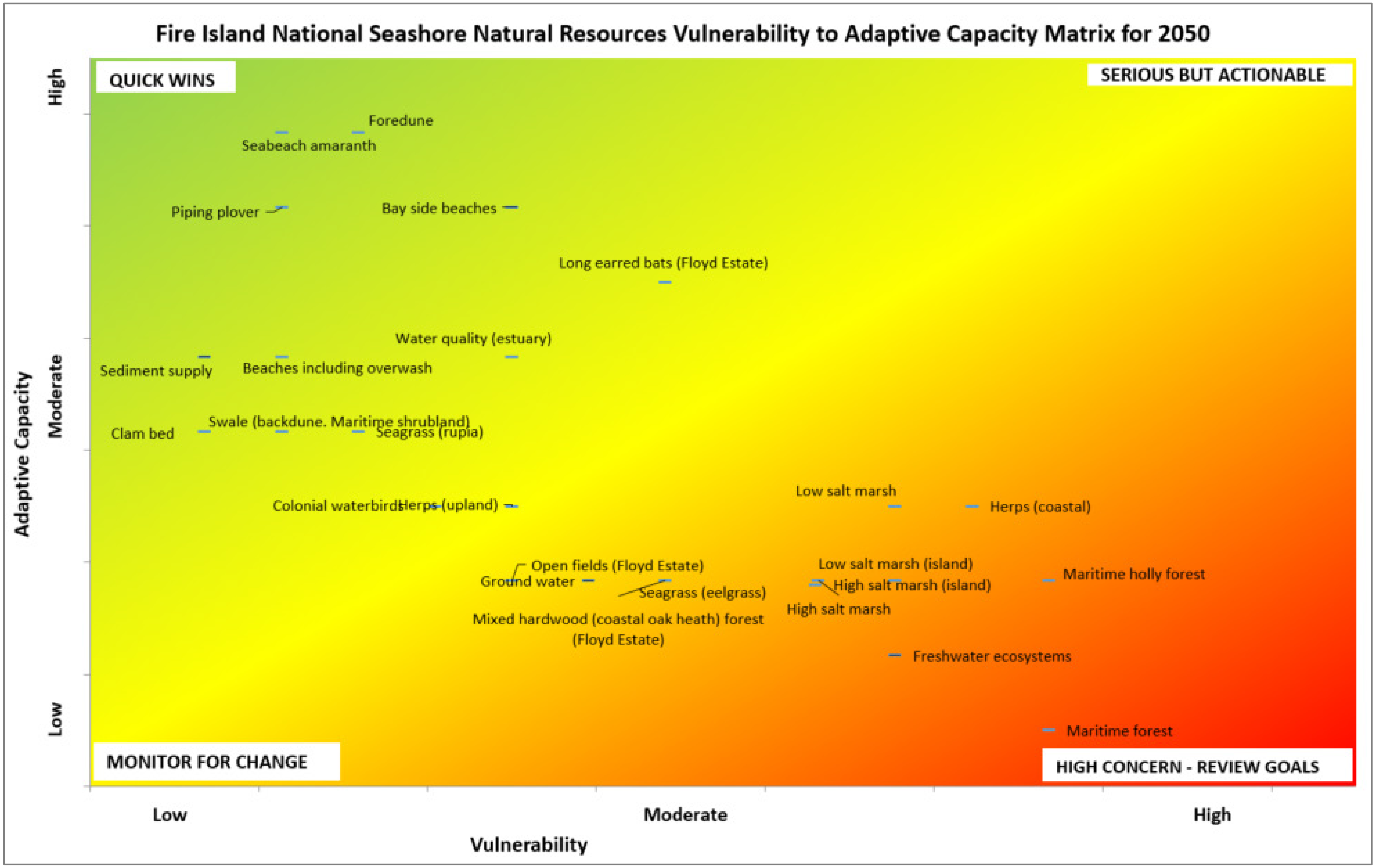

Figure 16. Comparison of vulnerability to adaptive capacity for natural resources in 2050 at Fire Island National Seashore, New York.

Recommendations

- Work through questions of how long we can protect the Sunken Forest, and the maritime holly forest more generally, and when ultimately we have to reconsider goals. The high vulnerability, low adaptive capacity and high significance of these resources makes being intentional about delaying or documenting loss a high priority. The management actions available have trade-offs with infrastructure, including the infrastructure that provides visitor access and interpretive value. Because management options are limited, if major management actions are decided against, this may transition to primarily a science need to document the loss; stressors such as groundwater change are being monitored, but have limited management options.
- Include geomorphic dynamism to advise the facilities and cultural resources management actions to help further understand and guide action. The data layers and assumptions going into this assessment are static and can't explain the complex coastal processes, though the discussion of each resource attempted to capture it. There is already a substantial research foundation to understand island geomorphology, but there are additional research needs to support implementing adaptation options as island change accelerates.
- In assessing the resources that are species, they primarily were assessed based on their primary habitats. For the early successional habitat species, piping plovers (*Charadrius melodus*) and seabeach amaranth (*Amaranthus pumilus*), non-climate stressors are a dominant threat, and need to be considered, along with the tradeoffs of managing climate and non-climate stressors. If indeed these are Quick Wins, climate adaptation can be incorporated into management actions already underway for these species, such as by preparing for more frequent or intense storm events.

Facility Assets

Key Messages

Facility assets in Fire Island NS play a critical role in protecting and providing public access to the valued cultural and natural resources at the park. A majority of the assets are moderately to highly vulnerable (82%) to climate change due to the topography of most of the park on a low lying barrier island, with the exception of facility assets at the William Floyd Estate. These assets have a combined current replacement value over $155M (from the NPS Facilities Management Software System (FMSS) database).

Of the 153 facility assets assessed, there were 22 structural assets that increased their vulnerability over the three time frames, with the majority occurring by 2050. There were no changes in the vulnerability of transportation assets over time. A majority of these facility assets have high adaptive capacity (92%) due to the nature of these assets, though action is contingent upon timely funding and decisions on long-term strategies to provide safe access to the park.

Areas of concern for Facilities include the Fire Island Light Station, marina associated infrastructure, headquarters, and emergency access to the island for the park and communities. An opportunity exists to reduce the maintenance of boardwalks in some areas by accelerating the transition to temporary roll-up walkways as piloted in parts of the park.

Vulnerability

To assess vulnerability of facility assets, the following indicators were used based on the SOP/WCU protocol (NPS, 2016a).

Exposure Indicators

- Flooding potential
- Extreme Event Flooding
- Sea Level Rise Inundation
- Shoreline Change
- Reported Coastal Hazards

Sensitivity Indicators

- Flood Damage Potential (Elevated)
- Storm Resistance and Condition
- Historical Damage
- Protective Engineering
- Additional Sensitivity Indicators for Bridges (From National Bridge Inventory)
  - Bridge Clearance
  - Scour Rating

- Bridge Condition
- Bridge Age

A majority of facility assets have moderate to high exposure to climate change (76% of structures and 91% of transportation) (Tables 8, 9 and 10). There was no change in exposure scores for transportation assets, though 18 structures had increased exposure from moderate to high in 2050 and another 14 increased in 2100. These changes were clustered around headquarters, Sailors Haven and Watch Hill. Increases in sea level rise and erosion accounted for most of the increases in exposure. Almost all assets on the island currently (2020 time frame) have high vulnerability. There were no changes in structures for low or minimal exposure. Following the SOP/WCU protocol (NPS, 2016a), this assessment categorizes those assets that did not score exposed for any of the exposure indicators as minimal. Those assets with minimal exposure scores were not analyzed for sensitivity.

Table 8. Facility assets exposure results summary for 2020 at Fire Island National Seashore, New York.

	High Exposure		Moderate Exposure		Low Exposure		Minimal Exposure		
Assets in 2020	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**Total #**
Structures	9	9%	65	66%	8	8%	16	16%	98
Transportation	45	51%	35	40%	5	6%	3	3%	88
All facility assets	54	29%	100	54%	13	7%	19	10%	186

Note: Sum of percentages may not be equal to 100 due to rounding. Between time frames there was only one change in exposure for a transportation asset from moderate to high from 2020 to 2100. Culverts were added to this analysis which resulted in a greater number of transportation assets assessed compared to the SOP/WCU protocol.

Table 9. Facility assets exposure results summary for 2050 at Fire Island National Seashore, New York.

	High Exposure		Moderate Exposure		Low Exposure		Minimal Exposure		
Assets in 2050	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**Total #**
Structures	27	28%	47	48%	8	8%	16	16%	98
Transportation	45	51%	35	40%	5	6%	3	3%	88
All facility assets	72	39%	82	44%	13	7%	19	10%	186

Note: Sum of percentages may not be equal to 100 due to rounding. Between time frames there was only one change in exposure for a transportation asset from moderate to high from 2020 to 2100. Culverts were added to this analysis which resulted in a greater number of transportation assets assessed compared to the SOP/WCU protocol.

Table 10. Facility assets exposure results summary for 2100 at Fire Island National Seashore, New York.

Assets in 2100	High Exposure #	High Exposure %	Moderate Exposure #	Moderate Exposure %	Low Exposure #	Low Exposure %	Minimal Exposure #	Minimal Exposure %	Total #
Structures	41	42%	33	34%	8	8%	16	16%	98
Transportation	45	51%	35	40%	5	6%	3	3%	88
All facility assets	86	46%	68	37%	13	7%	19	10%	186

Note: Sum of percentages may not be equal to 100 due to rounding. Between time frames there was only one change in exposure for a transportation asset from moderate to high from 2020 to 2100. Culverts were added to this analysis which resulted in a greater number of transportation assets assessed compared to the SOP/WCU protocol.

For those assets that scored low to high exposure, they were then assessed for their sensitivity. There were 158 (95%) facility assets (that have some exposure) scored as moderate to high sensitivity (Table 11). Transportation assets had a significant percentage (67%) scored as high sensitivity due to the nature of a dynamic barrier island shoreline and dune system. The transportation assets with the highest Asset Priority Index scores (API) were for Seabay Beach Cedar and Maple Courts, followed by the Watch Hill, Sailors Haven and Barrett Beach Channels. This is of concern and merits attention considering the ongoing challenges to fund annual maintenance and the potential for extreme weather events that go beyond the scope of this analysis. Transportation assets that had low sensitivity were all on elevated land at the William Floyd Estate. Several structural assets in the Light Station have high sensitivity—store house, oil house, tool house, check station and annex housing unit. This is attributable to the flood damage potential, condition and historical damage. The Lighthouse Check Station and Annex Housing Unit are ranked as moderate on the API.

Table 11. Facility assets sensitivity results summary at Fire Island National Seashore, New York. Sum of percentages may not be equal to 100 due to rounding.

Assets	High Sensitivity #	High Sensitivity %	Moderate Sensitivity #	Moderate Sensitivity %	Low Sensitivity #	Low Sensitivity %	Total # Analyzed	Excluded * (Min. Exposure) #	Excluded * (Min. Exposure) %
Structures	22	27%	54	66%	6	7%	82	16	16%
Transportation	57	67%	25	29%	3	4%	85	3	3%
All facility assets	79	47%	79	47%	9	5%	167	19	22%

* Assets with minimal exposure (in no climate stressor areas) were excluded from the sensitivity and adaptive capacity analysis. Total # analyzed is different for compared to exposure and vulnerability.

Combining the exposure and sensitivity scores for each of the three time frames, Fire Island has a majority of facility assets scored as high or moderate vulnerability—80% in 2020 (Table 12), 83% in 2050 (Table 13) and 2100 (Table 14). Almost all of the transportation assets are highly vulnerable (83%) already in 2020 with no changes in the following two time frames. Similarly, to the exposure analysis, almost all of the facility assets on the island are highly vulnerable with the exception for the few structural assets located in the highest parts of the island or built above the Base Flood Elevation such as the Sailors Haven Visitor Center. The exposure, sensitivity and vulnerability scores by each stressor for each time frame are shown in Appendix F.

Table 12. Facility assets vulnerability results summary for 2020 at Fire Island National Seashore, New York.

	High Vulnerability		Moderate Vulnerability		Low Vulnerability		Minimal Vulnerability		
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**Total # Analyzed**
Structures	30	31%	38	39%	14	14%	16	16%	98
Transportation	73	83%	8	9%	4	5%	3	3%	88
All facility assets	103	55%	46	25%	18	10%	19	10%	186

* Assets with minimal exposure (in no climate stressor areas) were excluded from the sensitivity and adaptive capacity analysis. Total # analyzed is different for compared to exposure and vulnerability. Percentages are based on total assets (analyzed plus the excluded) for each asset type. Sum of percentages may not be equal to 100 due to rounding.

Table 13. Facility assets vulnerability results summary for 2050 at Fire Island National Seashore, New York.

	High Vulnerability		Moderate Vulnerability		Low Vulnerability		Minimal Vulnerability		
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**Total # Analyzed**
Structures	42	43%	31	32%	9	9%	16	16%	98
Transportation	73	83%	8	9%	4	5%	3	3%	88
All facility assets	115	62%	39	21%	13	7%	19	10%	186

* Assets with minimal exposure (in no climate stressor areas) were excluded from the sensitivity and adaptive capacity analysis. Total # analyzed is different for compared to exposure and vulnerability. Percentages are based on total assets (analyzed plus the excluded) for each asset type. Sum of percentages may not be equal to 100 due to rounding.

Table 14. Facility assets vulnerability results summary for 2100 at Fire Island National Seashore, New York.

	High Vulnerability		Moderate Vulnerability		Low Vulnerability		Minimal Vulnerability		
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**Total # Analyzed**
Structures	47	48%	26	27%	9	9%	16	16%	98
Transportation	73	83%	8	9%	4	5%	3	3%	88
All facility assets	120	65%	34	18%	13	7%	19	10%	186

* Assets with minimal exposure (in no climate stressor areas) were excluded from the sensitivity and adaptive capacity analysis. Total # analyzed is different for compared to exposure and vulnerability. Percentages are based on total assets (analyzed plus the excluded) for each asset type. Sum of percentages may not be equal to 100 due to rounding.

The distribution of vulnerability for facility assets can be seen in Figure 17. Almost every asset on the island is either moderately or highly vulnerable already in 2020. Figure 18 shows the details of facility asset vulnerability in select areas of interest.

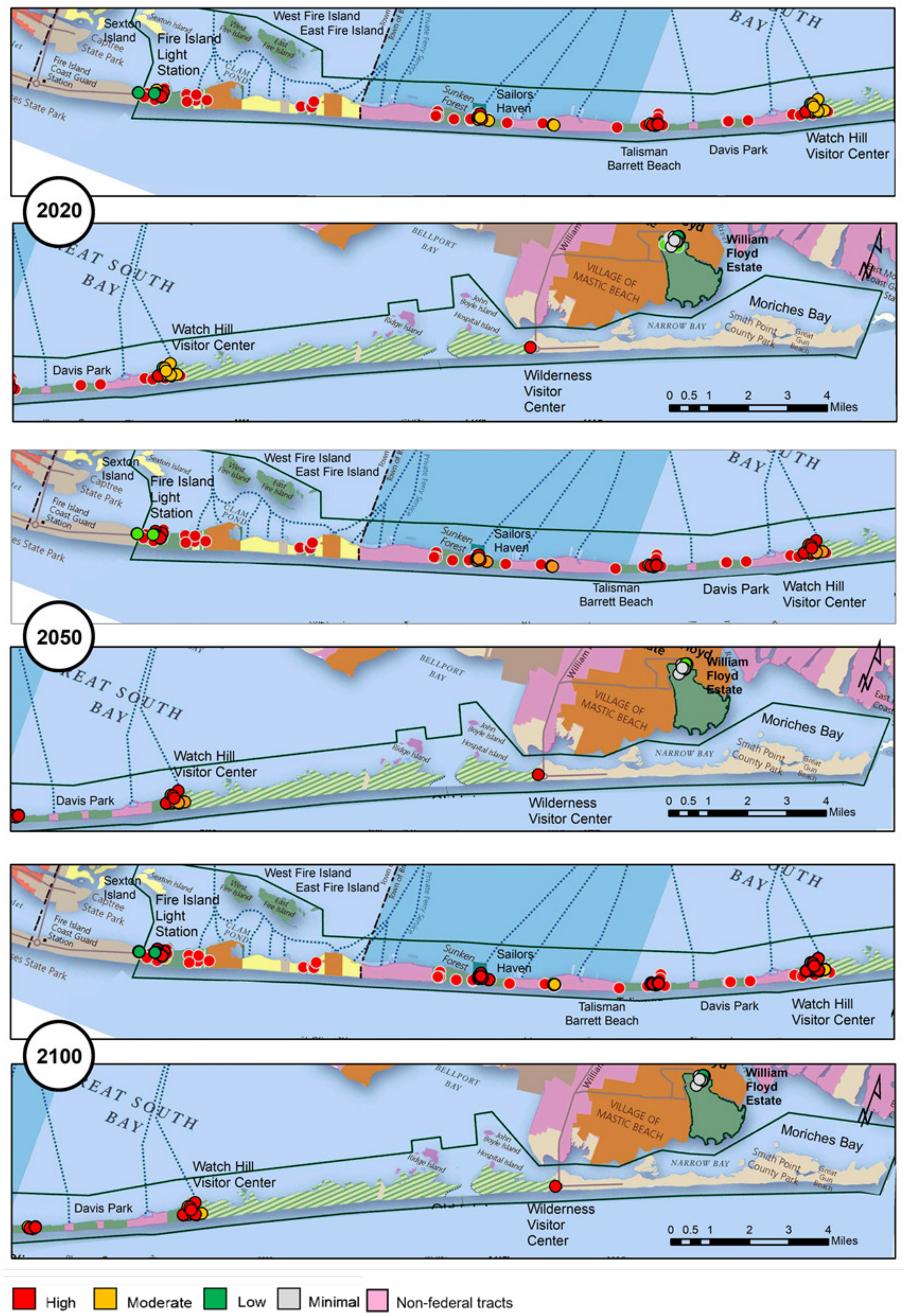

Figure 17. Vulnerability of facilities by 2100 based on climate projections at Fire Island National Seashore, New York.

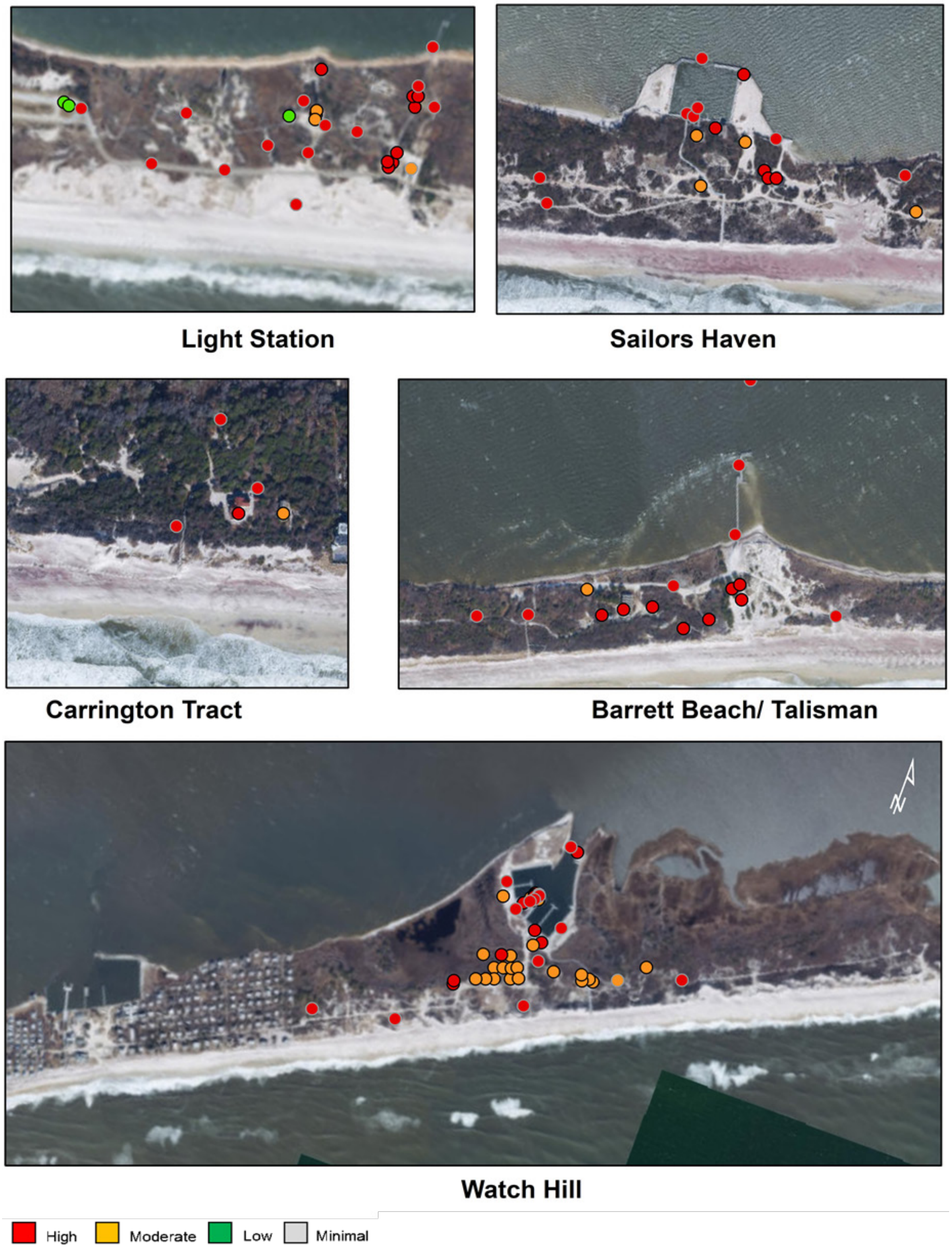

Figure 18. Vulnerability of facilities by 2100 for specific areas based on climate projections at Fire Island National Seashore, New York.

One difference of this assessment from the SOP/WCU protocol (NPS, 2016a) is the tracking of vulnerability over the three time frames. Transportation assets started with mostly high vulnerability and there were no changes over time. There were 17 structural asset changes in vulnerability between 2020 and 2050 (Table 15). Most of these changes occur in the Patchogue, Sailor Haven and Watch Hill areas. There is a single change in vulnerability for the lighthouse area, though most of the assets are already highly vulnerable. There were only five changes in vulnerability between 2050 and 2100. These were structures in Sailor Haven and Watch Hill. The projections used in the assessment are conservative, though they still show that with minimal climate changes most assets are already moderately to highly vulnerable in the near to medium term. Using other projections that are not as conservative would likely the degree of vulnerability of assets beyond the highly vulnerable category over the time frame assessed.

Table 15. Facility assets that had changes in vulnerability over time at Fire Island National Seashore, New York.

Location	Area	2020 Vulnerability	2050 Vulnerability	2100 Vulnerability
BU-HQ-76 Park Headquarters	Headquarters	Moderate	High	High
BU-HQ-72 Headquarters Annex	Headquarters	Moderate	High	High
BU-HQ-78 Vehicle Vessel Shop	Headquarters	Moderate	High	High
BU-HQ-80A Patchogue Ferry Terminal	Headquarters	Moderate	High	High
BU-SH-104 Visitor Center	Sailors Haven	Low	Moderate	Moderate
BU-SH-Fire Cache	Sailors Haven	Moderate	Moderate	High
Q-00SHBARN-HO-SH-105 Horse Barn	Sailors Haven	Moderate	Moderate	High
BU-WH-13 Marina Store	Watch Hill	Low	Moderate	Moderate
BU-WH-20 Maintenance Shop	Watch Hill	Moderate	High	High
BU-WH-22 Flammable Storage Building	Watch Hill	Moderate	Moderate	High
BU-WH-14 Dockmaster Office	Watch Hill	Moderate	High	High
BU-WH-15 Storage Building	Watch Hill	Moderate	High	High
BU-WH-16 Visitor Center	Watch Hill	Low	Moderate	Moderate
BU-WH-17 Marina Restroom	Watch Hill	Low	Moderate	Moderate
BU-WH-21 First Aid Room	Watch Hill	Moderate	High	High
BU-WH-26 Horse Barn	Watch Hill	Moderate	Moderate	High
BU-WH-32 Garbage Building	Watch Hill	Moderate	High	High
BU-WH-33 Electrical Panel Building	Watch Hill	Low	Moderate	Moderate
BU-WH-18 Restaurant	Watch Hill	Moderate	High	High
BU-WH-Dune Station Visitor Station	Watch Hill	Moderate	Moderate	High
BU-WH-Marina Shed	Watch Hill	Moderate	High	High
BU-LS-99 Lighthouse Boat House	Lighthouse	Moderate	High	High

The combined current replacement values (from the NPS FMSS database) for assets that are highly or moderately vulnerable in 2050 is over $155M (Table 16). This value is almost evenly split between transportation and structural assets. The highest value transportation assets that are highly vulnerable include the marinas, bulkheads, channels and boardwalks near Watch Hill, Sailors Haven, Barrett Beach and Patchogue. Structural assets of greatest value and highly or moderately vulnerable include the Fire Island Lighthouse, Annex Housing Unit, Keepers Quarters, the headquarters warehouse and ferry terminal. Of these the Lighthouse and Keepers Quarters also have high API scores.

Table 16. Facility assets that scored moderate or high vulnerability in 2050 at Fire Island National Seashore, New York. Current replacement values (CRV) comes from the National Park Service Facility Management Software System (NPS FMSS).

Vulnerability	#	%	CRV
High vulnerability	115	62%	$84,645,262
Moderate vulnerability	39	21%	$70,870,474
TOTAL high and moderate vulnerability	153	82%	$155,515,736

Adaptive Capacity

Assets that received exposure scores above minimal were assessed for adaptive capacity. In general, a great majority (92%) of the assets exposed to climate stressors have high adaptive capacity to reduce vulnerability (Table 17). The remainder of assets had moderate adaptive capacity. Details of the adaptive capacity scores for facility assets are in Appendix G. This is due to a combination of high physical (able to build or move assets), organizational (NPS ownership of the assets), and social (the importance of these assets to meeting cultural and natural resource mandates) capacities. In general, the economic component of adaptive capacity was scored low to moderate for most items, though this didn't reduce the overall adaptive capacity score significantly. On the economic component of adaptive capacity, it is unclear as to whether the NPS will be able to raise the funding over the coming decades for incremental maintenance and adaptation when other coastal areas are facing similar challenges. This larger regional and national perspective was not used to score adaptive capacity but certainly will be a factor. The Fire Island Lighthouse received moderate adaptive capacity due to the strong social support to maintain and the ability to move lighthouses, despite the significant financial costs required.

Table 17. Facility assets adaptive capacity (AC) results summary at Fire Island National Seashore, New York. Sum of percentages may not be equal to 100 due to rounding.

	High AC		Moderate AC		Low AC			Excluded * (Min. Exposure)	
Assets	#	%	#	%	#	%	Total # Analyzed	#	%
Structures	74	90%	8	10%	0	0%	82	16	16%
Transportation	78	93%	6	7%	0	0%	84	3	3%
All facility assets	152	92%	14	8%	0	0%	166	19	37%

* Assets with minimal exposure (in no climate stressor areas) were excluded from the adaptive capacity and sensitivity analysis. Total # analyzed is different for compared to exposure and vulnerability.

Relationship of Vulnerability to Adaptive Capacity

Looking at the vulnerability and adaptive capacity in combination provides additional insights into the areas of concern and how they could be linked to other assets when considering actions. From a structures standpoint (Figure 19), the assets are distributed in only two quadrants. Most of the William Floyd Estate assets, which are located upland back from the coastline are in the low vulnerability and high adaptive capacity quadrant (Quick Wins) that will not require immediate actions in the near term. The majority of structural assets from across the park are in the high vulnerability and high adaptive capacity quadrant (Serious but Actionable) which will require adaptation to allow continued use within existing goals and access requirements. Should there be a significant reduction in financial capacities to adapt then more assets will fall into the high vulnerability and low adaptive capacity quadrant (High Concern-Review Goals). These include the Fire Island Lighthouse and Keepers Quarters.

Transportation assets also clustered in two of the quadrants due to all assets having moderate to high adaptive capacity (Figure 20). William Floyd Estate had two resources that were in the 'Quick Wins' quadrant due to low vulnerability. The remainder of transportation assets were in the 'Serious But Actionable' quadrant. Watch Hill Channel and Barrett Beach Channel were both on the edge of the 'High Concern – Review Goals' quadrant. Should a significant change in sediment loading or dredging funds occur these assets will be of immediate concern. The Lighthouse to West Bay Walk and Davis Park West Dune Cut were both in the 'High Concern – Review Goals' quadrant. These assets merit a deeper analysis to determine the sustainability of these assets in relation to the park's goals and objectives.

Most assets have moderate to high adaptive capacity, though success will depend on adaptation actions being taken in a timely and effective manner. Fire Island NS should track these assets carefully as the climate changes and extreme events occur. This process should be revisited to rescore adaptive capacity every five to ten years in light of changing political, ecological and economic contexts. The cumulative number of assets needing action and their linkages across individual assets is a critical aspect to keep in mind when considering adaptation options.

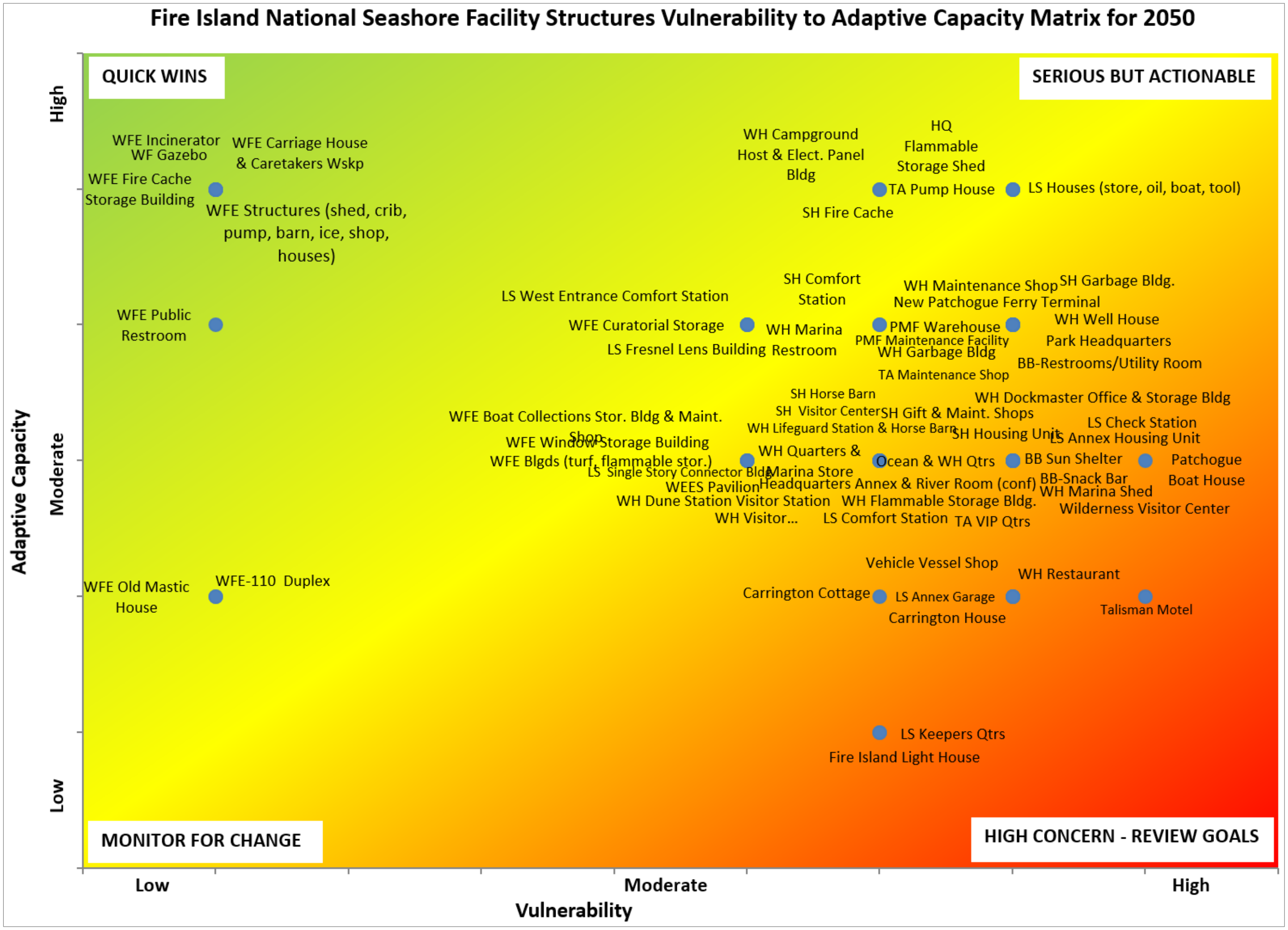

Figure 19. Comparison of vulnerability to adaptive capacity for a selection of structural facility assets in 2050 at Fire Island National Seashore, New York. Excludes 16 structural assets that scored minimal exposure and didn't get sensitivity or adaptive capacity scores.

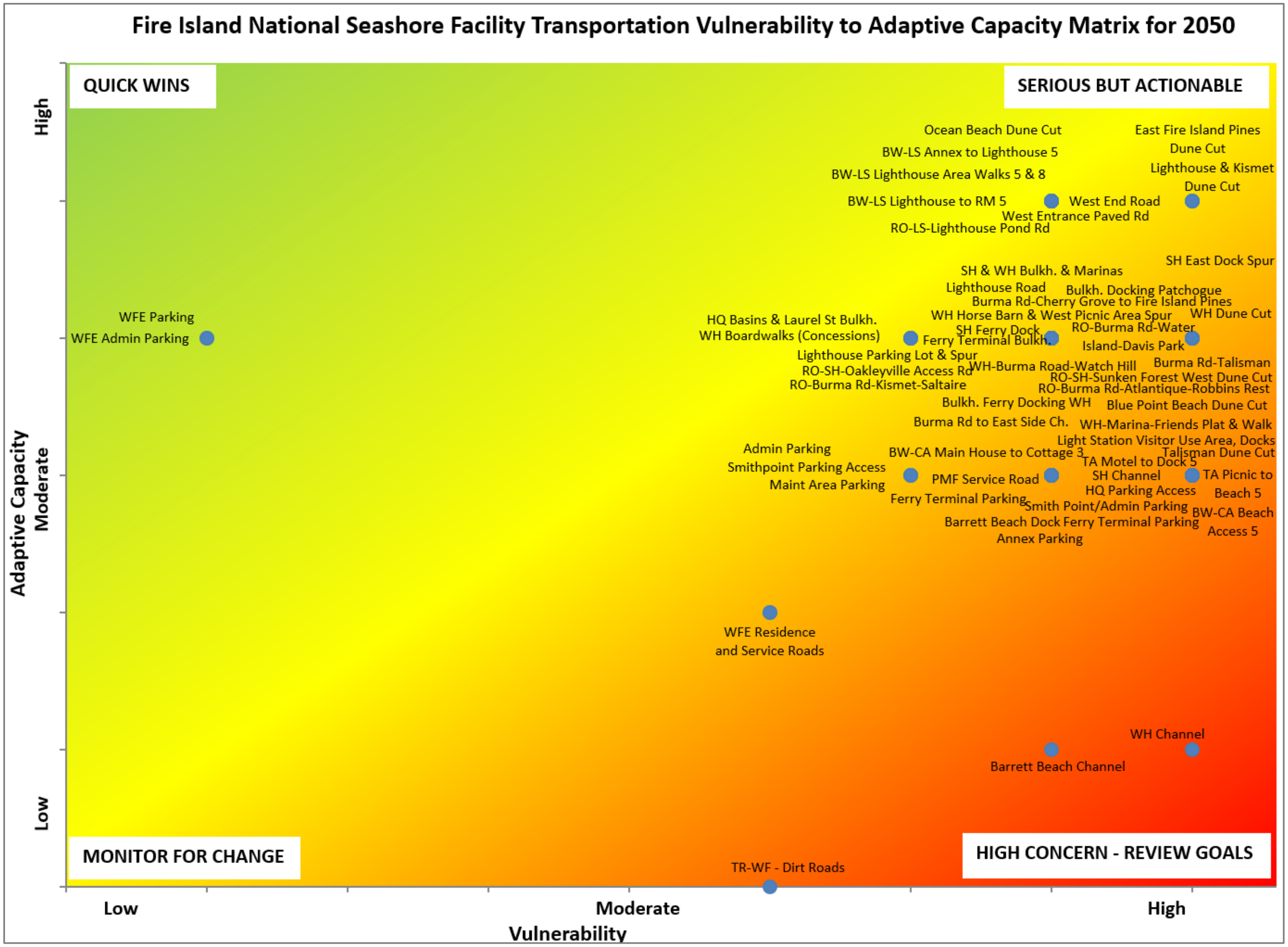

Figure 20. Comparison of vulnerability to adaptive capacity for a selection of transportation facility assets in 2020 at Fire Island National Seashore, New York. Excludes 3 transportation assets that scored minimal exposure and didn't get sensitivity or adaptive capacity scores.

Priority Facility Assets

The Fire Island NS's Facilities Workgroup identified priority issues based on how assets that were scored as a high or moderate vulnerability would influence their ability to achieve their stated mandates and management goals.

Wharfs, docks and associated facilities are critical to ensure access including during emergencies. Shoaling from sediment transport and erosion reduce access through channels to docks including Sailors Haven, Watch Hill and Talisman/Barrett Beach. Decisions will need to be made regarding elevating associated assets or retreating. This would require an extensive decision making process with local communities.

Maintaining access roads on the island in support of park programs and community safety is a key service of the facilities team. In 2013 after Superstorm Sandy the park received funding to rehabilitate the gravel road from Kismet to the western boundary of the park, which included raising it about a foot. Another source of funds has been allocated to improve the resiliency of the same road east of the gate which goes to Kismet. This road will also be raised with material as much as 24 inches, depending on funding and construct-ability in the same footprint. The park considers this road the only access road to the community. There are no plans on raising roads East of Kismet, even though it is the one route all the way to Cherry Grove (no interior route at Cherry Grove).

Boardwalks are continually undergoing repairs and in some places relocation due to erosion. The staff have transitioned to removable boardwalks in certain locations that have worked well. In the long term an assessment should be done on how to expand the application of these removable boardwalks. Boardwalks along the bayside of the island will need further analysis as most sites including the Sunken Forest which is already experiencing significant erosion.

Recommendations

- Coordination needs include coordinate with Cultural Resources and Natural Resources program areas on integration issues. Coordinate with local government on how to integrate climate projections into long-range infrastructure plans and how to balance the NPS's resources to maintain systems that significantly service the neighboring communities (roads, marinas, water and power lines).
- Management needs include review the priority list and sort by timeline, available resources, and sequencing. Seek win-win options with other program areas and partners to reduce barriers for change.
- Develop a long-term plan for the facilities in the Lighthouse Complex.
- Assess the viability to replace highly vulnerable boardwalks with the removable designs that have been tested for other areas of the park.

Incorporating Goals

What are the implications of the vulnerability scores for Fire Island NS to achieve its goals and how should adaptation happen? For the goals that need to be revisited based on the likely climate changes, what are the right adaptation actions to take and when to do them? This section of the report looks at how to respond to the vulnerability assessment in light of park goals.

Goals at Risk

A next step in the Climate Smart Conservation framework after a vulnerability assessment is to reconsider conservation goals in light of climate change (Stein et al. 2014). At the start of the assessment, each workgroup was asked to articulate the current goals that determine current priorities and management actions. We started from language in the draft Foundation Document and General Management Plan (NPS, 2015a), but that language was not in goal form. At the third workshop, with the vulnerability and adaptive capacity in mind, the group as a whole revisited these goals. Part of the learning process was realizing that some of what had originally been listed as goals were more like methods or vision statements. This is similar to what was experienced in the first pilot at Colonial National Historical Park (Ricci et al. 2019a). Without clear, measurable goals it is challenging to assess how likely the vulnerability will impact on achieving goals and when potential to act.

The park should consider clarifying the current goals to assess which of those may need to be revised in light of vulnerability, and whether any of them will no longer be attainable in the future or if new goals will be needed. The integrated discussion demonstrated where there are overlapping goals/methods statements, and the important role of interpretation and communication. The language of the goals and revised goals would need to be further refined if they are intended to be used beyond this initial exercise. Based on the many resources that fall in the high vulnerability-low adaptive capacity Reconsider Goals quadrant, it would appear that at least some of the park's goals will need to be revised for the coming decades. In the next section an example of a proposed evolution of goals for the William Floyd Estate is provided. This process can get complicated due to the multiple interests across program areas, though there will likely be benefits such as coordination, clarity of long-term purpose and function, and cost savings.

There is another critical reason for revisiting the goals with results from a vulnerability assessment. There is a need for criteria or thresholds in order to interpret the meaning and consequences of the vulnerability results. A risk assessment is a common tool for incorporating these elements to put potential vulnerabilities into a decision-making framework. Identifying the specific thresholds for risk analysis are challenging for many organizations. Using a combination of vulnerability scores and planning tools to develop adaptation strategies such as decision points, adaptation pathways and goal statements, groups can weave together an analysis that builds off of existing materials and organizational processes.

Evolving Goals for William Floyd Estate

Park goals for the William Floyd Estate are to preserve and rehabilitate the historical features, which needs to be refined in recognition of changes in sea level, erosion, marsh migration, and groundwater change. Since another key goal is to maintain the Estate as a living classroom it is important to emphasize and develop its educational and interpretive aspects. One of the biggest impediments to attaining this goal is access to the site, particularly the lower portions. Among the impediments to attaining the education and interpretation goal are inundated lands, restricted ability to get there physically, expanding and changing wetlands, overgrowth of forests, and obstructions across roads such as tree falls. Accessibility impediments affect park staff as well as park visitors. The one thing worse than having key features of the Estate disappear over the next twenty years, is having it disappear without having the capability to tell the story.

The NPS preferred alternative (B) for the Estate in the General Management Plan would:

> *"advance the vision of the William Floyd Estate as a historical park and museum where visitor activities and experiences would focus on understanding and appreciating the historical relevance of William Floyd and his descendants, the evolution of the site from agricultural plantation to recreational retreat, and the political, social, and economic forces that shaped this family and their use of the property. The value of the Estate as a large area of undeveloped land in a developed community would be more fully recognized. Cultural, natural, and recreational opportunities would be expanded, as appropriate within the context of the Estate's purpose and significance. The interpretative emphasis would be broadened to embrace more of the property's historic regional context, with more collaborative exhibits and programming taking place with other institutions, both on and off-site." (NPS, 2015)*

In sum, the Park goals for the William Floyd Estate, are to preserve and rehabilitate the historical features. These need to be refined to clarify what exactly they mean in the face of climate impacts. The Park needs to modify the definition of rehabilitation of the Estate landscape that is set out in the General Management Plan (NPS, 2016b). It is not realistic to prevent sea level rise and groundwater change or increased storm impacts.

The opportunity to track and interpret how the Estate landscape is moving, in real time over the backdrop of knowledge of its condition three centuries ago provides a tremendous opportunity to tell that story.

Reflections and Next Steps

Conducting a rapid climate change vulnerability assessment is just the beginning of a long-term process for adapting to changes originating from climate and non-climate sources. At the last workshop participants reflected on the assessment experience then outlined some potential next steps for moving forward.

Reflections

The following summarizes the reflections on the process, tools and outputs of this assessment.

Results

- There was a limited number of resources that changed vulnerability across the three time frames, with most changes in moderate to high vulnerability between 2020 and 2050. This is likely due to a combination of most resources on the island are already highly vulnerable and the conservative sea level rise projections used in this assessment.
- As part of developing adaptation strategies for specific resources, it may be necessary to revisit the vulnerability process at the site level, especially where natural resources which were assessed parkwide interact with specific assets. There also needs to be a comprehensive and dynamic sediment transport model to fully understand the likely future projections for Fire Island. USGS and USACE have been working on components of sediment models for Fire Island NS for years and so NPS should continue to coordinate with these agencies to ensure that as the models become more comprehensive, they meet multiple management needs. Changes in groundwater on Fire Island will impact cultural resources, the Sunken Forest, structures and communities.

Benefits of Integrated Vulnerability Assessment

- The assessment provided a generalized screening tool that assessed vulnerability in a consistent framework across program areas to spur discussions of how to use vulnerability and adaptive capacity to adapt to climate change parkwide.
- Park staff recognized the need to prepare for addressing climate change in the near to medium-term. There are significant gaps in management knowledge including a lack of a dynamic sediment transport model and shoreline protection infrastructure interacts with sediment processes and this process highlighted areas to prioritize filling gaps.

Integration

- The assessment can be used to provide input to various planning processes used by park staff for today’s programing and future planning. These include:
    - Mainstream climate and vulnerability information into other planning processes
    - Resource Stewardship Strategy
    - Annual and 5-year work plans for program areas
    - Environmental Impact Statements
    - Capital Investment Strategy

- Hurricane Preparedness Planning
- Support for partners and coordination with FIMI and FIMP projects
- Baseline and existing conditions report (NRCA, Cultural Resource Stewardship Assessment)
- Section 106 and 110 – Cultural resources that are on or eligible for the National Register of Historic Places
- Incorporate climate and shoreline change into interpretation programming

- The importance of discussing facility assets, cultural and natural resources within the same process became obvious to all: they are interdependent. This being said, it was apparent that all resources and assets (across resource program areas or even within) are not necessarily valued in the same way or for the same reasons. One person said 'being able to look at a location and see the natural, cultural and facility vulnerabilities all in one snapshot was powerful and useful.'
- The process revealed differences among the three program areas (and even within the program areas) illustrating the varying stages of awareness, methods of assessment, and adaptation approaches. This provided opportunities for lessons to be learned across program areas and within a park staff.
- One person captured a thought shared by many in saying 'We're all so busy and think short-term, but all know the long-term, in terms of climate change + sea level rise impacts to a barriers island. This process was important in slowing down, actually talking about them, and what that means for the future of the seashore.'
- Engaging across disciplines in focal areas lent itself to interpretation, which helped articulate the integration and tell a story of the past, present and future.

Framework

- A majority of participants rated the framework as very effective or effective, though a fair number (25%) gave it only a fair scoring, showing that there is room for improvement to meet the varying needs across the NPS. Formulating and applying a common framework across program areas was a challenge, given the different issues and opportunities. The Cultural Resources Workgroup found it challenging to apply expert judgement in some of the scoring processes, though they understood and trusted the final scores. The human dimension of adaptive capacity was very important to the Facilities and Cultural Resources Workgroups, and was also worthwhile to the Natural Resources Workgroup. Employing the POSE adaptive capacity framework brought to the fore the realities of how society and economics could impact efforts to develop adaptation plans.
- It was challenging to assess cultural resources' adaptive capacity due to the complications surrounding the concepts of significance and priorities. Significance was a challenge to define in the first pilot site, though Fire Island NS group used the method developed in the pilot without complications. There was a larger question related to prioritization. Vulnerability alone does not determine priority for adaptation actions, it needs to be a combination of significance

and vulnerability, but it was beyond the scope of this effort to evaluate significance of each resource (Rockman et al. 2016). Developing methods to do so is an important next step that is currently being developed in related efforts.

- LGBTQ resources are an important part of the history and culture of the Fire Island communities. However, the assessment framework did not have a straightforward way to include particular ethnographic resources to explore their vulnerability to climate change. This could be an area of future study specific to these resources.

Process

- All of the participants agreed or strongly agreed that the process was effective for facilitating worthwhile discussions and providing valuable outputs. Thus most of the participants also thought the assessment increased their ability to incorporate vulnerability into park planning and implementation.
- Workgroups brought in expert judgement directly related to the park, broader expertise from partners and was complemented by National and Regional NPS perspectives. The effectiveness was improved with strong local leadership, such as by having park staff lead each workgroup. There were significant benefits from conducting the assessment internally with the staff and partners that can't be matched by contracting consultants to do the analysis, though it was a substantial time commitment.
- Conducting much of the assessment over the course of three face-to-face workshops built trust and buy-in among and within the program areas. It also reduced fears of the process, allowing equal footing and better understanding of perspectives and priorities among program areas.
- A significant portion of the work was done outside of the workshops via conference calls. The success of the workgroups was enhanced by the opportunities to discuss materials and issues as a group during calls to prepare for as well as analyze the results of the three workshops. It is important to include enough time and funding to allow for a multi-stage process in the vulnerability assessments.
- Identifying stressors (for each program area) enabled each workgroup to deal with multiple facets of the climate change issue that were affecting their resources, not just sea level rise. This made the process more relevant for coastal and inland parks alike. One limitation of this process was that it treated all stressors equally, as there was not a simple way to weight the most important stressors differently than the secondary ones.
- Workshop exercises drilled down to particular geographic areas of concern (focal areas) to allow the integration to happen; the integration was more about the adaptation than the vulnerability. This was an effective way for the three program areas to work together to combine expertise and yielded a number of viable adaptation ideas that in many cases reinforced and supported adaptation needs of mutual benefit.

Projections

- Future assessments should choose sea level rise projections based what the park and/or their adjacent stakeholders are using, based on best available, localized, science. While there was justification to using scenarios to align with consistent national NPS protocols (Caffrey et al.

2018), because they were lower than what is being used by local partners, they lacked buy in, and the process will need to be updated.

- Given that this was a rapid assessment, we used bathtub models for sea level rise scenarios which did not capture the barrier beach dynamics of Fire Island NS. However, the workshop discussions included experts that have used their knowledge and experience in local studies, therefore we were able to adjust the findings and recommendation based on the reality of how the dynamic system works (Wilson et al. 2019 and Psuty et al. 2008).

Communication

- In addition to developing a communication plan for sharing the results of this assessment through the Interpretation and Education programs, articulating key messages and climate stories were part of the workshop process. Educating field staff, especially interpretive staff, will be critical; they have been thinking a lot about climate change and when provided the vulnerability information, they are able to communicate it to visitors and communities.

Partnerships

Local partners will be key in implementing adaptation pathways for parks. In conducting an integrated assessment each park will determine which partners need to be involved in the assessment and at what stage: Fire Island NS identified that the it was important to invite representatives from the 17 residential communities to be part of the process. Including other key stakeholders (i.e. non-profit organizations including The Nature Conservancy and Seatuck, state and federal agencies, academic researchers), can benefit from diverse information gathering, honest discussion about issues and opportunities to build partnerships and get buy-in for taking next steps.

- The three workshop process was a challenge for stakeholders from the communities to participate in fully. The third workshop agenda was adjusted to target their input for the final day, but there needs to be a way to design the process to include input of partners at a less involved scale. Partners from academic institutions and sister agencies were able to commit to the three workshop format and their input was invaluable.
- Incorporate into other NPS documents/processes: Park staff envisioned the results of the vulnerability assessment being incorporated into other existing planning documents and processes of the NPS. This could increase organizational acceptance of the results and knowledge of how to apply the actions into ongoing short-term and long-term management planning. Specific planning processes to incorporate these results include the Resource Stewardship Strategy. Implementation of existing plans including the General Management Plan (NPS, 2016b), the Wilderness Breach Management Plan (NPS, 2018), and FIMP (USACE, 2016) and FIMI (USACE, 2014).
- Disseminate with NPS Staff and Partners: A core principle of this vulnerability assessment was that understanding and acting on the results depended as much on NPS and park staff organizational capacity as it does on the specific technical findings. Thus all park staff should be informed and engaged in application of these vulnerability results. The assessment began with the three program areas of Cultural Resources, Natural Resources, and Facilities. There are other program areas that were involved who should be updated and involved in navigating

strategies for adaptation planning. These include interpretation, law enforcement, and administration. Fire Island NS staff is also proactive in communicating with local communities. Since this assessment was conducted, the staff have convened two community meetings to share and discuss the results. Getting partner input on how best to partner with the communities on next steps was an important part of the final day of the third workshop.

In conclusion, key to moving forward is engaging partnerships with local governments, neighboring associations as well as national groups that share an interest. Fire Island NS has a strong foundation to build from in these areas that should help accelerate the adaptation planning process. The vulnerability assessment data and maps can be a valuable resource for jumpstarting the adaptation planning process and integrating into existing planning processes. They can be used to bring onboard new partners and help them appreciate the underlying vulnerability issues and changes over time.

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Appendix A. Climate Projections Used in Assessment at Fire Island National Seashore

Climate Summary – Fire Island National Seashore

The following materials were provided to workshop participants as part of a handout summary and presentation of climate projections at workshop 1.

Table A-1. Summary of trends and projections for temperature and precipitation (Northeast Climate Adaptation Science Center, FIIS Climate Change Profile).

Trends	Projections
It is warming, especially lows and in winter	Warming is projected to continue, rising 6–10 °F by the end of the century. Fastest warming is in Summer.
Precipitation has increased slightly, but weak compared to temperature, and not outside of the normal range of natural variability	Precipitation increases are expected annually, though strongest in the winter, potential drying in the summer with continued intensifying extremes
Extreme precipitation has increased dramatically in frequency, intensity, and duration	Warming impacts many other aspects of climate

Table A-2. Current climate and observed trends for temperature and precipitation (Northeast Climate Adaptation Science Center, FIIS Climate Change Profile).

Trends and Observations		Average Annual Temperature	Average Annual Precipitation	Area Affected (summer)
Current	Current climate	51–55° F	46–50"	–
Observed trends	Trends since 1900 [2]	+ 3° F	+ 8"	–
	Seasonal (per decade)	+ 0.16° F	+ 0.39"	–
	Extremely warm minimums (lows)	–	–	+ 60%
	Extremely warm maximums (highs)	–	–	+ 50%
	Heaviest rain extremes (1 day)	–	+ 20%	–
	Winter (per decade)	+ 0.24° F	–	–
	Spring (per decade)	+ 0.14° F	–	–
	Summer (per decade)	+ 0.11° F	–	–
	Fall (per decade)	+ 0.12° F	+ 0.24"	–

Table A-3. Future projections for temperature and precipitation (Northeast Climate Adaptation Science Center, FIIS Climate Change Profile).

Climate Variables		**Mid-century (~2050)1**	**By 2100**
Projected temperature	Average annual temperature	–	+ 2–10°F
	Freeze-free period	+25 days	–
	Days over 90°F	+15 days	–
Projected precipitation	Nights below freezing	−30 nights	–
	Days over 1”	+20%	–
	Days over 4”	+65–80%	–
	Dry spell length	+1 day	–

Sea Level Rise

Sea level rise is accelerating over time. Future sea level rise projections vary depending on our choices about emissions, how sensitive ice sheets and glaciers are to warming and local factors. By 2050 we can expect between 0.15 and 0.54 feet. By 2100 we can expect between 1.31 and 7.23 feet. For this assessment we are using NPS estimates of 0.46 ft by 2030, 0.85 ft by 2050 and 2.51 ft by 2100 marked by stars.

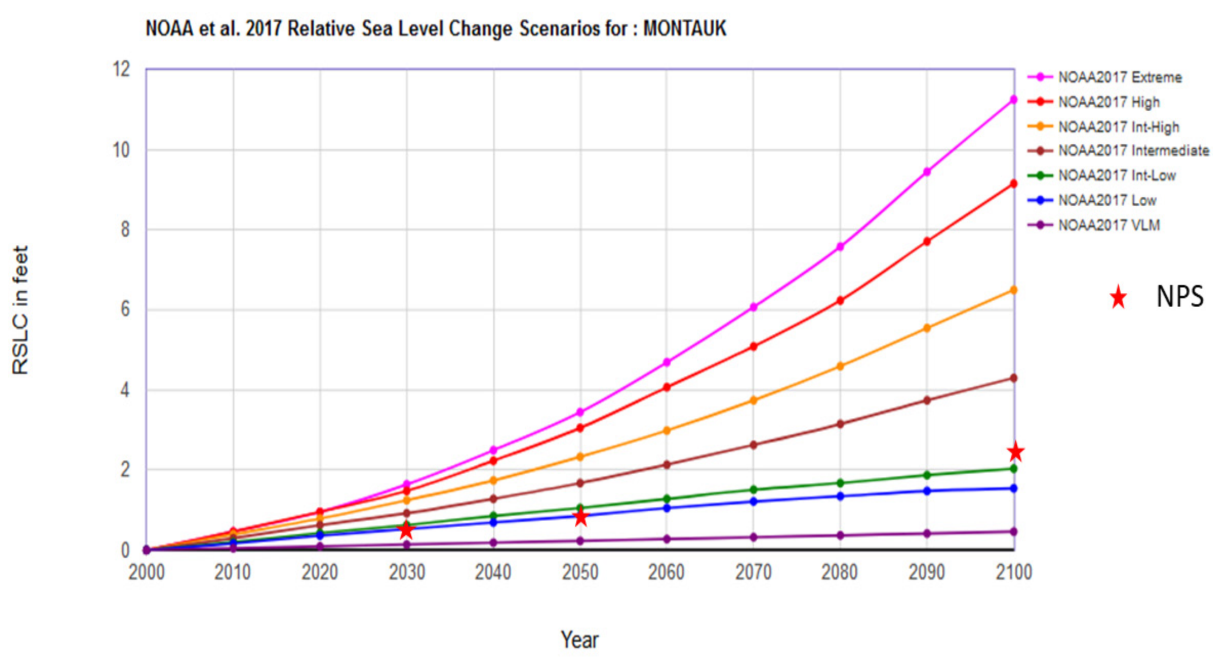

Figure A-1. Relative sea level rise projections from US Army Corps of Engineers Sea Level Curve Calculator for Montauk, New York. Stars mark scenarios used in vulnerability assessment for Fire Island National Seashore.

Table A-4. Historical and projected sea level and storm trends for Fire Island National Seashore, New York.*

Sea Level and Storm Surge Trends	Historical	2030[1]	2050[2]	2100[3]
Historical sea level trend, 1947–2014, Montauk tide gauge	+0.13 in/yr	N/A	N/A	N/A
Number of tropical storms, depression, extratropical, and subtropical storm paths within 10 miles of Fire Island, 1842–2014	19	N/A	N/A	N/A
Estimated storm surge height[4] (Category 1, mean tide), 2014	1.3 ft	N/A	N/A	N/A
Estimated storm surge height[4] (Category 4, mean tide), 2014	20.6 ft	N/A	N/A	N/A
High emissions scenario (RCP 8.5) Projected sea level	N/A	+0.46 ft	+0.85 ft	+2.51 ft

* Historical tide gauge data from the Montauk, NY tide gauge show that sea level around Fire Island National Seashore (FIIS) is rising (IPCC 2013; NOAA Tides and Currents 2012). FIIS has not been directly in the path of any hurricane-strength storms over the last century; however, it has been directly struck by at least 7 tropical or extratropical storms since 1882. Storms are expected to intensify over the next century. At least one Saffir-Simpson category 1 hurricane should be expected to travel up to FIIS by 2100.

University of Colorado, Department of Geological Sciences, Boulder, CO. November 4, 2015. Contacts: Maria Caffrey, maria.caffrey@colorado.edu; Rebecca Beavers, rebecca_beavers@nps.gov

[1] Calculated by Caffrey et al. (2018) using IPCC data.

[2] Calculated by Caffrey (2015a), using high emission scenario. This was used by Tormey et al. (2018) and therefore used as the scenario for this assessment. Since 2030 SLR was not included in the Caffrey (2015a), Caffrey et al. (2018) was used for that year.

[3] Ensemble mean based on data used for figure 13.20 by the IPCC (2013).

[4] Storm surge heights are projected on top of current mean sea level for Fire Island Lighthouse. It should be expected that potential storm surge heights will change over time based on changes in mean sea level.

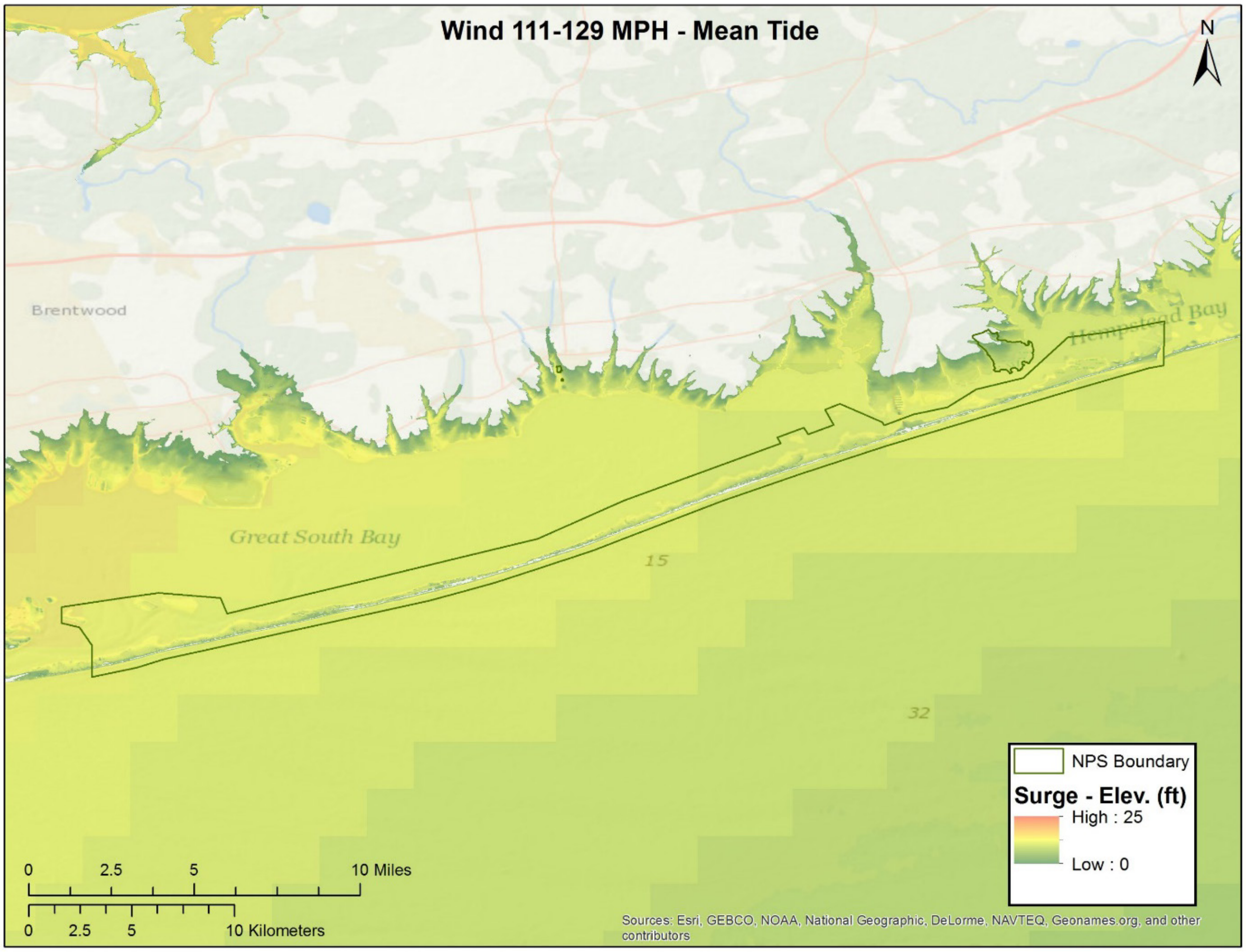

Figure A-2. Storm surge inundation for Fire Island National Seashore, New York: Sea lake and overland surges from Hurricanes. Based on Category 3 hurricane, and does not include sea level rise (Caffrey et al. 2015b).

Extreme Water Levels

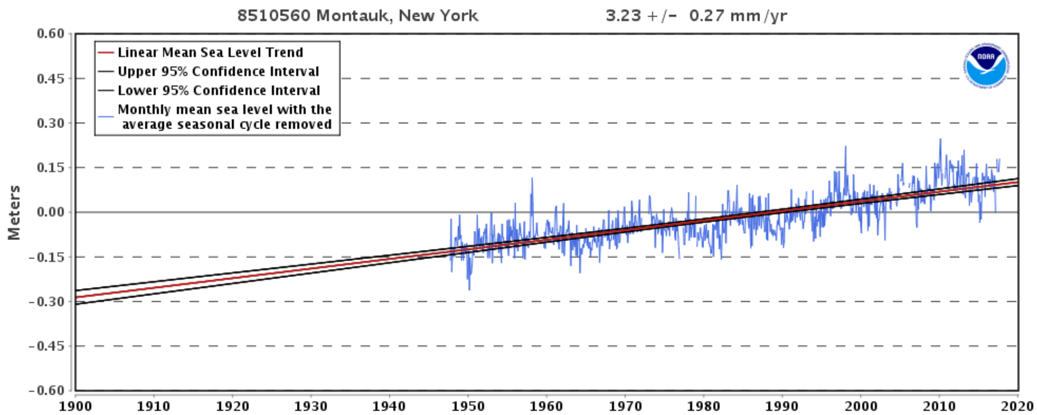

Figure A-3. Mean sea level trend at Montauk, New York National Oceanic and Atmospheric Administration tide gauge from 1927 to 2015, which is equivalent to a change of 1.51 feet in 100 years (NOAA, 2016).

Appendix B. Cultural Resources Vulnerability Assessment Data Set

Table B-1. Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Blue Point Life Saving Station	concrete pad	0	0	1	0	0	0	1	1	1	1	5	3	Moderate
Blue Point Life Saving Station	concrete pad	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Blue Point Life Saving Station	concrete debris	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Blue Point Life Saving Station	cistern	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Blue Point Life Saving Station	concrete slab	0	0	1	0	0	0	1	1	1	1	5	3	Moderate
Blue Point Life Saving Station	dump area	0	0	1	0	0	0	1	1	1	1	5	3	Moderate
Blue Point Life Saving Station	foundation 1	0	0	1	0	0	0	1	1	1	1	5	3	Moderate
Blue Point Life Saving Station	angle iron	0	0	1	0	0	0	1	1	1	1	5	3	Moderate
Blue Point Life Saving Station	Mid to late 20th century midden	1	0	0	0	0	0	1	1	1	1	5	4	High
Blue Point Life Saving Station	Early 20th century midden	1	0	1	0	0	0	1	1	1	1	6	4	High
Blue Point Life Saving Station	concrete pad	1	0	1	0	0	0	0	1	1	1	5	4	High
Blue Point Life Saving Station	concrete pad	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Blue Point Life Saving Station	concrete debris	0	0	1	0	0	0	1	1	1	1	5	3	Moderate
Blue Point Life Saving Station	concrete slab	0	0	1	0	0	0	1	1	1	1	5	3	Moderate

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Blue Point Life Saving Station	dump area	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Blue Point Life Saving Station	foundation 1	1	0	1	0	0	0	0	1	0	1	4	4	High
Blue Point Life Saving Station	angle iron	1	0	1	0	0	0	0	1	0	1	4	4	High
Camp Cheerful	metal sink	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Camp Cheerful	metal sink	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Camp Cheerful	metal sink	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Camp Cheerful	metal sink	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Camp Cheerful	metal sink	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Camp Cheerful	metal pipe	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Camp Cheerful	concrete	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Camp Cheerful	sand dune elevation	1	0	1	0	0	0	1	1	0	1	5	4	High
Camp Cheerful	scrub	1	0	1	0	0	0	1	1	0	1	5	4	High
Carrington House	Shed/Outhouse	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Carrington House	Carrington House	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Carrington House	Carrington Cottage	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Fire Island Lighthouse	U.S.C.G. Annex flag pole	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Fire Island Lighthouse	Concrete cradles	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Fire Island Lighthouse	Fire Island Light Station – Terrace	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	artifact scatter	0	0	1	0	0	0	1	1	1	1	5	3	Moderate

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Fire Island Lighthouse	artifact scatter	1	0	1	0	0	0	1	1	1	1	6	4	High
Fire Island Lighthouse	rubble	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Fire Island Lighthouse	rubble	1	0	1	0	0	0	1	1	1	1	6	4	High
Fire Island Lighthouse	rubble	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Fire Island Lighthouse	brick scatter	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Fire Island Lighthouse	cast iron sewer pipe	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Fire Island Lighthouse	Burma Road	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Boat House	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Fire Island Lighthouse	Fire Island Lighthouse	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Keeper's Quarters/ Visitor Center	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Fire Island Light Station – Tool House	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Store House	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Fire Island Light house – Oil House	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Fire Island Light Station – Annex Garage	0	1	1	0	0	1	1	1	0	1	6	3	Moderate

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Fire Island Lighthouse	U.S.C.G. Annex Building	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	1827 Lighthouse foundation	0	1	1	1	0	1	1	1	1	1	8	4	High
Fire Island Lighthouse	1827 Lighthouse foundation Arch. Site	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Engine House Foundation	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Radio Tower Foundations	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Power House Foundation	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Flagpole – Fire Island Light Station	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	artifact scatter	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Fire Island Lighthouse	artifact scatter	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Fire Island Lighthouse	rubble	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Fire Island Lighthouse	rubble	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Fire Island Lighthouse	rubble	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Fire Island Lighthouse	brick scatter	0	1	1	1	0	0	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Gate FIIS Light Station	0	1	1	0	1	0	1	1	1	1	7	4	High

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ SPATIAL ORGANIZATION	0	1	1	1	1	0	1	1	1	1	8	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOSUE_ LAND USE	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ VEGETATION	0	1	1	1	1	0	1	1	1	1	8	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ CIRCULATION	0	1	1	1	1	0	1	1	1	1	8	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ BUILDINGS AND STRUCTURES	0	1	1	1	1	0	1	1	1	1	8	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ VIEWS AND VISTAS	0	1	1	0	0	0	1	1	0	1	5	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ SMAL SCALE FEATURES	0	1	1	1	1	0	1	1	1	1	8	4	High
Smith Point Coast Guard Station	cut limestone pieces	0	0	1	1	1	1	1	1	1	1	8	4	High

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Smith Point Coast Guard Station	cement walk	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S1	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S2	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S3	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S4	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S5?	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	structure S5?	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Smith Point Coast Guard Station	cylindrical metal oil tank	0	1	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	well center point	0	1	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	coal scatter	0	1	1	1	0	1	1	1	0	1	7	4	High
Whale House Point	pos well house Q11 (floor slab)	0	0	1	0	0	1	1	1	1	1	6	3	Moderate
Whale House Point	misc house	0	0	1	0	0	1	1	1	1	1	6	3	Moderate
Whale House Point	house pos Q5	0	0	1	0	0	1	1	1	1	1	6	3	Moderate
Whale House Point	house pos Q19	0	0	1	0	0	1	1	1	1	1	6	3	Moderate
Whale House Point	concrete walk	0	0	1	0	0	1	1	1	1	1	6	3	Moderate
Whale House Point	debris	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Whale House Point	dock	1	0	1	1	1	1	1	1	0	1	8	4	High
William Floyd Estate	Squirrel Lane	0	0	0	0	0	0	1	0	1	1	3	2	Low
William Floyd Estate	Brick Walkway	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Meadow Ground Path	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Corduroy Road	1	0	0	1	1	0	1	1	1	1	7	4	High
William Floyd Estate	Headstone/ Phebo Floyd	0	0	0	0	0	1	0	1	1	1	4	3	Moderate

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	New Barn	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Wind Mill	0	1	0	0	0	1	1	1	1	1	6	3	Moderate
William Floyd Estate	Barn	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Corn Crib	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Woodshed	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Carriage House	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Caretaker Workshop Ranger Station	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Estate House Old Mastic House?	0	0	0	0	0	1	0	1	1	1	4	3	Moderate
William Floyd Estate	Ice House	0	0	0	0	0	1	0	1	1	1	4	3	Moderate
William Floyd Estate	Storage Crib	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Old Shop	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Pump House	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Incinerator	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Floyd's Pond	0	1	0	0	0	1	1	1	1	1	6	3	Moderate
William Floyd Estate	Folly Pond	0	1	0	0	0	1	1	1	1	1	6	3	Moderate

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	Rye Pond	0	1	0	0	0	1	1	1	1	1	6	3	Moderate
William Floyd Estate	South Pond	0	1	0	0	0	1	1	1	1	1	6	3	Moderate
William Floyd Estate	Teal Pond	0	1	0	0	0	1	1	1	1	1	6	3	Moderate
William Floyd Estate	Mosquito Ditches	1	0	0	1	0	1	1	1	0	1	6	4	High
William Floyd Estate	Great Ditch	1	0	0	1	0	1	1	1	1	1	7	4	High
William Floyd Estate	Lawrence Creek	1	0	0	0	0	1	1	1	0	1	5	4	High
William Floyd Estate	Floyd Estate Gazebo	0	1	0	0	0	1	1	1	1	1	6	3	Moderate
William Floyd Estate	Lopped Tree Line	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	Slave markers	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	Cisterns/Wells	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	Graveyard Fence	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	William Floyd Gravestone	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Nicoll & Tabitha Floyd Gravestones	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Floyd Estate High Board Fence	–	–	0	0	0	0	0	1	1	1	3	2	Low

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	CULTURAL LANDSCAPE_WFE_NATURAL SYSTEMS AND FEATURES	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_SPATIAL ORGANIZATION	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_VEGETATION	0	0	0	0	1	1	1	1	1	1	6	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE_CIRCULATION	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_BUILDINGS AND STRUCTURES	0	1	0	0	0	1	1	1	1	1	6	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE_VIEWS AND VISTAS	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ CONSTRUCTED WATER FEATURES	1	0	0	1	1	1	1	1	1	1	8	4	High

* 1=exposed, 0= not exposed

Table B-1 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/ Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	CULTURAL LANDSCAPE_WFE_SMALL SCALE FEATURES	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ ARCHEOLOGICAL SITES	1	0	0	1	0	0	0	1	1	1	5	4	High
William Floyd Estate	Entire Estate – Arch. Site	–	–	0	0	0	1	0	1	1	1	4	3	Moderate

* 1=exposed, 0= not exposed

Table B-2. Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Blue Point Life Saving Station	concrete pad	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	concrete pad	0	1	1	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	concrete debris	0	1	1	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	cistern	0	1	1	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	concrete slab	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	dump area	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	foundation 1	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	angle iron	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	Mid to late 20th century midden	1	0	0	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	Early 20th century midden	1	0	1	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	concrete pad	1	0	1	1	0	1	0	1	1	1	7	4	High
Blue Point Life Saving Station	concrete pad	0	1	1	1	0	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	concrete debris	0	0	1	1	0	1	1	1	1	1	7	4	High
Blue Point Life Saving Station	concrete slab	0	0	1	1	0	1	1	1	1	1	7	4	High
Blue Point Life Saving Station	dump area	0	1	1	1	0	1	1	1	0	1	7	4	High
Blue Point Life Saving Station	foundation 1	1	0	1	1	0	1	0	1	0	1	6	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-2 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Blue Point Life Saving Station	angle iron	1	0	1	1	0	1	0	1	0	1	6	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal pipe	0	1	1	1	0	1	1	1	0	1	7	4	High
Camp Cheerful	concrete	0	1	1	1	0	1	1	1	0	1	7	4	High
Camp Cheerful	sand dune elevation	1	0	1	1	0	1	1	1	0	1	7	4	High
Camp Cheerful	scrub	1	0	1	1	0	1	1	1	0	1	7	4	High
Carrington House	Shed/Outhouse	0	1	1	0	0	1	1	1	1	1	7	4	High
Carrington House	Carrington House	0	1	1	0	0	1	1	1	1	1	7	4	High
Carrington House	Carrington Cottage	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Fire Island Lighthouse	U.S.C.G. Annex flag pole	0	1	1	0	1	1	1	1	0	1	7	4	High
Fire Island Lighthouse	Concrete cradles	0	1	1	0	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	Fire Island Light Station – Terrace	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	artifact scatter	0	0	1	1	1	1	1	1	1	1	8	4	High
Fire Island Lighthouse	artifact scatter	1	0	1	1	1	1	1	1	1	1	9	4	High
Fire Island Lighthouse	rubble	0	1	1	1	1	1	1	1	1	1	9	4	High
Fire Island Lighthouse	rubble	1	0	1	1	1	1	1	1	1	1	9	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-2 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Fire Island Lighthouse	rubble	0	1	1	1	1	1	1	1	1	1	9	4	High
Fire Island Lighthouse	brick scatter	0	1	1	1	1	1	1	1	1	1	9	4	High
Fire Island Lighthouse	cast iron sewer pipe	0	1	1	1	1	1	1	1	0	1	8	4	High
Fire Island Lighthouse	Burma Road	0	1	1	0	1	1	1	1	1	1	8	4	High
Fire Island Lighthouse	Boat House	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Fire Island Lighthouse	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Keeper's Quarters/ Visitor Center	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Fire Island Light Station – Tool House	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Store House	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Fire Island Light house – Oil House	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Fire Island Light Station – Annex Garage	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	U.S.C.G. Annex Building	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	1827 Lighthouse foundation	0	1	1	1	0	1	1	1	1	1	8	4	High
Fire Island Lighthouse	1827 Lighthouse foundation Arch. Site	0	1	1	1	0	1	1	1	1	1	8	4	High
Fire Island Lighthouse	Engine House Foundation	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Radio Tower Foundations	0	1	1	0	0	1	1	1	1	1	7	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-2 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Fire Island Lighthouse	Power House Foundation	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Flagpole – Fire Island Light Station	0	1	1	0	1	1	1	1	0	1	7	4	High
Fire Island Lighthouse	artifact scatter	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	artifact scatter	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	rubble	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	rubble	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	rubble	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	brick scatter	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	Gate FIIS Light Station	0	1	1	0	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ SPATIAL ORGANIZATION	–	–	1	1	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ LAND USE	–	–	1	0	0	0	1	1	0	1	4	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ VEGETATION	–	–	1	1	1	0	1	1	1	1	7	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-2 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE _CIRCULATION	–	–	1	1	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE BUILDINGS AND STRUCTURES	–	–	1	1	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_VIEW S AND VISTAS	–	–	1	0	0	0	1	1	0	1	4	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ SMAL SCALE FEATURES	–	–	1	1	1	0	1	1	1	1	7	4	High
Smith Point Coast Guard nn	cut limestone pieces	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	cement walk	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S1	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S2	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S3	0	0	1	1	1	1	1	1	1	1	8	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-2 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Smith Point Coast Guard Station	structure S4	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Statio	structure S5?	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	structure S5?	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	cylindrical metal oil tank	0	1	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	well center point	0	1	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	coal scatter	0	1	1	1	0	1	1	1	0	1	7	4	High
Whale House Point	pos well house Q11 (floor slab)	0	0	1	1	1	1	1	1	1	1	8	4	High
Whale House Point	misc house	0	0	1	1	1	1	1	1	1	1	8	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-2 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Whale House Point	house pos Q5	0	0	1	1	1	1	1	1	1	1	8	4	High
Whale House Point	house pos Q19	0	0	1	1	1	1	1	1	1	1	8	4	High
Whale House Point	concrete walk	0	0	1	1	1	1	1	1	1	1	8	4	High
Whale House Point	debris	0	1	1	1	1	1	1	1	0	1	8	4	High
Whale House Point	dock	1	0	1	1	1	1	1	1	0	1	8	4	High
William Floyd Estate	Squirrel Lane	0	0	0	0	0	0	1	0	1	1	3	2	Low
William Floyd Estate	Brick Walkway	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Meadow Ground Path	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Corduroy Road	1	0	0	1	1	0	1	1	1	1	7	4	High
William Floyd Estate	Headstone/ Phebo Floyd	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	New Barn	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Wind Mill	0	1	0	0	0	1	1	1	1	1	6	3	Moderate
William Floyd Estate	Barn	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Corn Crib	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Woodshed	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Carriage House	0	0	0	0	0	0	0	1	1	1	3	2	Low

* Exposure scored exposed (1) or not exposed (0)

Table B-2 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	Caretaker Workshop Ranger Station	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Estate House Old Mastic House?	0	0	0	0	0	1	0	1	1	1	4	3	Moderate
William Floyd Estate	Ice House	0	0	0	0	0	1	0	1	1	1	4	3	Moderate
William Floyd Estate	Storage Crib	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Old Shop	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Pump House	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Incinerator	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Floyd's Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Folly Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Rye Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	South Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Teal Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Mosquito Ditches	1	0	0	1	1	0	1	1	0	1	6	4	High
William Floyd Estate	Great Ditch	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	Lawrence Creek	1	0	0	0	1	1	1	1	0	1	6	4	High
William Floyd Estate	Floyd Estate Gazebo	0	1	0	0	0	1	1	1	1	1	6	3	Moderate

* Exposure scored exposed (1) or not exposed (0)

Table B-2 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	Lopped Tree Line	0	0	0	0	1	1	1	1	1	1	6	3	Moderate
William Floyd Estate	Slave markers	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	Cisterns/Wells	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	Graveyard Fence	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	William Floyd Gravestone	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Nicoll & Tabitha Floyd Gravestones	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Floyd Estate High Board Fence	–	–	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ NATURAL SYSTEMS AND FEATURES	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ SPATIAL ORGANIZATION	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ VEGETATION	0	0	0	0	1	1	1	1	1	1	6	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ CIRCULATION	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ BUILDINGS AND STRUCTURES	0	1	0	0	0	1	1	1	1	1	6	3	Moderate

* Exposure scored exposed (1) or not exposed (0)

Table B-2 (continued). Cultural exposure 2020 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ VIEWS AND VISTAS	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ CONSTRUCTED WATER FEATURES	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ SMALL SCALE FEATURES	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ ARCHEOLOGICAL SITES	1	0	0	1	0	0	0	1	1	1	5	4	High
William Floyd Estate	Entire Estate – Arch. Site	–	–	0	0	0	1	0	1	1	1	4	3	Moderate

* Exposure scored exposed (1) or not exposed (0)

Table B-3. Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Blue Point Life Saving Station	concrete pad	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	concrete pad	0	1	1	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	concrete debris	0	1	1	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	cistern	0	1	1	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	concrete slab	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	dump area	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	foundation 1	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	angle iron	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	Mid to late 20th century midden	1	1	0	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	Early 20th century midden	1	0	1	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	concrete pad	1	0	1	1	1	1	0	1	1	1	8	4	High
Blue Point Life Saving Station	concrete pad	0	1	1	1	1	1	1	1	1	1	9	4	High
Blue Point Life Saving Station	concrete debris	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	concrete slab	0	0	1	1	1	1	1	1	1	1	8	4	High
Blue Point Life Saving Station	dump area	0	1	1	1	1	1	1	1	0	1	8	4	High
Blue Point Life Saving Station	foundation 1	1	0	1	1	1	1	0	1	0	1	7	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-3 (continued). Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Blue Point Life Saving Station	angle iron	1	0	1	1	1	1	0	1	0	1	7	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal sink	0	1	1	1	1	1	1	1	1	1	9	4	High
Camp Cheerful	metal pipe	0	1	1	1	1	1	1	1	0	1	8	4	High
Camp Cheerful	concrete	0	1	1	1	1	1	1	1	0	1	8	4	High
Camp Cheerful	sand dune elevation	1	1	1	1	1	1	1	1	0	1	9	4	High
Camp Cheerful	scrub	1	1	1	1	1	1	1	1	0	1	9	4	High
Carrington House	Shed/Outhouse	0	1	1	0	0	1	1	1	1	1	7	4	High
Carrington House	Carrington House	0	1	1	0	0	1	1	1	1	1	7	4	High
Carrington House	Carrington Cottage	0	1	1	0	0	0	1	1	1	1	6	3	Moderate
Fire Island Lighthouse	U.S.C.G. Annex flag pole	0	1	1	0	1	1	1	1	0	1	7	4	High
Fire Island Lighthouse	Concrete cradles	0	1	1	0	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	Fire Island Light Station – Terrace	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	artifact scatter	0	0	1	1	1	1	1	1	1	1	8	4	High
Fire Island Lighthouse	artifact scatter	1	1	1	1	1	1	1	1	1	1	10	4	High
Fire Island Lighthouse	rubble	0	1	1	1	1	1	1	1	1	1	9	4	High
Fire Island Lighthouse	rubble	1	1	1	1	1	1	1	1	1	1	10	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-3 (continued). Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Fire Island Lighthouse	rubble	0	1	1	1	1	1	1	1	1	1	9	4	High
Fire Island Lighthouse	brick scatter	0	1	1	1	1	1	1	1	1	1	9	4	High
Fire Island Lighthouse	cast iron sewer pipe	0	1	1	1	1	1	1	1	0	1	8	4	High
Fire Island Lighthouse	Burma Road	0	1	1	0	1	1	1	1	1	1	8	4	High
Fire Island Lighthouse	Boat House	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Fire Island Lighthouse	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Keeper's Quarters/ Visitor Center	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Fire Island Light Station – Tool House	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Store House	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	Fire Island Light house – Oil House	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Fire Island Light Station – Annex Garage	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	U.S.C.G. Annex Building	0	1	1	0	0	1	1	1	0	1	6	3	Moderate
Fire Island Lighthouse	1827 Lighthouse foundation	0	1	1	1	0	1	1	1	1	1	8	4	High
Fire Island Lighthouse	1827 Lighthouse foundation. Arch. Site	0	1	1	1	0	1	1	1	1	1	8	4	High
Fire Island Lighthouse	Engine House Foundation	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Radio Tower Foundations	0	1	1	0	0	1	1	1	1	1	7	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-3 (continued). Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Fire Island Lighthouse	Power House Foundation	0	1	1	0	0	1	1	1	1	1	7	4	High
Fire Island Lighthouse	Flagpole – Fire Island Light Station	0	1	1	0	1	1	1	1	0	1	7	4	High
Fire Island Lighthouse	artifact scatter	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	artifact scatter	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	rubble	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	rubble	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	rubble	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	brick scatter	0	1	1	1	0	1	1	1	0	1	7	4	High
Fire Island Lighthouse	Gate FIIS Light Station	0	1	1	0	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ SPATIAL ORGANIZATION	–	–	1	1	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_LAN D USE	–	–	1	0	0	0	1	1	0	1	4	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ VEGETATION	–	–	1	1	1	0	1	1	1	1	7	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-3 (continued). Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ CIRCULATION	–	–	1	1	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ BUILDINGS AND STRUCTURES	–	–	1	1	1	0	1	1	1	1	7	4	High
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ VIEWS AND VISTAS	–	–	1	0	0	0	1	1	0	1	4	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ SMAL SCALE FEATURES	–	–	1	1	1	0	1	1	1	1	7	4	High
Smith Point Coast Guard Station	cut limestone pieces	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	cement walk	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S1	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S2	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S3	0	0	1	1	1	1	1	1	1	1	8	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-3 (continued). Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Smith Point Coast Guard Station	structure S4	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	structure S5?	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	structure S5?	0	0	1	1	1	1	1	1	1	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	tower footing	1	0	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	cylindrical metal oil tank	0	1	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	well center point	0	1	1	1	1	1	1	1	0	1	8	4	High
Smith Point Coast Guard Station	coal scatter	0	1	1	1	1	1	1	1	0	1	8	4	High
Whale House Point	pos well house Q11 (floor slab)	0	0	1	1	1	1	1	1	1	1	8	4	High
Whale House Point	misc house	0	0	1	1	1	1	1	1	1	1	8	4	High

* Exposure scored exposed (1) or not exposed (0)

Table B-3 (continued). Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
Whale House Point	house pos Q5	0	0	1	1	1	1	1	1	1	1	8	4	High
Whale House Point	house pos Q19	0	0	1	1	1	1	1	1	1	1	8	4	High
Whale House Point	concrete walk	0	0	1	1	1	1	1	1	1	1	8	4	High
Whale House Point	debris	0	1	1	1	1	1	1	1	0	1	8	4	High
Whale House Point	dock	1	0	1	1	1	1	1	1	0	1	8	4	High
William Floyd Estate	Squirrel Lane	0	0	0	0	0	0	1	0	1	1	3	2	Low
William Floyd Estate	Brick Walkway	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Meadow Ground Path	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Corduroy Road	1	1	0	1	1	0	1	1	1	1	8	4	High
William Floyd Estate	Headstone/ Phebo Floyd	0	0	0	0	0	1	0	1	1	1	4	3	Moderate
William Floyd Estate	New Barn	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Wind Mill	0	1	0	0	0	1	1	1	1	1	6	3	Moderate
William Floyd Estate	Barn	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Corn Crib	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Woodshed	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Carriage House	0	0	0	0	0	0	0	1	1	1	3	2	Low

* Exposure scored exposed (1) or not exposed (0)

Table B-3 (continued). Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	Caretaker Workshop Ranger Station	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Estate House Old Mastic House?	0	0	0	0	0	1	0	1	1	1	4	3	Moderate
William Floyd Estate	Ice House	0	0	0	0	0	1	0	1	1	1	4	3	Moderate
William Floyd Estate	Storage Crib	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Old Shop	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Pump House	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Incinerator	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Floyd's Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Folly Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Rye Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	South Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Teal Pond	0	1	0	0	1	1	1	1	1	1	7	4	High
William Floyd Estate	Mosquito Ditches	1	1	0	0	1	1	1	1	0	1	7	4	High
William Floyd Estate	Great Ditch	1	1	0	1	1	1	1	1	1	1	9	4	High
William Floyd Estate	Lawrence Creek	1	1	0	1	1	1	1	1	0	1	8	4	High
William Floyd Estate	Floyd Estate Gazebo	0	1	0	0	0	1	1	1	1	1	6	3	Moderate

* Exposure scored exposed (1) or not exposed (0)

Table B-3 (continued). Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	Lopped Tree Line	0	0	0	0	1	1	1	1	1	1	6	3	Moderate
William Floyd Estate	Slave markers	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	Cisterns/Wells	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	Graveyard Fence	0	0	0	0	0	1	1	1	1	1	5	3	Moderate
William Floyd Estate	William Floyd Gravestone	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Nicoll & Tabitha Floyd Gravestones	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	Floyd Estate High Board Fence	–	–	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ NATURAL SYSTEMS AND FEATURES	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ SPATIAL ORGANIZATION	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ VEGETATION	0	0	0	0	1	1	1	1	1	1	6	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ CIRCULATION	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ BUILDINGS AND STRUCTURES	0	1	0	0	0	1	1	1	1	1	6	3	Moderate

* Exposure scored exposed (1) or not exposed (0)

Table B-3 (continued). Cultural exposure 2100 at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	FEMA_ VE	FEMA_ A	Breach	Erosion	SLR	Water_ table	Surge	Precip_ Event	Fire	Wind	Exp_ Raw	Exp_ Binned	Exp_ Rank
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ VIEWS AND VISTAS	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ CONSTRUCTED WATER FEATURES	1	0	0	1	1	1	1	1	1	1	8	4	High
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ SMALL SCALE FEATURES	0	0	0	0	0	0	0	1	1	1	3	2	Low
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ ARCHEOLOGICAL SITES	1	0	0	1	0	0	0	1	1	1	5	4	High
William Floyd Estate	Entire Estate – Arch. Site	–	–	0	0	0	1	0	1	1	1	4	3	Moderate

* Exposure scored exposed (1) or not exposed (0)

Table B-4. Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
Blue Point Life Saving Station	concrete pad	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	concrete pad	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	concrete debris	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	cistern	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	concrete slab	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	dump area	4	2	1	1	4	3	1	1	17	3	Moderate
Blue Point Life Saving Station	foundation 1	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	angle iron	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	Mid to late 20th century midden	4	2	4	1	4	3	1	1	20	3	Moderate
Blue Point Life Saving Station	Early 20th century midden	4	2	4	1	4	3	1	1	20	3	Moderate
Blue Point Life Saving Station	concrete pad	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	concrete pad	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	concrete debris	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	concrete slab	4	2	1	1	4	2	1	1	16	3	Moderate
Blue Point Life Saving Station	dump area	4	2	1	1	4	3	1	1	17	3	Moderate
Blue Point Life Saving Station	foundation 1	4	2	1	1	4	2	1	1	16	3	Moderate

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-4 (continued). Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
Blue Point Life Saving Station	angle iron	4	2	1	1	4	2	1	1	16	3	Moderate
Camp Cheerful	metal sink	4	2	1	1	4	2	1	1	16	3	Moderate
Camp Cheerful	metal sink	4	2	1	1	4	2	1	1	16	3	Moderate
Camp Cheerful	metal sink	4	2	1	1	4	2	1	1	16	3	Moderate
Camp Cheerful	metal sink	4	2	1	1	4	2	1	1	16	3	Moderate
Camp Cheerful	metal sink	4	2	1	1	4	2	1	1	16	3	Moderate
Camp Cheerful	metal pipe	4	2	1	1	4	2	1	1	16	3	Moderate
Camp Cheerful	concrete	4	2	1	1	4	2	1	1	16	3	Moderate
Camp Cheerful	sand dune elevation	4	2	1	1	4	2	1	1	16	3	Moderate
Camp Cheerful	scrub	4	2	1	1	4	2	1	1	16	3	Moderate
Carrington House	Shed/Outhouse	4	3	3	1	4	1	4	4	24	3	Moderate
Carrington House	Carrington House	4	2	2	1	4	1	4	4	22	3	Moderate
Carrington House	Carrington Cottage	4	2	2	1	4	1	4	4	22	3	Moderate
Fire Island Lighthouse	U.S.C.G. Annex flag pole	4	4	1	1	3	1	1	2	17	3	Moderate
Fire Island Lighthouse	Concrete cradles	4	4	1	1	4	1	1	1	17	3	Moderate
Fire Island Lighthouse	Fire Island Light Station – Terrace	4	4	3	4	4	3	2	1	25	4	High
Fire Island Lighthouse	artifact scatter	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	artifact scatter	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	rubble	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	rubble	4	2	1	1	4	3	1	1	17	3	Moderate

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-4 (continued). Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
Fire Island Lighthouse	rubble	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	brick scatter	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	cast iron sewer pipe	4	2	1	1	4	2	1	1	16	3	Moderate
Fire Island Lighthouse	Burma Road	4	4	2	1	4	4	1	1	21	3	Moderate
Fire Island Lighthouse	Boat House	4	4	3	2	4	3	4	3	27	4	High
Fire Island Lighthouse	Fire Island Lighthouse	4	4	3	2	4	3	2	1	23	3	Moderate
Fire Island Lighthouse	Keeper's Quarters/ Visitor Center	4	4	3	4	4	3	3	1	26	4	High
Fire Island Lighthouse	Fire Island Light Station – Tool House	4	4	2	2	4	3	4	4	27	4	High
Fire Island Lighthouse	Store House	4	4	2	1	4	3	4	4	26	4	High
Fire Island Lighthouse	Fire Island Lighthouse – Oil House	4	4	2	1	4	3	2	1	21	3	Moderate
Fire Island Lighthouse	Fire Island Light Station – Annex Garage	4	4	4	1	4	2	2	2	23	3	Moderate
Fire Island Lighthouse	U.S.C.G. Annex Building	4	4	4	4	4	3	1	2	26	4	High
Fire Island Lighthouse	1827 Lighthouse foundation	4	4	3	3	4	3	1	1	23	3	Moderate
Fire Island Lighthouse	1827 Lighthouse found. Arch. Site	4	4	3	3	4	3	1	1	23	3	Moderate
Fire Island Lighthouse	Engine House Foundation	4	4	2	4	3	3	1	1	22	3	Moderate

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-4 (continued). Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
Fire Island Lighthouse	Radio Tower Foundations	4	4	2	4	3	3	1	1	22	3	Moderate
Fire Island Lighthouse	Power House Foundation	4	4	2	4	3	3	1	1	22	3	Moderate
Fire Island Lighthouse	Flagpole – Fire Island Light Station	4	4	1	1	3	3	1	2	19	3	Moderate
Fire Island Lighthouse	artifact scatter	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	artifact scatter	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	rubble	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	rubble	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	rubble	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	brick scatter	4	2	1	1	4	3	1	1	17	3	Moderate
Fire Island Lighthouse	Gate FIIS Light Station	4	4	2	1	4	1	1	1	18	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ SPATIAL ORGANIZATION	4	3	2	1	4	2	2	1	19	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOSUE_ LAND USE	4	1	1	1	2	1	1	1	12	2	Low
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ VEGETATION	4	2	2	1	3	2	2	1	17	3	Moderate

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-4 (continued). Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ CIRCULATION	4	2	2	1	4	2	1	1	17	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ BUILDINGS AND STRUCTURES	4	3	2	2	4	3	2	2	22	3	Moderate
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ VIEWS AND VISTAS	4	1	1	1	2	1	1	1	12	2	Low
Fire Island Lighthouse	CULTURAL LANDSCAPE_ LIGHTHOUSE_ SMAL SCALE FEATURES	4	2	2	1	3	2	2	1	17	3	Moderate
Smith Point Coast Guard Station	cut limestone pieces	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	cement walk	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	structure S1	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	structure S2	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	structure S3	4	4	1	1	4	2	1	1	18	3	Moderate

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-4 (continued). Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
Smith Point Coast Guard Station	structure S4	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	structure S5?	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	tower footing	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	structure S5?	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	tower footing	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	tower footing	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	tower footing	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	cylindrical metal oil tank	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	well center point	4	4	1	1	4	2	1	1	18	3	Moderate
Smith Point Coast Guard Station	coal scatter	4	1	1	1	4	3	4	1	19	3	Moderate
Whale House Point	pos well house Q11 (floor slab)	4	4	1	1	4	2	1	1	18	3	Moderate
Whale House Point	misc house	4	4	1	1	4	2	1	1	18	3	Moderate

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-4 (continued). Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
Whale House Point	house pos Q5	4	4	1	1	4	2	1	1	18	3	Moderate
Whale House Point	house pos Q19	4	4	1	1	4	2	1	1	18	3	Moderate
Whale House Point	concrete walk	4	4	1	1	4	2	1	1	18	3	Moderate
Whale House Point	debris	4	4	1	1	4	3	1	1	19	3	Moderate
Whale House Point	dock	4	4	4	1	4	2	3	1	23	3	Moderate
William Floyd Estate	Squirrel Lane	1	1	1	1	2	2	1	1	10	2	Low
William Floyd Estate	Brick Walkway	1	1	1	1	2	1	1	1	9	2	Low
William Floyd Estate	Meadow Ground Path	1	1	3	1	2	3	1	1	13	2	Low
William Floyd Estate	Corduroy Road	1	1	3	4	2	3	1	1	16	3	Moderate
William Floyd Estate	Headstone/ Phebo Floyd	1	1	1	3	4	3	1	4	18	3	Moderate
William Floyd Estate	New Barn	1	1	1	1	2	2	4	3	15	2	Low
William Floyd Estate	Wind Mill	1	1	1	2	4	1	1	4	15	2	Low
William Floyd Estate	Barn	1	1	1	1	2	2	4	3	15	2	Low
William Floyd Estate	Corn Crib	1	1	1	1	3	2	4	4	17	3	Moderate
William Floyd Estate	Woodshed	1	1	1	1	2	2	4	4	16	3	Moderate
William Floyd Estate	Carriage House	1	1	1	1	2	2	4	4	16	3	Moderate

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-4 (continued). Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
William Floyd Estate	Caretaker Workshop Ranger Station	1	1	1	1	3	2	4	4	17	3	Moderate
William Floyd Estate	Estate House Old Mastic House?	1	1	1	4	4	2	4	4	21	3	Moderate
William Floyd Estate	Ice House	1	1	1	4	4	2	4	4	21	3	Moderate
William Floyd Estate	Storage Crib	1	1	1	1	2	2	4	4	16	3	Moderate
William Floyd Estate	Old Shop	1	1	1	1	2	2	4	4	16	3	Moderate
William Floyd Estate	Pump House	1	1	1	1	2	2	4	4	16	3	Moderate
William Floyd Estate	Incinerator	1	1	1	1	2	2	1	4	13	2	Low
William Floyd Estate	Floyd's Pond	1	2	4	2	2	1	1	1	14	2	Low
William Floyd Estate	Folly Pond	1	2	4	2	2	1	1	1	14	2	Low
William Floyd Estate	Rye Pond	1	2	4	2	2	1	1	1	14	2	Low
William Floyd Estate	South Pond	1	2	4	2	2	1	1	1	14	2	Low
William Floyd Estate	Teal Pond	1	1	3	2	2	1	1	1	12	2	Low
William Floyd Estate	Mosquito Ditches	1	2	4	2	2	1	1	1	14	2	Low
William Floyd Estate	Great Ditch	1	2	4	2	2	1	1	1	14	2	Low
William Floyd Estate	Lawrence Creek	1	2	3	2	2	1	1	1	13	2	Low
William Floyd Estate	Floyd Estate Gazebo	1	1	1	1	3	2	4	4	17	3	Moderate

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-4 (continued). Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
William Floyd Estate	Lopped Tree Line	1	1	1	2	2	2	4	4	17	3	Moderate
William Floyd Estate	Slave markers	1	1	1	2	3	1	4	4	17	3	Moderate
William Floyd Estate	Cisterns/Wells	1	1	1	1	2	1	1	1	9	2	Low
William Floyd Estate	Graveyard Fence	1	1	1	2	3	1	4	4	17	3	Moderate
William Floyd Estate	William Floyd Gravestone	1	1	1	3	4	1	1	4	16	3	Moderate
William Floyd Estate	Nicoll & Tabitha Floyd Gravestones	1	1	1	3	4	1	1	4	16	3	Moderate
William Floyd Estate	Floyd Estate High Board Fence	1	1	1	1	4	1	4	4	17	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE _NATURAL SYSTEMS AND FEATURES	1	2	4	4	2	2	3	2	20	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE _SPATIAL ORGANIZATION	1	2	3	3	2	2	2	2	17	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE _VEGETATION	1	2	2	3	3	2	4	4	21	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE _CIRCULATION	1	2	3	1	3	3	1	2	16	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE _BUILDINGS AND STRUCTURES	1	1	1	1	3	2	4	3	16	3	Moderate

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-4 (continued). Cultural sensitivity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	S_ Breach	S_ Erosion	S_ SLR	S_Water table	S_ Surge	S_Precip Event	S_ Fire	S_ Wind	Sens_ Raw	Sens_ Bin	Sens_ Rank
William Floyd Estate	CULTURAL LANDSCAPE_WFE _VIEWS AND VISTAS	1	1	1	1	1	1	3	2	11	2	Low
William Floyd Estate	CULTURAL LANDSCAPE_WFE _CONSTRUCTED WATER FEATURES	1	2	4	4	2	2	1	1	17	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE _SMALL SCALE FEATURES	1	1	1	2	3	2	3	3	16	3	Moderate
William Floyd Estate	CULTURAL LANDSCAPE_WFE _ARCHEOLOGICA L SITES	1	2	2	3	3	3	1	1	16	3	Moderate
William Floyd Estate	Entire Estate – Arch. Site	1	1	1	1	1	1	1	1	8	1	Minimal

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table B-5. Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020			2050			2100		
			Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank
Blue Point Life Saving Station	FIIS00003.01	concrete pad	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.02	concrete pad	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.03	concrete debris	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.04	cistern	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.05	concrete slab	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.06	dump area	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.07	foundation 1	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.08	angle iron	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00002.00	Mid to late 20th century midden	7	4	High	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00002.00	Early 20th century midden	7	4	High	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.00	concrete pad	7	4	High	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.00	concrete pad	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.00	concrete debris	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.00	concrete slab	6	3	Moderate	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.00	dump area	6	3	Moderate	7	4	High	7	4	High

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Table B-5 (continued). Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020			2050			2100		
			Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank
Blue Point Life Saving Station	FIIS00003.00	foundation 1	7	4	High	7	4	High	7	4	High
Blue Point Life Saving Station	FIIS00003.00	angle iron	7	4	High	7	4	High	7	4	High
Camp Cheerful	FIIS00009.00	metal sink	6	3	Moderate	7	4	High	7	4	High
Camp Cheerful	FIIS00009.00	metal sink	6	3	Moderate	7	4	High	7	4	High
Camp Cheerful	FIIS00009.00	metal sink	6	3	Moderate	7	4	High	7	4	High
Camp Cheerful	FIIS00009.00	metal sink	6	3	Moderate	7	4	High	7	4	High
Camp Cheerful	FIIS00009.00	metal sink	6	3	Moderate	7	4	High	7	4	High
Camp Cheerful	FIIS00009.00	metal pipe	6	3	Moderate	7	4	High	7	4	High
Camp Cheerful	FIIS00009.00	concrete	6	3	Moderate	7	4	High	7	4	High
Camp Cheerful	FIIS00009.00	sand dune elevation	7	4	High	7	4	High	7	4	High
Camp Cheerful	FIIS00009.00	scrub	7	4	High	7	4	High	7	4	High
Carrington House	n/a	Shed/Outhouse	6	3	Moderate	7	4	High	7	4	High
Carrington House	n/a	Carrington House	6	3	Moderate	7	4	High	7	4	High
Carrington House	n/a	Carrington Cottage	6	3	Moderate	6	3	Moderate	6	3	Moderate
Fire Island Lighthouse	n/a	U.S.C.G. Annex flag pole	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	n/a	Concrete cradles	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	40926	Fire Island Light Station – Terrace	8	4	High	8	4	High	8	4	High
Fire Island Lighthouse	FIIS00007.00	artifact scatter	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	artifact scatter	7	4	High	7	4	High	7	4	High

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Table B-5 (continued). Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020			2050			2100		
			Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank
Fire Island Lighthouse	FIIS00008.00	rubble	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	rubble	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	rubble	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	brick scatter	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	cast iron sewer pipe	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	n/a	Burma Road	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	040916	Boat House	7	4	High	8	4	High	8	4	High
Fire Island Lighthouse	022292	Fire Island Lighthouse	6	3	Moderate	6	3	Moderate	6	3	Moderate
Fire Island Lighthouse	022293	Keeper's Quarters/ Visitor Center	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	040919	Fire Island Light Station – Tool House	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	040918	Store House	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	040917	Fire Island Light house – Oil House	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	040915	Fire Island Light Station – Annex Garage	6	3	Moderate	6	3	Moderate	6	3	Moderate
Fire Island Lighthouse	040920	U.S.C.G. Annex Building	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	n/a	1827 Lighthouse foundation	7	4	High	7	4	High	7	4	High

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Table B-5 (continued). Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020			2050			2100		
			Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank
Fire Island Lighthouse	FIIS00007.00	1827 Lighthouse found. Arch. Site	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	040921	Engine House Foundation	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	040924	Radio Tower Foundations	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	040925	Power House Foundation	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	n/a	Flagpole – Fire Island Light Station	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00007.00	artifact scatter	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	artifact scatter	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	rubble	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	rubble	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	rubble	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	FIIS00008.00	brick scatter	6	3	Moderate	7	4	High	7	4	High
Fire Island Lighthouse	n/a	Gate FIIS Light Station	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	n/a	CULTURAL LANDSCAPE_LIGHTHOUSE_ SPATIAL ORGANIZATION	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	n/a	CULTURAL LANDSCAPE_LIGHTHOSUE_ LAND USE	5	3	Moderate	5	3	Moderate	5	3	Moderate

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Table B-5 (continued). Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020			2050			2100		
			Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank
Fire Island Lighthouse	n/a	CULTURAL LANDSCAPE_LIGHTHOUSE_ VEGETATION	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	n/a	CULTURAL LANDSCAPE_LIGHTHOUSE_ CIRCULATION	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	n/a	CULTURAL LANDSCAPE_LIGHTHOUSE_ BUILDINGS AND STRUCTURES	7	4	High	7	4	High	7	4	High
Fire Island Lighthouse	n/a	CULTURAL LANDSCAPE_LIGHTHOUSE_VI EWS AND VISTAS	5	3	Moderate	5	3	Moderate	5	3	Moderate
Fire Island Lighthouse	n/a	CULTURAL LANDSCAPE_LIGHTHOUSE_ SMAL SCALE FEATURES	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	cut limestone pieces	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	cement walk	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	structure S1	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	structure S2	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	structure S3	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	structure S4	7	4	High	7	4	High	7	4	High

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Table B-5 (continued). Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020 Sum_ BinE+BinS	2020 Vuln_ Final	2020 Vuln_ Rank	2050 Sum_ BinE+BinS	2050 Vuln_ Final	2050 Vuln_ Rank	2100 Sum_ BinE+BinS	2100 Vuln_ Final	2100 Vuln_ Rank
Smith Point Coast Guard Station	FIIS00005.00	structure S5?	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	tower footing	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	structure S5?	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	tower footing	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	tower footing	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	tower footing	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	cylindrical metal oil tank	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	well center point	7	4	High	7	4	High	7	4	High
Smith Point Coast Guard Station	FIIS00005.00	coal scatter	7	4	High	7	4	High	7	4	High
Whale House Point	FIIS00004.00	pos well house Q11 (floor slab)	6	3	Moderate	7	4	High	7	4	High
Whale House Point	FIIS00004.00	misc house	6	3	Moderate	7	4	High	7	4	High
Whale House Point	FIIS00004.00	house pos Q5	6	3	Moderate	7	4	High	7	4	High

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Table B-5 (continued). Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020			2050			2100		
			Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank
Whale House Point	FIIS00004.00	house pos Q19	6	3	Moderate	7	4	High	7	4	High
Whale House Point	FIIS00004.00	concrete walk	6	3	Moderate	7	4	High	7	4	High
Whale House Point	FIIS00004.00	debris	6	3	Moderate	7	4	High	7	4	High
Whale House Point	FIIS00004.00	dock	7	4	High	7	4	High	7	4	High
William Floyd Estate	n/a	Squirrel Lane	4	2	Low	4	2	Low	4	2	Low
William Floyd Estate	40910	Brick Walkway	4	2	Low	4	2	Low	4	2	Low
William Floyd Estate	n/a	Meadow Ground Path	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	n/a	Corduroy Road	7	4	High	7	4	High	7	4	High
William Floyd Estate	40932	Headstone/ Phebo Floyd	6	3	Moderate	5	3	Moderate	6	3	Moderate
William Floyd Estate	7487	New Barn	4	2	Low	4	2	Low	4	2	Low
William Floyd Estate	40931	Wind Mill	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	7486	Barn	4	2	Low	4	2	Low	4	2	Low
William Floyd Estate	7482	Corn Crib	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	7481	Woodshed	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	7480	Carriage House	5	3	Moderate	5	3	Moderate	5	3	Moderate

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Table B-5 (continued). Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020			2050			2100		
			Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank
William Floyd Estate	7479	Caretaker Workshop Ranger Station	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	291	Estate House Old Mastic House?	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	7483	Ice House	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	7484	Storage Crib	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	7485	Old Shop	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	22691	Pump House	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	22692	Incinerator	4	2	Low	4	2	Low	4	2	Low
William Floyd Estate	40936	Floyd's Pond	5	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	40936	Folly Pond	5	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	40936	Rye Pond	5	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	40936	South Pond	5	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	40936	Teal Pond	5	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	n/a	Mosquito Ditches	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	40914	Great Ditch	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	n/a	Lawrence Creek	6	3	Moderate	6	3	Moderate	6	3	Moderate

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Table B-5 (continued). Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020			2050			2100		
			Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank
William Floyd Estate	FIIS00013.00	Floyd Estate Gazebo	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	40913	Lopped Tree Line	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	40934	Slave markers	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	40929	Cisterns/Wells	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	040928	Graveyard Fence	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	n/a	William Floyd Gravestone	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	n/a	Nicoll & Tabitha Floyd Gravestones	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	40927	Floyd Estate High Board Fence	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	n/a	CULTURAL LANDSCAPE_WFE_NATURAL SYSTEMS AND FEATURES	7	4	High	7	4	High	7	4	High
William Floyd Estate	n/a	CULTURAL LANDSCAPE_WFE_SPATIAL ORGANIZATION	7	4	High	7	4	High	7	4	High
William Floyd Estate	n/a	CULTURAL LANDSCAPE_WFE_ VEGETATION	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	n/a	CULTURAL LANDSCAPE_WFE_ CIRCULATION	7	4	High	7	4	High	7	4	High
William Floyd Estate	n/a	CULTURAL LANDSCAPE_WFE_BUILDINGS AND STRUCTURES	6	3	Moderate	6	3	Moderate	6	3	Moderate
William Floyd Estate	n/a	CULTURAL LANDSCAPE_WFE_VIEWS AND VISTAS	4	2	Low	4	2	Low	4	2	Low

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Table B-5 (continued). Cultural vulnerability 2020, 2050, 2100 at Fire Island National Seashore, New York.*

Resource Factor	ASMIS or LCS #	Resource/Factor	2020			2050			2100		
			Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank	Sum_ BinE+BinS	Vuln_ Final	Vuln_ Rank
William Floyd Estate	n/a	CULTURAL LANDSCAPE_WFE_ CONSTRUCTED WATER FEATURES	7	4	High	7	4	High	7	4	High
William Floyd Estate	n/a	CULTURAL LANDSCAPE_WFE_SMALL SCALE FEATURES	5	3	Moderate	5	3	Moderate	5	3	Moderate
William Floyd Estate	n/a	CULTURAL LANDSCAPE_WFE_ ARCHEOLOGICAL SITES	7	4	High	7	4	High	7	4	High
William Floyd Estate	FIIS00001.00	Entire Estate – arch. Site	4	2	Low	4	2	Low	4	2	Low

* Vulnerability scored minimal (1), low (2), moderate (3) or high (4). n/a = not applicable

Appendix C. Cultural Resources Adaptive Capacity Assessment Data Set at Fire Island National Seashore.

Table C-1. Cultural adaptive capacity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	Physical	Organizational	Social	Economic	Overlap	AC_ Sum	AC_ Rank	Comments
Blue Point Life Saving Station	concrete pad	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	concrete pad	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	concrete debris	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	cistern	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	concrete slab	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	dump area	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	foundation 1	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	angle iron	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	Mid to late 20th century midden	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	Early 20th century midden	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	concrete pad	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	concrete pad	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	concrete debris	1	2	2	1	–	6	Moderate	–

* Adaptive capacity scored minimal (1), low (2), moderate (3) to high (4). NR = natural resources. Fac. = facilities.

Table C-1 (continued). Cultural adaptive capacity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	Physical	Organizational	Social	Economic	Overlap	AC_ Sum	AC_ Rank	Comments
Blue Point Life Saving Station	concrete slab	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	dump area	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	foundation 1	1	2	2	1	–	6	Moderate	–
Blue Point Life Saving Station	angle iron	1	2	2	1	–	6	Moderate	–
Camp Cheerful	metal sink	1	2	2	1	–	6	Moderate	–
Camp Cheerful	metal sink	1	2	2	1	–	6	Moderate	–
Camp Cheerful	metal sink	1	2	2	1	–	6	Moderate	–
Camp Cheerful	metal sink	1	2	2	1	–	6	Moderate	–
Camp Cheerful	metal sink	1	2	2	1	–	6	Moderate	–
Camp Cheerful	metal pipe	1	2	2	1	–	6	Moderate	–
Camp Cheerful	concrete	1	2	2	1	–	6	Moderate	–
Camp Cheerful	sand dune elevation	1	2	2	1	–	6	Moderate	–
Camp Cheerful	scrub	1	2	2	1	–	6	Moderate	–
Carrington House	Shed/Outhouse	3	2	2	1	–	8	Moderate	–
Carrington House	Carrington House	3	2	2	3	–	10	High	–
Carrington House	Carrington Cottage	3	2	2	3	–	10	High	–
Fire Island Lighthouse	U.S.C.G. Annex flag pole	3	3	3	2	–	11	High	–
Fire Island Lighthouse	Concrete cradles	3	1	2	1	–	7	Moderate	–
Fire Island Lighthouse	Fire Island Light Station – Terrace	2	2	3	1	Fac.	8	Moderate	If moved then building up the area around it which would impact other resources. Highest tourist attraction
Fire Island Lighthouse	artifact scatter	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	artifact scatter	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	rubble	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	rubble	1	2	3	1	–	7	Moderate	–

* Adaptive capacity scored minimal (1), low (2), moderate (3) to high (4). NR = natural resources. Fac. = facilities.

Table C-1 (continued). Cultural adaptive capacity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	Physical	Organizational	Social	Economic	Overlap	AC_ Sum	AC_ Rank	Comments
Fire Island Lighthouse	rubble	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	brick scatter	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	cast iron sewer pipe	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	Burma Road	3	3	3	2	–	11	High	–
Fire Island Lighthouse	Boat House	3	2	2	3	–	10	High	–
Fire Island Lighthouse	Fire Island Lighthouse	2	2	3	1	Fac.	8	Moderate	Only reinforce the sub-foundation but not moving.
Fire Island Lighthouse	Keeper's Quarters/ Visitor Center	2	2	3	1	Fac.	8	Moderate	–
Fire Island Lighthouse	Fire Island Light Station – Tool House	2	2	3	1	Fac.	8	Moderate	–
Fire Island Lighthouse	Store House	2	2	3	1	Fac.	8	Moderate	–
Fire Island Lighthouse	Fire Island Light house – Oil House	2	2	3	1	Fac.	8	Moderate	–
Fire Island Lighthouse	Fire Island Light Station – Annex Garage	2	2	3	1	Fac.	8	Moderate	–
Fire Island Lighthouse	U.S.C.G. Annex Building	3	2	2	2	Fac.	9	Moderate	–
Fire Island Lighthouse	1827 Lighthouse foundation	3	2	3	2	–	4	Low	ranked diff. based on resource division. Came down to integrity that limits physical options
Fire Island Lighthouse	1827 Lighthouse foundation Arch. Site	1	2	3	1	–	12	High	–
Fire Island Lighthouse	Engine House Foundation	3	2	1	1	–	7	Moderate	–
Fire Island Lighthouse	Radio Tower Foundations	3	2	1	1	–	7	Moderate	–
Fire Island Lighthouse	Power House Foundation	3	2	1	1	–	7	Moderate	–
Fire Island Lighthouse	Flagpole – Fire Island Light Station	3	2	2	2	–	9	Moderate	–
Fire Island Lighthouse	artifact scatter	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	artifact scatter	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	rubble	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	rubble	1	2	3	1	–	7	Moderate	–

* Adaptive capacity scored minimal (1), low (2), moderate (3) to high (4). NR = natural resources. Fac. = facilities.

Table C-1 (continued). Cultural adaptive capacity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	Physical	Organizational	Social	Economic	Overlap	AC_ Sum	AC_ Rank	Comments
Fire Island Lighthouse	rubble	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	brick scatter	1	2	3	1	–	7	Moderate	–
Fire Island Lighthouse	Gate FIIS Light Station	3	3	2	3	–	11	High	–
Fire Island Lighthouse	CULTURAL LANDSCAPE_LIGHTHOUSE_ SPATIAL ORGANIZATION	1	1	1	1	–	4	Low	–
Fire Island Lighthouse	CULTURAL LANDSCAPE_LIGHTHOUSE_ LAND USE	3	3	3	3	–	12	High	–
Fire Island Lighthouse	CULTURAL LANDSCAPE_LIGHTHOUSE_ VEGETATION	3	3	3	3	–	12	High	–
Fire Island Lighthouse	CULTURAL LANDSCAPE_LIGHTHOUSE_ CIRCULATION	3	3	2	3	–	11	High	–
Fire Island Lighthouse	CULTURAL LANDSCAPE_LIGHTHOUSE_ BUILDINGS AND STRUCTURES	2	2	3	2	–	9	Moderate	–
Fire Island Lighthouse	CULTURAL LANDSCAPE_LIGHTHOUSE_ VIEWS AND VISTAS	3	3	3	3	–	12	High	–
Fire Island Lighthouse	CULTURAL LANDSCAPE_LIGHTHOUSE_ SMAL SCALE FEATURES	3	3	3	3	–	12	High	–
Smith Point Coast Guard Station	cut limestone pieces	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	cement walk	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	structure S1	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	structure S2	1	2	2	1	–	6	Moderate	–

* Adaptive capacity scored minimal (1), low (2), moderate (3) to high (4). NR = natural resources. Fac. = facilities.

Table C-1 (continued). Cultural adaptive capacity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	Physical	Organizational	Social	Economic	Overlap	AC_ Sum	AC_ Rank	Comments
Smith Point Coast Guard Station	structure S3	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	structure S4	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	structure S5?	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	tower footing	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	structure S5?	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	tower footing	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	tower footing	1	2	1	1	–	5	Low	–
Smith Point Coast Guard Station	tower footing	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	cylindrical metal oil tank	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	well center point	1	2	2	1	–	6	Moderate	–
Smith Point Coast Guard Station	coal scatter	1	2	2	1	–	6	Moderate	–
Whale House Point	pos well house Q11 (floor slab)	1	2	2	1	–	6	Moderate	–
Whale House Point	misc house	1	2	2	1	–	6	Moderate	–
Whale House Point	house pos Q5	1	2	2	1	–	6	Moderate	–
Whale House Point	house pos Q19	1	2	2	1	–	6	Moderate	–
Whale House Point	concrete walk	1	2	2	1	–	6	Moderate	–
Whale House Point	debris	1	2	2	1	–	6	Moderate	–
Whale House Point	dock	1	2	2	1	–	6	Moderate	–
William Floyd Estate	Squirrel Lane	2	2	2	2	–	8	Moderate	–
William Floyd Estate	Brick Walkway	3	3	2	3	–	11	High	–

* Adaptive capacity scored minimal (1), low (2), moderate (3) to high (4). NR = natural resources. Fac. = facilities.

Table C-1 (continued). Cultural adaptive capacity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	Physical	Organizational	Social	Economic	Overlap	AC_ Sum	AC_ Rank	Comments
William Floyd Estate	Meadow Ground Path	1	1	1	1	–	4	Low	–
William Floyd Estate	Corduroy Road	1	1	2	1	–	5	Low	–
William Floyd Estate	Headstone/ Phebo Floyd	3	2	3	1	–	9	Moderate	–
William Floyd Estate	New Barn	3	3	3	2	–	11	High	–
William Floyd Estate	Wind Mill	3	1	1	1	–	6	Moderate	–
William Floyd Estate	Barn	3	3	3	2	–	11	High	–
William Floyd Estate	Corn Crib	3	3	3	2	–	11	High	–
William Floyd Estate	Woodshed	3	3	3	2	–	11	High	–
William Floyd Estate	Carriage House	3	3	3	2	–	11	High	–
William Floyd Estate	Caretaker Workshop Ranger Station	3	3	3	2	–	11	High	–
William Floyd Estate	Estate House Old Mastic House?	3	3	3	3	–	12	High	–
William Floyd Estate	Ice House	3	3	3	2	–	11	High	–
William Floyd Estate	Storage Crib	3	3	3	2	–	11	High	–
William Floyd Estate	Old Shop	3	3	3	2	–	11	High	–
William Floyd Estate	Pump House	3	3	3	2	–	11	High	–
William Floyd Estate	Incinerator	3	2	2	1	–	8	Moderate	–
William Floyd Estate	Floyd's Pond	1	2	1	1	NR	5	Low	–
William Floyd Estate	Folly Pond	1	2	1	1	NR	5	Low	–
William Floyd Estate	Rye Pond	1	2	1	1	NR	5	Low	–
William Floyd Estate	South Pond	1	2	1	1	NR	5	Low	–
William Floyd Estate	Teal Pond	1	2	1	1	NR	5	Low	–
William Floyd Estate	Mosquito Ditches	1	2	1	1	–	5	Low	–
William Floyd Estate	Great Ditch	1	2	1	1	–	5	Low	–
William Floyd Estate	Lawrence Creek	1	2	1	1	–	5	Low	–
William Floyd Estate	Floyd Estate Gazebo	3	3	2	2	–	10	High	–
William Floyd Estate	Lopped Tree Line	1	1	1	1	–	4	Low	–
William Floyd Estate	Slave markers	3	3	3	3	–	12	High	–
William Floyd Estate	Cisterns/Wells	1	1	1	1	–	4	Low	–

* Adaptive capacity scored minimal (1), low (2), moderate (3) to high (4). NR = natural resources. Fac. = facilities.

Table C-1 (continued). Cultural adaptive capacity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	Physical	Organizational	Social	Economic	Overlap	AC_ Sum	AC_ Rank	Comments
William Floyd Estate	Graveyard Fence	3	3	3	3	–	12	High	–
William Floyd Estate	William Floyd Gravestone	3	3	3	3	–	12	High	–
William Floyd Estate	Nicoll & Tabitha Floyd Gravestones	3	3	3	3	–	12	High	–
William Floyd Estate	Floyd Estate High Board Fence	3	3	3	3	–	12	High	–
William Floyd Estate	CULTURAL LANDSCAPE_WFE_NATURAL SYSTEMS AND FEATURES	2	3	2	2	–	9	Moderate	–
William Floyd Estate	CULTURAL LANDSCAPE_WFE_SPATIAL ORGANIZATION	1	2	1	1	–	5	Low	–
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ VEGETATION	2	2	2	2	–	8	Moderate	–
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ CIRCULATION	2	2	2	2	–	8	Moderate	–
William Floyd Estate	CULTURAL LANDSCAPE_WFE_BUILDINGS AND STRUCTURES	3	3	3	2	–	11	High	–
William Floyd Estate	CULTURAL LANDSCAPE_WFE_VIEWS AND VISTAS	3	3	2	3	–	11	High	–
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ CONSTRUCTED WATER FEATURES	1	2	1	1	–	5	Low	–
William Floyd Estate	CULTURAL LANDSCAPE_WFE_SMALL SCALE FEATURES	3	3	2	3	–	11	High	–

* Adaptive capacity scored minimal (1), low (2), moderate (3) to high (4). NR = natural resources. Fac. = facilities.

Table C-1 (continued). Cultural adaptive capacity at Fire Island National Seashore, New York.*

Geographic Area	Resource/Factor	Physical	Organizational	Social	Economic	Overlap	AC_ Sum	AC_ Rank	Comments
William Floyd Estate	CULTURAL LANDSCAPE_WFE_ ARCHEOLOGICAL SITES	1	2	1	1	–	5	Low	–
William Floyd Estate	Entire Estate – Arch. Site	1	2	3	1	–	7	Moderate	–

* Adaptive capacity scored minimal (1), low (2), moderate (3) to high (4). NR = natural resources. Fac. = facilities.

Appendix D. Natural Resources Vulnerability Assessment Data Set at Fire Island National Seashore.

Table D-1. Natural resources vulnerability scoring at Fire Island National Seashore, New York.

	Vulnerability Score*		
Resources	**2020**	**2050**	**2100**
Seagrass (eelgrass)	9	13	13
Seagrass (widgeongrass)	8	9	9
Clam bed	7	7	7
Water quality (estuary)	11	11	11
High salt marsh (island)	15	15	15
Low salt marsh (island)	16	16	16
High salt marsh	15	15	15
Low salt marsh	16	16	16
Piping plover	8	8	8
Seabeach amaranth	8	8	8
Colonial waterbirds	10	10	10
Beaches (including overwash)	8	8	8
Foredune	7	9	9
Swale (backdune, maritime shrubland)	8	8	9
Long-eared bats (William Floyd Estate)	13	13	13
Herps (coastal)	17	17	17
Herps (upland)	11	11	13
Maritime forest	14	18	18
Maritime holly forest	14	18	18
Mixed hardwood (coastal oak heath) forest (William Floyd Estate)	13	13	13
Open fields (William Floyd Estate)	4	7	11
Freshwater ecosystems (high bush blueberry shrub swamp, northern interdunal cranberry swale)	12	16	16
Sediment supply	7	7	7
Ground water	12	12	12
Bayside beaches	11	11	11

* Vulnerability based on 0–28 (minimal <=5; Low 6–10; Moderate 11–14; High 15+).

Table D-2. Natural resources exposure analysis of climate stressors 1–3, Fire Island National Seashore, New York.*

Resources	Sea Level Rise Inundation			Ground Water Change (depth to water, depth to freshwater-saltwater interface)			Severe Storms and Flooding (surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	2020	2050	2100	2020	2050	2100	2020	2050	2100
Seagrass (eelgrass)	N	Y	Y	N	N	N	Y	Y	Y
Seagrass (widgeongrass)	N	Y	Y	N	N	N	Y	Y	Y
Clam bed	N	N	N	N	N	N	Y	Y	Y
Water quality (estuary)	N	N	N	N	N	N	Y	Y	Y
High salt marsh (island)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Low salt marsh (island)	Y	Y	Y	Y	Y	Y	Y	Y	Y
High salt marsh	Y	Y	Y	Y	Y	Y	Y	Y	Y
Low salt marsh	Y	Y	Y	Y	Y	Y	Y	Y	Y
Piping plover	Y	Y	Y	N	N	N	Y	Y	Y
Seabeach amaranth	Y	Y	Y	N	N	N	Y	Y	Y
Colonial waterbirds	Y	Y	Y	N	N	N	Y	Y	Y
Beaches (including overwash)	Y	Y	Y	N	N	N	Y	Y	Y
Foredune	N	Y	Y	N	N	N	Y	Y	Y
Swale (backdune, maritime shrubland)	N	Y	Y	Y	Y	Y	Y	Y	Y
Long-eared bats (William Floyd Estate)	N	N	N	Y	Y	Y	Y	Y	Y
Herps (coastal)	Y	Y	Y	N	N	N	Y	Y	Y
Herps (upland)	N	N	Y	Y	Y	Y	Y	Y	Y
Maritime forest	N	Y	Y	Y	Y	Y	Y	Y	Y
Maritime holly forest	N	Y	Y	Y	Y	Y	Y	Y	Y
Mixed hardwood (coastal oak heath) forest (William Floyd Estate)	N	N	N	Y	Y	Y	Y	Y	Y
Open fields (William Floyd Estate)	N	N	Y	N	Y	Y	Y	Y	Y
Freshwater ecosystems (high bush blueberry shrub swamp, northern interdunal cranberry swale)	N	Y	Y	Y	Y	Y	Y	Y	Y
Sediment supply	Y	Y	Y	N	N	N	Y	Y	Y

* Exposure scored – yes exposed (Y) or not exposed (N)

Table D-2 (continued). Natural resources exposure analysis of climate stressors 1–3, Fire Island National Seashore, New York.*

Resources	Sea Level Rise Inundation			Ground Water Change (depth to water, depth to freshwater-saltwater interface)			Severe Storms and Flooding (surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	2020	**2050**	**2100**	**2020**	**2050**	**2100**	**2020**	**2050**	**2100**
Ground water	Y	Y	Y	Y	Y	Y	Y	Y	Y
Bayside beaches	Y	Y	Y	N	N	N	Y	Y	Y

* Exposure scored – yes exposed (Y) or not exposed (N)

Table D-3. Natural resources exposure analysis: climate stressors 4–7, Fire Island National Seashore, New York.*

Resources	Erosion			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)			Water Quality (estuarine)		
	2020	2050	2100	2020	2050	2100	2020	2050	2100	2020	2050	2100
Seagrass (eelgrass)	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
Seagrass (widgeongrass)	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
Clam bed	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
Water quality (estuary)	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
High salt marsh (island)	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
Low salt marsh (island)	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
High salt marsh	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
Low salt marsh	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
Piping plover	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Seabeach amaranth	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Colonial waterbirds	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Beaches (including overwash)	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Foredune	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Swale (backdune, maritime shrubland)	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Long-eared bats (William Floyd Estate)	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Herps (coastal)	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
Herps (upland)	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Maritime forest	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Maritime holly forest	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Mixed hardwood (coastal oak heath) forest (William Floyd Estate)	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N

* Exposure scored – yes exposed (Y) or not exposed (N)

Table D-3 (continued). Natural resources exposure analysis: climate stressors 4–7, Fire Island National Seashore, New York.*

Resources	Erosion			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)			Water Quality (estuarine)		
	2020	2050	2100	2020	2050	2100	2020	2050	2100	2020	2050	2100
Open fields (William Floyd Estate)	N	N	Y	N	N	N	Y	Y	Y	N	N	N
Freshwater ecosystems (high bush blueberry shrub swamp, northern interdunal cranberry swale)	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Sediment supply	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
Ground water	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
Bayside beaches	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y

* Exposure scored – yes exposed (Y) or not exposed (N)

Table D-4. Natural resources vulnerability to climate stressors 1–3, Fire Island National Seashore, New York.*

Resources	Sea Level Rise Inundation			Ground Water Change (depth to water, depth to freshwater-saltwater interface)			Severe Storms And Flooding (Surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	2020	2050	2100	2020	2050	2100	2020	2050	2100
Seagrass (eelgrass)	0	4	4	0	0	0	1	1	1
Seagrass (widgeongrass)	0	1	1	0	0	0	1	1	1
Clam bed	0	0	0	0	0	0	1	1	1
Water quality (estuary)	0	0	0	0	0	0	1	1	1
High salt marsh (island)	4	4	4	3	3	3	1	1	1
Low salt marsh (island)	4	4	4	3	3	3	1	1	1
High salt marsh	4	4	4	3	3	3	1	1	1
Low salt marsh	4	4	4	3	3	3	1	1	1
Piping plover	1	1	1	0	0	0	3	3	3
Seabeach amaranth	1	1	1	0	0	0	3	3	3
Colonial waterbirds	4	4	4	0	0	0	1	1	1
Beaches (including overwash)	1	1	1	0	0	0	3	3	3
Foredune	0	2	2	0	0	0	3	3	3
Swale (backdune, maritime shrubland)	0	0	1	1	1	1	3	3	3
Long-eared bats (William Floyd Estate)	0	0	0	4	4	4	3	3	3
Herps (coastal)	4	4	4	0	0	0	3	3	3
Herps (upland)	0	0	2	3	3	3	2	2	2
Maritime forest	0	4	4	4	4	4	3	3	3
Maritime holly forest	0	4	4	4	4	4	3	3	3
Mixed hardwood (coastal oak heath) forest (William Floyd Estate)	0	0	0	4	4	4	3	3	3
Open fields (William Floyd Estate)	0	0	2	0	3	3	2	2	2
Freshwater ecosystems (high bush blueberry shrub swamp, northern interdunal cranberry swale)	0	4	4	3	3	3	4	4	4
Sediment supply	1	1	1	0	0	0	2	2	2

* Vulnerability scored minimal or no benefit (0 or 1), low (2), moderate (3), high (4)

Table D-4 (continued). Natural resources vulnerability to climate stressors 1–3, Fire Island National Seashore, New York.*

Resources	Sea Level Rise Inundation			Ground Water Change (depth to water, depth to freshwater-saltwater interface)			Severe Storms And Flooding (Surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	2020	**2050**	**2100**	**2020**	**2050**	**2100**	**2020**	**2050**	**2100**
Ground water	2	2	2	1	1	1	3	3	3
Bayside beaches	3	3	3	0	0	0	3	3	3

* Vulnerability scored minimal or no benefit (0 or 1), low (2), moderate (3), high (4)

Table D-5. Natural resources vulnerability to climate stressors 4–7, Fire Island National Seashore, New York.*

Resources	Erosion			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)			Water Quality (estuarine)		
	2020	2050	2100	2020	2050	2100	2020	2050	2100	2020	2050	2100
Seagrass (eelgrass)	3	3	3	0	0	0	1	1	1	4	4	4
Seagrass (widgeongrass)	2	2	2	0	0	0	2	2	2	3	3	3
Clam bed	1	1	1	0	0	0	1	1	1	4	4	4
Water quality (estuary)	3	3	3	0	0	0	3	3	3	4	4	4
High salt marsh (island)	4	4	4	0	0	0	1	1	1	2	2	2
Low salt marsh (island)	4	4	4	0	0	0	1	1	1	3	3	3
High salt marsh	4	4	4	0	0	0	1	1	1	2	2	2
Low salt marsh	4	4	4	0	0	0	1	1	1	3	3	3
Piping plover	3	3	3	0	0	0	1	1	1	0	0	0
Seabeach amaranth	3	3	3	0	0	0	1	1	1	0	0	0
Colonial waterbirds	4	4	4	0	0	0	1	1	1	0	0	0
Beaches (including overwash)	3	3	3	0	0	0	1	1	1	0	0	0
Foredune	3	3	3	0	0	0	1	1	1	0	0	0
Swale (backdune, maritime shrubland)	3	3	3	0	0	0	1	1	1	0	0	0
Long-eared bats (William Floyd Estate)	3	3	3	0	0	0	3	3	3	0	0	0
Herps (coastal)	3	3	3	0	0	0	4	4	4	3	3	3
Herps (upland)	2	2	2	0	0	0	4	4	4	0	0	0
Maritime forest	4	4	4	0	0	0	3	3	3	0	0	0
Maritime holly forest	4	4	4	0	0	0	3	3	3	0	0	0
Mixed hardwood (coastal oak heath) forest (William Floyd Estate)	3	3	3	0	0	0	3	3	3	0	0	0
Open fields (William Floyd Estate)	0	0	2	0	0	0	2	2	2	0	0	0

* Vulnerability scored minimal or no benefit (0 or 1), low (2), moderate (3), high (4)

Table D-5 (continued). Natural resources vulnerability to climate stressors 4–7, Fire Island National Seashore, New York.*

Resources	Erosion			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)			Water Quality (estuarine)		
	2020	2050	2100	2020	2050	2100	2020	2050	2100	2020	2050	2100
Freshwater ecosystems (high bush blueberry shrub swamp, northern interdunal cranberry swale)	2	2	2	0	0	0	3	3	3	0	0	0
Sediment supply	2	2	2	0	0	0	1	1	1	1	1	1
Ground water	2	2	2	0	0	0	4	4	4	0	0	0
Bayside beaches	3	3	3	0	0	0	1	1	1	1	1	1

* Vulnerability scored minimal or no benefit (0 or 1), low (2), moderate (3), high (4)

Table D-6. Natural resources sensitivity to climate stressors 1–3, Fire Island National Seashore, New York.*

Resource	Sea Level Rise (sea level rise projections above base)			Ground Water Change (geo-chemistry of ground water; ground water table levels)			Severe Storms and Flooding (surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	Score	**Why**	**Result**	**Score**	**Why**	**Result**	**Score**	**Why**	**Result**
Seagrass (eelgrass)	4	migration toward light is blocked	loss	1	modest effect, localized	potential enhancement effect	1	nor'easters are more of a problem on bayside	benign or potentially beneficial
Seagrass (widgeongrass)	1	can migrate to light	could replace eelgrass	1	modest effect, localized	potential enhancement effect	1	nor'easters are more of a problem on bay-side	benign or potentially beneficial
Clam bed	1	happy	–	1	–	–	1	overwash and burial	–
Water quality (estuary)	1	potential increased water exchange with ocean, flushing	potentially beneficial to estuarine water quality, related to breaches	2	fluctuations in discharge (more water now being discharged to oceans, reduces function in maintaining balance)	minor compared to human impacts	1	breaches benefit wq, episodic flushing is beneficial,	beneficial
High salt marsh (island)	4	rate of sea level rise outpaces sediment availability, low supply now no room for migration	degradation or loss	3	wetter,	water logging	1	potential sediment source, possible net benefit	location dependent

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-6 (continued). Natural resources sensitivity to climate stressors 1–3, Fire Island National Seashore, New York.*

Resource	Sea Level Rise (sea level rise projections above base)			Ground Water Change (geo-chemistry of ground water; ground water table levels)			Severe Storms and Flooding (surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	Score	**Why**	**Result**	**Score**	**Why**	**Result**	**Score**	**Why**	**Result**
Low salt marsh (island)	4	rate of sea level rise outpaces sediment availability, low supply now, no room for migration	degradation or loss	3	not well understood	water logging	1	potential sediment source, possible net benefit	location dependent
High salt marsh	4	rate of sea level rise outpaces sediment availability, low supply now	degradation or loss, squeezed	3	wetter,	water logging	1	potential sediment source, possible net benefit	location dependent
Low salt marsh	4	rate of sea level rise outpaces sediment availability, low supply now	degradation or loss	3	not well understood	water logging	1	potential sediment source, possible net benefit	location dependent
Piping plover	1	better habitat	Potential expansion	1	–	–	3	loss of habitat too quickly – lag time between habitat loss and habitat creation	loss of habitat or seasonal breeding opportunity, reduced breeding numbers

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-6 (continued). Natural resources sensitivity to climate stressors 1–3, Fire Island National Seashore, New York.*

Resource	Sea Level Rise (sea level rise projections above base)			Ground Water Change (geo-chemistry of ground water; ground water table levels)			Severe Storms and Flooding (surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	Score	Why	Result	Score	Why	Result	Score	Why	Result
Seabeach amaranth	1	better habitat	potential expansion	1	early successional plant in upper beach (w/ shallow root system), not really dependent on the groundwater	–	3	loss of habitat too quickly – some lag time between habitat loss and habitat creation	decline in population
Colonial waterbirds	4	in bay islands especially, loss of habitat, areas getting wetter	moving to areas outside the park	2	not well understood (went with what we put for low marsh and marsh islands)	–	1	(went with what we put for low marsh and marsh islands)	–
Beaches (including overwash)	1	adjusted to sea level rise	beach will move but still exist, overwash can be beneficial	1	–	–	3	when storms are more frequent narrow beaches if interacting with human baselines	narrowing of beaches, impacts to back barrier environments (dunes, swales)
Foredune	2	slower to adjust to sea level rise	effect on swale behind	1	–	–	3	requires periods of quiescence	fewer foredunes forming, more discontinuous, also loss

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-6 (continued). Natural resources sensitivity to climate stressors 1–3, Fire Island National Seashore, New York.*

Resource	Sea Level Rise (sea level rise projections above base)			Ground Water Change (geo-chemistry of ground water; ground water table levels)			Severe Storms and Flooding (surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	Score	**Why**	**Result**	**Score**	**Why**	**Result**	**Score**	**Why**	**Result**
Swale (backdune. maritime shrubland)	1	requires frequent inundation	potential expansion of swales	1	–	–	3	increased, frequency of inundation of swales on annual basis will prevent recovery	habitat inability to recover when buried frequently by sand
Long-eared bats (William Floyd Estate)	4	associated with mixed hardwood forest, fresh water	loss of habitat, for roosting and potentially for maternity colonies.	4	freshwater areas (which they rely on for nourishment) may become more saline. Also the habitat which they rely on.	loss of trees (loss of habitat) and loss of freshwater resources for bats (impacts their survival)	3	see mixed hardwood forests	less habitat
Herps (coastal)	4	affected by Bayside beaches	loss of nesting habitat	2	see bayside beaches + salt marsh	–	3	see bayside beaches (habitat dependent)	loss of habitat
Herps (upland)	2	more adaptable	varies by species	3	see fields + mixed hardwoods	–	2	see fields + mixed hardwoods. Could be a 2 or 3.	loss of habitat
Maritime forest	4	intolerant to salinity	degradation, loss/ death, conversion to high salt marsh or bay beach	4	intolerant to salinity, waterlogging	loss of trees (blown down, mortality)	3	,potentially beneficial (thin canopy, foster regeneration), but mitigating factors… low-lying areas,	benefits limited due to deer, other factors

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-6 (continued). Natural resources sensitivity to climate stressors 1–3, Fire Island National Seashore, New York.*

Resource	Sea Level Rise (sea level rise projections above base)			Ground Water Change (geo-chemistry of ground water; ground water table levels)			Severe Storms and Flooding (surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	Score	Why	Result	Score	Why	Result	Score	Why	Result
Maritime holly forest	4	intolerant to salinity	degradation, loss/ death, conversion to high salt marsh or bay beach	4	intolerant to salinity, waterlogging	loss of trees (blown down, mortality)	3	,potentially beneficial (thin canopy, foster regeneration), but mitigating factors… low-lying areas,	benefits limited due to deer, other factors
Mixed hardwood (coastal oak heath) forest (William Floyd Estate)	4	intolerant to salinity	degradation, loss/ death, conversion to high salt marsh or bay beach	4	intolerant to salinity, waterlogging	loss of trees (blown down, mortality)	3	,potentially beneficial (thin canopy, foster regeneration), but mitigating factors… low-lying areas,	benefits limited due to deer, other factors
open fields (William Floyd Estate)	2	intolerant to salinity	might create a good habitat	3	the fields in the lower acreage will become more saturated	fields will be more saturated but they will remain as open fields	2	the fields in the lower acreage will be susceptible to this but they will still remain as open fields	they will be flooded more often but will still remain
Freshwater ecosystems (high bush blueberry shrub swamp, northern interdunal cranberry swale)	4	when twice per day, intolerant to salinity	will convert to salt marsh	3	salt water intrusion, rising water table, intolerant to salinity	habitat change and loss	4	increased frequency of inundation will cause change	–
Sediment supply	1	free up some sediment, abandon some supply offshore	potentially increased	1	–	–	2	drives imbalances in cross shore fluxes	more rapid retreat of the ocean shoreline, slower recovery

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-6 (continued). Natural resources sensitivity to climate stressors 1–3, Fire Island National Seashore, New York.*

Resource	Sea Level Rise (sea level rise projections above base)			Ground Water Change (geo-chemistry of ground water; ground water table levels)			Severe Storms and Flooding (surge zone from Category 3 storm; FEMA AE zone, historic flooding (same as facilities))		
	Score	**Why**	**Result**	**Score**	**Why**	**Result**	**Score**	**Why**	**Result**
Ground water	2	more brackish with frequent overwash, and lower dunes, shallower depth of fresh water	possible effect on groundwater chemistry, infrequent episodic inundation	1	–	–	3	increased salinity, increased water levels, elevate interface with salt water at depth,	change in characteristics, quickly to several weeks to years
Bayside beaches	3	contact with vegetation that prevents sediment from entering system	narrowing and loss of beach	1	potential for creating wetlands and incipient water surface features in adjacent habitats	–	3	storms are main mechanism for adding sediment to system from overwash processes, inlet processes as well (but limited)	narrowing and loss of beach

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-7. Natural resources sensitivity to climate stressors 4–7, Fire Island National Seashore, New York.*

Resource	Erosion (USGS Buffer from shoreline (same as facilities) FEMA V ZONE, COASTAL A ZONE)			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Drought (dry spell length)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)		
	Score	Why	Result	Score	Why	Result	Score	Why	Result	Score	Why	Result
Seagrass (eelgrass)	3	sediment starvation effect on platform, in association with retreating shoreline	localized loss	2	temporary impact on turbidity and light	–	1	reduced ice cover has positive effect	potential benefit	4	water temp important, light, runoff secondary (turbidity), PC02 may be beneficial	loss
Seagrass (widgeongrass)	2	sediment starvation effect on platform, in association with retreating shoreline	localized loss	2	temporary impact on turbidity and light	–	1	reduced ice cover has positive effect	potential benefit	3	water temp important, light, runoff secondary (turbidity), PC02 may be beneficial	could gain at eelgrass's loss
Clam bed	1	–	–	1	dilute food	–	1	–	–	4	affect food resources,	potential loss of resource
Water quality (estuary)	3	turbidity, bury shellfish	loss of marsh, shellfish beds	3	inflow or outflow > salinity, nutrients, quantity & timing episodic,	perhaps degradation	2	marine ice decline, affect algal blooms, turbidity,	perhaps degradation	4	hypoxia, warmer water chemical effects, possible acidity	degradation
High salt marsh (island)	4	basic mechanics of marsh loss	marsh loss	1	affects ground water level: extremes matter, runoff, rain (waterlogging), or drought (beneficial to marsh)	–	2	becoming the middle of their range, changing marine ice, geochemical cycles	? potential invasive species in future	2	possible effects of pH, not well understood	–

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-7 (continued). Natural resources sensitivity to climate stressors 4–7, Fire Island National Seashore, New York.*

Resource	Erosion (USGS Buffer from shoreline (same as facilities) FEMA V ZONE, COASTAL A ZONE)			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Drought (dry spell length)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)		
	Score	**Why**	**Result**	**Score**	**Why**	**Result**	**Score**	**Why**	**Result**	**Score**	**Why**	**Result**
Low salt marsh (island)	4	basic mechanics of marsh loss	marsh loss	1	affects ground water level: extremes matter, runoff, rain (waterlogging), or drought (beneficial to marsh)	–	2	becoming the middle of their range, changing marine ice, geochemical cycles	? potential invasive species in future	3	possible effects of pH, not well understood	impacts on shellfish could adversely affect the marsh
High salt marsh	4	basic mechanics of marsh loss	marsh loss	1	affects ground water level: extremes matter, runoff, rain (waterlogging), or drought (beneficial to marsh)	–	2	becoming the middle of their range, changing marine ice, geochemical cycles	? potential invasive species in future	2	possible effects of pH, not well understood	–
Low salt marsh	4	basic mechanics of marsh loss	marsh loss	1	affects ground water level: extremes matter, runoff, rain (waterlogging), or drought (beneficial to marsh)	–	2	becoming the middle of their range, changing marine ice, geochemical cycles	? potential invasive species in future	3	possible effects of pH, not well understood	impacts on shellfish could adversely affect the marsh

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-7 (continued). Natural resources sensitivity to climate stressors 4–7, Fire Island National Seashore, New York.*

Resource	Erosion (USGS Buffer from shoreline (same as facilities) FEMA V ZONE, COASTAL A ZONE)			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Drought (dry spell length)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)		
	Score	Why	Result	Score	Why	Result	Score	Why	Result	Score	Why	Result
Piping plover	3	loss of habitat too quickly – lag time between habitat loss and habitat creation	loss of habitat or seasonal breeding opportunity, reduced breeding numbers	1	don't see an initial connection, but could discuss?	–	2	can affect eggs, breeding if temps too high	reduced breeding success	3	would affect their food sources in/around their habitat	reduced breeding/ fledgling success, dampened energy reserves, population reduction
Seabeach amaranth	3	loss of habitat too quickly – lag time between habitat loss and habitat creation	decline in population	1	normal rain patterns are ok	–	2	ranges to South Carolina	reduced population	1	mainly found on ocean side	–
Colonial waterbirds	4	same justification	–	1	same justification	–	2	same justification	–	3	would affect their food sources in/around their habitat	could be a point of discussion though!
Beaches (including overwash)	3	chronic erosion is more of the problem, narrow beaches if interacting with human baselines, loss of sand supply	narrowing of beaches, impacts to back barrier environments (dunes, swales)	1	–	–	1	–	–	1	–	–
Foredune	3	–	–	1	–	–	1	–	–	1	–	–

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-7 (continued). Natural resources sensitivity to climate stressors 4–7, Fire Island National Seashore, New York.*

Resource	Erosion (USGS Buffer from shoreline (same as facilities) FEMA V ZONE, COASTAL A ZONE)			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Drought (dry spell length)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)		
	Score	Why	Result	Score	Why	Result	Score	Why	Result	Score	Why	Result
Swale (backdune. maritime shrubland)	3	–	–	1	–	–	3	can cause stress but can survive, evapo-transpiration	invasive species, altering function, composition of species depending on the range of the species	1	–	–
Long-eared bats (William Floyd Estate)	3	see mixed hardwood forests	–	3	impacts to habitat + prey availability (insects), then impacts breeding and foraging success for females.	–	3	Impacts to habitat + prey availability (insects), then impacts breeding and foraging success for females.	–	1	–	–
Herps (coastal)	3	loss of nesting habitat	–	4	changes in precipitation have an impact on herps, both coastal and upland, even slight changes can impact their survival.	–	4	changes in temperature have an impact on herps, both coastal and upland, even slight changes can impact their survival.	–	3	coastal herps primarily rely on the estuarine system for food availability, so went with same scoring as colonial waterbirds.	–

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-7 (continued). Natural resources sensitivity to climate stressors 4–7, Fire Island National Seashore, New York.*

Resource	Erosion (USGS Buffer from shoreline (same as facilities) FEMA V ZONE, COASTAL A ZONE)			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Drought (dry spell length)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)		
	Score	Why	Result	Score	Why	Result	Score	Why	Result	Score	Why	Result
Herps (upland)	2	see fields + mixed hardwoods. (could be a 2 or 3)	–	4	changes in precipitation have an impact on herps, both coastal and upland, even slight changes can impact their survival.	–	4	changes in temperature have an impact on herps, both coastal and upland, even slight changes can impact their survival.	–	1	–	–
Maritime forest	4	bayside shoreline forest loss continues, 50%: sea level rise, storms, sediment starvation (needs overwash, dune protection, bulkheading), transition to high marsh	loss, transition	3	precip major driver of ground water levels, extremes can adversely affect the holly, in drought, roots exposed to salinity; or wetness	loss	3	can cause stress but can survive, evapo-transpiration	invasive species, altering function, composition of species depending on the range of the species	1	–	–

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-7 (continued). Natural resources sensitivity to climate stressors 4–7, Fire Island National Seashore, New York.*

Resource	Erosion (USGS Buffer from shoreline (same as facilities) FEMA V ZONE, COASTAL A ZONE)			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Drought (dry spell length)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)		
	Score	Why	Result	Score	Why	Result	Score	Why	Result	Score	Why	Result
Maritime holly forest	4	bayside shoreline forest loss continues, 50%: sea level rise, storms, sediment starvation (needs overwash, dune protection, bulkheading), transition to high marsh	loss, transition	3	precip major driver of ground water levels, extremes can adversely affect the holly, in drought, roots exposed to salinity; or wetness	loss	2	forest pests moving north, invasive plant species, propagation relies on winter cold (which also prevents invasive to establish)	stressed, lower propagation, pitch pine loss	1	–	–
Mixed hardwood (coastal oak heath) forest (William Floyd Estate)	3	erosion impacts are the same as the forests on Fire Island but there is a bit more of a buffer from the large marsh that is there now	loss, transition	3	precip major driver of ground water levels, extremes can adversely affect the holly, in drought, roots exposed to salinity; or wetness	loss	2	forest pests moving north, invasive plant species, propagation relies on winter cold (which also prevents invasive to establish)	stressed, lower propagation, pitch pine loss	1	–	–
Open fields (William Floyd Estate)	2	lower acrage fields will be more vulnerable but other fields should last for a bit longer	loss	2	still an open field regardless of precipitation	drier	2	still an open field regardless of temp	more susceptible to invasive species	1	–	–

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Table D-7 (continued). Natural resources sensitivity to climate stressors 4–7, Fire Island National Seashore, New York.*

Resource	Erosion (USGS Buffer from shoreline (same as facilities) FEMA V ZONE, COASTAL A ZONE)			Precipitation (peak daily rainfall, mean annual rainfall, days >2" of rainfall)			Drought (dry spell length)			Temperature (days below freezing, days greater than 95 degrees, mean daily high and low temperatures)		
	Score	Why	Result	Score	Why	Result	Score	Why	Result	Score	Why	Result
Freshwater ecosystems (high bush blueberry shrub swamp, northern interdunal cranberry swale)	2	bayside erosion, close to bay can produce loss, not within the core of the island	loss along bayside	3	salt water interface, interaction with ground water, precip is primary recharge	can dry out, too high salinity, leading to loss or degradation	4	can cause stress but can survive, evapo-transpiration	invasive species, altering function, composition of species depending on the range of the species	1	–	–
Sediment supply	2	drives imbalances in cross shore fluxes	more rapid retreat of the ocean shoreline, slower recovery	1	–	–	1	marine ice decline, effect on bay -side system	–	1	–	–
Ground water	2	breach bisects freshwater lens, narrowing lens if erosion on bayside and ocean side	change in characteristic, geometry, how water leaves the system	4	sole source of water into groundwater	–	4	Evapo-transpiration affects amount of recharge occurring before percolation	loss of water	1	–	–
Bayside beaches	3	reworking of features is ongoing, some are sacrificed to augment others	narrowing and loss of beach	1	–	–	2	loss of winter ice	–	1	secondary effects of wrack – generation over time, bind up sediments	–

* Sensitivity scored minimal (1), low (2), moderate (3) to high (4)

Appendix E. Natural Resources Adaptive Capacity Assessment Data Set at Fire Island National Seashore.

Table E-1. Natural resources adaptive capacity summary at Fire Island National Seashore, New York.

Resource	Total Adaptive Capacity Score*	Total Adaptive Capacity Levels*	Physical – Intrinsic	Physical – Technology	Organization	Social	Economic
Seagrass (eelgrass)	8	Moderate	1	1	3	2	1
Seagrass (widgeongrass)	10	Moderate	2	2	3	2	1
Clam bed	10	Moderate	1	1	3	3	2
Water quality (estuary)	11	Moderate	1	2	3	3	2
High salt marsh (island)	8	Moderate	1	2	2	2	1
Low salt marsh (island)	8	Moderate	1	2	2	2	1
High salt marsh	8	Moderate	1	2	2	2	1
Low salt marsh	9	Moderate	2	2	2	2	1
Piping plover	13	Low	2	3	3	2	3
Seabeach amaranth	14	Low	2	3	3	3	3
Colonial waterbirds	9	High	2	2	2	2	1
Beaches (including overwash)	11	High	3	3	2	2	1
Foredune	14	Moderate	2	3	3	3	3
Swale (backdune, maritime shrubland)	10	Moderate	3	3	2	1	1
Long-eared bats (William Floyd Estate)	12	Moderate	2	2	3	2	3
Herps (coastal)	9	Moderate	2	2	2	2	1
Herps (upland)	9	Moderate	2	2	2	2	1
Maritime forest	6	High	1	1	2	1	1
Maritime holly forest	8	Moderate	1	1	2	2	2
Mixed hardwood (coastal oak heath) forest (William Floyd Estate)	8	Moderate	2	2	2	1	1
Open fields (William Floyd Estate)	8	Moderate	1	3	2	1	1
Freshwater ecosystems (high bush blueberry shrub swamp, northern interdunal cranberry swale)	7	Moderate	2	1	2	1	1

* Total adaptive capacity levels – low (5–9), moderate (10–12), high (13–15). POSE scored minimal (1), low (2), moderate (3) to high (4)

Table E-1 (continued). Natural resources adaptive capacity summary at Fire Island National Seashore, New York.

Resource	Total Adaptive Capacity Score*	Total Adaptive Capacity Levels*	Physical – Intrinsic	Physical – Technology	Organization	Social	Economic
Sediment supply	11	Moderate	3	3	2	2	1
Ground water	8	Low	2	2	1	2	1
Bayside beaches	13	High	3	3	3	2	2

* Total adaptive capacity levels – low (5–9), moderate (10–12), high (13–15). POSE scored minimal (1), low (2), moderate (3) to high (4)

Table E-2. Natural resources adaptive capacity detailed at Fire Island National Seashore, New York.

Resource	Total Adaptive Capacity Score*	Rank	Physical – Intrinsic	Physical – Technology	Physical Notes	Organization	Org Notes	Social	Social Notes	Economic	Economic Notes	Division Overlap
Seagrass (eelgrass)	8	L	1	1	TECH: improved water quality is helpful,	3	general support on gathering information; organizations have expressed as priority; water quality programs setting targets for SAV	2	mixed views on seagrass; washes up on beach	1	Sea Grant funding in south shore estuaries	–
Seagrass (widgeongrass)	10	M	2	2	TECH: improved water quality is helpful; better able to handle temperature, replanting possible	3	general support on gathering information; organizations have expressed as priority; water quality programs setting targets for SAV	2	mixed views on seagrass; washes up on beach	1	–	–
Clam bed	10	M	1	1	acidity impacts; water temperature; increased organic matter in water column	3	broad institutional interest, much effort, but not necessarily yielding results	3	viewed as a bellweather for improvements in the estuary as a whole	2	$ in shellfish restoration, businesses supporting re-seeding;	–
Water quality (estuary)	11	M	1	2	the system is able to heal itself, but CC indications going in the wrong direction against this; temp, acidity, nitrogen, hypoxia; increased circulation is helpful, converting island to string of pearls could help	3	laws strongly favor	3	public strongly favors	2	reducing N will be helpful but challenges of WQ greater than available resources; reducing acidity, temp impacts, less likely to attract $$	–
High salt marsh (island)	8	L	1	2	nowhere to go, will be lost; TECH: spoil islands do last for a while	2	regulated the same way as mainland marshes–not all bay islands within park jurisdiction except up to mean high water line	2	gun club example, value makes people put money into it; some have value to public distinct from NPS view	1	gun club example, value makes people put money into it	–
Low salt marsh (island)	8	L	1	2	nowhere to go, will be lost TECH: spoil islands do last for a while	2	regulated the same way as mainland marshes– not all bay islands within park jurisdiction except up to mean high water line	2	gun club example, value makes people put money into it; some have value to public distinct from NPS view	1	gun club example, value makes people put money into it	–
High salt marsh	8	L	1	2	inherent limitations given limited sediment input and SLR; some hi marsh already migrating in low areas i.e. Sunken forest; depends on slope in back barrier; TECH: re-engineering to perfect marsh not possible	2	some of the elements are in place Wertheim NWR	2	attitude changing but we aren't there yet	1	little of available $ will go to marsh restoration compared to overwash fans and beaches	–
Low salt marsh	9	L	2	2	some hi marsh replaced by low marsh; depends on slope in back barrier; most vulnerable to sediment supply; losing at an unsustainable rate TECH: reengineering to perfect marsh not possible	2	some of the elements are in place; Wertheim NWR	2	attitude changing but we aren't there yet	1	little of available $ will go to marsh restoration compared to overwash fans and beaches	–
Piping plover	13	H	2	3	site specific, lag on adapting to new habitat, strong monitoring program and technology suited to needs; losing at unsustainable rate	3	T&E listed	2	community opposition to restrictions, but is improving	3	dependable base funding for monitoring, potential for FIMP and other mitigation funds for additional measures	need to consider role of geomorphic change tradeoffs with Facilities / Communities priority of maintaining roads/closing breaches

* Total adaptive capacity levels – low (5–9), moderate (10–12), high (13–15). POSE scored minimal (1), low (2), moderate (3) to high (4)

Table E-2 (continued). Natural resources adaptive capacity detailed at Fire Island National Seashore, New York.

Resource	Total Adaptive Capacity Score*	Rank	Physical – Intrinsic	Physical – Technology	Physical Notes	Organization	Org Notes	Social	Social Notes	Economic	Economic Notes	Division Overlap
Seabeach amaranth	14	H	2	3	very similar to plover re-disturbance, highly fluctuating as an upper beach annual	3	–	3	higher on beach than plovers, so restrictions are less an issue	3	paired with plovers	need to consider role of geomorphic change tradeoffs with Facilities / Communities priority of maintaining roads/closing breaches
Colonial waterbirds	9	L	2	2	habitat dependent – marshes all received low scores, without habitat being highly adaptable, species wouldn't be able to continue existing in the area, birds are able to move around more easily and would potentially find new areas, TECH: if the habitat is unable to adapt and exist with SLR – it would be possible to create structures for certain species, but may be difficult to impossible to create new habitat for others	2	with state listed species, and the migratory bird act, coordination between organizations already occurs and would continue	2	Colonial waterbirds are somewhat charismatic but not a huge support / awareness of, no champions	1	Lack of funding	–
Beaches (including overwash)	11	M	3	3	natural processes well suited to adapt, technology responses available and well developed: what we are considering are ones related to removing impediments to natural processes, not the ones that first came to mind about dune building, nourishment	2	multiple interests, but not well coordinated; FIMP may improve and will make more timely, has not been; jurisdiction for federal tracts, communities have to mean high tide; meets multiple goals	2	conflicting concept of beaches, naturally functioning with habitat values vs desire for constructed beaches; lack of awareness is driving conflict; strong history of increasing capacity to build trust and work together with communities, but solutions continue to be contentious	1	economic compromise: there's existing and FIMP potential for major funding much of it has been preferred towards actions that interfere with naturally functioning beaches; USACE $ for very specific things, amounts currently directed towards the adaptation options needed are not well aligned for naturally functioning beach processes	–
Foredune	10	M	2	3	similar to beaches, but foredune takes longer to develop	2	same as beach	2	similar challenges as beaches and fewer supporters; homeowners see value of dunes more than beachgoers	1	same as beaches	–
Swale (backdune, maritime shrubland)	10	M	3	3	TECH: artificial overwashes left untouched can produce swales over time; engineered dunes yield swales at same time, may add variety of plants, shrubbery (New Jersey example – except when there are houses behind it), no need to do this however	2	are groups and programs that would be interested in this	1	few people aware of, interested in this vegetation – see Sailor's Haven example	1	not in NY / Long Island	–

* Total adaptive capacity levels – low (5–9), moderate (10–12), high (13–15). POSE scored minimal (1), low (2), moderate (3) to high (4)

Table E-2 (continued). Natural resources adaptive capacity detailed at Fire Island National Seashore, New York.

Resource	Total Adaptive Capacity Score*	Rank	Physical – Intrinsic	Physical – Technology	Physical Notes	Organization	Org Notes	Social	Social Notes	Economic	Economic Notes	Division Overlap
Long-eared bats (William Floyd Estate)	12	M	2	2	somewhat adaptable in that they can move to different trees (when habitat shifts northward), TECH: we could create artificial roosting areas (bat houses or larger, restored / planted trees) that are artificial but would support their natural need to roost	3	NPS and USFWS concerned and involved since it' s a federally listed species, and because of that laws, authorities and coordination are in place	2	bats are somewhat charismatic and it is an endangered species; however there are no champions and little awareness of the importance of this region (or park) to bats	3	support for funding because it is a federally listed species	–
Herps (coastal)	9	L	2	2	highly dependent on habitat – bayside beaches and marshes, rating lands between both habitats scoring.	2	would be difficult to create new habitat for these species	2	DEC already have in place regulations to help protect diamondback terrapins (i.e. crab pot regulations), NPS would coordinate with outside sources if populations were threatened	1	lack of funding	–
Herps (upland)	9	L	2	2	somewhat adaptable in that they can move TECH: potential to create natural or artificial areas for hibernating turtles, could attempt to restore animals to areas further north (if needed)	2	NPS would coordinate, and work with researchers that have been studying box turtles	2	box turtles (and other upland herps) are somewhat charismatic but not a huge support/awareness of, no champions	1	although herps may be somewhat charismatic, not sure if there would be a lot of funding to support certain projects; no species (as of now) are federally listed	–
Maritime forest	6	L	1	1	groundwater as biggest issue and tech options not viable; we can monitor	2	same ecological value as maritime holly, but globally recognized or in enabling legislation; limited ability to take effective or timely action; younger version of maritime holly forest, with CC won't have time to develop into one	1	–	1	–	–
Maritime holly forest	8	L	1	1	groundwater as biggest issue and tech options not viable; we can monitor	2	globally recognized (not currently T&E); in enabling legislation; limited ability to take effective or timely action	2	–	2	–	–

* Total adaptive capacity levels – low (5–9), moderate (10–12), high (13–15). POSE scored minimal (1), low (2), moderate (3) to high (4)

Table E-2 (continued). Natural resources adaptive capacity detailed at Fire Island National Seashore, New York.

Resource	Total Adaptive Capacity Score*	Rank	Physical – Intrinsic	Physical – Technology	Physical Notes	Organization	Org Notes	Social	Social Notes	Economic	Economic Notes	Division Overlap
Mixed hardwood (coastal oak heath) forest (William Floyd Estate)	8	L	2	2	forests can shift, just takes a lot longer to do relative to other systems; scored it a 2 because there's more room to shift northward (relative to forests on FI) and we believe it would change tree spp; TECH: some actions can be taken (SPB eradication/suppression somewhat caused by climate change) to make the NR more functioning; could attempt to restore forest in other areas of Floyd Estate because we have a little more room. composition when areas get wet (oaks to gum) but it wouldn't be lost like the maritime forests	2	NPS would coordinate.	1	this system is not seen as particularly unique; wouldn't garner support itself like the species that inhabit it would	1	little to no funding available	–
Open fields (William Floyd Estate)	8	L	1	3	not much in terms of naturally intrinsic qualities to adapt, only in that they are so highly managed now (so there's already such a human element in how they are managed), TECH: since the open fields are highly managed (via mowing) they could be created in a more favorable area (one's that are further south that will end up being wet from SLR could be restored further north) – understanding this would be negative to the cultural landscape integrity	2	NPS would coordinate	1	this system is not seen as particularly unique (although open fields and grasslands are!); wouldn't garner support itself like the species that inhabit it would	1	little to no funding available	–
Freshwater ecosystems (high bush blueberry shrub swamp, northern interdunal cranberry swale)	7	L	2	1	driven by groundwater systems; limited where they can move to; may be opportunities for new fresh water wetlands as groundwater rises – high uncertainty; difference between William Floyd Estate more adaptive than on Fire Island, tech options not available or space for assisted migration on island, but could be higher on William Floyd	2	motivation there, but options limited, limited institutional capacity, more focus has been on tidal wetlands, rare plants (currently state listed), wetlands protections provide starting point	1	limited constituency	1	not competitive	–

* Total adaptive capacity levels – low (5–9), moderate (10–12), high (13–15). POSE scored minimal (1), low (2), moderate (3) to high (4)

Table E-2 (continued). Natural resources adaptive capacity detailed at Fire Island National Seashore, New York.

Resource	Total Adaptive Capacity Score*	Rank	Physical – Intrinsic	Physical – Technology	Physical Notes	Organization	Org Notes	Social	Social Notes	Economic	Economic Notes	Division Overlap
Sediment supply	11	M	3	3	sediment is fairly abundant and varies spatially, similar to beaches	2	lots of federal, state and local interest; FIIS is a key player; neighbors have to coordinate to get permit	2	people discussing, whether or not we agree on solutions; public often lacking full understanding of sediment supply; hear messages that don't represent natural processes part of the story (importance of infrastructure and public safety gets more attention / traction)	1	expensive to do anything; have been in good shape on sediment sources; FIMP beneficial use sets up competition for natural sediment supplies	–
Ground water	8	L	2	2	groundwater system adjusts to new conditions; as island decreases in size, so does groundwater system; salt water / fresh water interface changing, options addressing wastewater measures, technology available for water quality, some lag in effectiveness; tech not available for quantity	1	limited staff capacity or monitoring, does not raise high enough as priority; in communities septic enforcement/variances limited	2	lack of awareness; focus on groundwater flooding	1	on Long Island, a priority, but not on Fire Island	note that technology/options such as dewatering that may be proposed for facilities or CR would be negative NR AC
Bayside beaches	13	H	3	3	bay beaches will maintain themselves in the future; methods available to provide extra sediment where needed	3	many orgs want bay beaches retained	2	less interest than in ocean beaches	2	new attitude by NYS, tentative USACOE plan would support physical technology (4 million cu yd)	–

* Total adaptive capacity levels – low (5–9), moderate (10–12), high (13–15). POSE scored minimal (1), low (2), moderate (3) to high (4)

Appendix F. Facility Assets Vulnerability Assessment Data Set at Fire Island National Seashore.

Table F-1. Facilities structures exposure 2020 at Fire Island National Seashore, New York.

ID	Location	Area	FEMA _VE	FEMA _A	Erosion	SLR _2020	Surge _Cat3	Historic Flood	Score_ Step1	Binned _Raw	VE_ Auto High	Exposure _Unmod	Exposure	Exposure Rank
1	Q-00000154-HO-TA-154 Ocean Quarters	TA	4	–	1	1	4	1	11	3	4	4	4	High
2	BU-HQ-76 Park Headquarters	HQ	–	4	1	1	4	4	14	3	–	3	3	Moderate
3	BU-HQ-72 Headquarters Annex	HQ	–	4	1	1	4	4	14	3	–	3	3	Moderate
4	Q-00000103-HO-SH-103 Sailors Haven Housing Unit	SH	–	4	1	1	4	4	14	3	–	3	3	Moderate
5	BU-HQ-73 Patchogue Boat House	HQ	–	4	1	1	4	4	14	3	–	3	3	Moderate
6	BU-HQ-77 PMF Maintenance Facility	HQ	–	1	1	1	4	4	11	3	–	3	3	Moderate
7	BU-HQ-78 Vehicle Vessel Shop	HQ	–	4	1	1	4	4	14	3	–	3	3	Moderate
8	Q-00000006-HO-WH-06 Quarters #6	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
9	Q-00000002-HO-WH-02 Quarters #2	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
10	BU-HQ-79 PMF Warehouse	HQ	–	4	1	1	4	4	14	3	–	3	3	Moderate
11	Q-00000003-HO-WH-03 Quarters #3	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
12	Q-00000004-HO-WH-04 Quarters #4	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
13	Q-00000005-HO-WH-05 Quarters #5	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
14	Q-00000007-HO-WH-07 Quarters #7	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
15	BU-HQ-81 River Room (Conference)	HQ	–	4	1	1	4	4	14	3	–	3	3	Moderate
16	Q-00000008-HO-WH-08 Quarters #8	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
17	Q-00000009-HO-WH-09 Quarters #9	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
18	Q-00000010-HO-WH-10 Quarters #10	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
19	Q-00000011-HO-WH-11 Quarters #11	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
20	Q-00000012-HO-WH-12 Quarters #12	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
21	Q-00000001-HO-WH-01 Quarters#1	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
22	BU-WF-224 Curatorial Storage	WF	–	1	–	1	4	1	7	2	–	2	2	Low
23	BU-LS-219 Single Story Connector Building	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
24	Q-00000151-HO-CA-151 Carrington House	CA	4	–	1	1	4	1	11	3	4	4	4	Moderate
25	BU-LS-93a Comfort Station	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
26	Q-00000152-HO-CA-152 Carrington Cottage	CA	–	4	1	1	4	1	11	3	–	3	3	Moderate

* Exposure scored not exposed (1) and exposed (4). Areas are Headquarters (HQ), Talisman (TA), Sailor's Haven (SH), Watch Hill (WH), Light Station (LS), Barrett Beach (BB) and William Floyd Estate (WF)

Table F-1 (continued). Facilities structures exposure 2020 at Fire Island National Seashore, New York.

ID	Location	Area	FEMA _VE	FEMA _A	Erosion	SLR _2020	Surge _Cat3	Historic Flood	Score_ Step1	Binned _Raw	VE_ Auto High	Exposure _Unmod	Exposure	Exposure Rank
27	Q-00000104-HO-SH-102 Quarters#102	SH	–	4	1	1	4	4	14	3	–	3	3	Moderate
28	BU-SH-107 Comfort Station	SH	–	4	1	1	4	1	11	3	–	3	3	Moderate
29	BU-SH-104 Visitor Center	SH	–	4	1	1	4	4	14	3	–	3	3	Moderate
30	BU-OP-51 Wilderness Visitor Center	OP	4	–	–	1	4	4	13	3	4	4	4	High
31	BU-TA-156 Maintenance Shop	TA	–	4	1	1	4	1	11	3	–	3	3	Moderate
32	BU-TA-157 Comfort Station	TA	–	4	1	1	4	1	11	3	–	3	3	Moderate
33	BU-TA-158 Pump House	TA	4	–	1	1	4	1	11	3	4	4	4	High
34	BU-WH-13 Marina Store	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
35	BU-LS-94 Annex Garage	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
36	BU-LS-96 Store House	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
37	BU-LS-97 Oil House	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
38	BU-LS-98 Tool House	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
39	BU-LS-99 Lighthouse Boat House	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
40	BU-WH-20 Maintenance Shop	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
41	BU-WH-22 Flammable Storage Building	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
42	BU-LS-91 Fire Island Light House	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
43	BU-LS-92 Keepers Quarters	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
44	BU-LS-93 Check Station	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
45	Q-00SHBARN-HO-SH-105 Horse Barn	SH	–	4	1	1	4	4	14	3	–	3	3	Moderate
46	BU-SH-106 Gift Shop & Snack Bar	SH	4	–	4	1	4	4	17	3	4	4	4	High
47	BU-SH-109 Maintenance Shop	SH	–	4	1	1	4	4	14	3	–	3	3	Moderate
48	BU-SH-111 Garbage Building	SH	4	–	4	1	4	4	17	3	4	4	4	Moderate
49	BU-WF-222 Turf Equipment Storage Building	WF	–	1	1	1	4	1	8	2	–	2	2	Moderate
50	BU-WF-223 Fire Cache Storage Building	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
51	BU-WF-221 Flamable Storage Building	WF	–	1	1	1	4	1	8	2	–	2	2	Low
52	BU-WH-14 Dockmaster Office	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
53	BU-WH-15 Storage Building	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
54	BU-WH-16 Visitor Center	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate

* Exposure scored not exposed (1) and exposed (4). Areas are Headquarters (HQ), Talisman (TA), Sailor's Haven (SH), Watch Hill (WH), Light Station (LS), Barrett Beach (BB) and William Floyd Estate (WF)

Table F-1 (continued). Facilities structures exposure 2020 at Fire Island National Seashore, New York.

ID	Location	Area	FEMA _VE	FEMA _A	Erosion	SLR _2020	Surge _Cat3	Historic Flood	Score_ Step1	Binned _Raw	VE_ Auto High	Exposure _Unmod	Exposure	Exposure Rank
55	BU-WH-17 Marina Restroom	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
56	BU-WH-21 First Aid Room	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
57	BU-WH-34 Well House	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
58	BU-WH-24a Dune Station Restroom (women's)	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
59	BU-WH-24b Dune Station Restroom (men's)	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
60	BU-WH-29 Laundry/Compressor Building	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
61	BU-WH-25 Lifeguard Station	WH	–	4	1	1	4	1	11	3	–	3	3	Moderate
62	BU-WH-26 Horse Barn	WH	–	4	–	1	4	4	13	3	–	3	3	Moderate
63	BU-WH-32 Garbage Building	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
64	BU-WH-33 Electrical Panel Building	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
65	BU-WH-36 Campground Host Building	WH	–	4	–	1	4	1	10	3	–	3	3	Moderate
66	BU-WF-181 Old Mastic House	WF	–	1	1	1	1	1	5	1	–	1	1	minimal
67	BU-WF-189 Wood Shed	WF	–	1	1	1	1	1	5	1	–	1	1	minimal
68	BU-WF-183 Storage Crib	WF	–	1	1	1	1	1	5	1	–	1	1	minimal
69	BU-WF-194 Pump House	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
70	BU-WF-184 Old Shop	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
71	BU-WF-185 New Barn	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
72	BU-WF-182 Ice House	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
73	BU-WF-188 Corn Crib	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
74	BU-WF-190 Carriage House	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
75	BU-WF-191 Caretakers Workshop	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
76	BU-WF-186 Old Barn	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
77	Q-00000155-HO-TA-155 VIP Quarters	TA	4	–	1	1	4	1	11	3	4	4	4	High
78	BU-TA-153 Talisman Motel	TA	4	–	1	1	4	1	11	3	4	4	4	High
79	Q-0000WFE1/WFE2-HO-WF-110 Duplex	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
80	BU-WH-18 Restaurant	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
81	Q-0000100D-HO-LS-93 Annex Housing Unit	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
82	BU-WF-200-Public Restroom	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal

* Exposure scored not exposed (1) and exposed (4). Areas are Headquarters (HQ), Talisman (TA), Sailor's Haven (SH), Watch Hill (WH), Light Station (LS), Barrett Beach (BB) and William Floyd Estate (WF)

Table F-1 (continued). Facilities structures exposure 2020 at Fire Island National Seashore, New York.

ID	Location	Area	FEMA _VE	FEMA _A	Erosion	SLR _2020	Surge _Cat3	Historic Flood	Score_ Step1	Binned _Raw	VE_ Auto High	Exposure _Unmod	Exposure	Exposure Rank
83	BU-HQ-80A New Patchogue Ferry Terminal	HQ	–	4	1	1	4	4	14	3	–	3	3	Moderate
84	BU-WF-225-Window Storage Building	WF	–	1	1	1	4	1	8	2	–	2	2	Moderate
85	BU-BB-Snack Bar	BB	–	4	1	1	4	1	11	3	–	3	3	Moderate
86	BU-BB-Restrooms/Utility Room	BB	–	4	1	1	4	1	11	3	–	3	3	Moderate
87	BU-WF-Boat Collections Storage Building	WF	–	1	1	1	4	1	8	2	–	2	2	Low
88	BU-WH-Dune Station Visitor Station	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate
89	BU-WF-Maintenance Shop	WF	–	1	1	1	4	1	8	2	–	2	2	Moderate
90	BU-WF-Gazebo	WF	–	1	1	1	1	1	5	1	–	1	1	Moderate
91	BU-BB-Sun Shelter	BB	4	–	1	1	4	1	11	3	4	4	4	High
92	BU-LS-West Entrance Comfort Station	LS	–	1	1	1	4	1	8	2	–	2	2	Low
93	BU-WEES Pavilion	LS	–	1	1	1	4	1	8	2	–	2	2	Low
94	BU-WF-Incinerator	WF	–	1	1	1	1	1	5	1	–	1	1	Minimal
95	BU-LS-Fresnel Lens Building	LS	–	4	1	1	4	4	14	3	–	3	3	Moderate
96	BU-HQ-PMF Flammable Storage Shed	HQ	–	4	1	1	4	4	14	3	–	3	3	Moderate
97	BU-SH-Fire Cache	SH	–	4	1	1	4	4	14	3	–	3	3	Moderate
98	BU-WH-Marina Shed	WH	–	4	1	1	4	4	14	3	–	3	3	Moderate

* Exposure scored not exposed (1) and exposed (4). Areas are Headquarters (HQ), Talisman (TA), Sailor's Haven (SH), Watch Hill (WH), Light Station (LS), Barrett Beach (BB) and William Floyd Estate (WF)

Table F-2. Facilities Structures Exposure 2050 at Fire Island National Seashore, New York.*

ID	Location	Area	FEMA _VE	FEMA _A	Erosion	SLR _2050	Surge _Cat3	Historic Flood	Score _Step1	Binned _Raw	VE_ Auto High	Exposure _Unmod	Exposure	Exposure Rank
1	Q-00000154-HO-TA-154 Ocean Quarters	TA	4	–	4	1	4	1	14	3	4	4	**4**	High
2	BU-HQ-76 Park Headquarters	HQ	–	4	4	1	4	4	17	4	–	4	**4**	High
3	BU-HQ-72 Headquarters Annex	HQ	–	4	4	1	4	4	17	4	–	4	**4**	High
4	Q-00000103-HO-SH-103 Sailors Haven Housing Unit	SH	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
5	BU-HQ-73 Patchogue Boat House	HQ	–	4	4	1	4	4	17	4	–	4	**4**	High
6	BU-HQ-77 PMF Maintenance Facility	HQ	–	1	1	1	4	4	11	3	–	3	**3**	Moderate
7	BU-HQ-78 Vehicle Vessel Shop	HQ	–	4	4	1	4	4	17	4	–	4	**4**	High
8	Q-00000006-HO-WH-06 Quarters #6	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
9	Q-00000002-HO-WH-02 Quarters #2	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
10	BU-HQ-79 PMF Warehouse	HQ	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
11	Q-00000003-HO-WH-03 Quarters #3	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
12	Q-00000004-HO-WH-04 Quarters #4	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
13	Q-00000005-HO-WH-05 Quarters #5	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
14	Q-00000007-HO-WH-07 Quarters #7	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
15	BU-HQ-81 River Room (Conference)	HQ	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
16	Q-00000008-HO-WH-08 Quarters #8	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
17	Q-00000009-HO-WH-09 Quarters #9	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
18	Q-00000010-HO-WH-10 Quarters #10	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
19	Q-00000011-HO-WH-11 Quarters #11	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
20	Q-00000012-HO-WH-12 Quarters #12	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
21	Q-00000001-HO-WH-01 Quarters#1	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
22	BU-WF-224 Curatorial Storage	WF	–	1	1	1	4	1	8	2	–	2	**2**	Low
23	BU-LS-219 Single Story Connector Building	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
24	Q-00000151-HO-CA-151 Carrington House	CA	4	–	1	1	4	1	11	3	4	4	**4**	High
25	BU-LS-93a Comfort Station	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
26	Q-00000152-HO-CA-152 Carrington Cottage	CA	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
27	Q-00000104-HO-SH-102 Quarters#102	SH	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
28	BU-SH-107 Comfort Station	SH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate

* Exposure scored not exposed (1) and exposed (4). Areas are Headquarters (HQ), Talisman (TA), Sailor's Haven (SH), Watch Hill (WH), Light Station (LS), Barrett Beach (BB) and William Floyd Estate (WF)

Table F-2 (continued). Facilities Structures Exposure 2050 at Fire Island National Seashore, New York.*

ID	Location	Area	FEMA _VE	FEMA _A	Erosion	SLR _2050	Surge _Cat3	Historic Flood	Score _Step1	Binned _Raw	VE_ Auto High	Exposure _Unmod	Exposure	Exposure Rank
29	BU-SH-104 Visitor Center	SH	–	4	4	1	4	4	17	4	–	4	**4**	High
30	BU-OP-51 Wilderness Visitor Center	OP	4	–	4	1	4	4	17	4	4	4	**4**	High
31	BU-TA-156 Maintenance Shop	TA	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
32	BU-TA-157 Comfort Station	TA	–	4	4	1	4	1	14	3	–	3	**3**	Moderate
33	BU-TA-158 Pump House	TA	4	–	1	1	4	1	11	3	4	4	**4**	High
34	BU-WH-13 Marina Store	WH	–	4	4	1	4	4	17	4	–	4	**4**	High
35	BU-LS-94 Annex Garage	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
36	BU-LS-96 Store House	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
37	BU-LS-97 Oil House	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
38	BU-LS-98 Tool House	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
39	BU-LS-99 Lighthouse Boat House	LS	–	4	4	1	4	4	17	4	–	4	**4**	High
40	BU-WH-20 Maintenance Shop	WH	–	4	4	1	4	4	17	4	–	4	**4**	High
41	BU-WH-22 Flammable Storage Building.	WH	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
42	BU-LS-91 Fire Island Light House	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
43	BU-LS-92 Keepers Quarters	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
44	BU-LS-93 Check Station	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
45	Q-00SHBARN-HO-SH-105 Horse Barn	SH	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
46	BU-SH-106 Gift Shop & Snack Bar	SH	4	–	4	1	4	4	17	4	4	4	**4**	High
47	BU-SH-109 Maintenance Shop	SH	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
48	BU-SH-111 Garbage Building.	SH	4	–	4	4	4	4	20	4	4	4	**4**	High
49	BU-WF-222 Turf Equipment Storage Building	WF	–	1	1	1	4	1	8	2	–	2	**2**	Low
50	BU-WF-223 Fire Cache Storage Building	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
51	BU-WF-221 Flammable Storage Building	WF	–	1	1	1	4	1	8	2	–	2	**2**	Low
52	BU-WH-14 Dockmaster Office	WH	–	4	4	1	4	4	17	4	–	4	**4**	High
53	BU-WH-15 Storage Building	WH	–	4	4	1	4	4	17	4	–	4	**4**	High
54	BU-WH-16 Visitor Center	WH	–	4	4	1	4	4	17	4	–	4	**4**	High
55	BU-WH-17 Marina Restroom	WH	–	4	4	1	4	4	17	4	–	4	**4**	High
56	BU-WH-21 First Aid Room	WH	–	4	4	1	4	4	17	4	–	4	**4**	High

* Exposure scored not exposed (1) and exposed (4). Areas are Headquarters (HQ), Talisman (TA), Sailor's Haven (SH), Watch Hill (WH), Light Station (LS), Barrett Beach (BB) and William Floyd Estate (WF)

Table F-2 (continued). Facilities Structures Exposure 2050 at Fire Island National Seashore, New York.*

ID	Location	Area	FEMA _VE	FEMA _A	Erosion	SLR _2050	Surge _Cat3	Historic Flood	Score _Step1	Binned _Raw	VE_ Auto High	Exposure _Unmod	Exposure	Exposure Rank
57	BU-WH-34 Well House	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
58	BU-WH-24a Dune Station Restroom (women's)	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
59	BU-WH-24b Dune Station Restroom (men's)	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
60	BU-WH-29 Laundry/Compressor Building	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
61	BU-WH-25 Lifeguard Station	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
62	BU-WH-26 Horse Barn	WH	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
63	BU-WH-32 Garbage Building	WH	–	4	4	4	4	4	20	4	–	4	**4**	High
64	BU-WH-33 Electrical Panel Building	WH	–	4	4	1	4	4	17	4	–	4	**4**	High
65	BU-WH-36 Campground Host Building	WH	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
66	BU-WF-181 Old Mastic House	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
67	BU-WF-189 Wood Shed	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
68	BU-WF-183 Storage Crib	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
69	BU-WF-194 Pump House	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
70	BU-WF-184 Old Shop	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
71	BU-WF-185 New Barn	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
72	BU-WF-182 Ice House	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
73	BU-WF-188 Corn Crib	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
74	BU-WF-190 Carriage House	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
75	BU-WF-191 Caretakers Workshop	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
76	BU-WF-186 Old Barn	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
77	Q-00000155-HO-TA-155 VIP Quarters	TA	4	–	1	1	4	1	11	3	4	4	**4**	High
78	BU-TA-153 Talisman Motel	TA	4	–	1	1	4	1	11	3	4	4	**4**	High
79	Q-0000WFE1/WFE2-HO-WF-110 Duplex	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
80	BU-WH-18 Restaurant	WH	–	4	4	1	4	4	17	4	–	4	**4**	High
81	Q-0000100D-HO-LS-93 Annex Housing Unit	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
82	BU-WF-200-Public Restroom	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
83	BU-HQ-80A New Patchogue Ferry Terminal	HQ	–	4	4	1	4	4	17	4	–	4	**4**	High
84	BU-WF-225-Window Storage Building	WF	–	1	1	1	4	1	8	2	–	2	**2**	Low

* Exposure scored not exposed (1) and exposed (4). Areas are Headquarters (HQ), Talisman (TA), Sailor's Haven (SH), Watch Hill (WH), Light Station (LS), Barrett Beach (BB) and William Floyd Estate (WF)

Table F-2 (continued). Facilities Structures Exposure 2050 at Fire Island National Seashore, New York.*

ID	Location	Area	FEMA _VE	FEMA _A	Erosion	SLR _2050	Surge _Cat3	Historic Flood	Score _Step1	Binned _Raw	VE_ Auto High	Exposure _Unmod	Exposure	Exposure Rank
85	BU-BB-Snack Bar	BB	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
86	BU-BB-Restrooms/Utility Room	BB	–	4	1	1	4	1	11	3	–	3	**3**	Moderate
87	BU-WF-Boat Collections Storage Building	WF	–	1	1	1	4	1	8	2	–	2	**2**	Low
88	BU-WH-Dune Station Visitor Station	WH	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
89	BU-WF-Maintenance Shop	WF	–	1	1	1	4	1	8	2	–	2	**2**	Low
90	BU-WF-Gazebo	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
91	BU-BB-Sun Shelter	BB	4	–	1	1	4	1	11	3	4	4	**4**	High
92	BU-LS-West Entrance Comfort Station	LS	–	1	1	1	4	1	8	2	–	2	**2**	Low
93	BU-WEES Pavilion	LS	–	1	1	1	4	1	8	2	–	2	**2**	Low
94	BU-WF-Incinerator	WF	–	1	1	1	1	1	5	1	–	1	**1**	Minimal
95	BU-LS-Fresnel Lens Building	LS	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
96	BU-HQ-PMF Flammable Storage Shed	HQ	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
97	BU-SH-Fire Cache	SH	–	4	1	1	4	4	14	3	–	3	**3**	Moderate
98	BU-WH-Marina Shed	WH	–	4	4	1	4	4	17	4	–	4	**4**	High

* Exposure scored not exposed (1) and exposed (4). Areas are Headquarters (HQ), Talisman (TA), Sailor's Haven (SH), Watch Hill (WH), Light Station (LS), Barrett Beach (BB) and William Floyd Estate (WF)

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
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