

ASSESSING THE IMPACTS OF HURRICANE SANDY ON COASTAL HABITATS



Prime Hook National Wildlife Refuge Before and After Sandy

By: The American Littoral Society
For: The National Fish and Wildlife Foundation
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Introduction

Purpose

The American Littoral Society (ALS) was tasked by the National Fish and Wildlife Foundation (NFWF) with coordinating a regional assessment to rapidly evaluate the quantitative and qualitative environmental impacts associated with Hurricane Sandy, which recently struck the East Coast of the United States. The project was presented in two parts: an Interim Assessment Report was submitted to NFWF on November 21, 2012, and this document, the Final Assessment Report, was submitted on December 17, 2012. As embodied in the Final Assessment Report, the project focuses on the physical effects the storm had on coastal habitats and the target species which depend on them. It also identifies realistic opportunities to address and remediate critical storm-related challenges facing those species. This information will help prioritize funding of projects intended to provide relief to high value conservation targets in the affected region.

Geographic Area

The general area of interest is within the primary footprint of the storm in the mid-Atlantic coastal areas and includes the Delaware Bay, coastal New Jersey, the Hudson-Raritan Estuary, Jamaica Bay and Long Island Sound (“the project area”).

Project Components

The project consists of two components: (1) information gathered from telephone surveys and interviews of natural resource managers and NGOs; and (2) the establishment of a website that maintains geospatial images demonstrating the changes caused by Sandy to beaches, dunes, tidal marshes and maritime forests, and serves as a repository for the posting of information, including photos of impacts sustained by the storm.

Information Sources

This project allows readers to view the data collected in several ways: (1) by reading the narrative summary in the report; (2) by reading the Impact Trends section of the report at pp. 22-29, which highlights issues common to the entire project area; (3) by accessing the CRSSA geospatial data at <http://www.crssa.rutgers.edu/projects/coastal/sandy/>; (4) by viewing the comprehensive summary table of persons contacted and impacts identified in Exhibit 1; and (5) by viewing the priority project summaries set forth in Exhibit 3.

Project Partners

ALS’s partners in this effort are the Hudson River Foundation (HRF) and the Rutgers University Grant F. Walton Center for Remote Sensing and Spatial Analysis (CRSSA). To avoid duplication of effort, ALS deferred to the HRF with regard to the survey work in the Hudson/Raritan Estuary and related environs. Accordingly, ALS incorporates by reference, and refers readers to, the interim findings and final report of the HRF.

ALS would like to extend its heartfelt thanks to all of the people and organizations that contributed to this project and who are dedicated to the protection of our natural resources on a daily basis. They made this effort possible and it is through their continued hard work that recovery will be achieved.

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The Survey

The survey portion of the assessment consisted of individual telephone calls, conference calls and email inquiries to resource managers, NGOs, and state and federal personnel familiar with the target region and who would likely be involved in field assessments of impacts caused by Sandy. Managers and superintendents of National Wildlife Refuges, National Wildlife Areas, State and County Parks, key personnel from the U.S. Fish and Wildlife Service, the New Jersey Department of Environmental Protection, New York Department of Environmental Protection, and the Connecticut Department of Energy and Environmental Protection were contacted, as well as national, state and local environmental and conservation organizations (hereafter, collectively referred to as “resource managers”). Each contact was queried about overall impacts to resources, impacts to any and all habitats within the resource, species affected by the impacts, any secondary impacts to habitats or species that were anticipated, immediate and longer-term remediation needs, and financial or other resources necessary to carry out such remediations.

A comprehensive summary of contacts made through the survey process and information elicited from those contacts is set forth in Table 1, attached hereto as **Exhibit 1**. A Rapid Assessment Questionnaire was developed to guide the telephone interviews, and is posted on the aforementioned website for resource managers to fill out as additional information is acquired. A copy of the questionnaire is attached hereto as **Exhibit 2**. In addition, the resource managers were forwarded a one page priority project template in which they could identify priority restoration projects, the project location, problems to be resolved, estimated funding needs, species impacted and a general start and end date for project implementation. This effort yielded more than 30 responses, each of which are attached hereto as **Exhibit 3**.

The physical assessments of damages suffered in the region are still underway and there is much work to be done before a full understanding of the impacts and their implications are achieved. Nevertheless, the ongoing and extraordinary efforts of resource managers to date have provided evidence of numerous issues in and around their areas of concern. Some of the major issues and hard-hit areas identified through the survey process are summarized below, both through discussions of a variety of habitats impacted at specific locations, such as parks or wildlife refuges, or through a discussion of certain habitats that were particularly hard hit within the project area sub-regions.

It is important to note that the decision not to include impacts to specific areas in the summaries below is in no way indicative of their severity or importance, but reflects only the authors’ attempts at brevity .

Summary of Specific Impacts

Delaware Bay/Atlantic Coast - Delaware and Southern New Jersey

Prime Hook National Wildlife Area

While several areas in Delaware fared well during the storm, such as the Cedar Swamp Wildlife Area and Bombay Hook National Wildlife Refuge, others were hit hard. At Prime Hook National Wildlife Refuge, breaches to dunes that separate the barrier island from its 4,200 acre freshwater marsh caused significant saltwater inundation. Although there are some freshwater and brackish portions remaining, most of the marsh has been converted to saltwater. The dune breaches are an ongoing problem that began with a storm event in 2008 and continued to worsen over the years, with Sandy wielding a major blow. In its current state, the marsh will not be able to sustain the species of ducks and other waterfowl that depend on the freshwater marsh, and the number of waterfowl that visit the site has dropped significantly over the past several years. The circumstances at Prime Hook are changing rapidly as a result of increased storm surges and sea level rise, and its resource managers are concerned that, without a more permanent and feasible solution, the freshwater marsh is not sustainable.

Forsythe National Wildlife Refuge

Saltwater intrusion is also an issue at the Forsythe National Wildlife Refuge in New Jersey, where severe damage to the dikes at Galloway Township allowed sea water to enter the freshwater impoundments. Beach erosion and displacement is also severe, and it remains to be seen whether the dynamic system will recover on its own. Dunes washed to the backside of the barrier islands, potentially creating new piping plover nesting habitat, but there are also several areas where sea water is now able to cross the islands at high tide. A major problem at Forsythe is the extensive deposition of household refuse and debris along the intertidal/forest areas, including more than 130 boats, most severely in the Stafford/Tuckerton area and Brick Township. The boats in this 22-mile long wrack line along with numerous leaking home heating oil tanks, add the strong potential for gross contamination to concerns that the tidal marsh under the debris will be killed.

Delaware Bay Horseshoe Crab Spawning Beaches

Several beaches along the Delaware Bay in New Jersey extending from Reed's Beach to Pierce's Point in Cape May County, and Moore's Beach in Cumberland County, were severely damaged by the storm. These areas serve as critical spawning habitat for horseshoe crabs which, in turn, serve as a food source for the red knot, an important shorebird proposed for inclusion on the Federal Endangered Species List. There was a loss of 2 to 3 feet of sand on all of these beaches and the force of the storm placed most of this sand well above the normal high tide line and out of reach of spawning crabs. The portions of beaches that did remain are covered with debris, including chunks of asphalt and bricks strewn throughout the substrate, which will have a significant impact upon crab spawning by negating their ability to dig in to lay eggs. In addition, larger debris such as concrete pipes, slabs, and pilings have created impingement hazards and will further hamper or prevent spawning. These beaches also serve as habitat for a number of other shorebirds, including ruddy turnstone, sanderling, sandpiper, dunlin, and short-billed dowitcher.

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Inlets of Southern New Jersey

The inlets that create openings to the line of barrier islands between the Atlantic Ocean and New Jersey's bays provide some of the most important nesting shorebird habitat in the project area. Many of these inlets, including Hereford Inlet, Townsend's Inlet, Corson's Inlet, Great Egg Harbor Inlet and Brigantine Inlet, suffered significant damage. The berms and forming dunes in these areas were flattened, rendering them less suitable for nesting and vulnerable to nest flooding. It is unlikely that, in their current state, these inlets will be able to support the large least tern colonies that have utilized them in recent years. Other species impacted by this loss of habitat include piping plover, American oystercatcher, least tern, black skimmer and common tern.

Dunes and Beaches

Numerous beaches along the Atlantic Coast were severely eroded, including in the towns of Stone Harbor and Avalon, and at the north end of Corson's Inlet State Park near Ocean City. Dunes were flattened and sand was lost causing the elevation of these beaches to be lowered. The lower elevations render the already compromised beaches vulnerable to additional impacts by exposing them to high or neap tide flooding as well as storm surges and wave action from winter storms. This has the potential to further erode nesting habitat for shorebirds such as the piping plover, and to subject the nests in the remaining habitat to flooding.

Tidal Marsh/Sediment Prey Communities

Inundation of tidal marshes and intertidal sediment/substrate was prevalent throughout the coastal area, with some reportedly under water for more than five days. Although many of the marsh grasses survived and even fared well, the same cannot be said for the invertebrates and small mammals, such as rodents, voles and small rabbits that inhabit these areas. The small mammal population has been reportedly "wiped out" in many areas, creating a food shortage for northern harriers and other species that prey upon them. The impacts and implications to the invertebrates has been described as a "big unknown" but could be devastating to the long-legged wading birds that prey upon this community, including great blue heron, black crowned night heron, yellow crowned night heron, snowy egret, great egret, American bittern, least bittern, glossy ibis and white ibis.

Fringe Forests

Although the storm did cause short term inundation to many forested habitats along the coast, it may be difficult to assess the direct impacts to these areas specifically caused by Sandy. Coastal forests have been under assault for some time from the gradual but steady movement of saltwater farther inland as a result of rising tides and sea level. It is likely that Sandy has contributed to this problem by creating numerous breaches in the natural protections that stand between the saltwater and the forests. Regardless of the cause, the impacts to coastal forests, which have been described as steadily "losing ground," will be significant. Fringe forests provide nesting habitat for rookeries of rare wading birds, such as yellow-crowned night heron and other wading species, as well as important nesting habitat for raptors and song birds. The most important role of fringe forests is as migratory stopover habitat for long distance neotropical migrant birds. As many as 75

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species of long distance migrants, some of them rare, depend upon these critical stopover forests during their long migrations. The Atlantic coastal strip is known to have the highest densities by far of migratory birds, especially juveniles, due to the northwest winds along the ocean during the fall migration period.

New and Moved Habitat

In many areas, the storm surge from Sandy created new habitat by adding sand to beaches and existing barrier and spoil islands, and moved other habitat by pushing sand and dunes westward. While the creation of habitat is a plus for beach nesting shorebirds and other shore and migratory species, it has also created a series of new problems that must be addressed. Much of this habitat has been created or moved to areas easily and heavily accessed by humans and dogs. In addition, it is not known as habitat to the municipalities and other entities engaged in recovery efforts and is extremely vulnerable to damage from the bulldozing and moving of sand that is going on right now as towns attempt to replace dunes and shore up their beaches. Immediate steps must be taken to identify these new habitats and work with towns and the public generally to protect them from both recovery efforts and human traffic. Protocols must be developed that address dune configuration, sand movement (scraping, transport), sand fencing, vegetation (planting and removal), beach raking and other traditional restoration and flood protection methods.

Ineffective Restoration/Protection Proposals

Resource managers throughout the entire project area expressed concerns over the potential for ineffective and even harmful recovery projects, ranging from planting dune grass and creating dunes in the wrong areas to structural “solutions” such as sea walls and tide gates. Everyone expressed an interest in a concerted effort to demonstrate the effectiveness of more natural approaches, such as the restoration or creation of salt marshes, barrier islands, properly placed dune systems and dredge spoil islands.

Summary of Specific Impacts

Raritan Bay/Hudson River, Northern New Jersey and New York

This area was assessed separately through a survey conducted by our partner in this project, the Hudson River Foundation (HRF). Accordingly, in addition to the summary information below, this report adopts and incorporates by reference, and refers the reader to, the interim and final assessment reports of the HRF submitted to NFWF under separate cover.

Cheesequake State Park

Cheesequake State Park is uniquely situated between suburban southern New Jersey and Urban northern New Jersey, is bisected by the Garden State Parkway, and sits adjacent to the Raritan River. It is home to a variety of habitats, including open fields, saltwater and freshwater marshes, a white cedar swamp, pine barrens, and a northeastern hardwood forest and suffered several different types of damage from Sandy, including the following:

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- The loss of over 300 trees, including 100-year old oaks and several Atlantic white cedars, reducing habitat for numerous species, such as woodpecker, screech owls, flying squirrels, changing the park aesthetic and creating a void that has the potential to be filled by invasive/nuisance species.
- There is a 4 to 6 foot deep layer of organic tidal debris in the marshes comprised mostly of reeds and other vegetation, combined with tires, duck blinds and other man-made structures. Estimated to weigh approximately 100,000 tons, this debris layer will stunt the growth of vegetation impacting not only the crabs that dwell there, but the kingfishers, herons and gulls that feed upon them.
- Several vernal pools in the lowland forest were destroyed by the storm surge. These pools are prime habitat for a variety of frogs, toads and salamanders.
- The tremendous tidal surge caused saltwater intrusion into the cedar swamp populated by Atlantic white cedars. In addition, there was significant saltwater intrusion into Hooks Creek Lake, a freshwater lake that is habitat for a variety of species of fish that were killed off by the high salinity levels.
- The saltwater intrusion at Hooks Creek Lake is exacerbated by the fact that the dam at the lake area and its associated culvert has been compromised by the storm and the outflow pipe is broken. In addition, the inflow pipe from Landing Creek to Perrine Pond was damaged.

The Arthur Kill

The massive storm surge from Sandy made its way into the Arthur Kill, the narrow waterway that separates New Jersey from Staten Island, New York. As it did so, the surge flooded the land and numerous industrial facilities that line the Arthur Kill's banks, damaging several bulk fuel tanks and releasing approximately 378,000 gallons of diesel fuel into the waterway. Two other spills were reported in the same area, but were described by responding officials as "small" and the "equivalent of one tanker truck each."¹ As the storm surge continued north, so did the oil, contaminating the marshes along the banks of the Arthur Kill, the marshes and waters of its creeks and tributaries, including Woodbridge Creek, Smith Creek Inlet and Rum Creek on the New Jersey side, and the marshes and shores of Staten Island. Several birds were found dead in the area, and others were coated with oil, although the species were not identified. The oil contamination appears to be the most significant impact in this area and, although the precise impacts have yet to be determined, it has the potential to cause widespread problems, including harm to the numerous fish species that inhabit these waters, invertebrates in the sediment and intertidal substrate, and the small mammals and wading birds that inhabit and feed in the marshes. Fish and invertebrate species known to inhabit

¹ "Arthur Kill Oil Spill: Hurricane Sandy's Surge Dumps Diesel Into New Jersey Waterway," Kirkham, Chris, Huffingtonpost.com, November 1, 2012; "Oil Spills, Other Hurricane Sandy Damage Present NJ with Potential Pollution Headaches," Hutchins, Ryan, The Star Ledger, November 14, 2012, posted on NJ.Com.

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these waters include American eel, American conger eel, bluefish, mummichog, striped bass, menhaden, silversides (Atlantic and inland), white perch, weakfish, lady crab and blue crab.

The Hudson, Raritan, Passaic and Hackensack Rivers Newark and Raritan Bays, the Arthur Kill and Kill van Kull

Flooded by the 12-foot storm surge and inoperable due to intentional shutdowns and the loss of electric power, several major sewage treatment plants released raw or partially treated sewage into local waterways. The Passaic Valley Sewerage Commission treatment plant released an estimated 400 to 500 million gallons of untreated wastewater into Newark Bay for several days, with the total amount discharged estimated to be in the billions of gallons. The Middlesex County Utilities Authority treatment plant in Sayreville, NJ released about 300 million gallons per day into the Raritan River for an unknown period of days. Similar problems were suffered by the North Hudson Sewerage Authority near the Hudson River in Hoboken, NJ and the Bayshore Regional Sewerage Authority in Union Beach, NJ, on the Raritan Bay. State officials issued an advisory against fishing, eating fish or coming in contact with the waters of the Hudson, Raritan, Passaic and Hackensack Rivers, Newark and Raritan Bays and the Arthur Kill and the Kill van Kull. Described as an “ecological catastrophe” the releases pose several threats, including the creation of oxygen depleted dead zones in affected waterways caused by waste-fed algal blooms; high concentrations of E. coli bacteria and other pathogens that can be ingested by fish and sicken them and the species that feed upon them; and a general degradation of water quality. The overall impacts to the numerous species that inhabit this area remain to be seen.²

Hackensack River

A fairly large fish kill was reported on the shores of the Hackensack River as a result of the storm. It is believed that the fish, mostly carp, were carried with the surge, but were stranded on the shore when the waters retreated. Similar fish-out-of-water sightings, also carp, were observed along the tracks adjacent to the Meadowlands by New Jersey Transit commuters in the days after the storm.³

Outerbridge Crossing Area/Meadowlands

Concerns were raised about a new species of leopard frog that was discovered in Staten Island in 2009, was subsequently found in the Meadowlands of New Jersey, and recently confirmed through DNA testing to be a new, previously unidentified species. Resource managers are uncertain at this time if an assessment is being done to determine the impacts of Sandy on this freshwater species, particularly through saltwater inundation of its grassy habitat, or from the oil and sewage spills.

² “Environmentalists Call for Investigation of NJ Plant Over Sewage Spill During Hurricane Sandy,” Stunsky, Steve, The Star Ledger, November 15, 2012, posted on NJ.Com; “Officials: Avoid Contact With Water, Fish from Northern NJ Waterways,” Strunsky, Steve, The Star Ledger, November 2, 2012, posted on NJ.Com.

³ “Sandy’s Other Toll: Fish Out of Water,” Marritz, Ilya, WNYC News, November 16, 2012, posted on WNYC.org.

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Prall's Island

Located in the Arthur Kill off of Staten Island, Prall's Island was once the source of the area's largest heron and egret colonies. The island suffered from a complete overwash from the storm surge, as well as damage to trees and other plants from both the surge and high winds. Debris that was previously scattered along the island's edges is now piled in the middle and deer fencing established to protect heron nesting areas has been knocked down. In addition, the salt marshes on the island were covered with oil from the spills in the Arthur Kill. Several oil-covered birds were brought to a rehabilitation facility on Staten Island by volunteers. Impacts to the island, particularly the marshes, threaten the long-legged wading birds that inhabit them, including glossy ibis, black-crowned night heron, little blue heron, snowy egret, cattle egret, and great egret.

Summary of Specific Impacts Jamaica Bay, New York

Jamaica Bay Wildlife Refuge (Gateway National Recreation Area)

The East and West Ponds, two freshwater ponds at the refuge, were breached by the storm surge and waves and inundated with saltwater. The land that formerly stood between the ponds and the Bay, and that served as part of the loop trail around the West Pond, has been washed away. The breaches have transformed the ponds entirely, and rendered them unable to support the species that depended upon them for freshwater, including snow geese, lesser and greater scaup, ruddy duck, ring-necked duck, green-winged teal, northern pintail, American widgeon, and gadwall. This transformation will also have impacts on snapping turtles that inhabit the area and can tolerate some salinity, but not the levels currently found in the ponds. Overwash of the dunes at the refuge added sand to the beaches, creating additional diamondback terrapin habitat.

Restored Jamaica Bay Salt Marsh Islands

The salt marsh islands are the result of a major restoration project undertaken by the Army Corps of Engineers, City and State agencies, and environmental organizations, and are comprised of five islands created from dredged spoils. Once constructed, each island is planted with a combination of low and high marsh plants and seed. Construction of Elders Point East and Elders Point West was completed in 2007 and 2012, respectively, restoring approximately 80 acres of marshland. Yellow Bar was completed in 2012, creating 42 acres of marsh. Two new islands, Rulers Bar and Blackwall Island, have been constructed but are sand only at this time and scheduled for planting in 2013. The integrity of the islands remained intact during the storm. There was no significant shift in sand placement and no damage to existing plantings, with the exception of the loss of minimal vegetation from a recently-plugged area at Yellow Bar. Planting of Rulers Bar and Blackwall will go on as scheduled this spring. Large amounts of debris were deposited on the islands by Sandy and will need to be removed immediately so as not to damage the existing marshes.

Summary of Specific Impacts

Long Island Sound, New York and Connecticut

Otis Pike Wilderness Area, Great South Bay, Long Island

The storm surge caused a breach in the barrier island at this area, also known as the Otis Pike High Dune Wilderness Area, the only federally-designated wilderness area in New York State. Resource managers familiar with the area consider the breach an opportunity for species recovery, including for hard clams, eelgrass, bay scallops, American eel and associated fish and waterfowl. However, breaches in New York's barrier islands are subject to immediate closure pursuant to a Breach Contingency Plan prepared by the U.S. Army Corps of Engineers in partnership with the New York Department of Environmental Conservation. Developed in the mid-1990s after a series of storms eroded the barrier islands in Westhampton, the Breach Contingency Plan has never been fully activated until now.⁴ It remains to be seen if documentation regarding the positive effects of the breach at Otis Pike will exclude it from closure operations.

Flooding, North Fork, Long Island

When the Long Island Rail Road constructed the train tracks to carry commuters to and from New York City, untold acres of wetlands were filled in the process. This not only fragmented important habitat, but gave the flood waters associated with storm events nowhere to go. This problem is heightened by the fact that there are not enough culverts in the area to divert the flow, and those that are in place are too small. During storms like Sandy, this creates a dam-like circumstance across the entire North Fork in which storm surge waters back up and cause extensive flooding, damaging additional habitat and property. If more and larger culverts are installed to restore the natural hydrologic flow of the area, it will enhance the wetlands that remain as well as the nearshore substrate. This will allow for the restoration of populations of American eel, alewife, river otter and salamanders that are native to the area.

Transition of Native Tree Habitat, North Fork, Long Island

The storm felled many large trees along the roadways and in the suburban neighborhoods of the North Fork area. As with other storms, homeowners and government entities are replacing the felled trees, which are typically large native species such as pines, oaks, elms, sycamores, and beech trees, with smaller ornamentals. This tree replacement process has become a disturbing and continuous trend, and, over time, is completely changing the ecology of the area. Non-native ornamentals drastically reduce the carrying capacity of native insect herbivores and the animals that depend on them.⁵ Since 96% of terrestrial North American birds raise their young on a diet of insect protein, more native trees in a given area means more food and more birds. In addition, the planting of ornamentals changes the overall canopy height, affecting the nesting habitat potential for large birds, including owls, hawks and bald eagles which have recently been re-colonizing in the North Fork.

⁴ "New York District Activates Breach Contingency Plan After Sandy," Gardner, Chris, ACOE Public Affairs, posted on <http://www.nan.usace.army.mil/Media/NewsStories/.aspx>

⁵ "Bringing Nature Home," Tallamy, Doug, 2009.

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Great Gull Island

Located in New York off the Eastern End of Long Island Sound, Great Gull Island was completely breached in two locations by the storm. Additional large sections of beach along the edges of the island, including at both the north and south shores, were washed away. The significant erosion will impact this important habitat, which provides nesting sites for approximately 1600 pairs of federally endangered roseate tern, the largest colony in the Western Hemisphere, as well as 9500 pairs of common tern, a species listed as threatened in New York State.

Manursing Lake

Located in the Edith Reade Sanctuary in Rye, New York, Manursing Lake was the subject of a major two-part restoration project completed in 2011. The first part replaced an outdated, manually operated tidal gate with a more effective, electronically controlled gate that improved tidal flow in and out of the lake and improved its connection to Long Island Sound. The second part restored and created coastal habitat, including a tidal creek, salt marshes and the lake's southern shoreline. Impacts to this area from Sandy are significant. The dunes and vegetation that stood between the Sound and the lake have been destroyed, leaving nothing but 200 feet of field and road to prevent further inundation to the salt marsh and lake. Inundation is likely to occur as a result of normal winter storm activity, but a significant storm event could cut a permanent channel between the two waters. Enormous amounts of sand and rock have been pushed onto the fields and access roads, and sections of the salt marsh have been buried by sand and debris. Portions of the lake shore have eroded, and some cliffs at the north end of the beach have eroded significantly.

Falkner Island

Falkner Island, part of the Stewart McKinney National Wildlife Refuge and located off the coast of Guilford, Connecticut, is renowned as one of the most important nesting grounds for roseate tern on the East Coast. Each year, approximately 260-360 roseate terns and 6000 to 8000 common terns nest on the island. Consisting of only 4.5 acres before Hurricane Sandy, nearly 1/3 of the island was completely lost to the storm.

Beach and Dune Erosion/Lowered Elevation/Salt Marsh Protections

The immense tidal surge caused the overwashing of dunes and significant erosion throughout Long Island Sound. As a result, the elevation of nesting areas has been lowered, rendering them vulnerable to repeated flooding and overwash from the winter storms ahead. This will impact the populations of piping plover, American oystercatcher, least tern and common tern that breed and nest there, as well as migratory shorebirds such as sanderling, semipalmated sandpiper, ruddy turnstone, black-bellied plover and red knot that visit these areas each year.

Dune and/or beach erosion problems have occurred at the following areas:

- Jones Beach, Wantagh, NY
- Orient Beach State Park, Orient, NY

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- Prospect Point and Half Moon Beach, North Hempstead, NY
- Milford Point, Milford, CT
- Sandy Point, Morse Point, West Haven, CT
- Salt Island, off the coast of Westbrook, CT;
- Harkness Memorial State Park (including William A. Niering Natural Area Preserve), Waterford, CT
- Silver Sands State Park, Milford, CT
- Pattagansett Marsh Preserve, East Lyme, CT
- Rocky Neck State Park, East Lyme, CT
- Hattchetts Point Natural Area, Old Lyme, CT

In other areas, the beach and dune erosion has removed protections for adjacent salt marsh habitat, rendering them vulnerable to inundation from winter storms and high tides. These areas include:

- Mansuring Lake, Rye, NY
- Waterford Town Beach, Waterford Pleasure Beach, Waterford, CT
- Pattagansett Marsh Preserve, East Lyme, CT
- Hattchetts Point Natural Area, Old Lyme, CT

New and Moved Habitat

The storm actually moved existing habitat and created new habitat in numerous areas by moving dunes and depositing additional sand. As is the case in New Jersey, the creation of habitat is a plus for beach nesting shorebirds and other shore and migratory species in Long Island Sound, but it has also created a series of new issues that must be addressed. Much of this habitat has been created or moved to areas easily accessed by humans. In addition, it is extremely vulnerable to damage from recovery efforts that are going on right now as towns attempt to replace dunes and shore up their beaches. A stewardship program is necessary to identify new habitat and work with towns and the public to protect it from both recovery efforts and human traffic. This issue has been noted as a potential problem at the following locations:

- Orient Beach State Park, Orient, NY
- Prospect Point and Half Moon Beach, North Hempstead, NY
- Long Beach, Stratford, CT
- Sandy Point Island, West Haven, CT
- Mumford Cove and Bluff Point State Park, Groton, CT
- Harkness Memorial State Park, Waterford, CT
- Griswold Point, Old Lyme, CT
- Meunketesuck, Salt and Duck Islands, Westbrook, CT
- Hamonasset Beach State Park, Madison, CT
- Falkner Island, Guilford, CT
- Morse Point, Milford, CT
- Pleasure Beach, Bridgeport, CT

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- Cockenone Island, Westport, CT
- Greater Norwalk Islands, Great Captains Island, Greenwich, CT

Channel Blockage/Tidal Flow Interference

Resource managers identified numerous circumstances where sand or sediment was pushed into tidal marshes or waterways, blocking the flow and causing other associated impacts. At the Waterford Town Beach and Pleasure Beach, breaches of the barrier dune combined with beach erosion are causing sands to erode into the adjacent estuary of Alewife Cove. This threatens to shift and obstruct the cove's outlet to Long Island Sound. At Rocky Neck State Park in East Lyme, CT, accumulated sand is preventing flow and proper tidal flushing of the Bride Brook channel, one of the largest alewife runs in Connecticut. At the Silver Sands State Park in Milford, extensive amounts of sand have accumulated in the Great Creek tidal marsh. At Harkness Memorial State Park in Waterford, the outlet of Goshen Cove, an estuarine embayment and tidal creek, is currently blocked by sand and sediment. And at Lynde Point in Old Saybrook, the storm pushed a dune into the tidal marsh blocking the flow of a tidal creek. Water is accumulating behind this blockage, transforming the tidal marsh into a freshwater swamp.

Damage to Eel Grass

Although no specific sites were identified, resource managers at a recent Long Island Sound Study Habitat Restoration Workgroup Meeting identified damage to eel grass, mainly from being buried by eroding dunes, as one of their major concerns. The need for a full assessment of the impacts of Sandy on eelgrass was also identified as a concern in Delaware and New Jersey, including by the Barnegat Bay Partnership. An incident of significant eelgrass damage was reported at Ninigret Pond in Charlestown, Rhode Island. According to one resource manager, bales of eelgrass were piled up on land deeper than he has ever seen it before, with piles ranging from 6 to 18 inches deep. He does not know the implications of this going forward and was unable to determine at this time whether the sediment and substrate that support the eelgrass beds was damaged.

Issues in Long Island Sound, Generally

At the Long Island Sound Study Habitat Restoration Workgroup Meeting held on December 4, a list of ecological concerns was compiled that includes the following:

- Extensive wrack mats are smothering habitat and have the potential to create invasive species problems
- Large downed trees created holes in the forest canopy, creating the opportunity for invasive species to move in (especially in New York City area)
- Water quality concerns associated with CSOs
- Impacts on habitat for listed and sensitive species (roseate tern, eel grass burial from eroding dunes)
- Habitat conversion
- Vulnerability leading to knee-jerk rebuilding actions

Geospatial Change Data

To develop a real scale assessment of physical damage to critical coastal habitats, this component of the project employed pre- and post-storm digital aerial photographic imagery to assess and classify the severity of the physical impact to coastal beach, dune, salt marsh and maritime forest habitats. The post-storm imagery was made available by overflights conducted by the U.S. Geological Survey and NOAA in geo-corrected format allowing for comparison with pre-storm imagery.⁶ This imagery is currently available for the New Jersey Atlantic coast, Raritan Bay, New York Harbor, Jamaica Bay and large sections of the Long Island coast of both New York and Connecticut. Although Delaware Bay was not included in the overflights, oblique aerial imagery for this area was collected by the Civil Air Patrol and coordinated by the Federal Emergency Management Agency, as well as by Art Trembanis of the University of Delaware and Andrew Coburn of Western Carolina University.⁷

The pre- and post-storm imagery was put into ArcGis for visual interpretation and damage assessment. The broader project area was gridded into individual 2500' x 2500' image tiles and classified as to the dominant natural habitat. The coarse scale assessment of the severity of damage to individual areas is based upon the following rating scheme: No Damage, Minimal Damage (low), Moderate Damage and Severe Damage.

Students from the Rutgers University Introduction to Aerial Photo Interpretation course undertook the initial visual interpretation. This initial interpretation then underwent two rounds of further quality control and editing by skilled image interpreters.

The classification scheme for the different categories is demonstrated through the following examples:

Beach/Dune

- No Damage – no discernable change
- Minimal (low) Damage – thinning of beach (>50'), debris deposited
- Moderate Damage – strong evidence of overwash; loss of dune vegetation; moderate thinning of beach (50-100')
- High Damage – new overwash channels opened connecting ocean to bay; major loss of dune vegetation leaving largely barren areas, major thinning or migration of beach (>100')

⁶ <http://storms.ngs.noaa.gov/storms/sandy>

⁷ <http://fema.apps.esri.com/checkyourhome>; <http://psds.shutterfly.com/hurricanesandy>;
<https://picasaweb.google.com/psdspix>

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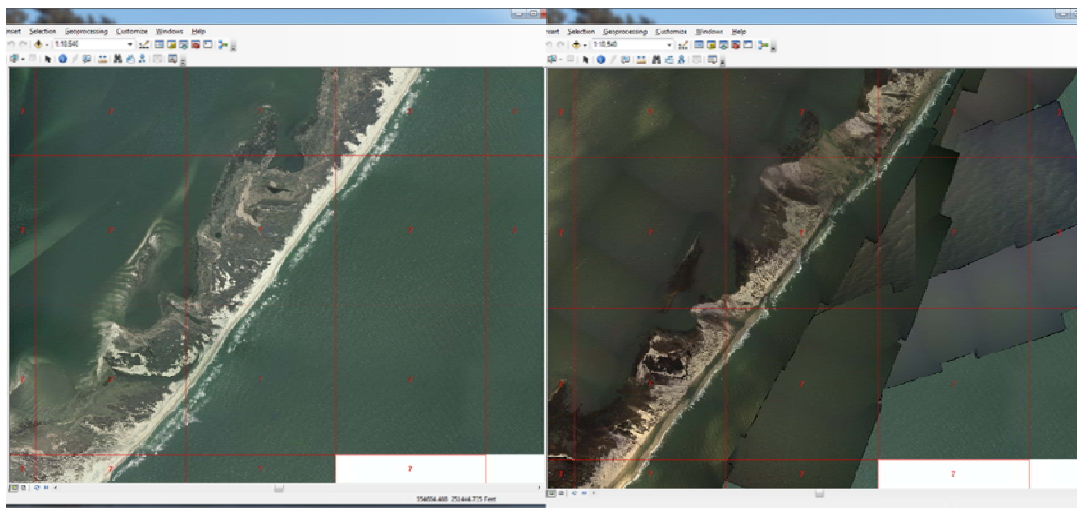


Figure 1. Example of Pre- vs. Post-Imagery for the Holgate section of Forsythe National Wildlife Refuge, New Jersey, showing High Impact with active overwash channels and several hundred feet of landward migration of the barrier island.

Tidal Marsh

- No Damage
- Minimal (low) Damage – evidence of new wrack and debris deposited
- Moderate Damage – minor erosion/loss of marsh edge; small areas of sand deposited; medium size areas of wrack/debris
- High Damage – major erosion/loss of bayward marsh edge; large areas of sand & wrack deposits within marsh proper; re-arrangement of tidal creek channels

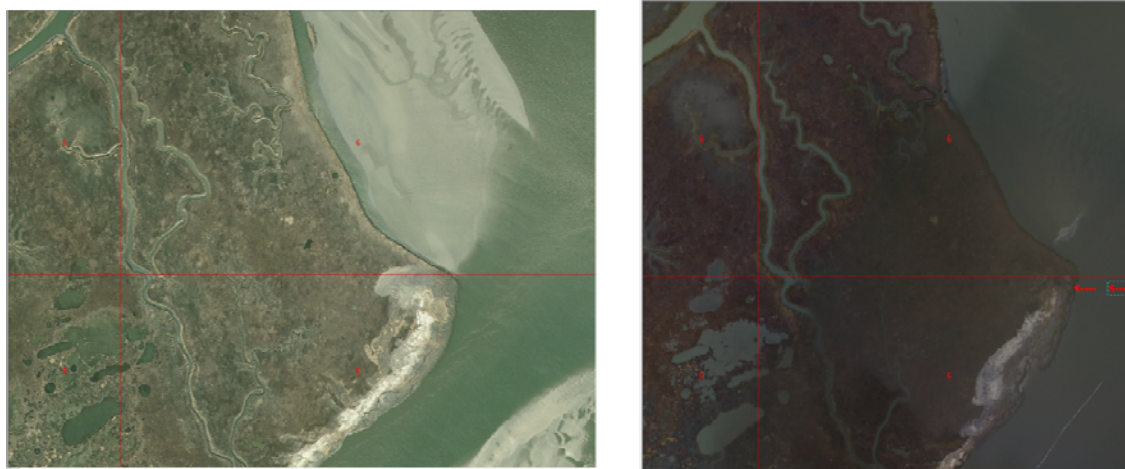


Figure 2. Example of Pre- vs. Post-Imagery for the Brigantine section of Forsythe NWR, NJ showing High Impact with active overwash of sand onto the salt marsh and several hundred feet of landward migration of the marsh edge.

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Maritime Forest

- No Damage
- Minimal (low) Damage – evidence of a few fallen trees (5%)
- Moderate Damage – 5-25% trees fallen creating numerous small canopy gaps <1 acre in size
- High Damage – >25% of trees fallen creating large (i.e., > 1 acre in size) canopy



Figure 3. Example of Pre- vs. Post-Imagery for the Brigantine section of Forsythe NWR, NJ showing Moderate Impact to maritime forest areas with numerous small canopy gaps.

Geospatial Imagery Results

The following is a narrative summary of the geospatial imaging portion of the project, identifying specific “hotspots” of damage, as well as areas that fared well during the storm. After the narrative is Table 1, a summary of damage in the entire project area, presented as the percentage of habitat in each geographic zone according to damage severity class. Following Table 1 several figures are presented depicting the distribution of impacts for all habitat categories through geospatial imaging for the New Jersey Atlantic Coast (Figure 4); Raritan Bay, Sandy Hook Bay, Lower New York Bay and Jamaica Bay (Figure 5); Long Island Sound (Figure 6); and Delaware Bay (Figure 7). Additional pre- and post- storm images and impact maps can be viewed at the CRSSA website at <http://www.crssa.rutgers.edu/projects/coastal/sandy/>. The imagery results as describe below and depicted in the maps and images, correlate closely with the information obtained during the survey portion of this project.

Beach and Dune

As might be expected, the remotely sensed damage assessment suggests that beach and dune habitats experienced a much higher degree of physical damage than coastal marshes or maritime forests. While large areas experienced Low to Moderate levels of damage, High Damage, as defined in the methods above, were comparatively scarce.

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Beach and dune habitat along the New Jersey Atlantic coastline was particularly hard hit with approximately 65% experiencing Moderate Damage and a few areas showing High Damage (**Table 1**). The “natural” beaches of Little Beach and Holgate, part of the Forsythe National Wildlife Refuge, experienced extensive overwash and erosion resulting in significant landward migration (**Figure 4**). Stone Harbor Point in Cape May County, with its low profile and lack of dunes, experienced extensive overwash. The bayside of Sandy Hook and the shorelines of Raritan and Jamaica Bays experienced Moderate to Low levels of impact (**Figure 5**).

Most of the shoreline along Long Island Sound experienced Low Damage with a few areas of Moderate Damage generally associated with exposed points and islands such as Hammonasset Point and the Norwalk Islands in Connecticut, and inlets such as Oyster Bay and Northport Bay, in New York (**Figure 6**). Due to the comparative scarcity of imagery over Delaware Bay, this area was not as systematically surveyed as the other study areas. Interpretation of the available imagery suggests that approximately 30% of Delaware Bay beaches were Moderately to Highly impacted, with a few hotspots of damage along the southern shoreline on the Delaware side and the northern shoreline on the New Jersey side, such as East Point Lighthouse (**Figure 7**).

Salt Marsh

Coastal salt marshes were impacted to a much lesser degree showing much higher resistance to storm surge (**Table 1**). Only a few marsh areas received High Damage levels due to storm-related erosion and these hotspots were located primarily along the New Jersey coast near the head of major inlets. For example, marsh islands in Forsythe National Wildlife Refuge and the Tuckerton Wildlife Management Area located west of Brigantine and Little Egg Harbor Inlet were hotspots of High impact (**Figure 4**). Approximately 14 to 17% of New Jersey coast, Long Island Sound and NY Harbor-Raritan-Jamaica Bay marshes experienced Moderate Damage levels while 54 to 64% experienced Low levels of damage (**Figures 5, 6**). Wrack deposits were visible in many back-bay marsh areas, often at the marsh/upland forest edge. This was especially evident in Jamaica Bay. The analysis may underestimate the amount of wrack deposit, especially where obscured by dense *Phragmites* reed stands or maritime shrubs and scrub.

Maritime Forest

Damage to maritime or coastal zone forests was more difficult to assess, but a number of locations did show blow-down of trees and canopy gaps. However, a comparatively smaller percentage of the area was assessed at Moderate Damage, 9%, 2% and 1% for the New Jersey shore, NY Harbor and Long Island Sound study areas respectively, and Low Damage, 26%, 22% and 33% for the New Jersey shore, NY Harbor and Long Island Sound study areas respectively (**Table 1**). Along the New Jersey coast, some of the hotspots of damage occurred in the Gunning River areas of the Forsythe National Wildlife Refuge and at Cheesequake Park.

The results for each category of habitat in the project area are summarized in Table 1.

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	Land Cover	Total #	Impact							
			None	%	Low	%	Moderate	%	High	%
Delaware Bay	Beach/Dune	56	18	32	21	38	14	25	3	5
	Marsh	4			2	50			2	50
	Forest	1	1	100						
Jersey shore	Beach/Dune	391	24	6	146	37	167	43	54	14
	Marsh	725	152	21	464	64	99	14	10	1
	Forest	368	202	55	134	36	32	9	0	0
NY Harbor Raritan B. Jamaica B.	Beach/Dune	151	13	9	100	66	37	25	1	1
	Marsh	120	23	19	77	64	20	17	0	0
	Forest	54	41	76	12	22	1	2	0	0
Long Island Sound	Beach/Dune	502	65	13	294	59	143	28	0	0
	Marsh	246	68	28	138	56	40	16	0	0
	Forest	310	205	66	102	33	3	1	0	0

Table 1- Summary of Hurricane Sandy damage assessment for selected natural habitats in the Mid-Atlantic coastal region. The # represents the number of 2500' x 2500' tiles in each category. The % represents the percentage of the habitat in that geographic zone by damage severity class.

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HURRICANE SANDY RAPID ASSESSMENT
New Jersey Atlantic Coast

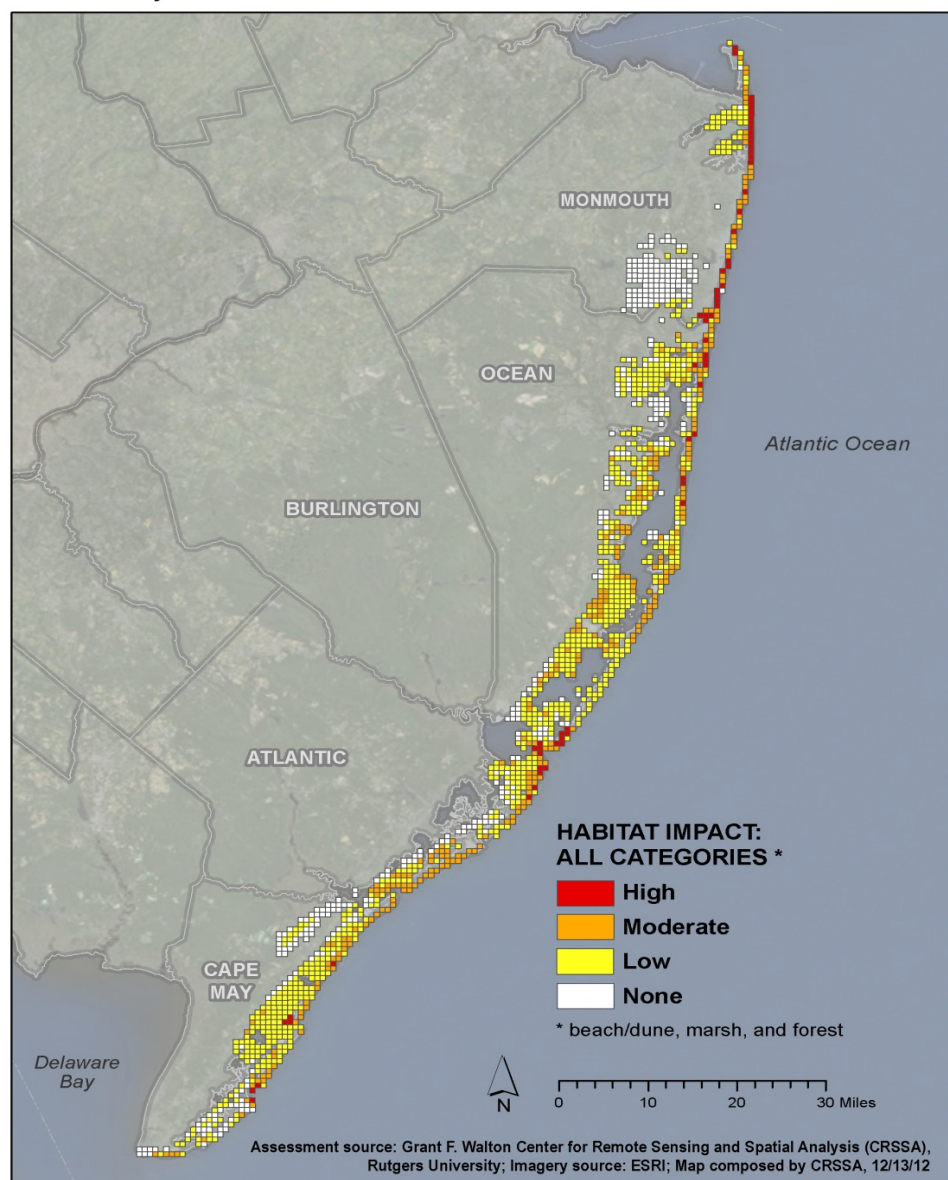


Figure 4. New Jersey Atlantic shoreline study area: map of Hurricane Sandy Damage Assessment for all three categories of habitat dune/beach, tidal marsh and maritime forest.

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HURRICANE SANDY RAPID ASSESSMENT

Raritan Bay, Sandy Hook Bay, Lower New York Bay, Jamaica Bay

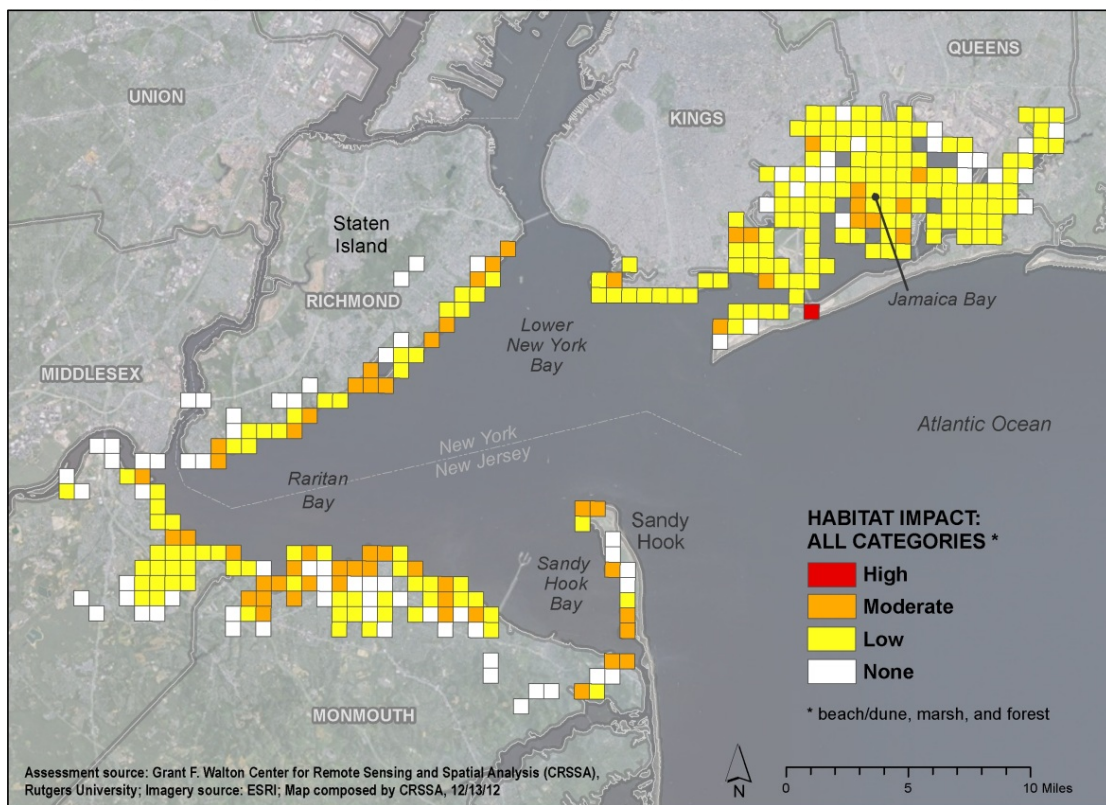


Figure 5. New York Harbor- Raritan-Jamaica Bays study area: map of Hurricane Sandy Damage Assessment for all three categories of habitat dune/beach, tidal marsh and maritime forest.

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HURRICANE SANDY RAPID ASSESSMENT Long Island Sound

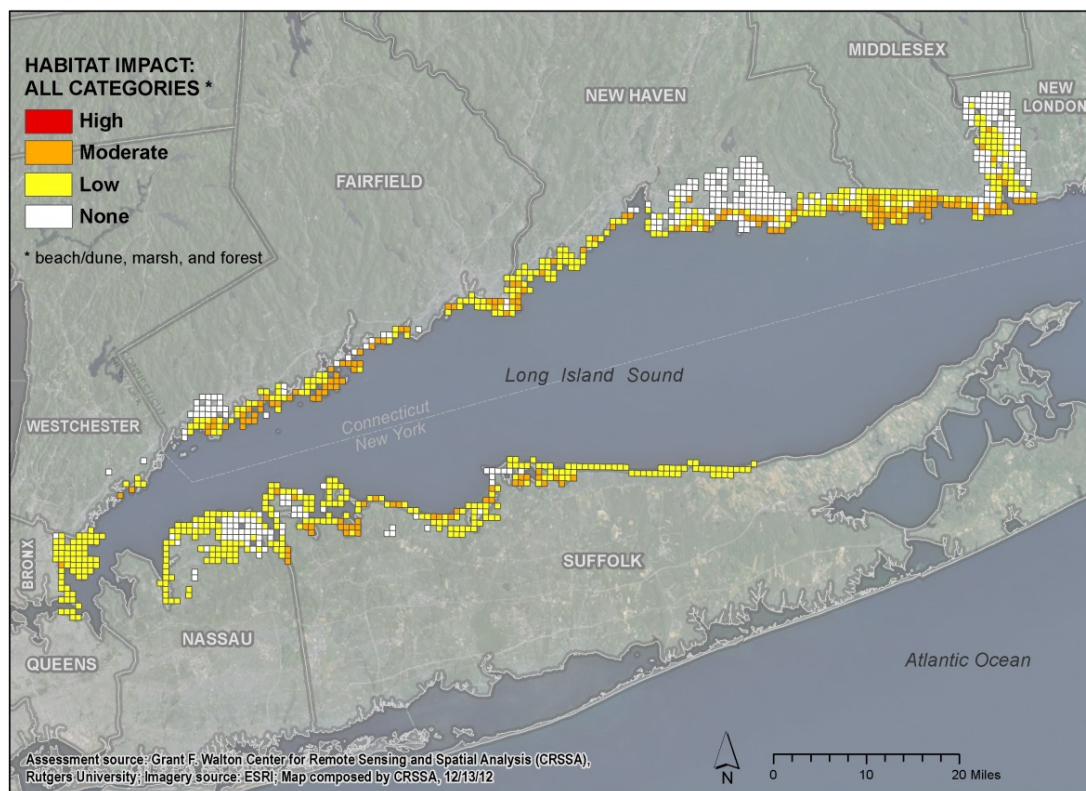


Figure 6. Long Island Sound study area: map of Hurricane Sandy Damage Assessment for all three categories of habitat dune/beach, tidal marsh and maritime forest.

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HURRICANE SANDY RAPID ASSESSMENT Delaware Bay

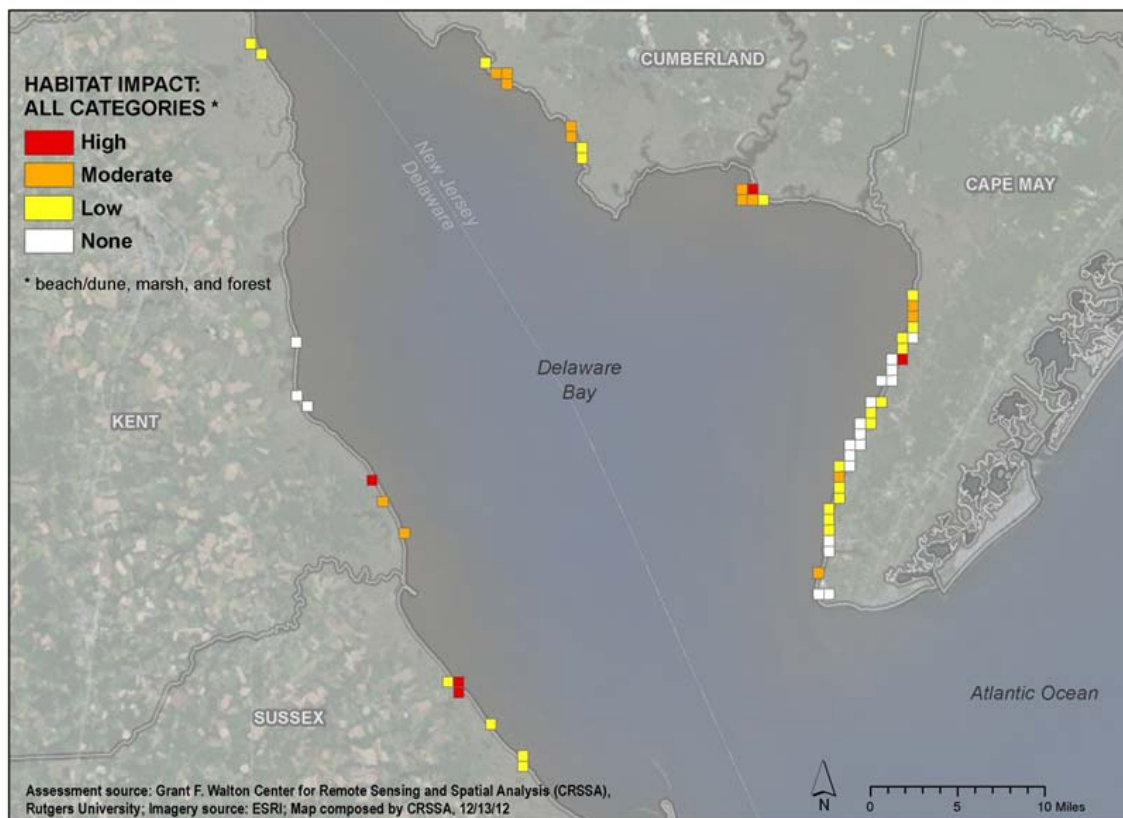


Figure 7. Delaware Bay study area: map of Hurricane Sandy Damage Assessment for all three categories of habitat dune/beach, tidal marsh and maritime forest.

Impact Trends

The data collected clearly demonstrates certain impact trends, meaning problems or issues that were noted by resource managers throughout the project area.

Impact Trend 1 – Beach and Dune Erosion /Destruction of Habitat

The most significant and consistent impact reported by the resource managers was beach erosion caused by the extreme storm surge and wave action associated with Sandy. This was the case at several Delaware Bay beaches in New Jersey, including Reeds Beach to Pierce's Point in Cape May County, some of the most important spawning habitat for horseshoe crabs, where 2 to 3 feet of sand were lost and remaining sand was pushed out of reach of spawning crabs. This was also the case at the north end of Corson's Inlet State Park near Ocean City, New Jersey, where the ocean breached a section of dunes flooding the interior and significantly damaging the already seriously eroded piping plover habitat. Similar incidents were reported at Forsythe National Wildlife Refuge in a beach area that serves as piping plover habitat but cannot be easily restored due to its "wilderness" status.

In Jamaica Bay, the devastation continued, as the storm surge washed away the strip of land that separated the East and West Ponds from the Bay, transforming the freshwater ponds into saltwater inlets. In Long Island Sound, two of the most important nesting grounds for the federally endangered roseate tern were badly damaged. Great Gull Island in New York was breached in two places and Falkner Island off the coast of Connecticut, lost nearly 1/3 of its entire land mass. Similarly, Griswold Point in Old Lyme was hit by the storm surge with such force that it is no longer attached to the mainland.

The erosion impacts described by the resource managers through the survey process are consistent with the geospatial data collected by CRSSA. That data demonstrates that 65% of New Jersey's beach and dune habitat suffered moderate to high damage, and that more than 50% of the beach and dune habitat in the Hudson/Raritan Jamaica Bay region and Long Island Sound suffered a similar fate.

Impact Trend 2 – Beach and Dune Erosion/Lower Elevations

The immense storm surge and resultant beach and dune erosion created another problem by lowering the elevation of beaches throughout the project area. The lower elevations have rendered the already compromised beaches vulnerable to additional impacts from high or neap tide flooding as well as from storm surges and wave action that will inevitably come with winter storms. Additional nesting habitat for shorebirds, such as the Piping Plover will be lost, and the nests that are established in the remaining habitat will be subjected to flooding. This low elevation problem was specifically observed at beaches at Stone Harbor and Avalon in New Jersey, Great Gull Island and Manursing Lake in New York and Milford Point and Sandy Point in Connecticut, to name just a few. In addition, the inlets of Southern New Jersey, including Hereford Inlet, Townsend's Inlet, Corson's Inlet, Great Egg Harbor Inlet and Brigantine Inlet were particularly hard hit by this phenomenon.

Impact Trend 3 – New and Moved Habitat

Throughout the project area, the storm surge from Sandy created new habitat by adding sand to beaches and existing barrier and spoil islands, and moved other habitat by pushing sand and dunes westward. While the creation of habitat is a plus for beach nesting shorebirds and other shore and migratory species, it has also created a series of new problems that must be addressed and that were raised by resource managers in every state surveyed. Much of this habitat has been created or moved to areas easily and heavily accessed by humans. In addition, it is not known as habitat to the municipalities and other entities engaged in recovery efforts and is extremely vulnerable to damage from the bulldozing and moving of sand that is occurring right now.

Impact Trend 4 - Deposits of Debris/Wrack Line

Another significant trend associated with the storm surge is the amount of debris, both organic and manmade, deposited in marshes and other important habitats. In Forsythe National Wildlife Refuge, this debris or wrack line extends along the entire 22-acres of Service-owned property at the marsh/forest interface. In the days immediately following the storm, Forsythe personnel counted more than 100 boats, numerous hot tubs and entire houses among this debris, adding the potential for gross contamination from oil and gas leaks to their concerns.

In Cheesequake State Park, located adjacent to the Raritan Bay, there is a 4 to 6 foot deep layer of organic tidal debris in the marshes comprised mostly of reeds and other vegetation, combined with tires, duck blinds and other man-made structures. Estimated at approximately 100,000 tons, this debris layer will stunt the growth of vegetation impacting not only the crabs that dwell there, but the kingfishers, herons and gulls that feed upon them.

Debris was also noted as a problem at Prall's Island in Staten Island, at the Jamaica Bay Salt Marsh Islands and in the coastal salt marshes of the McKinney National Wildlife Refuge. The Long Island Sound Study Habitat Restoration Workgroup identified the extensive wrack mats throughout the Sound as a significant post-Sandy impact, noting that they are smothering existing habitat and creating the potential for invasive species to move in.

Impact Trend 5 – Saltwater Inundation

Saltwater inundation was a serious problem noted by numerous resource managers, including in the following circumstances:

- **Prime Hook National Wildlife Refuge, DE** – Breaches to dunes separating the barrier island from the fresh-water marsh area led to an inundation of the marsh with sea water. There are some freshwater or brackish areas left, but most of the

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marsh has been converted to saltwater and will be unable to sustain the ducks and other bird species that utilize the freshwater marsh.

- **Forsythe National Wildlife Refuge, NJ** – The storm surge hit a dirt and gravel dike with such force that it burst, causing saltwater from the bay to inundate a freshwater pond that served as habitat for American black duck and Atlantic Brant.
- **Cheesequake State Park, NJ** – The tremendous tidal surge in this area caused significant saltwater intrusion into the cedar swamp populated by Atlantic white cedars. In addition, there was significant saltwater intrusion into Hooks Creek Lake, a freshwater lake that is habitat for a variety of fish that were killed off by the high salinity levels.
- **Outerbridge Crossing/Meadowlands, NY/NJ** – It is currently unknown whether flooding and saltwater inundation in this area impacted the habitat of a new species of Leopard Frog discovered in Staten Island in 2009, subsequently found in the Meadowlands and recently confirmed through DNA testing to be a previously unidentified species.
- **Jamaica Bay Wildlife Refuge, NY** – The East and West Ponds, two freshwater ponds that provide habitat for numerous species, including several species of duck and snapping turtles, were breached and the land that separated the ponds from the Bay was wiped out, transforming them into saltwater inlets of the Bay.

Impact Trend 6 – Impacts to Prey Communities

Inundation of tidal marshes and intertidal sediment/substrate was prevalent throughout the coastal area of New Jersey, New York and Connecticut, with some areas in New Jersey reportedly under water for more than five days. Although many of the marsh grasses survived and even fared well, the same cannot be said for the invertebrates and small mammals, such as rodents and voles, that inhabit these areas. The small mammal population has been reportedly “wiped out” in many areas, creating a food shortage for the northern harriers that prey upon them. The impacts and implications of the storm to invertebrates has been described as a “big unknown” but could be devastating to the long-legged wading birds that prey upon this community, including great blue heron, black-crowned night heron, yellow crowned night heron, snowy egret, great egret, American bittern, least bittern, glossy ibis and white ibis. The need to further assess the impacts to these communities and to the species that depend upon them as a food source was noted as an important source of concern by resource managers in Southern New Jersey, the Raritan Bay area of New Jersey, New York and Connecticut.

Impact Trend 7 – Opportunities for Invasive Species

Hurricane Sandy created two specific opportunities for invasive species. One was created in areas where a large number of trees were felled. Specific concerns over this problem were noted at Cheesequake State Park, in the Raritan Bay area of New Jersey, where more than 300 trees were lost, including 100-year old oaks and numerous Atlantic White Cedars. Similar concerns were raised about Soundview Park in the Bronx River Forest, where the loss of trees opened holes in the forest canopy, and at the nearby New York Botanical Gardens, where more than 200 trees were downed. The second opportunity exists in areas where intertidal and nearshore plant species were destroyed or damaged. This was noted as a potential problem throughout Long Island Sound, where extensive wrack mats line the shores and are smothering intertidal and nearshore habitat. This may also become a problem in parts of Southern New Jersey, including at the Forsythe National Wildlife Refuge, where Sandy deposited a 22-mile long wrack line at the marsh/forest interface.

The CRSAA geospatial data provides additional insight regarding areas of concern with respect to invasive species. These include the areas in which the imaging demonstrated tree blow down and canopy gaps, such as at the Gunning River area of the Forsythe National Wildlife Refuge and Cheesequake State Park in New Jersey. They also include the marsh islands in Forsythe, the Tuckerton Wildlife Management Area west of Brigantine and the Little Egg Harbor Inlet, all hotspots of marsh impact in New Jersey, as well as Jamaica Bay, where wrack deposits in the marshes were prevalent.

Impact Trend 8 – Industrial Contamination

Significant contamination to waterways occurred during the storm from the flooding of industrial facilities located adjacent to waterways and from antiquated and inoperable sewage treatment plants. Some notable contamination events include the following:

- As the storm surge flooded the banks of the Arthur Kill, several bulk fuel tanks were damaged, releasing nearly 378,000 gallons of diesel fuel into the water. Oil contamination from this and two smaller oil spills in the area was far reaching, and oil coated the marshes along the shores of Staten Island and New Jersey, the birds and marshes of Prall's Island, the birds, marshes and grasslands of the Outerbridge Crossing area and Meadowlands - the known habitat of a recently discovered new species of Leopard Frog - and the marshes and waters of various creeks and tributaries, including Woodbridge Creek, Smith Creek Inlet, and Rum Creek in New Jersey.
- Flooded by the storm surge and rendered inoperable due to power outages, several major sewage treatment plants released raw or partially treated sewage into local waterways. The Passaic Valley Sewerage Commission treatment plant released an estimated 400 to 500 million gallons of untreated wastewater into the Newark Bay for several days, with the total amount discharged estimated to be in the billions of gallons. The Middlesex County Utilities Authority treatment plant in Sayreville, New Jersey released about 300 million gallons per day into the Raritan

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River for an unknown period of days. State officials issued advisories for the waters of the Hudson, Raritan, Passaic and Hackensack Rivers, Newark and Raritan Bays and the Arthur Kill and the Kill van Kull.

- In Bridgeport, Connecticut, 15 to 20 million gallons of partially treated sewage went into Long Island Sound when the city's two treatment plants were inundated by tidal surges. In Ledyard, a backup generator for the town's treatment plant failed causing officials to pump approximately 60,000 gallons of raw sewage into Seth Williams Brook. Similar problems and releases were reported in Branford, East Lyme, Fairfield, Greenwich, New Hartford and New Haven.⁸

Impact Trend 9 – Destruction of Manmade Structures

Many of the problems experienced were the result of the failure of man-made structures in the face of the storm, including the following:

- The saltwater impoundments at the Heislerville Wildlife Management Area in Cumberland County, New Jersey, were decimated during the storm. NJ DEP Land Management personnel have restored the dikes temporarily, but additional work will be needed for proper restoration.
- The saltwater inundation of the freshwater pond at Forsythe National Wildlife Refuge was the result of a dirt and gravel dike that burst from the force of the storm surge.
- The saltwater intrusion at the freshwater lake at Cheesequake State Park is exacerbated by the fact that the dam at the lake area with a culvert underneath has been compromised by the storm and the outflow pipe is broken. In addition, the inflow pipe from Landing Creek to Perrine Pond was damaged.
- Too few and too small, the stormwater culverts placed in and around the North Fork of Long Island were overwhelmed by the storm surge, causing massive inland flooding in this area.
- An earthen berm at Sunken Meadow State Park adjacent to Sunken Meadow Creek in Connecticut was wiped out by the storm. This turned out to be a positive event in that, in accordance with the work of the Connecticut Fund for the Environment/Save the Sound, the berm was scheduled to be removed to restore 100 acres of salt marsh as part of an anadromous fish project.

⁸ "Connecticut Treatment Plants Discharging Raw Sewage," Collins, Dave, Associated Press, October 30, 2012, posted on Boston.com.

Impact Trend 10 – The Success of “Natural” Systems

On numerous occasions during the survey, resource managers were quick to point out that, despite the destruction that occurred, several natural features remained intact. These include dunes, bluffs, marshes, barrier and bay islands, many of which are not purely natural in that they were created or enhanced through restoration projects. Regardless of their origins, in many cases these features protected not only wildlife habitat, but park facilities and other commercial and residential structures, providing added incentive to expand their use for flood and storm protection. Below are just a few examples of the resilience of these features.

Dunes

As is documented in this report, dunes throughout the project area were breached, flattened, washed away or pushed westward, leaving the beaches and marshes they protect vulnerable to impacts from future storms and surges. However, without them, the damage would have been much worse and, in many areas, dunes were credited with major saves. At the Cape May Wildlife Refuge, a new road constructed last year at tremendous cost was untouched by either water or sand due to the dunes standing between it and the water. At Seven Presidents Oceanfront Park in Long Branch, New Jersey, the combination of a wide beach, well-established dune system and a substantial bluff protected the boardwalk and pavilion behind them. At the Bayshore Waterfront Park, which experienced a 7 foot tidal surge, the recently reconstructed dune between the upland portion of the park and Sandy Hook Bay protected the historic Cedric Wilson House. The unprotected Monmouth Marina adjacent to the park was completely destroyed by the surge and may be abandoned rather than rebuilt. When the state-of-the-art Wildwoods Convention Center was built in 2002, an expansive sand dune was put in place at the same time to serve as a natural barrier to tidal water damage. This sand dune is being cited as the reason that, despite widespread destruction in the area, the Center was untouched by Sandy. And, in Seaside Park, the dunes are credited with protecting most of the ocean front homes standing behind them from any significant damage.

Natural dune systems, such as those at Barnegat Light, provided a strong defense against the ocean storm surge and significantly limited damage to property and infrastructure. Furthermore, some locations, such as Avalon Dunes, which have a natural beach, in part because they are managed for nesting shorebirds, and utilize a less intensive beach maintenance regimen (i.e., less mechanical beach raking and sand transfers), appear to have been more resilient than nearby or adjacent beaches that were subject to more heavy maintenance activities.

Marshes/Meadows

Situated at the southern tip of the Cape May Peninsula, the South Cape May Meadows Preserve includes over 200 acres of critical habitat comprised of dunes, freshwater wetlands, meadows, ponds and a mile of beach. The Meadows was the subject of a major restoration project in 2004 to return the area to its more natural state to benefit wildlife and add protection for local communities from coastal flooding. The project included

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beach restoration, building up of the dunes, restoration of freshwater flow through the wetland, control of invasive species, the creation of shorebird foraging and nesting areas and the installation of water control structures. The Meadows fared very well during the storm and achieved its goal of flood protection. Although water from the surge reached the dunes and the beach was reshaped, the dunes remained intact, as did the salt marshes. During the storm, the City of Cape May suffered a broken storm pipe and directed the resultant overflow into the Meadows. According to resource managers in the area, the Meadows handled the extra water well.

In Jersey City, New Jersey, Lincoln Park covers 270 acres of recreation fields and natural areas and was the site of a major restoration project that began in 2010 and was recently completed. The project restored 42 acres of wetland, stream and salt marsh habitat on the Hackensack River to create new habitat for birds and fish and to provide coastline support against climate change. The wetland restoration included the clearing of illegally dumped debris, excavation of over 250,000 cubic yards of material, adding 4,000 feet of new inter-tidal channels and connecting the pond to the Hackensack River to create a functioning tidal wetland. According to resource managers who visited the site after Sandy, the area experienced “zero damage.”

Salt Marsh Islands

The Jamaica Bay Salt Marsh Islands are the result of a major restoration effort that began in 2005 and continues to this day. Located in the heart of a complex urban ecosystem, the five islands are constructed from dredged spoils from the deepening of major shipping channels. Three of the islands have been completed and planted, and two have been constructed and are scheduled for planting in 2013. Visits to the islands post-Sandy found that, other than the deposit of significant amounts of debris, there was no damage to existing plantings and no significant shift in sand placement on the islands, including to the two most recently established sand-only islands. A resource manager involved in the project noted that the islands “did exactly what they were supposed to do” by absorbing the energy of the waves and storm surge.

Impact Trend 11 – Concern Regarding New and Ineffective Protection Efforts

All of the resource managers expressed their concerns regarding the various plans to implement protective measures along the coast that may be ineffective and even harmful in the face of future storm events. Proposals being discussed range from creating dunes in areas where they cannot be sustained, to the development of structural “solutions” such as sea walls, tide gates and flood gates. However, this discussion must begin with or at least include an understanding of the mechanics and effectiveness of more natural approaches, such as the restoration or creation of salt marshes, barrier and bay islands and properly placed dynamic dune systems

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Impact Trend 12 – Common Data Gaps

Resource managers agreed that, while much data has been collected, additional information must be obtained regarding impacts to the following habitats and any the secondary impacts they might cause:

- Eelgrass
- Intertidal Substrate/Sediment
- Intertidal and nearshore invertebrate and small mammal communities and the species they support
- Species adjustments to newly created and moved habitats
- Coastal Forests
- Shellfish Beds
- Essential Fish Habitat

Recommendations – Priority Projects

Based on the information gathered to date, including, but not limited to the priority project summaries compiled in Exhibit 3, the following represent just a sample of the high-priority remediation opportunities.

1. Prime Hook National Wildlife Refuge, Milton, Delaware

The storm caused significant breaches to dunes that separate the barrier island from an impounded freshwater marsh area. While there are some freshwater and brackish marsh areas remaining, they are minimal as most of it has been inundated and converted to saltwater. As a result, the marsh will not be able to sustain the species of ducks and other fresh-water dependent birds that consistently utilize the area. This is an ongoing problem, as previous breaches have occurred beginning with a storm in 2008 and continuing with several storms thereafter, but Sandy caused the breach to widen significantly and increased the inundation. The numbers of waterfowl on site have dropped significantly since 2008. Without a permanent solution to this problem, the increase in storm activity and surges combined with sea level rise are such that the freshwater marsh area is simply not sustainable. Remediation would entail studying the issue to determine if a more permanent, durable and feasible solution is available. Costs associated with this remediation are still being assessed. According to the Interim Assessment Report prepared by Manomet,⁹ costs to repair the dunes to restabilize the marsh impoundment, stabilize eroded beach areas and remove debris that is on site, are an estimated 2 million dollars. This does not include a study to determine whether a solution to this ongoing problem exists.

⁹ Hurricane Sandy Rapid Assessment Interim Report, Created by the Atlantic Flyway Shorebird Business Strategy Planning Team, November 2012.

2. Delaware Bay Horseshoe Crab Spawning Beaches Cape May County, Cumberland County, New Jersey

This site actually encompasses several beaches along the Delaware Bay in New Jersey extending from Reed's Beach to Pierce's Point in Cape May County, and Moore's Beach in Cumberland County. These areas serve as critical spawning habitat for horseshoe crabs which, in turn, serve as a food source for the red knot, an important shore bird proposed for inclusion on the Federal Endangered Species List. There was a loss of 2 to 3 feet of sand on all of these beaches. The force of the storm pushed most of this sand well above the normal high tide line and out of reach of spawning crabs. The portions of beaches that did remain are covered with debris, including chunks of asphalt and bricks strewn throughout the substrate, which will have a significant impact upon crab spawning by negating their ability to dig in to lay eggs. In addition, larger debris such as concrete pipes, slabs and pilings, creates impingement hazards and will further hamper or prevent spawning. Costs for debris/rubble removal and beach replenishment from Reed's Beach to Pierce's Point are estimated at \$10 million dollars. Costs for debris/rubble removal and beach restoration at Moore's Beach are estimated at \$300,000.

3. Forsythe National Wildlife Refuge, Galloway Township, New Jersey

Sandy caused several problems at Forsythe, including the following:

- A debris field was created between the marsh/forest interface that extends along the entire 22 miles of Service-owned property and includes at least 100 boats, houses and other large items. Managers are concerned that there will be gross contamination from gas and oil leaks, among other things. They are also concerned that the habitat will be destroyed by attempts to remove this debris.
- Barrier Beach dunes were breached and the southern tip of Holgate suffered major erosion as a result. This is a Piping plover nesting area but it is also designated as a "wilderness" so beach restoration or habitat manipulation cannot be implemented without the proper approvals.
- The storm surge hit a dirt and gravel dike with such force that it burst, causing salt water from the bay to inundate a freshwater pond that serves as habitat for American black duck and Atlantic brant. Providing refuge for these two species was one of the main purposes for Forsythe's establishment.
- Wildlife drive that goes around the impoundments to, among other places, public wildlife viewing areas, is washed out. There is also damage to the internal cross dikes. DOT may provide assistance but only for the public portions of the impoundments.

Assistance with removal of the debris field, in particular, the boats that are a potential source of contamination to the marsh, should be undertaken immediately. Costs associated with remediation of these issues are still being assessed and communications

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are ongoing in an effort to secure equipment to remove the boats and other large debris from the wrack line without causing damage to the marshes.

4. Cheesequake State Park, Matawan, New Jersey

Cheesequake suffered several different types of damage from Sandy, including the loss of over 300 trees, changing the park aesthetic and creating a void that has the potential to be filled by invasive/nuisance species. There is a 4 to 6 foot deep layer of organic tidal debris in the marshes comprised mostly of reeds and other vegetation, combined with tires, duck blinds and other man-made structures. Estimated to weigh approximately 100,000 tons, this debris layer will stunt the growth of vegetation impacting not only the crabs that dwell there, but the kingfishers, herons and gulls that feed upon them. Several vernal pools in the lowland forest that serve as prime habitat for frogs, toads and salamanders were destroyed by the storm surge and there was significant saltwater intrusion into Hooks Creek Lake, a freshwater lake that is habitat for a variety of fish that were killed off by the high salinity levels. The problems at Hooks Creek Lake are exacerbated by the fact that the dam at the lake and its associated culvert and outflow pipe has been compromised by the storm. In addition, the inflow pipe from Landing Creek to Perrine Pond was damaged.

The Superintendent of Cheesequake Park submitted four priority project summaries, requesting funds to restore two osprey nesting platforms that were knocked over by the storm (\$4,500); rebuild the vernal pools in the lowland forest (\$9,500); repair the damage to the outflow pipe at Hooks Creek Lake (\$25,000); and restock Hooks Creek Lake with native fish such as bass, catfish, sunfish, carp and crappie, that were killed off by the saltwater inundation (\$3,500).

5. Otis Pike Wilderness Area, Great South Bay, Long Islands, New York

The storm surge caused a breach in the barrier island at Otis Pike, the only federally-designated wilderness area in New York State. Resource managers familiar with the area consider the breach to be an opportunity for species recovery, including for hard clams, eelgrass, bay scallops, American eel and associated fish and waterfowl. However, breaches in New York's barrier islands are subject to immediate closure pursuant to a Breach Contingency Plan developed by the U.S. Army Corps of Engineers in the mid-1990s after a series of storms eroded the barrier islands in Westhampton. The Breach Contingency Plan has never been fully activated until now and it is unknown if documentation regarding the positive effects of the breach at Otis Pike will exclude it from closure operations. The Nature Conservancy Long Island is seeking \$100,000 to conduct such a study and provide evidence of the positive effects in an effort to persuade the Corps to allow the barrier island to follow its natural course. The results may impact the way other barrier islands are treated under the Breach Contingency Plan in the future.

6. North Fork Native Tree Project, Southold, New York

The storm felled many large trees along the roadways and in the suburban neighborhoods of the North Fork area. As with other storms, homeowners and government entities are replacing the felled trees, which are typically large native species such as pines, oaks, elms, sycamores, and beech trees, with smaller ornamentals. This tree replacement process has become a disturbing trend that continues with each storm and over time, is changing the ecology of the area. Non-native ornamentals drastically reduce the carrying capacity of native insect herbivores and the animals that depend on them. Since 96% of terrestrial North American birds raise their young on a diet of insect protein, more native trees in a given area means more food and more birds. The planting of ornamentals also changes the overall canopy height, affecting the nesting habitat potential for large birds, including owls, hawks and bald eagles which have recently been re-colonizing in the North Fork area.

To address this problem in conjunction with Sandy recovery efforts, members of Southold's Planning Department would like to plant 1500 native oaks in the area in combination with a public outreach and education program regarding the importance of large native trees in the landscape. Southold has requested \$175,000 for this effort

7. Sunken Meadow State Park, Kings Park, New York

Portions of the berm and access road transecting Sunken Meadow Creek was breached and eroded away by the storm surge. Although this is an overall positive outcome in that it restored tidal flow to the creek, the banks at the creek mouth continue to erode and access to the eastern side of the park has been interrupted. To correct these immediate problems and ensure the creek provides a stable, open riverine migratory corridor, Save the Sound, in partnership with the New York State Office of Parks, seeks \$250,000 to implement erosion control and scour protection efforts, including regrading of the channel and removal of corroded pipes and concrete debris. Part of a larger \$1.3 million effort, this portion of the project will benefit a variety of species, including alewife, striped bass, juvenile bluefish, winter flounder, weakfish, silverside, killifish, American eel and various shellfish, waterfowl, shorebirds and wading birds. Engineering designs for this portion of the project are already complete.

8. Lynde Point, Old Saybrook, Connecticut

Although it caused numerous incidents of saltwater intrusion into freshwater lakes and ponds throughout the project area, Hurricane Sandy caused the opposite problem at Lynde Point. There, the storm surge pushed a dune into a tidal marsh, creating a dam that is blocking the flow of the tidal creek and preventing it from reaching the adjacent marsh. As water accumulates behind this dam, the tidal marsh is rapidly transforming into a freshwater swamp. The tidal marsh provides critical habitat for a variety of species of fish, birds, plants and mussels, many of which are regionally, nationally or globally rare, and is important breeding habitat for seaside sparrow, saltmarsh sharp-tailed sparrow,

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willet and black duck. The Lynde Point Land Trust seeks \$5,875 to excavate the dam and restore the proper flow of the tidal creek.

9. Rocky Neck State Park, East Lyme, Connecticut

Significant beach and dune erosion caused sand to accumulate in the Bride Brook channel, cutting off flow to this tidal creek and its surrounding tidal marsh. Bride Brook is one of the largest alewife runs in Connecticut, and restoration of the waterway is critical to assuring alewives are able to migrate into the marsh area to spawn. The Connecticut Department of Energy and Environmental Protection has requested \$1,000,000 to remove the accumulated sand from the Bride Brook channel, renourish the beach, restore the dune system, plant vegetation to stabilize the beach and dunes to prevent further erosion into the creek, and to control invasive species.

**10. Stewardship Program to Protect New and Moved Habitat
New Jersey, New York, Connecticut**

In many areas, the storm surge from Sandy created new habitat by adding sand to beaches and existing barrier and spoil islands, and moved existing habitat by pushing sand and dunes westward. Although the creation of habitat is a plus for beach nesting shorebirds and other shore and migratory species, it has also created a series of new problems that must be addressed. Much of this habitat has been created or moved to areas easily and heavily accessed by humans. In addition, it is not known as habitat to the municipalities and other entities engaged in recovery efforts and is extremely vulnerable to damage from the bulldozing and moving of sand that is going on right now as towns attempt to replace dunes, remove debris from marshes and other vegetated areas, and shore up their beaches. Resource managers along the entire East Coast Agree that immediate steps must be taken to identify and inventory these new habitats, work with towns and the public generally to protect the habitat from both recovery efforts and human traffic, and develop protocols that address dune configuration, sand movement (scraping, transport), sand fencing, vegetation (planting and removal), beach raking and other traditional restoration and flood protection methods. This was identified as a priority project by, among others, the Conserve Wildlife Foundation of New Jersey, Audubon New York, Audubon Connecticut, the Connecticut Audubon Society and The Nature Conservancy.

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Prime Hook National Wildlife Refuge DE	Art Coppola, Manager	Barrier Island Dunes Freshwater Marsh	Breaches to dunes that separate barrier island from impounded freshwater marsh. Marsh inundated with salt water.	Ducks and other waterfowl that rely on freshwater marsh as feeding, breeding, nesting.	Repair dunes; work with FWS & Corps to create more permanent solution to protect marsh.	Impoundment repair, \$2 million Study for long-term solution, \$150,000
Cedar Swamp Wildlife Area DE	Greg Moore, Manager	None at this time	Very little damage to resources or habitat – mostly structural. Park is open.	N/A	None at this time	N/A
Bombay Hook National Wildlife Refuge DE	Oscar Reed, Manager	None at this time	Advised that overall, BH fared well during storm. Lost some trees, received approximately 7" of rain, but no immediate habitat impacts noted.	N/A	None at this time	N/A
Maurice River, Eastern Shore DE Bay NJ	Danielle Kreeger, Partnership for DE Estuary	Salt Marsh Shorelines	Questions regarding integrity of different shorelines, i.e., living, rip rap, bulkhead, untreated salt marsh, post storm need to be answered.	Terrapin, blue crab, horseshoe crab, American eel, white perch, mummichogs, wading birds, eagles, osprey	Perform on the ground measurements using RTK-GPS plus image analysis of aerial photos pre and post storm to compare shoreline retreat rates	\$35,000
Maurice River, Money Island, NJ	Danielle Kreeger	Wetlands	Sandy has highlighted the importance of coastal wetlands in abating storm surge based on greater damage sustained by properties without fringing wetlands.	Terrapin, blue crab, horseshoe crab, American eel, white perch, mummichogs, wading birds, eagles, osprey	Install new living shoreline along vulnerable salt marsh to serve as test during future storm events	\$90,000

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Maurice River, Dividing Creek, Dennis Creek, NJ	Danielle Kreeger	Wetlands Shorelines	Storm caused substantial erosion and degradation of wetland shorelines.	Terrapin, blue crab, horseshoe crab, American eel, white perch, mummichogs, wading birds, eagles, osprey	Use aerial imagery to assess retreat rates of vegetated tidal marshes in DE estuary and Barnegat Bay over past 5 years; install monitoring transects at each MACWA station to track erosion patterns	\$120,000
Cape May National Wildlife Refuge NJ	Brian Braudis, Manager	Beaches Upland forests	Lost 20 trees, but no permanent or long term damage; 2-mile beach unit lost 10 yards of sand; damage to boardwalk, public viewing area. Marsh Boardwalk Trail and dune trail closed to public	Piping plover and other beach nesting birds.	He anticipates sand will return on its own by next year's nesting season. Other damage structural. Dunes protected new road.	Preliminary estimate for repairs to boardwalk trail and other trails, \$40,000 – to be updated.
Delaware Bay Reeds Bch, Cooks Bch, Kimbles Bch, Pierces Pt. NJ	Amanda Dey, NJ DEP Larry Niles, LJ Niles Assoc.	Beaches Marsh Oyster Reef	Beach erosion, overwash, rubble exposure, debris on beaches impeding spawning/feeding of horseshoe crabs shorebird feeding and habitat	Horseshoe crabs red knot, ruddy turnstone, sanderling, sandpiper, dunlin, short-billed dowitcher	Rubble removal, beach replenishment	beach replenishment, \$10 million
Delaware Bay Moore's Bch NJ	Amanda Dey, Larry Niles	Beaches Oyster reef	Beach erosion, debris, exposed peat and rubble on beach.	Horseshoe crabs, red knot, ruddy turnstone, sanderling, sandpiper, dunlin, short-billed dowitcher	Beach restoration, rubble/debris removal, creation of oyster cultivation structures	\$300,000

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Delaware Bay Fortescue – Fishermen's Bch, Rabin's Bch NJ	Amanda Dey, Larry Niles	Beaches	Heavy erosion, sand loss, damage at Fishermen's beach, erosion, floods at neap tide. Raybin's damaged from riprap put in place to protect road	Semi-palmated sandpipers, red knots, ruddy turnstones, sanderlings	Beach restoration, rubble removal	
Delaware Bay Heislerville Impoundments NJ	Amanda Dey, Larry Niles	Beaches	Destruction of dikes around impoundments, debris and exposed rubble on beach	Important high tide roost area for nearly 50,000 shore birds, only rookery on Del Bay Coast of NJ	Dike restoration, rubble removal	\$100,000
Cape May Point State Park NJ	Janet, Admin.	None at this time	Advised no issues, all parts of park and trails open, no impacts to habitat	N/A	N/A	N/A
Stone Harbor NJ	Amanda Dey, Larry Niles	Beaches Dunes	Stone harbor point was scoured to levels that will allow flooding during neap tides. Doubtful that beach nesting birds can use the area this year. Flooding will also diminish habitats usefulness for migratory shorebirds. Atlantic coast beaches severely damaged by sand loss. Dunes damaged, beach elevations lowered, exposing most areas to high tide flooding.	Support shorebirds year round; important night time roosting area for shorebirds foraging on Delaware Bay and Atlantic Coast marshes; piping plover, oystercatchers, terns, other beach nesting shore birds.	Beach restoration, replenishment, dune restoration	
Avalon NJ	Amanda Dey, Larry Niles	Beaches Dunes	Atlantic coast beaches severely damaged by sand loss. Dunes damaged, beach elevations lowered, exposing most areas to high tide flooding	Important habitat for beach nesting birds and migrating and wintering shore birds.	Beach restoration, replenishment, dune restoration	

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Cape May Meadows, Cape May, NJ	Patricia Burns, Society for Ecological Restoration Patricia Doerr, TNC	Beaches Dunes Frshw. Wetlands Salt Marshes	Fared very well during the storm - no damage. City of Cape May suffered a broken storm pipe and had to direct water into the Meadows, and it handled the extra water well. Water came up to the dunes and the beach was reshaped, but the dunes remained in tact, as did the salt marshes.	None	N/A	N/A
Hereford Inlet, Townsend Inlet, Corson's Inlet, Great Egg Harbor Inlet, Brigantine Inlet NJ	Todd Pover, Conserve Wildlife Foundation	Dunes Berms	These areas provide some of the most productive nesting shorebird habitat along the coast. Berms and forming dunes were flattened, rendering them much less suitable for nesting and vulnerable to nest flooding. Will be unable to support several large least tern colonies seen here in recent years.	Piping Plovers Least Tern Nesting shorebirds	Further assessment to determine if conditions improve or worsen over time.	
Back bays, spoil islands Southern NJ	David Mizrahi, NJ Audubon Society	Tidal Marshes Spoil Islands	Storm surge inundated and left debris in marsh areas, potentially destroying nesting habitat, especially in intercoastal waterways of NJ, e.g., Great Egg Harbor, Little Egg Harbor, Barnegat Bay	Common tern, forsters tern, black skimmer, American oystercatcher, laughing gull, little blue heron, snowy egret, great egret, tricolored heron, glossy ibis	Assessment of damage to tidal marshes, assess profiles of marsh and spoil islands, vegetation components and nesting habitat suitability	\$75,000

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Coastal Counties, NJ	David Mizrahi	Marsh Back Bays	Storm surge inundated and left debris in marsh areas, potentially wiping out invertebrates that serve as important food source for shore birds and breeding water birds.	Semipalmated sandpiper, short-billed dowitcher, lesser yellowlegs, dunlin, greater yellowlegs, black-bellied plover, semipalmated plover, spotted sandpiper, willet, clapper rail, black rail, American black duck	Assessment of damage to back bays and marsh areas, including invertebrate prey communities and impacts of same to shorebirds and breeding waterbirds	\$75,000
Corson's Inlet State Park NJ	Lorraine McCay, Supervisor	Beaches Dunes Upland forests	Strathmere section (southern tip) fared well; North end of park near ocean city, tremendous loss to dunes; dunes breached by ocean which went through to inlet flooded interior and damaged beach significantly. Lots of debris dumped along edge of upland forests – damage to forest not yet assessed.	Piping plover and other beach nesting birds.	Debris removal, assessment of damage to forests and see if birds relocate to south section.	
Seaview Harbor Marina, Longport, NJ	Todd Pover, CWF	Beach	Beach was impacted, should still provide sufficient habitat for NJ's most significant black skimmer colony.	Black skimmers NJ's only significant colony (200 +) utilizes this habitat	Further assessment to determine black skimmer use	
Ocean City NJ	Dave Jenkins NJ DEP	Marshes	Damage to a heron nesting site was reported. It is unknown if other similar habitat was impacted, but such impacts are anticipated.	Heron and other long-legged wading birds	Aerial surveys to assess damage to habitat/	

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Forsythe National Wildlife Refuge NJ	Virginia Rettig, Manager	Barrier Islands Beaches Intertidal Flats Dunes Tidal Salt Marshes Coastal Forests Freshwater Impoundment	22 miles of debris at marsh/forest interface (130 boats, entire houses) most severe at Stafford/Tuckerton and Brick Twp. Severe damage to dikes at Galloway allowed sea water in freshwater impoundments; Beach erosion/displacement severe; Major erosion at Holgate barrier beach dunes designated "wilderness"; Dunes washed to backside of barrier islands may create Piping Plover nesting habitat. Flood damage to dike/impoundments causing salt water inundation of fresh water pond	Marsh dwelling species from debris and oil/gas contamination; piping plover habitat on beaches; American black duck and Atlantic Brant in freshwater pond	Remove massive amounts of debris; restore beaches; repair dike and impoundments; restore freshwater pond. Other issues still being assessed	
Holgate, Long Beach Island, NJ	Carl Alderson, NOAA	Marsh Beaches Dunes	Contrast between areas that were protected by dunes and areas that were not is clear.	Shorebirds, wading birds, invertebrates	Assess areas for dune development projects, potential buy-out of residential properties	
South Barnegat Bay	Angela Padeletti, Partnership for the Delaware Estuary	Wetlands	Conducted a wetlands assessment in Delaware Bay and Barnegat Bay.	Approximately 30 meters of wetlands have been completely inundated in Southern Barnegat Bay.	Further assessment necessary.	
Island Beach State Park NJ	Ray Bukowski, Manager Todd Pover, CWF	Barrier Island Beaches Dunes	One of the largest undeveloped portions of the coast, but has not hosted beach nesting birds in recent years. Has not been surveyed to date due to severely limited access.	TBD	Area must be surveyed when access issues are resolved	

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Delaware Bay/ Southern coast NJ	Emile DeVito, NJ Cons. Foundation Mike Catania, Cons. Resources	Tidal Marshes Mudflats Sediment	Tidal marshes and soft sediment under and adjacent to them inundated with water for > 5 days had major impact on other species in invertebrate prey community. Extent and implications are a big unknown.	Shorebirds, wading birds and other invertebrate prey species.	Biological assessment of the state of the invertebrate community and its impacts on prey species.	
Southern coast NJ	Emile Devito, Mike Catania	Marshes Mudflats	Southern NJ is an important wintering area for Northern Harriers, which feed upon small rodents (mice, voles). It is believed that the rodent population was decimated by the surge. Harriers may move out of area due to lack of food.	Northern harrier and other animals that prey on the small rodent population.	Biological assessment of the state of the small rodent population and its impact on prey species.	
Delaware Bay/Southern coast NJ	Emile Devito, Mike Catania	Fringe Forests	Forests have been under assault for some time by salt water intruding farther into salt marshes and forest edging. Ongoing problem caused by rising tide, sea levels. Additional short term inundation does occur with storms, including Sandy.	Yellow-crowned night heron, rare wading birds, raptors, song birds, 75 species of long distant migratory birds, including juveniles.	Biological assessment to determine the extent and impacts of salt water intrusion upon fringe forests and possible solutions (if any) to same.	
Delaware Bay/Southern coast NJ	David Mizrahi	Spoil Islands	Concerns were raised about the impacts to the many dredge spoil islands that have been created over the years and to the birds that inhabit them.	Common tern, forsters tern, black skimmer	Survey of status of dredge spoil islands to determine impacts (erosion, habitat loss/creation).	

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Delaware Bay/NJ generally NJ	David Mizrahi	Eelgrass Beds	Damage to eelgrass beds is unknown at this time.	Supports crabs and fish, which in turn provide food for shorebird species and waterfowl.	Conduct assessment of status of eelgrass beds to determine impacts and secondary impacts to other species.	
Sandy Hook to Cape May NJ	Todd Pover, CWF	Beaches Dunes Inlets Spoil Islands Barrier Islands	New habitat was created in many locations along the coast, and existing habitat moved as a result of the storm. New/moved habitat is in many cases closer to human activity/access and vulnerable to storm recovery efforts	American oystercatcher, least tern, piping plover	Identification, prioritization and protection of new and moved beach nesting bird habitat, measure shorebird response to new habitat.	\$80,000.
Sandy Hook to Cape May NJ	Todd Pover, CWF	Beaches Dunes Inlets Spoil Islands Barrier Islands	Guidance for beach and dune maintenance and other recovery efforts are needed in new or existing habitat for beach nesting and migratory shorebirds.	American oystercatcher, Piping Plover, Least Tern, common tern, black skimmer, migratory shorebirds, including Red Knot	Develop protocols that address dune & sand maintenance, ensure habitat of shorebirds protected during recovery effort.	\$50,000
Ortley Beach, Brick Beach, Mantoloking, NJ	Carl Alderson, NOAA	Marsh Beaches Dunes	Contrast between areas that were protected by dunes and areas that were not is clear.	Shorebirds, wading birds, invertebrates	Assess areas for dune development projects, potential buy-out of residential properties	
Fisherman's Cove Conservation Area NJ	Ken Thoman, Monmouth County Parks	Beach Inlet	Last undeveloped property on Manasquan Inlet. Advised area is fine.	N/A	N/A	N/A

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Wreck Pond, Spring Lake/Sea Girt Border NJ	Todd Pover, CWF	Coastal Lake (tidal) Beaches	A new inlet was created by the storm, and both the towns of Spring Lake and Sea Girt have requested that it remain open. This could improve conditions for nesting shorebirds.	Piping plover, least tern, American oystercatchers	None	None
Seven Presidents Oceanfront Park NJ	Ken Thoman,	Dunes Beaches	Large developed dunes with wide beaches and bluff protected pavilion and boardwalk; other beach and dune areas wiped out.	Piping plover, least tern	Regrade sand recovered from inland, rebuild dunes, plant beachgrass, protective fencing	\$44,000
Long Branch and Sea Bright Beaches NJ	Todd Pover, CWF	Beaches	Many of the beaches in these towns were almost completely lost to erosion. The sand was washed west of the sea wall and into the developed communities.	Piping plover, least tern	Major beach replenishment; revisit value of seawall	
Gateway National Park at Sandy Hook NJ	Todd Pover, CWF Colin Grubel, HRF	Beaches Bay Islands Bayside beaches Dunes	Damage from widespread overwashing (record setting 32.5 foot wave east of beach), park is closed and inaccessible. Shore profile was completely changed, sand dunes were pushed several hundred feet west. Many dunes were completely flattened. Extent of damage to habitat unknown at this time although NPS staff reported that “good” habitat was created in the wider, northern sections of the park.	Piping plover, horseshoe crabs	Further assessment is necessary once access issues are resolved.	

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Sandy Hook to Cape May NJ	Todd Pover, CWF, Tim Dillingham, ALS	Beaches Bay Islands Marshes	Land managers at state and municipal levels are considering various storm protection methods and structures to protect property against future storms and surges that may be ineffective and have significant impacts on various habitats.	Shorebirds, horseshoe crabs, substrate invertebrates, small mammals	Launch an education/policy campaign re “natural” protections (bay, barrier, spoil islands, tidal marshes, dunes)	
Bayshore Waterfront Park Monmouth Marina NJ	Ken Thoman	Beaches Tidal Creeks Salt marshes Dunes Maritime shrubs	Dune was just reengineered, protected upland and historic building. No dune in front of marina, wiped out by 7 foot tidal surge. Advised beach and other habitat fine. Dune needs repair.	Focused on structures now - Will revisit to determine habitat impacts – horseshoe crabs and nesting shore birds	Dune, maritime forest restoration, regrade sand, sand fencing, plant beachgrass, bayberry, beach plum, eastern red cedar, coastal panic grass	\$53,000
Cheesequake State Park NJ	David Donnelly, Super.	Marsh Estuary	In Cheesequake estuary, storm knocked over 2 osprey nesting platforms/towers in saltwater marsh.	Osprey	Rebuild towers before birds return from South American nesting grounds.	\$4,500
Cheesequake State Park NJ	David Donnelly	Lowland Forest Vernal Pools	Shallow vernal pools that serve as prime habitat destroyed by storm surge	Frogs, toads, salamanders	Rebuild vernal pools, create escape structures for hatchlings	\$9,500
Cheesequake State Park NJ	David Donnelly.	Freshwater Lake	Significant damage at Hooks Creek Lake dam to disrupt outflow pipe, spillway and associated piping. Lake serves as valuable habitat for migrating species.	American eel, mummichog	Create temporary outflow structure, repair spillway box and piping	\$25,000
Cheesequake State Park NJ	David Donnelly,	Freshwater Lake	Surge inundated freshwater lake with over 8 feet of saltwater, killing off native fish species.	Bass, catfish, sunfish, carp, crappie	Restock lake with native fish species killed by salinity levels	\$3,500

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Cheesequake State Park NJ	Jim Faszak, Naturalist	Upland forests Cedar Swamp Marsh Freshwater lake	Significant loss of trees (> 300 oak and cedar); significant amount of debris in marsh; loss of trees creates opportunity for invasive species; inundation of small mammal habitat	Oak trees, Atlantic White Cedar, woodpeckers, screech owls, voles and moles, crabs, Kingfishers, gulls, herons in marsh,	Replant trees and other measures to negate invasive species, remove non-organic debris, restore hiking trails.	
Woodbridge Creek, NJ	Colin Grubel, HRF	Creeks Streams Marshes	NJ shores west of Arthur Kill were hit hard by oil spills, including Woodbridge Creek, Smith Creek Inlet, and Rum Creek. Other than oil, damage to marshes from storm itself is minimal.	Fish, invertebrates, small mammals, wading birds	Long term Impacts and implications of spills not yet known; assess flood protection measures employed by industries adjacent to waterways	
Hackensack River, NJ	Colin Grubel, HRF	River Marshes	The river, shores and marshes were contaminated by oil and sewage from spills. A fairly large fish kill was observed due either to increase in salinity as ocean water surged into river, or the stranding of fish carried by surge when tide retreated.	Fish, invertebrates, small mammals, wading birds	Long term Impacts and implications of spills not yet known; assess flood protection measures employed by industries adjacent to waterways and sewage plants	
Lincoln Park, Jersey City, NJ	Donald Stevens, Louis Berger Group	Marshes	He and David Bean of the NJDEP Office of Natural Resource Restoration visited the site post-Sandy notes that the restoration project is absolutely fine - there was "zero damage."	N/A	N/A	N/A
Newark, Sparta Mountain, Pinelands NJ	John Cecil, NJ Audubon Society	Forests	Storm caused significant damage to forests where stewardship program (Sparta, Newark) and sustainable forest project (pinelands) is underway, creating opportunity for non-native invasive plants to move in.	Golden-winged warbler, red-headed woodpecker, black-throated green warbler, northern waterthrush, Atlantic white cedar	Repair damaged deer exclosures, remove/replace downed trees, remove invasive plants	\$21,735

**EXHIBIT 1 – Summary Table of Impacts from Hurricane Sandy
American Littoral Society Final Assessment Report**

Resource	Contact	Coastal Features/Habitat Impacted	Issues	Species Impacted	Remediation/ Next Steps	Estimated Cost
Meadowlands, and Outerbridge Crossing area, NJ, NY (Staten Island)	Emile DeVito Colin Grubel	Marshes Meadows Freshwater Ponds	Concerns were raised over the new species of Leopard Frog discovered in these areas in and around 2009, including impacts of saltwater inundation, oil and sewage spills.	Leopard frog (new species)	Biological assessment	
Oakwood Beach, Cedar Grove Beach, Midland Beach, Staten Island, NY	Carl Alderson, NOAA	Marsh Beaches Dunes	Contrast between areas that were protected by dunes and areas that were not is clear.	Shorebirds, wading birds, invertebrates	Assess areas for dune development projects, potential buy-out of residential properties	
East Side of Staten Island NY	Colin Grubel, HRF	Beaches, Marshes, Nearshore understory, Bluffs	Sand was pushed inland as much as 60 feet from the shore and, in one spot, 150 feet inland; Nearshore understory species were covered with 3 inches of sand; Mats of phragmites were washed inward, smothering understory plants 300 to 400 feet from shore and were found in tree branches 10 feet high. Bluff at Great Kills formerly 10 to 12 feet high, reduced to gradual slope.	Shorebirds, invertebrates, small mammals, belted kingfishers, bank swallows, cliff swallows.	Beach restoration, bluff restoration, sand removal	
Mt. Loretto State Preserve, Staten Island, NY	Colin Grubel, HRF	Freshwater Ponds	Freshwater Brown's Pond surrounded by dead fish, mostly carp, most likely due to saltwater inundation.	Carp, other fish species, ducks, other freshwater-dependent shorebirds.	Restock with freshwater species	

EXHIBIT 1 – Summary Table of Impacts from Hurricane Sandy
American Littoral Society Final Assessment Report

Resource	Contact	Coastal Features/Habitat Impacted	Issues	Species Impacted	Remediation/ Next Steps	Estimated Cost
Prall's Island (Arthur Kill), West Shore Staten Island, NY	Colin Grubel, Hudson River Foundation	Salt Marshes Beaches	Oil spills in area covered the salt marshes on Prall's Island and the West shore of Staten Island. Oil-covered birds brought to a rehabilitation facility on Staten Island. Prall's Island was also subject to complete overwash, wrack and debris formerly at the edges of the island is now piled in the middle. Deer fencing protecting heron nesting vegetation knocked down.	Glossy ibis, black-crowned night heron, little blue heron, snowy egret, cattle egret, great egret, invertebrates, small mammals.	Oil spill clean up. Remove debris, replace protective deer fencing.	
Jamaica Bay Salt Marsh Islands NY	Dan Mundy, Jamaica Bay Ecowatcher	Barrier Islands Beaches	The islands fared very well during the storm. Islands did what they were supposed to by absorbing the energy of the waves and storm surge.	Numerous nesting shorebirds, wading birds and migratory species.	N/A	N/A
Jamaica Bay Wildlife Refuge, NY	Colin Grubel	Freshwater Ponds Bay Islands Dunes	Surge and waves cut 30-foot channels between the estuary and the East and West Ponds, causing saltwater inundation, connection to Bay	Diamondback terrapins, snapping turtles, freshwater dependent species	Repair channels between estuary and ponds allowing them to return to freshwater.	
Arverne, Far Rockaway, B30th to B 100 th Street, NY	Carl Alderson, NOAA	Marsh Beaches Dunes	Contrast between areas that were protected by dunes and areas that were not is clear.	Shorebirds, wading birds, invertebrates	Assess areas for dune development projects, potential buy-out of residential properties	

**EXHIBIT 1 – Summary Table of Impacts from Hurricane Sandy
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Resource	Contact	Coastal Features/Habitat Impacted	Issues	Species Impacted	Remediation/ Next Steps	Estimated Cost
Soundview Park, Bronx River Forest, Bronx, NY	Colin Grubel,	Salt Marsh Oyster Beds	Salt marsh restoration area intact. The surrounding area suffered wind damage; loss of trees opened holes in Bronx River Forest canopy. >200 trees lost at the nearby NY Botanical Gardens, opens area Japanese knotweed, an invasive species. Experimental oyster beds in park showed little damage; wild oyster beds at Soundview and nearby Castle Hill Park also had little to no damage.	Tree branches create habitat in river for American eels. Opportunity for invasive species	Parks Department may plant small replacement trees to shade out invasive species; Full assessment of oyster beds is being conducted later this month (December) to determine if preliminary findings are correct.	
Long Beach East, Lido Beach, Point Lookout Beach, Hempstead, Long Island, NY	Tara Schneider, Town of Hempstead	Beaches Dunes	Beaches and dunes experienced significant erosion, elevation loss.	Black skimmer, piping plover, least tern, common tern, gull-billed tern, American oystercatcher	Collect survey grade GPS data to assess total loss, coordinate with property owners to devise beach restoration plan, restore beach and elevation, rebuild primary dunes, monitor nesting habitat	\$500,000 (beach replenishment will be much more)
Otis Pike Wilderness Area, Great South Bay, Long Island, NY	Christopher Clapp, TNC Long Island	Barrier Islands Nearshore Waters	Breaches to NY barrier islands are subject to closure under ACOE Breach Contingency Plan. Breach at Otis Pike is beneficial and provides opportunity for species recovery.	Hard clam, eelgrass, bay scallop, American eel, fish, waterfowl	Document positive ecological effects of barrier island breach in effort to exclude Otis Pike from Breach Contingency Plan.	\$100,000

**EXHIBIT 1 – Summary Table of Impacts from Hurricane Sandy
American Littoral Society Final Assessment Report**

Resource	Contact	Coastal Features/Habitat Impacted	Issues	Species Impacted	Remediation/ Next Steps	Estimated Cost
Long Island National Wildlife Refuge Complex NY	Manomet, USFWS	Beaches Bay beaches Barrier Islands Marshes Coastal Ponds	Several units of the complex suffered from significant debris accumulation, particularly the waters of Wertheim unit. The Target Rock wildlife observation platform was damaged.	Nesting, wading and migrating shorebirds	Debris removal, repair Target Rock platform	\$500,00
Manursing Lake, Rye NY	Lynn Dwyer, NFWF	Beaches Lake Tidal Marshes Bluffs/Cliffs	Dunes, vegetation between Sound and Lake destroyed, vulnerable to inundation, sand and rock pushed onto fields and access roads, salt marsh buried by sand, debris, lake shore eroded, cliffs eroded	Shorebirds, beach nesting birds, wading birds, invertebrates, small mammals, cliff-dwelling birds	Restoration of dunes, vegetation, lake shore, cliffs; clean up of debris, sand	
Long Island Sound, NY & CT	Kelly Hines NY DEC, Habitat Restoration Workgroup	Beaches Dunes Forests Sediment Water Quality	Following issues noted by Workgroup as problems throughout LIS: extensive wrack mats smothering habitat, creating invasive species problem; downed trees in forest canopy creates opportunity for invasive species; water quality concerns from CSOs; Toxins in sediments disturbed, possibly spread; storm impacts on sensitive and listed species; habitat conversion; Knee-jerk recovery projects	Roseate tern, other nesting and migratory shorebirds, eel grass, invertebrate populations and their prey communities.	Further assessment of all of these potential problems and impacts to habitats are needed.	
Garvies Point Preserve, Glen Cove, NY	Hempstead Harbor Protection Committee	Beach Dunes Forest	Dunes and beaches suffered from erosion, undermining trees that will likely fall. Many additional trees were also felled by the storm.	Shorebirds		
Scudder's Pond, Sea Cliff, NY	Hempstead Harbor Protection Committee	Freshwater Pond	Saltwater backed up into the pond through the weir discharge pipe and from the storm surge from Tappan Beach crossing Shore Road. It is believe the plants in the pond will be able to withstand salt water intrusion, as it has happened before.	Freshwater-dependent ducks, birds, invertebrates	Assess impact of salt water intrusion on fish, invertebrate and plant species that inhabit pond, and to shorebirds that prey upon them.	

**EXHIBIT 1 – Summary Table of Impacts from Hurricane Sandy
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Resource	Contact	Coastal Features/Habitat Impacted	Issues	Species Impacted	Remediation/ Next Steps	Estimated Cost
Sunken Meadows State Park NY	Gwen McDonald Save the Sound Ariana Newell, NYS Parks	Earthen Berm/dam wiped out by storm surge.	Most of earthen berm/dam and access road wiped out by storm surge. Berm was targeted for removal to restore 100 acres of salt marsh. Banks at creek mouth continue to erode, access to eastern side of park interrupted.	Alewives, striped bass, juvenile bluefish, winter flounder, weakfish, silverside, killifish, American eel, shellfish, waterfowl, shorebirds, wading birds.	Regrade channel, remove corroded pipes and concrete debris to ensure stable, open riverine migratory corridor	\$225,000
Southold, North Fork, Long Island NY	Mark Terry, Laura Klahre, Town of Southold	Forests	Native large trees (oaks, elms, pines, sycamores) felled by Sandy and her predecessors are being replaced with smaller, non-native ornamentals, changing the overall canopy height and ecology of North Fork.	Owls, hawks, bald eagles, various birds, moths, butterflies, insects	Planting of 1500 native oaks along roadways; public information campaign re importance of native trees	\$165,000 for trees \$10,000 for campaign
Pipes Cove, Arshamo-maque Pond and Brushes Creek sub-watersheds North Fork, Long Island NY	Mark Terry, Laura Klahre	Wetlands Sediment/Substrate Flood Plains	Combination of historic wetlands loss from railroad construction and use of too few and too small culverts interrupts natural functions of remaining wetlands and causes significant and unnecessary flood conditions during storm events like Sandy.	Alewife, American eel, turtles, frogs, salamanders, river otters	Assess hydrogeologic conditions, including flow restrictions in normal and flood conditions, impacts on flood conditions, prepare plans, budget, timeline for capital improvements	\$300,000
Great Gull Island, Southold, NY	Helen Hays, American Museum of Natural History	Beaches Island	Island breached in two places, large areas of shore were washed away and the dock was destroyed.	Roseate tern, common tern	Assess extent of erosion, beach replenishment, nourishment.	\$250,000 erosion control \$500,000 repair dock

**EXHIBIT 1 – Summary Table of Impacts from Hurricane Sandy
American Littoral Society Final Assessment Report**

Resource	Contact	Coastal Features/Habitat Impacted	Issues	Species Impacted	Remediation/ Next Steps	Estimated Cost
All of Coastal Long Island NY	Jillian Liner Audubon, NY	Beaches Islands Inlets	New habitat was created, old habitat was moved in many locations along the entire coast. In many cases, new/moved habitat is closer to human activity/access and vulnerable to storm recovery efforts	Piping plover, American oystercatcher, least tern, common tern, roseate tern, black skimmer, red knot, semipalmated sandpiper, sanderling	Identification, prioritization and protection of new and moved beach nesting bird habitat, measure shorebird response to new habitat.	\$141,000
Mill River Restoration, Stamford, CT	Milton Puryear, Mill River Collaborative	River Marshes	Project unscathed by storm. A few newly-planted trees blew over, but no major erosion impacts or damage and the rest of their plantings held. The "cross veins" placed in the river to direct the water flow towards the center and away from the banks did their job and were very helpful in preventing damage. Demonstrates importance of next phase of restoration project.	Alewife, egrets, kingfisher, heron, osprey, eels, mink	Implement next phase of project, acquisition of easements to restore and control river banks through downtown Stamford	\$600,000
Penfield Reef, Fairfield, CT	Brian Thompson, et al., CT DEEP	Fish habitat	It was described as "largely washed away."	Shorebirds, sea ducks, bluefish, flounder, striped bass	Reef restoration	
Islands of LIS, All of coastal CT	Patrick Comins, Audubon, CT	Beaches Islands Inlets	New habitat was created, old habitat was moved in many locations along the entire coast. In many cases, new/moved habitat is closer to human activity/access and vulnerable to storm recovery efforts	Piping plover, American oystercatcher, least tern, common tern, roseate tern, black skimmer, red knot, semipalmated sandpiper, sanderling	Identification, prioritization and protection of new and moved beach nesting bird habitat, measure shorebird response to new habitat.	\$302,505

**EXHIBIT 1 – Summary Table of Impacts from Hurricane Sandy
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Resource	Contact	Coastal Features/Habitat Impacted	Issues	Species Impacted	Remediation/ Next Steps	Estimated Cost
Long Beach West, Stratford, CT	Gwen MacDonald Save the Sound	Barrier Island Beaches	Partial success story! 42 cottages abandoned and removed in 2010-2011. If remained, would have washed into Great Meadows Marsh. Entire island submerged, beach lost. Extent and significance of loss still being assessed.	Beach nesting shore birds Turtles	Unknown whether necessary - TBD	TBD
Silver Sands State Park, Milford, CT	Sally Snyder, CT DEEP	Beaches Dunes Tidal Marsh	Beach, shorelands, and dune systems seriously eroded by storm, sand accumulated in Great Creek tidal marsh	Piping plover, least tern, other tidal marsh flora, fauna	Remove sand from creek, renourish beach, restore dune system, plant vegetation, control invasive species	\$1,000,000 to \$1,250,000
Milford Point, Milford, CT	Anthony Zemba, CT Audubon Society	Barrier Beach	Significant erosion occurred to the barrier beach, which serves as breeding and migratory habitat for shorebirds and waterbirds.	Piping plover, least tern, American oystercatcher, common tern, sanderling, semipalmated sandpiper, white-rumped sandpiper, least sandpiper, ruddy turnstone, black-bellied plover, semipalmated plover, red knot	Conduct land survey to delineate area of barrier beach that lies above high tide line, beach nourishment, regrading	\$84,760
Sandy/Morse Point, West Haven, CT	Anthony Zemba	Barrier Beach	Significant erosion occurred to the barrier beach, which serves as breeding and migratory habitat for shorebirds and waterbirds. Sediment has been deposited in the outlet channel of inner bay between two points	Same as above	Land survey, beach nourishment, regarding, remove sediment in outlet channel, restore tidal flux into and out of inner bay	\$200,840

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Falkner Island, Guilford, CT	CT Audubon Society	Beaches Island	The island, a very important source of roseate tern habitat, lost approximately 1/3 of that habitat from erosion.	Roseate Tern	Assessment of extent of losses, beach nourishment, replenishment.	
Menunket-esuck Island and Duck Island, Westbrook, CT	Manomet USFWS	Beaches Islands	Both islands experienced excessive shoreline erosion.	Roseate tern, common tern	Placement of rip-rap and dredge spoils to stabilize islands and restore habitat.	\$700,000
Seaview Beach, Madison, CT	Steven Perelli, Seaview Beach Assoc.	Dunes	Storm significantly eroded dune.	Migratory birds, indigenous plovers	Regrade sand dispersed by storm to re-create primary dune, replanting of beach plum, dune grass	\$40,000
Pattagansett Marsh Preserve, Hatchets Point Natural Area, East Lyme, Old Lyme, CT	Adam Welchel, TNC CT	Dunes Salt Marsh Maritime scrub, Woodland	Storm eroded a combined length of 3800' of leading edge of dune system at two areas, reducing habitat and lessening protection of adjacent salt marsh	Maritime scrub woodland - black cherry, scarlet oak, white oak, white sassafras, common shadbush, bayberry, northern arrow-wood, black huckleberry, wild rose	Propagate stems of maritime scrub woodland vegetation for replanting the leading edge of two dune systems (3800' combined), invasive species control	\$50,000
Rocky Neck State Park, East Lyme, CT	Sally Snyder, CT DEEP	Beaches Dunes Tidal Creek Tidal Marsh	Sand accumulated in Bride Brook Creek, a tidal creek, and tidal marsh. Significant beach and dune erosion	Sharp-tailed sparrow, seaside goldenrod stem borer, alewife, other marsh species	Remove accumulated sand Bride Brook channel, renourish beach, stabilize dune	\$1,000,000

**EXHIBIT 1 – Summary Table of Impacts from Hurricane Sandy
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Resource	Contact	Coastal Features/Habitat Impacted	Issues	Species Impacted	Remediation/ Next Steps	Estimated Cost
Griswold Point/ Great Island, Old Lyme CT	Patrick Comins, CT Audubon Society	Beaches Dunes	<p>Tidal surge caused point to detach from mainland – is now an island. Habitat impacts at Griswold still being assessed but breach leaves Great Island, one of the most important saltmarsh sparrow nesting areas in the world, totally exposed to wave and current action.</p> <p>Also need to assess changes to flooding regimes at Griswold Point and damage to marshes, soft sediment substrate to determine impacts on saltmarsh sparrows – very sensitive to changes – 2" can make a difference.</p>	Saltmarsh sparrow	Physical and Biological assessment of extent of erosion and impacts on flooding, marshes, sediment and saltmarsh sparrow population.	
Lynde Point, Old Saybrook, CT	Stanford Brainerd, Lynde Point Land Trust	Dune Tidal Creek Tidal Marsh	Storm pushed dune into tidal marsh, blocking the flow of a tidal creek. Water is accumulating behind blockage turning tidal marsh into freshwater swamp	Piping plovers, all salt marsh flora and fauna	Excavate blockage, restore flow of tidal creek	\$5,875
Harkness Memorial State Park, Waterford, CT	Sally Snyder, CT DEEP	Beach Dunes Tidal Creek	The beach, shorelands and dune systems were significantly eroded by the storm, sediment and sand is blocking the outlet of Goshen Cove, an estuarine embayment and tidal creek	Piping plover, least tern, American bittern, insects, plants of tidal marsh	Dredge Goshen Cove, stabilize outlet to restore flows and tidal flushing, restore dune	\$750,000 – \$1,000,000
Waterford Town and Pleasure Beach, CT	Brian Flaherty, Town of Waterford	Barrier Dune Tidal Wetlands Estuary	The barrier dune protecting low lying developed areas and tidal wetlands was breached. Continued erosion will force sand into adjacent Alewife Cove, obstructing cove's outlet to LIS	Oystercatchers, great egret, little blue heron, great blue heron, year round and migratory waders and diving ducks	Repair dune breaches, rebuild dunes, erect sand fencing, elevated walkway over dune, plant dune and beach vegetation, signage	\$50,000

EXHIBIT 1 – Summary Table of Impacts from Hurricane Sandy
American Littoral Society Final Assessment Report

Resource	Contact	Coastal Features/Habitat Impacted	Issues	Species Impacted	Remediation/ Next Steps	Estimated Cost
All coastal areas, CT	Anthony Zemba, Sean Graesser, Patrick Comins, CT Audubon Society	Beaches Dunes Marshes	Debris piles along the beach are being cleaned up by municipalities with heavy equipment. The debris is very difficult to extract from vegetative habitat and dunes, and these natural features will be impacted by the clean up efforts.	Nesting shorebirds, migratory shorebirds.	Work with municipalities to identify and protect habitat during recovery efforts.	
All coastal areas, CT	Anthony Zemba, Sean Graesser, Patrick Comins, CT Audubon Society	Beaches Bay Islands Marshes	Land managers at state and municipal levels are considering various storm protection methods and structures to protect property against future storms and surges that may be ineffective and have significant impacts on various habitats.	Various	Launch an education/policy campaign to oppose problematic proposals (sea walls, tide gates, dunes and dune grass in inappropriate areas) and explain benefits of "natural" protections (bay, barrier, spoil islands, tidal marshes, dunes)	
Ninigret Pond, Charlestown, RI	Andrew McLaughlin, USFWS Jim Turenne, USDOA	Eel grass Oysterbeds	Eel grass beds were significantly damaged. There are bales of eelgrass piled up on land deeper than he has ever seen it before, from 6" to 18" deep. They were ripped out from the roots. Does not know implications of this going forward, unable to determine yet if sediment/substrate was damaged. Graduate student who planted and monitors oyster beds at Ninigret, advised that beds remain intact.	Eel grass and species that depend upon it.	Further assessment of eel grass situation in other waterways is necessary, as well as assessment of substrate/sediment.	

RAPID ASSESSMENT QUESTIONNAIRE

Entity Name*: _____

Managed By: _____

State/Location: _____

Contact Name: _____

Phone Number: _____

Date: _____

* Indicate if state or national park, wildlife refuge, conservation area and/or private land

Habitat Impacted: **Please check all that apply:**

☐ Barrier Islands

☐ Beaches

☐ Dunes

☐ Riparian Corridors

☐ Non-Beach Shorelines

☐ Intertidal Rocks

☐ Tidal Salt Marshes

☐ Freshwater Marshes

☐ Intertidal Flats/Mud Flats

☐ Shellfish Reefs

☐ Oyster Beds

☐ SAV

☐ Maritime/Coastal Forests

Other:

Questions:

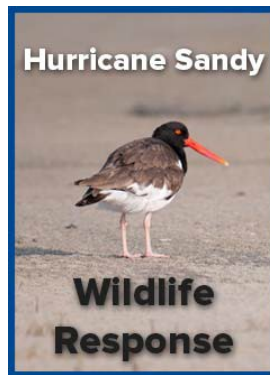
1. Have you personally visited the area to assess impacts? If yes, when, if not, identify source of information.
2. Which types of habitats were most impacted by the storm?
3. What was the nature of the impacts (e.g., flooding, salt water intrusion, beach erosion)?
4. What was the extent of the damage (minimal, extensive, total – acreage/percentage, footprint)?
5. Can you rank the significance of the damage to each type of habitat affected (from most significant to least, what is it based on – biological importance, acreage, is there a difference)
6. What species, if any, will be directly affected by the impacts, and in what way?

7. Are any of these species threatened or endangered or species of special concern?
8. What secondary or cumulative impacts do you anticipate (to other habitat and/or species)?
9. Are any species subject to secondary impacts threatened or endangered or species of special concern?
10. If the impacts were to a state or national park, wildlife refuge or other conservation area, describe the extent (in acres) and impact on functionality or value of conservation area.
11. Do you believe any of these impacts require immediate intervention? If yes, please explain.
12. Additional comments, including restoration needs and priorities?
13. Do you have photographs? If so, please post on CRSSA website.

EXHIBIT 3
Hurricane Sandy Habitat Restoration
Priority Project Summaries
American Littoral Society Final Assessment Report

The Priority Project Summaries contained in this Exhibit 3 were prepared by the resource managers at the request of the American Littoral Society. They are intended to provide an estimate of the actual funding necessary to complete each project and are not considered by the resource managers to be a complete or final proposal for funding.

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Conserve Wildlife Foundation of New Jersey
Contact Information:	Todd Pover Project Manager 2201 County Rt. 631 Woodbine, NJ 08270 (609) 628-0401 todd.pover@conservewildlifenj.org
Funds Requested:	\$87,500.00
Location:	Breeding and migratory shorebird habitat along the Atlantic Coast, New Jersey.
Recovery Needed:	Significant changes to coastal habitats have occurred and new habitat has been created. These habitats are extremely vulnerable to additional impacts, including from current and proposed storm recovery efforts.
Actions Proposed:	Coordinate with regulatory agencies and land/resource managers to ensure shorebirds and habitats are not impacted by storm recovery efforts; increase monitoring of beach nesting birds in light of significant changes to beach/dune habitat along the coast; identify, prioritize and preserve newly created nesting habitat. Develop guidelines for storm recovery and beach/dune maintenance that incorporate wildlife needs for critical habitats.
Species Benefitted:	Least Tern, Piping Plover, Black Skimmer, American Oystercatcher, various migratory shorebirds, including Red Knot.
Timeline:	December 1, 2012 – August 31, 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization: Partnership for the Delaware Estuary

Contact Information:	Danielle Kreeger 110 South Poplar St, Suite 202 Wilmington DE, 19801 302-655-4990 dkreeger@delwareestuary.org
Funds Requested:	\$35,000
Location:	Maurice River, NJ, eastern shore of Delaware Bay
Recovery Needed:	Assessing the survivability of 2010 installed Living Shorelines along the Maurice River, and compare to untreated areas as well as hard infrastructure.
Actions Proposed:	Method would be to perform on-the-ground measurements using RTK-GPS plus image analysis of aerial photos from pre- and post-Sandy to contrast shoreline retreat rates among living shoreline, rip rap, bulkhead, and untreated salt marsh edges in the Maurice River tributary, NJ Bayshore.
Species Benefitted:	Terrapins, blue crabs, horseshoe crabs, American eel, White perch, mummichugs, wading birds, eagles, osprey
Timeline:	March 2013-December 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization: Partnership for the Delaware Estuary

Contact Information: Danielle Kreeger
110 South Poplar St, Suite 202
Wilmington DE, 19801
302-655-4990
dkreeger@delwareestuary.org

Funds Requested: \$90,000

Location: Maurice River or Money Island, NJ, eastern shore
of Delaware Bay

Recovery Needed: Hurricane Sandy has highlighted the importance
of coastal wetlands in abating storm surge,
whereby coastal properties without fringing
wetlands appeared to sustain greater damage
than those with wetlands.

Actions Proposed: Unfortunately, funds are rarely available to test
new living shoreline R&D approaches within the
Delaware Estuary. We propose to use lessons
learned from our previous installation to install a
new living shoreline along a vulnerable salt
marsh along another section of the NJ Bayshore.

Species Benefitted: All fish and wildlife who rely on healthy edge salt
marsh habitats; terrapins, blue crabs, horseshoe
crabs, American eel, white perch, mummichugs,
wading birds, eagles, osprey

Timeline: January 2013-December 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Partnership for the Delaware Estuary
Contact Information:	Danielle Kreeger 110 South Poplar St, Suite 202 Wilmington DE, 19801 302-655-4990 dkreeger@delwareestuary.org
Funds Requested:	\$120,000
Location:	Maurice River, Dividing Creek and Dennis Creek, NJ, eastern shore of Delaware Bay
Recovery Needed:	Hurricane Sandy (and Irene/Lee in 2011) appears to have caused substantial erosion and degradation of wetland shorelines, which are extremely productive and important.
Actions Proposed:	Use aerial imagery to assess retreat rates of the vegetated edges of tidal marshes in the vicinity of MACWA stations in the Delaware Estuary and Barnegat Bay over the past 5 years, including post-Sandy. We also propose to install a set of permanent monitoring transects at each MACWA station to track future erosion patterns.
Species Benefitted:	All fish and wildlife who rely on healthy edge salt marsh habitats; terrapins, blue crabs, horseshoe crabs, American eel, white perch, mummichugs, wading birds, eagles, osprey
Timeline:	January 2013-December 2014

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



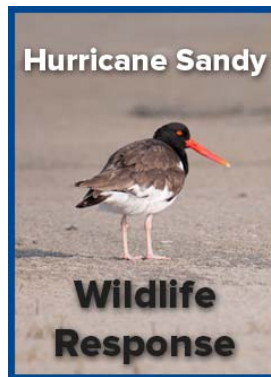
Lead Organization:	New Jersey Audubon Society
Contact Information:	David S. Mizrahi V.P. Research and Monitoring 600 Rte 47 North Cape May Courthouse, NJ 08210 (609) 861-1609 x17 david.mizrahi@njudubon.org
Funds Requested:	\$75,000.00
Location:	Back bay tidal marshes, spoil islands in inter-coastal waterways, New Jersey
Recovery Needed:	The storm surge inundated and left debris in marshes, potentially destroying nesting habitat for colonial waterbirds, especially in intercoastal waterways. Scouring of marshes and spoil islands could render these areas susceptible to tidal inundation during the nesting season.
Actions Proposed:	Assessment of damage to tidal marshes and spoil islands in intercoastal waterways for adverse affects to nesting colonial waterbirds. In particular, assess marsh and spoil island profiles, vegetation components and nesting habitat suitability.
Species Benefitted:	Common Tern, Forsters Tern, Black Skimmer, American Oystercatcher, Laughing Gull, Little Blue Heron, Snowy Egret, Great Egret, Tricolored Heron, Glossy Ibis.
Timeline:	December 1, 2012 – June 30, 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	New Jersey Audubon Society
Contact Information:	David S. Mizrahi V.P. Research and Monitoring 600 Rte 47 North Cape May Courthouse, NJ 08210 (609) 861-1609 x17 david.mizrahi@njudubon.org
Funds Requested:	\$75,000.00
Location:	Coastal marsh areas and back bays, Coastal Counties, New Jersey
Recovery Needed:	The storm surge inundated and left debris in marsh areas, potentially wiping out the invertebrates that serve as an important food source for shore birds and breeding water birds.
Actions Proposed:	Assessment of damage to back bays and marsh areas, including invertebrate prey community impacts of same to shore birds and breeding water birds, several of which are identified as species of High Concern in the US Shorebird Conservation Plan and/or are endangered or threatened.
Species Benefitted:	Semipalmated Sandpiper, Short-billed Dowitcher, Lesser Yellowlegs, Dunlin, Greater Yellowlegs, Black-bellied Plover, Semipalmated Plover, Spotted Sandpiper, Willet, Clapper Rail, Black Rail, American Black Duck
Timeline:	December 1, 2012 – June 30, 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Monmouth County Park System
Contact Information:	Ken Thoman 805 Newman Springs Rd. Lincroft, NJ 07738 732.842.4000 x 4267 kthoman@monmouthcountyparks.com
Funds Requested:	\$44,000 in materials, in-kind and volunteer contribution for labor.
Location:	Seven Presidents Oceanfront Park, Long Branch, NJ.
Recovery Needed:	Dune restoration
Actions Proposed:	Re-grade sand recovered from inland. Strategic sand fencing. Planting beachgrass.
Species Benefitted:	Piping plover, least tern benefit from the 'strategic' rebuilding of the dunes as per our existing CAFRA GP#29 Habitat Creation/Enhancement Permit.
Timeline:	Immediate

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Monmouth County Park System
Contact Information:	Ken Thoman 805 Newman Springs Rd. Lincroft, NJ 07738 732.842.4000 x 4267 kthoman@monmouthcountyparks.com
Funds Requested:	\$53,000 in materials, in-kind and volunteer contribution for labor.
Location:	Bayshore Waterfront Park, Port Monmouth, NJ.
Recovery Needed:	Dune, Maritime forest restoration
Actions Proposed:	Re-grade sand recovered from inland. Strategic sand fencing. Plant beachgrass, bayberry, beach plum, Eastern red-cedar, Coastal panic grass.
Species Benefitted:	Black-crowned Night-heron, Black Skimmer, Least Tern, Snowy Egret.
Timeline:	Immediate

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Cheesequake State Park
Contact Information:	David B. Donnelly Superintendent 300 Gordon Road Matawan, NJ 07747 (732) 566-2161 cspsupt@optonline.net
Funds Requested:	\$4,500.00
Location:	Cheesequake estuary
Recovery Needed:	Superstorm Sandy knocked over two osprey nesting platforms / towers located in the saltwater marsh.
Actions Proposed:	Rebuild the towers before the birds return from their South American nesting grounds.
Species Benefitted:	Osprey
Timeline:	January 1, 2013 – March 15, 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Cheesequake State Park
Contact Information:	David B. Donnelly Superintendent 300 Gordon Road Matawan, NJ 07747 (732) 566-2161 cspsupt@optonline.net
Funds Requested:	\$9,500.00
Location:	Cheesequake lowland forest
Recovery Needed:	Superstorm Sandy storm surge destroyed shallow vernal pools that are prime habitat for distinctive animals such as frogs, toads and salamanders.
Actions Proposed:	Rebuild the vernal pools and create escape structures for hatchlings.
Species Benefitted:	Vernal pool fauna.
Timeline:	January 1, 2013 – February 15, 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Cheesequake State Park
Contact Information:	David B. Donnelly Superintendent 300 Gordon Road Matawan, NJ 07747 (732) 566-2161 cspsupt@optonline.net
Funds Requested:	\$25,000.00
Location:	Hooks Creek Lake dam
Recovery Needed:	Significant damage has been done to disrupt the outflow pipe at the freshwater Hooks Creek Lake. This habitat is extremely valuable to the passage of migratory American Eel and Mummichog.
Actions Proposed:	Create temporary outflow structure and repair spillway box and piping.
Species Benefitted:	American Eel and Mummichog.
Timeline:	January 1, 2013 – April 15, 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Cheesequake State Park
Contact Information:	David B. Donnelly Superintendent 300 Gordon Road Matawan, NJ 07747 (732) 566-2161 cspsupt@optonline.net
Funds Requested:	\$3,500.00
Location:	Hooks Creek Lake
Recovery Needed:	Stormwater surge from Superstorm Sandy inundated the freshwater lake with over eight feet of salt water, which killed off native fish species such as bass, catfish, sunfish, carp and crappie.
Actions Proposed:	Restocking of lake with native fish species to replace lost numbers from increased salinity levels.
Species Benefitted:	Bald eagle, osprey, kingfisher and cormorant who regularly depend on these freshwater fish as a food source for their young.
Timeline:	June 1, 2013 – November 15, 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	New Jersey Audubon Society
Contact Information:	John Cecil, Vice President for Stewardship Wattles Stewardship Center 1024 Anderson Road Port Murray, NJ 07865 (908) 320-0394 John.cecil@njudubon.org
Funds Requested:	\$21,735
Location:	Sparta Mountain Greenway, City of Newark's Watershed lands, NJ Pinelands
Recovery Needed:	In areas where NJ Audubon is implementing Forest Stewardship Plans in Northern NJ plus a sustainable forestry project in the Pinelands, the hurricane's high winds caused significant damage by toppling large trees onto deer exclosures and causing tree blowdown in areas where non-native invasive plants threaten to thrive in now sun-exposed disturbance areas.
Actions Proposed:	Repair damaged deer exclosures; remove some of the downed trees to treat the invasive plants with hand or mechanical removal and herbicide spraying.
Species Benefitted:	Golden-winged Warbler, Red-headed Woodpecker, Black-throated Green Warbler, Northern Waterthrush, Atlantic White Cedar
Timeline:	January 1, 2013 – June 30, 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	The Nature Conservancy Long Island Chapter
Contact Information:	Christopher Clapp, Marine Scientist The Nature Conservancy on Long Island PO Box 5125 142 Route 114 East Hampton, NY 11978 631-329-3981, cclapp@tnc.org
Funds Requested:	\$100,000
Location:	Great South Bay, Long Island, NY
Recovery Needed:	Breaches in NY's barrier islands have been subject to closure pursuant to a Breach Contingency Plan. This has had detrimental impacts on the water quality and ecology of the Great South Bay. A new breach in the Otis Pike Wilderness area has opened the opportunity for species recovery. Documentation of the positive ecological effects of this breach will bolster the confidence of decision makers to allow the breach to run its natural course.
Actions Proposed:	Conduct a shallow water infauna survey to monitor the response of the benthic community to a breach in the barrier island. Evaluate hard clam spawning potential and recruitment.
Species Benefitted:	Hard Clams (<i>Mercenaria mercenaria</i>), Eelgrass (<i>Zostera marina</i>), Bay Scallop (<i>Argopecten irradians</i>), American Eel (<i>Anguilla rostrata</i>), and associated fish and waterfowl species.
Timeline:	June-October 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Save the Sound with NYS Office of Parks
Contact Information:	Ariana Newell Gwen Macdonald P.O. Box 247 142 Temple Street Babylon, NY 11702 New Haven, CT 06510 631.581.1072 203.787.0646 x123 Ariana.Newell@parks.ny.gov gmacdonald@savethesound.org
Funds Requested:	\$225,000 for erosion control, scour protection, removal of corroded pipes and debris (part of larger \$1.3 million project)
Location:	Sunken Meadow State Park, Kings Park, NY, North Shore of Long Island
Recovery Needed:	Berm and access road transecting Sunken Meadow Creek was breached and eroded away. Although tidal flow was restored, banks at the creek mouth continue to erode, access to eastern side of park interrupted.
Actions Proposed:	Regrade channel, remove corroded pipes and concrete debris to ensure stable, open riverine migratory corridor. Engineering designs are complete.
Species Benefitted:	Alewives, striped bass, juvenile bluefish, winter flounder, weakfish, silverside, killifish, American eel, various shellfish, waterfowl, shorebirds, and wading birds.
Timeline:	December 2012 – March 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Town of Southold, NY
Contact Information:	Mark Terry, Principal Planner Department of Planning Town of Southold Mark.Terry@town.southold.ny.us Laura Klahre, Land Management Steward Laura@blossommeadow.com
Funds Requested:	\$175,000
Location:	Town of Southold
Recovery Needed:	The storm felled many large trees along roadways and neighborhoods of the North Fork area. The felled trees, typically large native species such as oaks, elms, pines, sycamores, and beeches, are being replaced with smaller ornamentals (bradford pears, kwanzan cherries). This process has become a disturbing and ongoing trend that has caused changes to the overall canopy height, affecting nesting habitat for large birds including owls, hawks and bald eagles (bald eagles are starting to recolonize eastern Long Island). As large trees disappear from the landscape, so do the insects and birds.
Actions Proposed:	Planting of 1,500 native oaks along the roadways of Southold Town; public information campaign regarding the importance of large native trees in the landscape.
Species Benefitted:	Various birds, moths, butterflies, insects
Timeline:	2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



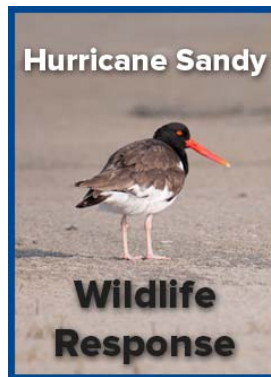
Lead Organization:	Town of Southold, NY
Contact Information:	Mark Terry, Principal Planner Department of Planning Town of Southold Mark.Terry@town.southold.ny.us Laura Klahre, Land Management Steward Laura@blossommeadow.com
Funds Requested:	\$300,000.00
Location:	Pipes Cove, Arshamomaque Pond and Brushes Creek subwatersheds
Recovery Needed:	Recovery of the natural functions of the North Fork's wetlands interrupted by railroad corridor to prevent flooding caused by wetlands loss and inadequate culvert system. Enhance remaining wetlands to allow for the recovery/restoration of native populations.
Actions Proposed:	Assess hydrogeologic conditions along railroad line and roadways within designated watersheds, including water flow restrictions under daily vs. storm scenario, model restricted flow's impact on storm surge/flooding, prepare specific plans, designs, drawings, budgets and timelines for capital improvements.
Species Benefitted:	Alewife, American Eel, turtles, frogs, salamanders, river otters
Timeline:	2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Great Gull Island Project
Contact Information:	Helen Hays Department of Vertebrate Zoology – Ornithology American Museum of Natural History Central Park West at 79 th Street New York, New York 10024 212-769-5794, hays@amnh.org
Funds Requested:	\$500,000 to repair dock \$250,000.00 (estimate) \$250,000.00 to dump rocks for erosion control
Location:	Great Gull Island, Eastern End of Long Island Sound
Recovery Needed:	The sea breached the island in two places and there are large areas along the edges of the island in addition to the breached areas where waves washed away large sections of the shore
Actions Proposed:	Place rocks to stabilize breached areas, consult with engineers about stabilizing serious erosion at both the north and south shore.
Species Benefitted:	Federally Endangered Roseate Tern, NY Threatened Common Tern
Timeline:	December 10, 2012 – October 13, 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Audubon NY
Contact Information:	Jillian Liner Director of Bird Conservation c/o Cornell Lab of Ornithology Ithaca NY 14850 607-262-0006
Funds Requested:	\$141,000
Location:	Long Island
Recovery Needed:	Changes to beach, dune and island habitat in Long Island due to erosion and over-washing of dunes, including lost habitat, habitat at lower elevations that is vulnerable to impacts from additional storm activity, and creation of new habitat that is vulnerable to human access and storm recovery activities.
Actions Proposed:	Assessment of potential habitat at target sites, identification and protection of new nesting areas from human access and recovery efforts, outreach in communities that are unfamiliar with sharing the shore with beach nesting birds.
Species Benefitted:	Piping Plover, American Oystercatcher, Least Tern, Common Tern, Roseate Tern. With Secondary targets of Black Skimmer, Red Knot, Semipalmated Sandpiper, Sanderling and other migratory shorebirds.
Timeline:	Spring 2013-Fall 2014

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Audubon Connecticut, Connecticut Audubon Society with CT DEEP, TNC, CT Ornithological Association and New Haven Bird Club
Contact Information:	Patrick Comins, Audubon Connecticut 185 East Flat Hill Road Southbury, CT 06488 (860)977-4469, pcomins@audubon.org
Funds Requested:	\$302,505 (total budget \$427,592; \$86,806 is already in place)
Location:	All of coastal CT, islands of Long Island Sound
Recovery Needed:	Habitat for coastal waterbirds was significantly altered along the entire CT coast, including on various islands in Long Island Sound. Changes include the creation of new habitat that is extremely vulnerable to human disturbance and damage from ongoing recovery efforts.
Actions Proposed:	Stewardship Program to identify and inventory new habitat, conduct outreach activities to inform public and land managers of habitat and implement protective measures.
Species Benefitted:	Piping Plover, American Oystercatcher, Least Tern, Common Tern, Roseate Tern, Black Skimmer, Snowy Egret, Great Egret, Red Knot, Semipalmated Sandpiper, Sanderling and other migratory shorebirds.
Timeline:	January 2013-March 2014.

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Mill River Collaborative
Contact Information:	Milton Puryear 888 Washington Blvd. Stamford, CT 06901 (203) 977-4713 Milton@millriverpark.com
Funds Requested:	\$600,000
Location:	Rippowam River, east bank from Main Street to Richmond Hill Avenue, Stamford, CT
Recovery Needed:	To facilitate the next section of Mill River habitat restoration project. First phase of project, including placement of cross veins in river to direct flow of water towards center and away from banks, was very effective in preventing damage from Sandy and emphasizes need for implementation of next phase.
Actions Proposed:	Acquisition of easements in order to restore and control the river banks through Downtown Stamford
Species Benefitted:	Alewife, egrets, kingfishers, herons, minks, eels, osprey
Timeline:	Acquisition in 2013 and first half of 2014 for construction start in late 2014.

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	CT Department of Energy and Environmental Protection
Contact Information:	Sally Snyder, Permits Coordinator CT Department of Energy and Environmental Protection 79 Elm Street Hartford, CT 06106-5127 (860) 424-3869 sally.snyder@ct.gov
Funds Requested:	\$1,000,000 - \$1,250,000
Location:	Silver Sands State Park, Milford, CT (contains Great Creek, Nettleton Creek and Fletchers Creek; habitat for piping plover)
Recovery Needed:	Beach, shorelands and dune systems eroded by storm; remove accumulated sand in Great Creek tidal marsh
Actions Proposed:	Remove accumulated sand in Great Creek tidal marsh; renourish the beach and restore the dune system, plant and stabilize, and control invasive species.
Species Benefitted:	Habitat for piping plover, least tern; and other tidal marsh flora and fauna.
Timeline:	2013-2014 (depending on obtaining necessary environmental permits)

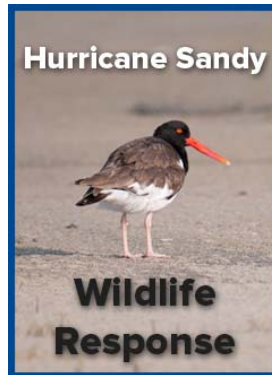
Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation

December 2012



Lead Organization:	Connecticut Audubon Society (on behalf of stakeholders)
Contact Information:	Anthony J. Zemba CHMM, Certified Ecologist Director of Conservation Services Connecticut Audubon Society 2325 Burr St. Fairfield, CT 06824 (203)259-6305, ext. 114 Azemba@ctaudubon.org
Funds Requested:	\$84,760 (engineer's est. available upon request)
Location:	Milford Point, Milford, CT
Recovery Needed:	Repair breeding and migratory shorebird/waterbird habitat on barrier beach
Actions Proposed:	Land Survey to delimit area of barrier beach that lies above the High Tide Line (HTL); Beach nourishment to restore eroded portions of the beach; re-grading to restore beach to original configuration
Species Benefitted:	Nesting and breeding populations of Piping Plover, American Oystercatcher, Least Tern and Common Tern; Migratory Shorebirds esp. Sanderling, Semipalmated Sandpiper, White-rumped Sandpiper, Least Sandpiper, Ruddy Turnstone, Black-bellied Plover, Semipalmated Plover, and Red Knot
Timeline:	Work anticipated for winter months of early 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



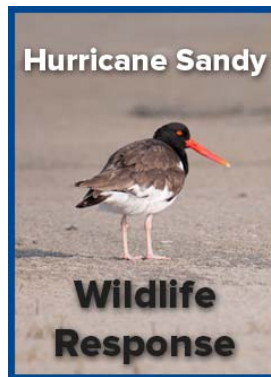
Lead Organization:	Connecticut Audubon Society (on behalf of stakeholders)
Contact Information:	Anthony J. Zemba CHMM, Certified Ecologist Director of Conservation Services Connecticut Audubon Society 2325 Burr St. Fairfield, CT 06824 (203)259-6305, ext. 114 Azemba@ctaudubon.org
Funds Requested:	\$200,480 (engineer's est. available upon request)
Location:	Sandy/Morse Point, West Haven, CT
Recovery Needed:	Repair breeding and migratory shorebird/waterbird habitat on barrier beach
Actions Proposed:	Land Survey to delimit area of barrier beach that lies above the High Tide Line (HTL); Beach nourishment to restore eroded portions of the beach; re-grading to restore beach to original configuration; recovery of eroded sediment that has been deposited within the outlet channel of the inner bay between the two points; restoration of tidal flux into and out of the inner bay (necessary to prevent invasion of <i>Phragmites australis</i>)
Species Benefitted:	Nesting and breeding populations of Piping Plover, American Oystercatcher, Least Tern and Common Tern; Migratory Shorebirds esp. Sanderling, Semipalmated Sandpiper, White-rumped Sandpiper, Least Sandpiper, Ruddy Turnstone, Black-bellied Plover, Semipalmated Plover, and Red Knot
Timeline:	Work anticipated for winter months of early 2013

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	The Nature Conservancy, Connecticut Chapter
Contact Information:	Adam Whelchel The Nature Conservancy 55 Church Street, 3 rd Floor New Haven, CT 06510 (860) 970-8442, awhelchel@tnc.org
Funds Requested:	\$50,000
Location:	Pattagansett Marsh Preserve, East Lyme, CT Hatchetts Point Natural Area, Old Lyme, CT
Recovery Needed:	Replanting of unique (state rare) maritime scrub woodland vegetation along a combined length of 3800' of coastal frontal dune system. Hurricane Sandy eroded the leading edge of the dunes at these two sites, reducing the amount of habitat and lessening the ability of these dunes to protect adjacent salt marsh habitat in the face of future storms.
Actions Proposed:	Propagate stems of maritime scrub woodland vegetation for use in replanting the leading edge of two dune systems. Action would coincide with invasive species control.
Species Benefitted:	Maritime scrub woodland natural community (includes black cherry, scarlet oak, white oak, white sassafras, common shadbush, bayberry, northern arrow-wood, black huckleberry and wild rose).
Timeline:	December 1, 2012 – November 30, 2014.

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Seaview Beach Association
Contact Information:	Steven Perelli 34 Grove Avenue Madison, CT 06443 (203) 245-7199
Funds Requested:	\$40,000.00
Location:	Seaview Beach, Tidal Beach, Inland Wetland, Seaview Avenue, Madison, CT
Recovery Needed:	Primary dune re-creation and vegetation/stabilization, replanting
Actions Proposed:	Regrading of storm dispersed beach sand to re- create primary dune, replanting of beach plum and dune grasses to anchor vulnerable and eroded dune bank
Species Benefitted:	Migratory birds, indigenous Plovers
Timeline:	Fall 2013 – Spring 2014

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Town of Westbrook CT
Contact Information:	Tom Odell Chairman, Conservation Commission 866 Boston Post Road Westbrook, CT 06498
Funds Requested:	\$100,000
Location:	Salt Island, Long Island Sound barrier island off coast of Westbrook, CT
Recovery Needed:	Restoration of severely eroded and undermined banks and restoration of nesting habitat of the eastern most and smallest of three barrier islands providing critical habitat for nesting and wading shore birds (other islands are Duck Island and Menunketesuck Island).
Actions Proposed:	Assess (engineer) design and implement project to stabilize and protect island from erosive actions of storms and sea level rise and restore nesting habitat; provide for safe seasonal eco-recreation.
Species Benefitted:	Least Tern, Oystercatcher, Piping Plover, Heron, Egret
Timeline:	January 1, 2013 – January 1, 2014

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Lynde Point Land Trust, Inc.
Contact Information:	Stanford Brainerd, President 6 Lyme Street Old Lyme, CT 06371 (860) 434 - 0694 shbrainerd@sbcglobal.net
Funds Requested:	\$ 5,875
Location:	Land Trust owned property on Long Island Sound at Lynde Point, Old Saybrook, CT
Recovery Needed:	Sandy pushed dune into tidal marsh, blocking flow of a tidal creek causing water to accumulate behind this dam transforming tidal marsh into freshwater swamp.
Actions Proposed:	Excavate dam, restoring flow of tidal creek.
Species Benefitted:	All plants and animals previously inhabiting salt water marsh. Piping Plovers are potentially nesting on dune.
Timeline:	February 2013 (commencement pursuant to CT DEEP temporary authorization)

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	CT Department of Energy and Environmental Protection
Contact Information:	Sally Snyder, Permits Coordinator CT Department of Energy and Environmental Protection 79 Elm Street Hartford, CT 06106-5127 (860) 424-3869 sally.snyder@ct.gov
Funds Requested:	\$1,000,000
Location:	Rocky Neck State Park, East Lyme, CT
Recovery Needed:	Remove accumulated sand in Bride Brook channel; restore flows and proper tidal flushing to the brook (a tidal creek) and tidal marsh; renourish the beach and restore the dune system, plant and stabilize, and control invasive species
Actions Proposed:	Remove accumulated sand in Bride Brook channel; renourish the beach and restore the dune system, plant and stabilize, and control invasive species
Species Benefitted:	Tidal marsh flora and fauna, including saltmarsh sharp-tailed sparrow, seaside goldenrod stem borer and especially alewife, one of the most important nurseries/runs in Connecticut
Timeline:	2013-2014 (depending on obtaining necessary environmental permits)

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	CT Department of Energy and Environmental Protection
Contact Information:	Sally Snyder, Permits Coordinator CT Department of Energy and Environmental Protection 79 Elm Street Hartford, CT 06106-5127 (860) 424-3869 sally.snyder@ct.gov
Funds Requested:	\$750,000 - \$1,000,000
Location:	Harkness Memorial State Park, Waterford, CT (includes William A. Niering Natural Area Preserve)
Recovery Needed:	Beach, shorelands and dune systems eroded by storm and sediment/sand blocking outlet of Goshen Cove, an estuarine embayment and tidal creek.
Actions Proposed:	Dredge Goshen Cove and stabilize outlet in order to restore flows and proper tidal flushing; and possibly restore dune habitat.
Species Benefitted:	Habitat for piping plover, least tern, American bittern and listed other birds, as well as insects and plants associated with tidal marsh and dunes, and fishes.
Timeline:	2015 (or earlier following completion of current site assessment and obtaining necessary environmental permits)

Recovery Projects for Coastal Habitat Affected by Hurricane Sandy
National Fish and Wildlife Foundation
December 2012



Lead Organization:	Town of Waterford, CT
Contact Information:	Brian Flaherty – Director, Recreation & Parks 15 Rope Ferry Road Waterford, CT 06385 860 444 - 5881
Funds Requested:	\$50,000.00 (\$35,000 for grading, fence and construction of elevated pedestrian walkway over dune; \$15,000 for restoration, plantings, installation)
Location:	Waterford Town Beach Waterford Pleasure Beach
Recovery Needed:	Barrier dune protecting low-lying developed areas and tidal wetlands was breached. Continued erosion will force sand into adjacent estuary of Alewife Cove, threatening to shift and obstruct the cove's outlet to Long Island Sound.
<u>Actions Proposed:</u>	Repair dune breaches, dune rebuilding, erect sand fencing and multi-lingual signs to guide pedestrians, install elevated cross-walk over dune, plant native dune and beach vegetation.
Species Benefitted:	Beachgrass, beach plum, bayberry, prickly pear spartina/blackgrass, nesting, shelter and foraging habitat for oystercatchers, great egret, little and great blue heron, and year-round and migratory waders and diving ducks species
Timeline:	December 1, 2012 - November 30, 2013