

HURRICANE SANDY

RAPID ASSESSMENT

Final Report

Created by the Atlantic Flyway Shorebird Business Strategy Planning Team



INTRODUCTION

Hurricane Sandy (Sandy) devastated portions of the Caribbean, the Mid-Atlantic and Northeastern United States, and Eastern Canada in late October 2012. While Sandy was only a category 1 storm off the coast of the Northeastern United States, the storm became the largest Atlantic hurricane on record, with winds spanning 1,100 miles (1,800 km) and was a category 2 storm at its peak intensity.

Human Impacts

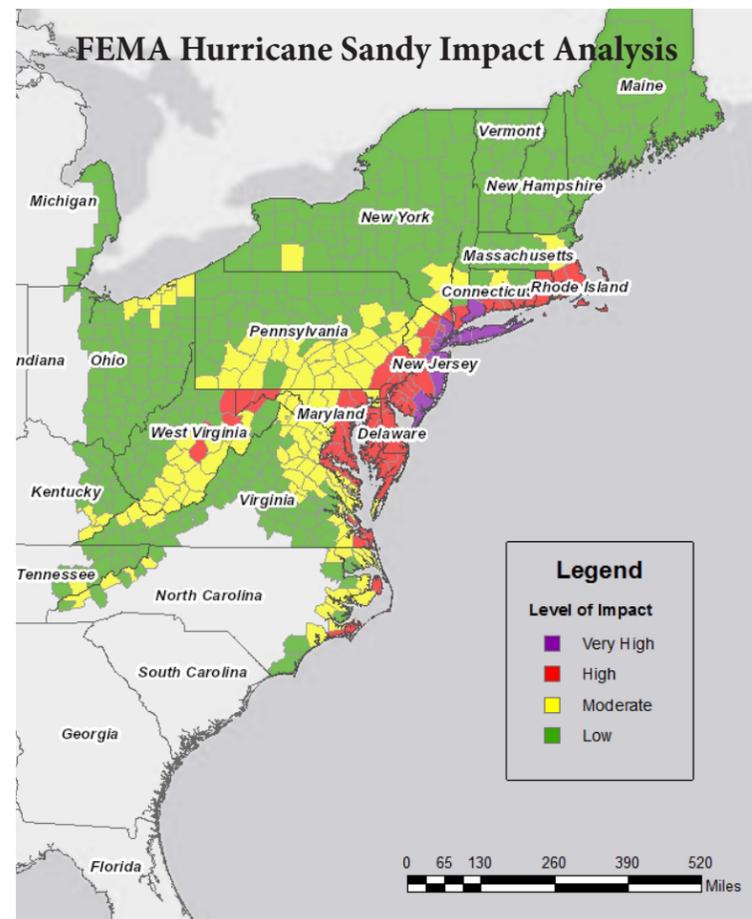
Early calculations indicate that Sandy may have caused more than \$200 billion in damages. Preliminary estimates of losses that include business interruption surpass \$50 billion. And tragically, at least 199 people were killed along the path of the storm in seven countries.

Wildlife Impacts

Habitats important to waterfowl and coastal waterbirds, including shorebirds, wading birds, and seabirds, were also impacted by Sandy. High winds and storm-driven water moved masses of coastal sediments, changing barrier landscapes, eroding important nesting islands, and blowing out dikes on impoundments managed specifically for migratory birds.

While biologists and managers continue to assess the damages to wildlife and wildlife habitat, actions can be taken to mediate negative impacts from the storm immediately, and protocols can be implemented to help minimize the long-term secondary effects of future storms. Long-term planning and the development of best management practices for those agencies responsible for moving sediments will have the most significant, sustained positive effects for coastal bird populations.

The material in this Final Report was collected by coastal biologists and land managers from federal, state, and private organizations in the days following Sandy's landfall. The damage to wildlife habitat from Hurricane Sandy, the recommended actions or projects to remediate those damages, and the costs of those repairs are all estimates.



The most tangible needs to remediate Sandy's impacts on important coastal bird habitats are centered on managed wetlands and small islands critical to nesting seabirds and migrating shorebirds. Breached dikes of impoundments managed for waterbirds, blown out water control structures, and acres of eroded sand from priority seabird colonies, are a few of the most notable examples of habitat restoration needs. For some species, especially those that depend upon open sand to nest and roost, Sandy's energy actually created new nesting and loafing opportunities. Several states and institutions have identified a funding need for comprehensive damage assessments that include site-specific information as well as species-level population data. Detailed assessment surveys of all waterbird habitats can help identify critical needs that may not be obvious until migration and nesting seasons.

In addition to the effects on bird habitat, these coastal areas are also used by millions of people for a variety of recreational activities. It is of particular note that many National Wildlife Refuges and State Game Management Areas continued with scheduled hunts and other activities soon after the storm devastated the areas. The courage that these State, Federal, and private managers showed in continuing with their efforts to sustain recreational uses is testament to the dedication of the professionals who are managing the recovery. This Interim Report is dedicated to those individuals who stayed on their posts to serve the American public during and after hurricane Sandy.

The following categories of coastal environments include partial lists of species using those sites and the objectives of remediation efforts for each.

EXECUTIVE SUMMARY

Hurricane Sandy moved massive amounts of coastal sediments with the extreme power of storm-driven water, changing barrier landscapes, eroding important bird nesting islands, and blowing out dikes of impoundments managed specifically for breeding, migrating, and wintering shorebirds, seabirds, wading birds, and waterfowl. Important habitats for high priority species like Piping Plover, Red Knot, American Black Duck, Tri-colored Heron, Least Bittern, and American Oystercatcher have been altered by this storm. While assessments are still being developed, actions can be taken right away to mediate negative impacts from the storm, and perhaps most importantly of all, protocols can be put into effect that will help minimize the long-term secondary effects of future storms:

- rebuild and stabilize critical waterbird nesting islands;
- immediate repair to access sites for management of conservation lands;
- assess and repair water control structures and pumps for managed wetlands;
- enhance stewardship capacity on beaches to protect newly created nesting habitat;
- clear debris and hazardous material from important waterbird habitat where possible; and
- develop and deliver Best Management Practices (BMPs) for federal and local coastal managers.

Overall cost estimate for projects in this final report is \$48.7 million.

The Time for Action

The cascading impact of storm surge and sand displacement by Sandy is well explained in a small, but critically important shorebird stopover site in Delaware Bay. A rapid response survey in the Reeds Beach area found horseshoe crab spawning habitat had decreased significantly due to the storm. With almost no sand for horseshoe crabs to spawn, the "lifeblood" of many migrating shorebirds in the Atlantic, horseshoe crab eggs, will be virtually nonexistent. The cascading effects of less eggs means that migrating shorebirds will not gain enough fat for their trip to Arctic breeding grounds. Studies have shown that without significant weight gain, shorebirds won't lay eggs to produce fledglings. If action is not taken to improve habitat immediately, Sandy will have significantly decreased carrying capacity for horseshoe crabs and shorebirds. The U.S. Fish and Wildlife Service is currently reviewing the status of the Red Knot, a migratory shorebird that has undergone dramatic declines in the last two decades and this latest event is almost certainly to have lasting effects on the recovery of this bird that travels some 10,000 miles on its yearly journey.

Strategic Conservation

Beach renourishment in response to Sandy is ongoing as information for this report was being gathered. While it is imperative to rebuild and stabilize many affected areas, work must be conducted in the most environmentally responsible way. For example, borrowing sand from inlet areas that are important as foraging sites for terns and other seabirds, and as spawning areas for a variety of commercial and prey fish, will simply transfer environmental damage to another habitat. With careful review and planning, and by following the actions and projects recommended in this report, further damage will be avoided while allowing beaches and other structures to be re-built.



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Mixed flock. Jim Fenton

NATURAL COASTAL ENVIRONMENTS

Impacted Species

American Oystercatcher
 Black Skimmer
 Gull-billed Tern
 Least Tern
 Piping Plover
 Roseate Tern
 Red Knot
 Ruddy Turnstone

Barrier coast, without coastal armoring or near-shore development

Barrier sand beach systems

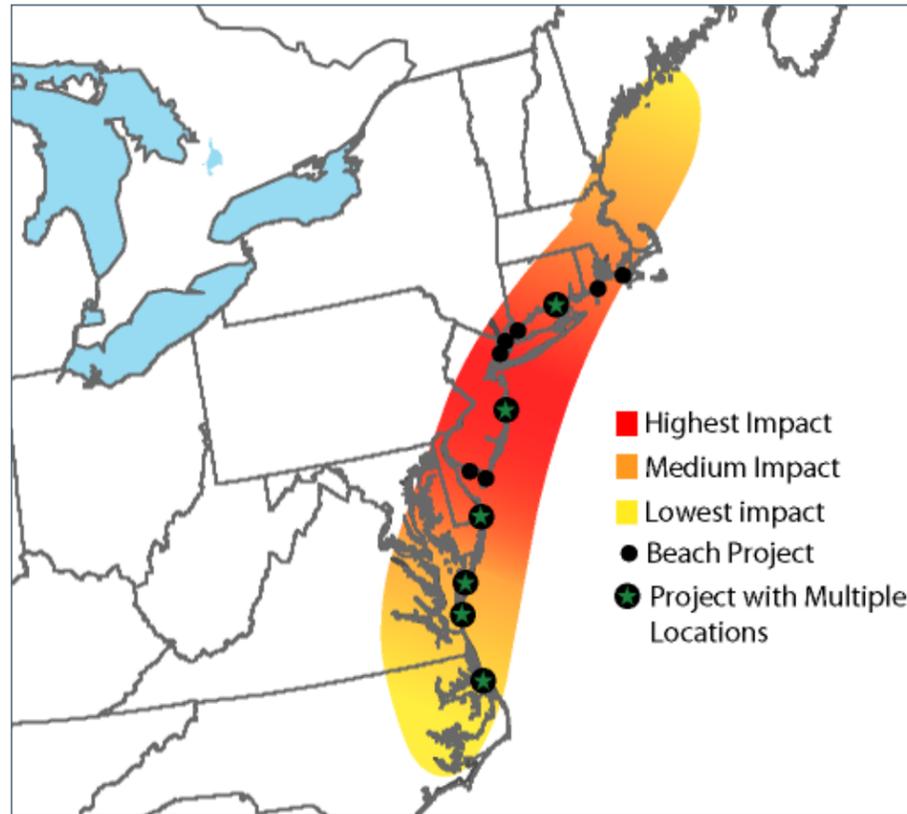
Critical to obligate beach-nesting shorebirds and seabirds. Critical to migrant shorebirds and seabirds, important feeding areas for some species of wading birds.

Alluvial sand spit islands

Critical to nesting seabirds and shorebirds, critical to migrant and wintering shorebirds for feeding and roosting, important to migrant and wintering seabirds.

Beach inlets

Highly dynamic barrier feature, critical to migrant shorebirds, critical to nesting shorebirds, important for nesting of some seabirds.



Hurricane Sandy caused dune erosion at Amagansett National Wildlife Refuge (USFWS) on Long Island, affecting available habitat for shorebirds like Black Skimmer (USFWS).

OBJECTIVES

1. Identify changes to beach profiles to predict redistribution of nesting effort in the spring
2. Allocate stewardship efforts in high recreational use areas during breeding and migration seasons
3. Support International Shorebird Monitoring spring and fall
4. Replace lost sand at critical seabird nesting islands

BEACH PROJECTS

Project	Type of Impact	Action	Location	Partners	Cost
Assessment of exposure and vulnerability of waterbird breeding areas to major storms in coastal Virginia	Beach erosion, marsh overwash, exposed rubble	Assess the exposure and vulnerability of waterbird breeding areas by developing a storm exposure metric, applying it to known breeding areas and evaluating the implications to breeding areas and the effects of climate change and sea level rise	Coastal plain of Virginia	Center for Conservation Biology at the College of William and Mary and Virginia Commonwealth University; TNC	\$200,000
Prioritization and preservation of suitable beach-nesting bird habitat in the post-Sandy landscape	Protection of highly suitable beach nesting bird habitat created by the storm	Generate landscape-scale habitat criteria for focal beach-nesting birds and remote sensing/spatial analysis data to reflect post-Sandy coastal landscape changes observed, and generate a predictive model of suitable breeding sites in NJ's post-storm landscape	Atlantic Coast of NJ from Gateway National Recreation Area - Sandy Hook Unit	Rutgers, The State University of NJ (RU), CWF, NJDFW - Endangered and Nongame Species Program	\$80,000
Mammalian predator management in coastal Virginia	Beach erosion, marsh overwash, exposed rubble	Strategically targeted removals of red fox and common raccoon on up to 14 barrier islands along the Virginia coast that were populated due to Sandy	Barrier islands in Virginia	TNC, USDA and other partners to be determined (USFWS, VDGIF)	\$200,000
Hurricane Sandy coastal waterbird stewardship program in New York and Connecticut	Beach erosion, dune overwash	Inventory the altered landscape for coastal waterbirds, deploy fencing and signage to new and existing nesting areas, and implement outreach activities to the public and to land managers	Coastal NY and CT	Audubon New York, Audubon Connecticut, and Connecticut Audubon Society in coordination with the NYS DEC, NYSOPRHP, CTDEEP, TNC, and USFWS	\$550,000
Create oyster reefs to attenuate waves to increase stable waters for horseshoe crab egg laying	Low density of horseshoe crab eggs, beach erosion	Work with local oyster producers at key sites along the bayshore adjacent to areas used by shorebirds and establish reefs to break wind-driven waves	Delaware Bay	Conserve Wildlife Foundation of NJ., NJ and DE state Fish and Wildlife, USFWS, NJ Audubon Wetland Institute	\$400,000

NATURAL COASTAL ENVIRONMENTS CONTINUED...

BEACH PROJECTS CONTINUED					
Project	Type of Impact	Action	Location	Partners	Cost
Replace signage and protective fencing in and around sensitive shorebird nesting areas	Over 800 signs and sign posts as well as miles of fencing missing due to high winds and beach erosion associated with Hurricane Sandy	Survey areas of shorebird nesting and dune protection areas, create updated signage, and place in secure locations	Jamaica Bay Unit, Brooklyn/Queens, NY and Sandy Hook Unit, Sandy Hook, NJ	NPS, NYC Audubon or possibly academic institutions	\$200,000
Management for beach nesting birds in Rhode Island	Beach erosion, dune overwash	Increase capacity for beach management and provide support to private landowners, state and town agencies in identification of strategies and implementation of management where new nesting habitat has been created in historically high public use areas	South Shore of Rhode Island	USFWS in close coordination with RI DEM, Local Conservancies, TNC, and other partners	\$213,500
Delaware Bay: Moore's Beach replenishment and rubble removal	Beach erosion, marsh overwash, exposed rubble	Rubble removal, beach replenishment, wave-attenuating oyster reef sustained by local oystermen	Delaware Bay-Moore's Beach	NJDFW (ENSP, BLM), Wetlands Institute, NJ	\$600,000
Enforcement of conservation management strategies at narrow coastal waterbird nesting sites	Beach and island erosion	Employ a full-time beach ranger whose responsibility will include enforcement closures of important nesting and foraging areas and post the sites with fencing and signage for coastal nesting birds	Dead Neck Sampsons Island, Barnstable, MA	Mass Audubon	\$99,132
Repair beach at Delaware Bay - Reeds Beach to Pierce's Point	Beach erosion, marsh overwash, exposed rubble	Rubble removal, beach replenishment, wave-attenuating oyster reef (off Cooks Beach) sustained by an agreement with local oyster producers	NJ Coastline	Middle Twp. NJ, State of NJ, US Army Corps of Engineers, Wetlands Institute	\$10,420,000



Management of some wildlife habitats can be challenging with breaches in barrier divides in fresh and saltwater (USFWS). Natural barrier coasts are highly dynamic and withstand the wash-over effects of storm surge, and can actually benefit some species of beach-nesting birds like Piping Plover (Jim Fenton).

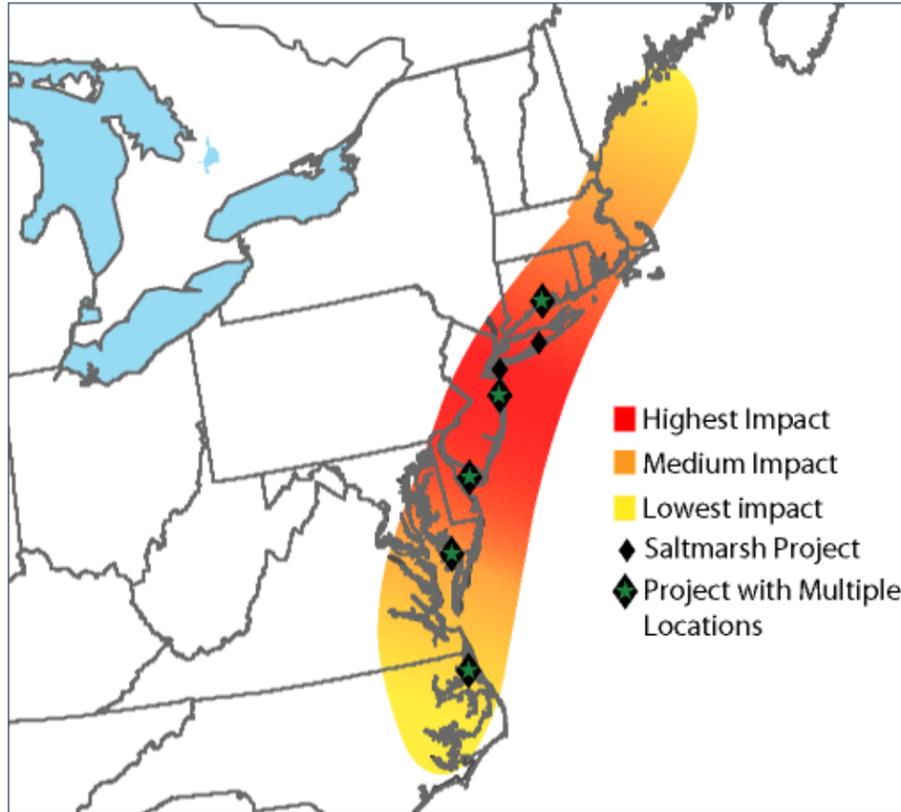
NATURAL COASTAL ENVIRONMENTS CONTINUED...

Impacted Species

- American Black Duck
- Atlantic Brant
- Black-bellied Plover
- Black Rail
- Black Tern
- Forster's Tern
- Greater Yellowlegs
- Little Blue Heron
- Marsh Wren
- Nelson's Sparrow
- Saltmarsh Sparrow
- Seaside Sparrow
- Tricolored Heron
- Whimbrel
- Willet

Saltmarsh Systems including marsh hammocks

Critical to saltmarsh obligate breeders, important to feeding nesting and roosting wading birds and migrant shorebirds



Extensive flooding into saltmarsh areas (USFWS) will impact nesting areas for species like American Oystercatcher (USFWS)

OBJECTIVES

1. Limit management activity
2. Deter adverse impacts from marsh debris cleaning attempts
3. Restore freshwater function of some ponds

SALTMARSH PROJECTS					
Project	Type of Impact	Action	Location	Partners	Cost
Map and remove debris fields in tidal wetlands in priority areas	Deposition of storm-derived debris on salt marshes suffocates and displaces high and low salt marsh and salt scrub habitats critical for the nesting of salt marsh sparrows and wading bird foraging.	Perform aerial surveys to locate debris field impairing wetland functions and remove debris	Jamaica Bay, Arthur Kill/Kill Van Kull, Littleneck Bay, East River/Long Island Sound	NYC Parks, NPS, and contractors	\$430,000
Repair extensive damage to refuge infrastructure, clean and remove hazardous materials and debris, and stabilize habitats at Long Island NWR Complex (NY)	Extensive amounts of debris and hazardous materials accumulated within an environmentally sensitive area with limited access over a 6.5 mile stretch of coastline, damage to wildlife observation platform	Repair structures and removal of debris and hazardous materials	Wertheim, Target Rock, Oyster Bay, Seatuck, Champlain Creel and Lido Beach, all within Long Island NWR Complex, Shirley, NY	USFWS	\$5,700,000
Assess the Impact of Hurricane Sandy on coastal Mid-Atlantic waterfowl habitat and food availability	Potential loss of waterfowl habitat, as Hurricane Sandy may have impacted the estimated 500,000 ha of productive natural salt marsh along the Mid-Atlantic Coast and the wildlife that rely on these coastal systems	Assess the impacts of Hurricane Sandy on waterfowl habitat availability, food availability, and use	Coastal Connecticut, Long Island, New York, Southern New Jersey, Delaware Bay Shore, and the Eastern Shore of Virginia on the Delmarva Peninsula	CT, NY, NJ, DE, VA, University of Delaware	\$750,000

URBAN AND STRUCTURED ENVIRONMENTS

Impacted Species

American Oystercatcher
 Dowitcher species
 Great Egret
 Little Blue Heron
 Piping Plover
 Red Knot
 Sanderling
 Semipalmated Sandpiper
 Snowy Egret
 Yellowlegs species

Urban and Structured Coastal Landscapes

Areas with coastal armoring, channeling, residential/municipal development, managed wetlands, areas with direct recreational access, and other areas specifically managed for wildlife.

Beach backed by development

Some important for migrant shorebird stopover foraging, important roosting areas, and some nesting habitat.

Dredge-spoil islands and other nesting islands, many of which are managed for birds

Critical seabird nesting, important shorebird nesting, important seabird and shorebird roosting.

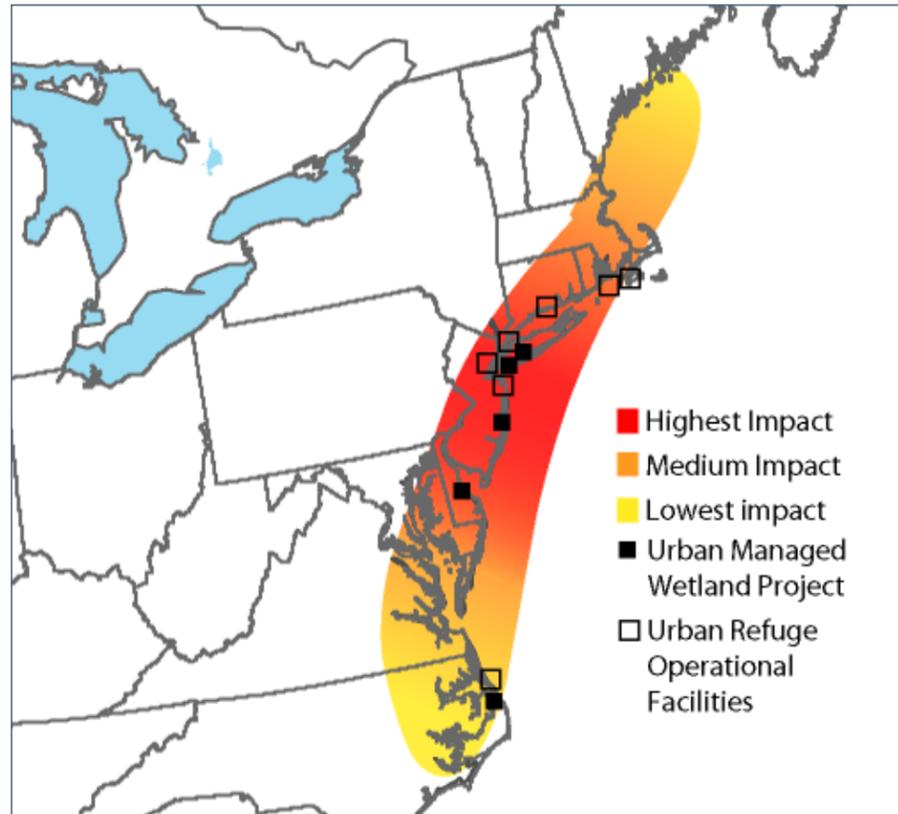
Urban influenced Back Barrier, non-beach coast

Important wading bird foraging.

Armored inlet, jetty, groin, bulkhead beach, or upland

Important roosting for some seabirds.

Managed wetland impoundments



After Hurricane Sandy, U.S. Fish and Wildlife Service staff and crews began to survey and assess damages to the Stewart B. McKinney's nine island units (USFWS/Tyler Greene). Lesser Yellowlegs (William Majoros)

OBJECTIVES

1. Restore breached dikes in managed wetlands
2. Replace water control structures
3. Repair access sites for enforcement and monitoring
4. Repair Refuge Operational Facilities

MANAGED WETLANDS IMPOUNDMENT PROJECTS					
Project	Type of Impact	Action	Location	Partners	Cost
Repair damage to refuge infrastructure and impoundments, clean and remove hazardous materials and debris, and stabilize habitats at Prime Hook NWR, Delaware	Damage to dikes, levees, and roadways, beach erosion, and debris and hazardous materials accumulated within 4,200 acres of coastal impoundments	Placement of rip-rap and dredge material, debris removal, repair impoundments, repair water control structures and facility structures used for wildlife observation	Prime Hook NWR, Milton, DE	USFWS	\$20,000,000
Restore and restabilize 5 miles of dike that create 6 impoundments and repair water control structures at Tuckahoe WMA, New Jersey	Extensive marsh overwash, water control structures damaged	Restore and restabilize the 5 miles of dike that create the 6 impoundments at the Tuckahoe Wildlife Management Area, repair/replace damaged water control structures	Outer Coastal Plain of Southern New Jersey; Tuckahoe WMA	NJDFW	\$1,500,000
Delaware Bay - Heislerville Impoundments dike restoration	Destruction of dikes around impoundments	Restore and restabilize dike and repair/replace damaged water control structures	Delaware Bay - Heislerville Impoundments	NJDFW, BLM	\$100,000
Repair East Pond breach at the Jamaica Bay Wildlife Refuge	Beach erosion led to saltwater intrusion in a previously closed freshwater pond	Obtain clean sand and place in new opening to restore the pond, explore options for natural shoreline stabilization in breached area to prevent future issues	Gateway NRA, Jamaica Bay Wildlife Refuge	Contracted entities	\$1,000,000
Repair West Pond breaches (2) at the Jamaica Bay Wildlife Refuge	Beach erosion led to saltwater intrusion in a previously closed fresh water pond	Obtain clean sand and place in new opening to restore the pond, explore options for natural shoreline stabilization in breached area to prevent future issues	Gateway NRA, Jamaica Bay Wildlife Refuge	Contracted entities	\$1,000,000
Replace valve system in East and West Ponds at the Jamaica Bay Wildlife Refuge	Damaged valve system	Determine most suitable replacement system and implement	Gateway NRA, Jamaica Bay Wildlife Refuge	NPS and contracted entities	\$650,000
Pea Island NWR North Pond pump station and water control structure repair	Damaged water control structures and pump head	Replace control structures and pump head to bring facility back on track for integrated waterbird management	Pea Island NWR, NC	USFWS	\$330,000
Pea Island NWR South Pond water control structure replacement	Damaged water control structure in the South Pond Impoundment Unit preventing necessary water level management	Replace water control structure to bring impoundment back on track for integrated waterbird management	Pea Island NWR, NC	USFWS	\$45,000

URBAN AND STRUCTURED ENVIRONMENTS CONTINUED...

NESTING ISLAND REFUGE OPERATIONAL FACILITIES PROJECTS					
Project	Type of Impact	Action	Location	Partners	Cost
Habitat restoration and recolonization of breeding Roseate and Common Terns on Muskeget Island	Habitat loss (island breeding sites) as a result of sea level rise and increased storm frequency	Hire staff to clear areas of debris, deploy decoys to attract high priority nesting birds back to the site, implement methods to dissuade gulls from nesting, and monitoring colonies after establishment, including the monitoring of foraging terns	Muskeget Island, Nantucket, Massachusetts	Mass Audubon	\$367,800
Restore Boat Access to Offshore Roseate Tern Nesting Colony	Break Water (~2000 lbs.) stones were rolled into the boat basin, severe damage of dock structure	Removal of stones from boat basin and repair of the dock structure, which is the only safe access to the island and is critical to the predator management conducted on the island.	Faulkner Island, Guilford, CT, Stewart B. McKinney NWR	USFWS	\$945,000
Restoration of North spit at Stewart B. McKinney NWR (CT), Falkner Island Unit	Beach erosion	Stabilize and replenish North spit for roseate and common terns as nesting habitat	Faulkner Island, Guilford, CT, Stewart B. McKinney NWR (North Spit)	USFWS	\$62,000
Restoration of Southern tip of island at Stewart B. McKinney NWR (CT) Falkner Island Unit	Southern tip of island measuring 12,379 square feet by 5 feet deep was damaged and eroded and requires stabilization	Stabilize and replenish Southern tip of island	Falkner Island, Guilford CT, Stewart B. McKinney NWR (Southern tip)	USFWS	\$230,000
Stabilization, nourishment and revegetation of tern & shorebird nesting habitat at Ram Island, MA	Beach erosion that affected the carrying capacity of one of the most important tern nesting islands in North America	(1) Conduct feasibility study; (2) design & engineering of project; (3) conduct permitting process; (4) construct project (stabilize, nourish, and revegetate island)	Ram Island, Mattapoisett, MA	MDFW	\$80,000
Great Gull Island - Dock Repair	Damage to dock that is only access to island	Replace large portions of the dock that were completely washed away and repair small remaining areas	Great Gull Island, Long Island Sound, NY	American Museum of Natural History	\$250,000



NPS Photo



Habitat restoration projects like the example above (NPS) will benefit species such as Common Tern. Jim Fenton

LONG-TERM REMEDIATION FOR IMPROVED RESPONSES TO STORMS AND BEACH ENGINEERING PROJECTS

Impacted Species

American Bittern
 American Black Duck
 American Oystercatcher
 Atlantic Brant
 Black-bellied Plover
 Black-crowned Night-Heron
 Black Rail
 Black Skimmer
 Black Tern
 Canvasback
 Caspian Tern
 Common Tern
 Dowitcher species
 Forster's Tern
 Great Black-backed Gull
 Great Blue Heron
 Great Egret
 Greater Yellowlegs
 Green Heron
 Gull-billed Tern
 King Rail
 Least Bittern
 Least Tern
 Little Blue Heron
 Laughing Gull
 Marsh Wren
 Northern Pintail
 Piping Plover
 Ruddy Turnstone
 Red Knot
 Roseate Tern
 Sanderling
 Saltmarsh Sharp-tailed Sparrow
 Seaside Sparrow
 Semipalmated Sandpiper
 Snowy Egret
 Tricolored Heron
 Willet
 Whimbrel
 Yellow-crowned Night-Heron
 Yellowlegs species

Barrier coasts are highly dynamic. Sand moves regularly by the forces of wind, rain, and tide. Some bird species like nesting shorebirds are dependent upon these shifting environments, and seek out vegetation-free open areas where the natural increase in vegetation over time has been set back by the natural movement of sand.

Hurricane Sandy moved millions of tons of sand and silt as she churned into the mid-Atlantic and northeastern United States. On natural barrier coasts, where development is lacking, the storm-driven water physically removed woody vegetation where shrubs and small trees had grown, exposing new open sand. In some cases this exposed sand will become high quality nesting habitat for rare beach-nesting species like Piping Plover, American Oystercatcher, and Least Tern. These exposed, vegetation-free areas are also sought out by migrant shorebirds and staging seabirds, where they can rest during high tide periods while not feeding. Understanding the many changes that resulted from Hurricane Sandy will take detailed investigations of the conditions where the changes occurred.

In contrast to natural barrier systems, large amounts of sand that is moved onto urban coasts as a result of storm surge usually end up where the sand is not wanted. Sand that is coveted on beaches is washed away, and can end up filling navigation channels for boating, covering coastal roads, and filling yards and driveways. Beach engineering projects that result from moving sand deposited where people do not want it can be very damaging to habitats for some species of birds. Best management practices for beach engineering projects need to be developed to so that the response to storms and the creation of beaches do not eliminate vital habitats for declining species of coastal birds.



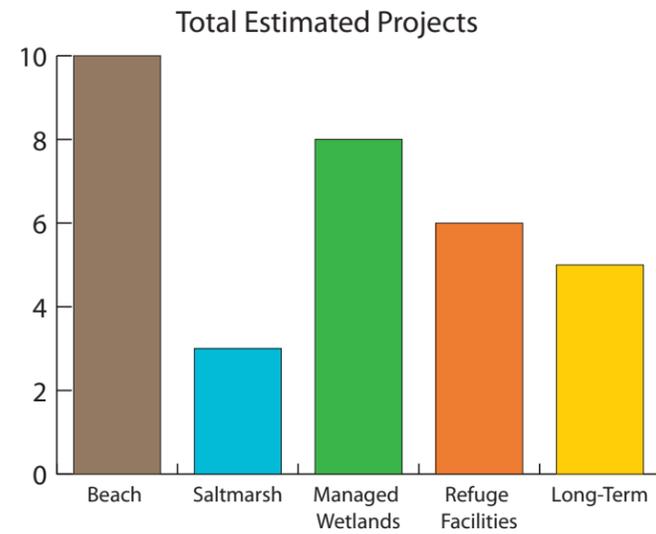
Damage to urban and built environments in New Jersey (USFWS) are devastating to both people and species like Whimbrel (Lynn Schmid).

OBJECTIVES

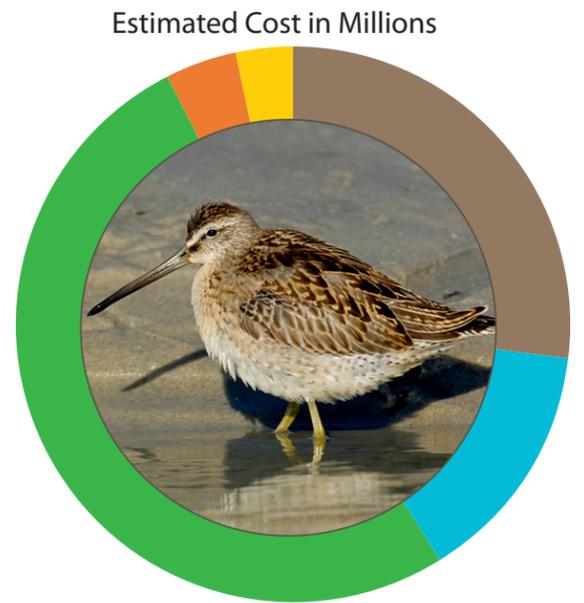
1. Develop Best Management Practices for coastal engineering efforts.
2. Conduct detailed assessments of long term changes in critical habitats to guide future conservation work.
3. Ensure lessons from the impacts and the response to hurricane Sandy are conveyed to appropriate agencies.
4. Understand how long term changes in climate will impact coastal conservation and plan for future impacts.

LONG-TERM & LARGE-SCALE ASSESSMENT PROJECTS					
Project	Type of Impact	Action	Location	Partners	Cost
Post Storm Response and Restoration Guidance for Beach Nesting Shorebirds, Migratory Shorebirds, and Their Habitats	Beach erosion, beach accretion, over-wash, changed dune configuration, beach scouring, vegetation removal	Coordinate with appropriate agencies for "restoration" efforts that have or are about begin in or adjacent to habitats for target shorebird species, develop a guidance document for restoration and recovery effort in areas of existing or newly created habitat	Atlantic Coast of NJ from Gateway National Recreation Area - Sandy Hook Unit to Cape May	CWFNJ	\$50,000
Development of database & map of coastal engineering projects within Atlantic Coast Flyway	Long Term: Learning from Sandy and planning for future storms	Compile existing engineering project information, determine impacts from engineering projects, develop decision tool for application of best management practices	Priority pilot projects at Cape Cod, Eastern Shore VA as control, with later expansion to more Atlantic Coast barrier islands, beaches, and shoals	ACJV, USACE Waterways Experiment Station; state coastal zone management programs; shorebird biologists & managers	\$100,000
Establishing state F&W agency jurisdiction over emerging sandbars following SC model	Facilitating responses to storm damage and creation of new sandbars	Agency land managers and legal staff develop agreements to manage new sandbars and intertidal areas around them	NJ, DE, NY, with wider application to other coastal states	State fish and wildlife agencies; AFWA; State lawyers &/or contracted legal team needed for project	\$300,000
Development of Best Management Practices (BMPs) for coastal engineering projects	Long Term: Learning from Sandy and planning for future storms	Develop comprehensive best management practices in cooperation with agencies that implement projects to guide coastal engineering work for best environmental outcomes	Entire impacted region, applicable to entire coast.	USACE; state coastal regulatory agencies; state wildlife agencies; shorebird researchers; coastal geologists; NGOs	\$200,000
Deploy Coastal Engineering Experts and Develop Agreements	Immediate reaction to storm can cause multiple additional environmental damage by improper techniques, sand borrow sites in sensitive areas, and vehicular damage, for example.	Deploy coastal engineering experts to work with various agencies and municipalities to develop agreements to use best management practices to guide coastal management and restoration.		USACE, state coastal regulatory agencies, state wildlife agencies, shorebird researchers, coastal geologists, NGO's	\$750,000

PROJECT TOTALS



The graph on the above left shows the number of projects submitted by partners for this final report which may increase as the extent of the damage becomes clearer. The pie chart on the right shows the costs for projects proposed by partners. Costs may increase as additional projects are identified.



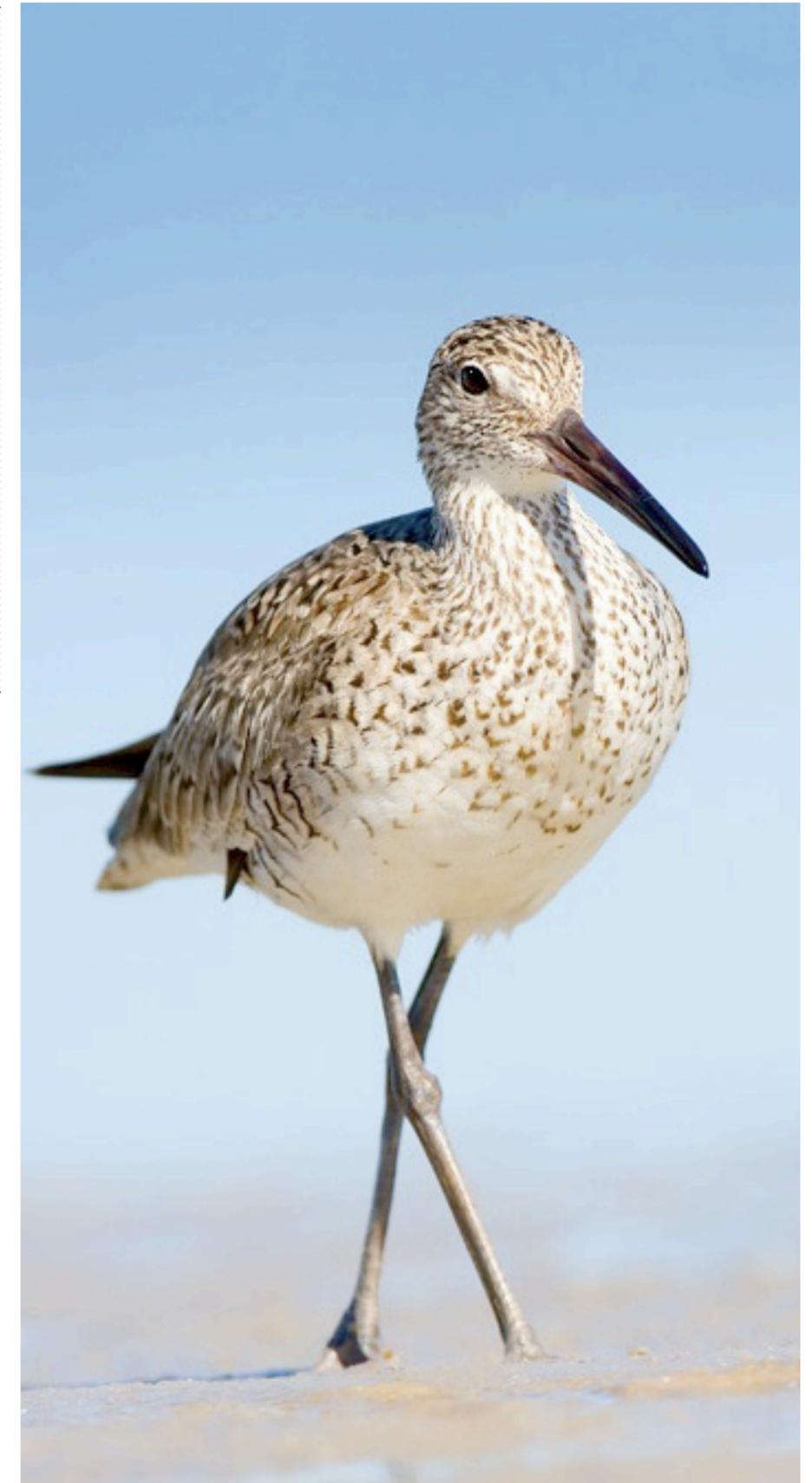
■ \$12.9	Beach
■ \$6.8	Saltmarsh
■ \$24.6	Managed Wetlands
■ \$1.9	Refuge Operating Procedures/Nesting Islands
■ \$1.4	Long-term & Large Scale



Road debris and over wash on Sachuest Point Road along the entrance to Sachuest Point National Wildlife Refuge (USFWS). The refuge shoreline is also an important place for migrating and wintering shorebirds, including Sanderlings (Jim Fenton).

ACKNOWLEDGMENTS

The material in this Final Report was compiled by Manomet Center for Conservation Sciences and the National Fish and Wildlife Foundation. The Foundation also provided major support to conduct the work involved. We are very grateful to the USFWS, Northeast Regional Office, for providing technical assistance and support. Key participants included staff from the Atlantic Flyway Shorebird Business Strategy, the North American Waterfowl Management Plan, and the North American Waterbird Conservation Plan. Input was received from the state and federal wildlife agencies throughout the affected region, along with many conservation groups. Special thanks go to L.J. Niles and Associates from New Jersey, and to the Connecticut Audubon Society, who provided in depth assessments in their respective states. We are particularly grateful for the many people who volunteered their time to assist with this assessment while also responding to the impacts of the hurricane.



Willet. William Majoros



