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Severe Marine Debris Event Report: Superstorm Sandy

Overview and Update to Congress | August 2013



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INTRODUCTION

This Severe Marine Debris Event Report provides an update on the activities federal agencies have undertaken to address marine debris associated with the October 2012 storm known as Superstorm Sandy as it made landfall in the United States. This event has been declared a Severe Marine Debris Event by the National Oceanic and Atmospheric Administration (NOAA). As required in the Marine Debris Act (33 U.S.C. 1951 et seq., as amended by Title VI of Public Law 112-213), NOAA is tasked with developing, in consultation with the Interagency Committee, interagency plans for the timely response to events determined by the Administrator to be severe marine debris events, including plans to: coordinate across agencies and with relevant state, tribal, and local governments to ensure adequate, timely, and efficient response; assess the composition, volume, and trajectory of marine debris associated with a severe marine debris event; and estimate the potential impacts of a severe marine debris event, including economic impacts on human health, navigation safety, natural resources, tourism, and livestock, including aquaculture. This report will serve as a comprehensive resource summarizing federal progress and involvement related to this effort, as of June 2013. This information is only a snapshot in time. Activities and efforts described in this report are ongoing and changing rapidly.

BACKGROUND

On Monday, October 22, 2012 a weather disturbance that developed south of Hispaniola became known as Tropical Storm Sandy, the 18th named storm of the Atlantic hurricane season. The storm's path turned and moved northward, making landfall in Jamaica on October 24 as a Category 1 hurricane. Upgraded to Hurricane Sandy, the storm further intensified into a Category 2 hurricane over the waters north of Jamaica and slammed into eastern Cuba at strong Category 2 intensity before weakening to a Category 1 hurricane to cross the Bahamas.

Conflicting models predicted that the storm would either then head out to sea once it was past the Bahamas, or move toward the Delaware and New Jersey coasts. These latter models ultimately proved to be correct, as Sandy began to take on a slight northwestward motion near the northern Bahamas instead of heading out to sea. On October 29, 2012, the coasts of New Jersey, New York, Delaware and Connecticut sustained a direct hit from the storm, which had once again been renamed as a "Superstorm," due to the combination of impact from offshore Atlantic waters with cold air flowing from the Arctic. Normally, according to NOAA's National Weather Service (NWS), a tropical storm like Sandy would weaken as it moved northward into cooler waters. A dip in the polar jet stream, however, fueled the storm once again to produce conditions that resembled a combination of hurricane and nor'easter, prompting the term "Superstorm."

This Superstorm, henceforth referred to as "Sandy," pummeled the coast with winds up to 115 mph, reaching over 820 miles with widespread storm surges, and left 285 fatalities in its path from the Caribbean Islands up the East Coast of the United States. Sandy became the most destructive tropical storm of the 2012 Atlantic Hurricane Season, as well as the largest Atlantic Hurricane on record, with winds spanning 1,100 miles.

In the United States, Sandy affected 24 states, including the entire Eastern Seaboard from Florida to Maine and west across the Appalachian Mountains to Michigan and Wisconsin, with particularly severe damage in New Jersey and New York. As its storm surge hit New York City, it flooded streets, tunnels and subway lines and cut power in and around the city. From there, Sandy took on another form, dumping snow across inland states such as West Virginia, Ohio and Kentucky, and later moved north into Canada. Damage in the United States alone has been estimated at over \$71 billion. Power outages, flooded transit systems, obliterated bridges, and decimated shoreline properties were left in its wake. Media coverage with images such as an iconic rollercoaster submerged in ocean waters off of the New Jersey shore have become forever linked with this storm.

IMPACT ASSESSMENT

As the devastation from Sandy was assessed, it became clear marine debris was an issue that would need to be addressed as part of the recovery effort for those states hardest hit. Not only does this marine debris pose potential hazards to navigation safety, commercial fishing grounds, and sensitive ecosystems, but a storm of such a magnitude as Sandy stirred up hazardous substances including paints, fuel, cleaners, and solvents from homes and sunken vessels. A combination of aerial, underwater, and shoreline surveys continue to be necessary to determine the quantity and location of marine debris in the impacted coastal areas of New Jersey and New York. These assessments allow federal agencies to estimate the debris' impact to ecosystems and economies and identify priority items for removal.

The nature of marine debris is such that the ecological impacts can vary depending on its type. As mentioned above, the types of marine debris assessed after Sandy includes a wide range of items. The storm caused large-scale destruction of both marine and land-based structures, resulting in debris of all sizes and types, including industrial, municipal, and natural, spread throughout the affected states. These items, combined with the aforementioned leaked contaminants, can produce significant hazards to human health and the environment. Marine debris in rivers, channels, and offshore Atlantic waters poses a significant hazard to navigation, vessels, fishing gear, and other equipment. After the storm, a number of waterways were closed due to the suspected presence of submerged debris, which stalled commerce in the region and caused further damage to the coastal economy.

The potential impacts of marine debris resulting from Sandy are varied and significant. The storm's winds and high waters pushed all sorts of debris from the barrier islands and Atlantic-facing shorelines into back bays and interior water bodies, where it is causing adverse impacts on both the physical and biological environment. Many wetland and fish habitats, migratory species breeding grounds, and nesting beaches are affected. The type of marine debris can impact habitats differently; items such as abandoned nets, plastic tarps, and small boats can smother or crush sensitive ecosystems and their bottom dwelling species. Fishing gear that was stored on barrier islands and pushed westward by Sandy into back bays has the potential to impact habitats and fisheries, capturing target and non-target species as well as local and migratory species, many of which are protected under the Endangered Species Act. Fishing line, nets, rope and other gear typical of a coastal human population can entangle, maim and even drown many wildlife species by encircling or ensnaring the animals. Entanglement can occur accidentally or when animals are attracted to the debris as part of normal behavior or out of curiosity. The impacts to species are not limited to just large debris items; smaller debris items such as bottle caps, lighters, and plastic pieces are also hazardous to wildlife. This debris can behave like and resemble food to animals. Once ingested, these materials can cause starvation and choking. There are potential indirect impacts to the environment associated with marine debris, as well. An impact of marine debris on shoreline habitats occurs on beaches as a result of debris removal efforts. Mechanical beach raking, accomplished with a tractor or human labor, is used to remove debris from the shoreline and can help to remove floatable material from beaches and marine shorelines. However, beach raking can also be harmful to aquatic vegetation, nesting birds, sea turtles, and other types of aquatic life. Natural storm events, such as Sandy, often mobilize existing submerged debris that was resting on the sea floor; once the ocean currents and wave energy are sufficient to move the item, the storm-mobilized debris can cause injury to various species and habitats as it moves throughout the water column.

In regard to navigation safety, debris from Sandy had adverse impacts on the many marinas, channels and waterways and nearshore areas that the region uses for commerce, shipping and fishing as well as recreation and tourism. Impacts to the boating and navigation community include damaged vessels, tangled fishing gear, and fouled anchor lines. After the storm, a number of waterways were closed due to the presence of submerged debris, which stalled commerce and tourism in the region and caused further damage to the coastal economy.

FEDERAL COORDINATION

In response to the widespread need for aid to recover from Sandy's impact, Congress approved a \$50.5 billion emergency relief measure to aid people whose homes were damaged or destroyed, as well as to business owners who suffered heavy losses. The supplemental funding will also pay for replenishing shorelines, repairing subway and commuter rail systems, fixing bridges and tunnels, and reimbursing local governments for emergency spending. Within this funding, \$50 million was designated specifically to NOAA for mapping, charting, geodesy services, and marine debris surveys for coastal states impacted by Sandy.

One of the lessons NOAA learned when surveying and mapping debris after Hurricane Katrina was the importance of strong relationships and clear communication between federal and state agencies. NOAA is a trusted name in the environmental response community, and its scientific support coordinators worked actively in the command posts with federal, state, and local responders immediately after Sandy made landfall. These pre-existing relationships within the response community provide great benefit to the complicated process of determining the quantity and location of marine debris in impacted coastal areas.

Due to differences in response activities across the states impacted by this storm, it is important to coordinate marine debris survey and response efforts at all levels of government. The NOAA Marine Debris Program (MDP) is using mapping tools and computer models to aid stakeholders in determining areas most likely to have accumulated submerged marine debris as a result of Sandy. This collaboration ensures that local priorities are represented in best management practices and contingency plans, which communities can use to reduce impacts in future events.

Efforts to address Sandy marine debris issues are underway. NOAA has conducted an initial analysis of pre-storm and post-storm imagery to build a rough baseline of impacts and performed shoreline assessments in order to map the locations of stranded items. Proactive efforts to address and prepare for marine debris removal in the states of highest impact include participating in public events, meetings, presentations and briefings to foster strategic partnerships, exchange data and raise awareness of the marine debris issue and the NOAA MDP itself, and to provide information to constituents in preparation for Sandy-related marine debris mitigation and removal. A subject matter expert from the NOAA MDP has met with many different federal, state, and local entities such as the American Littoral Society, Connecticut Department of Energy and Environmental Protection, Delaware Department of Natural Resources and Environmental Control, New Jersey Department of Environmental Protection, New York State Department of Environmental Conservation, and New York City Department of Parks and Recreation. Federal partners include the U.S. Coast Guard (USCG) U.S. Fish and Wildlife Service (USFWS) National Wildlife Refuge System, U.S. Environmental Protection Agency (EPA), Federal Emergency Management Agency (FEMA), U.S. Army Corps of Engineers (USACE), U.S. Geological Survey, and U.S. National Park Service (NPS).

NOAA's marine debris work overlaps with other NOAA offices (Office of Coast Survey's hydrographic mapping, National Geodetic Survey's shoreline mapping, Coastal Services Center's coastal resiliency efforts) and the impacted NPS lands, USFWS Refuge System, EPA regional response teams, USCG pollution and navigation response, and the USACE federally maintained channels. NOAA is identifying opportunities to incorporate marine debris efforts in other agencies' activities to streamline and avoid

duplication where possible. NOAA has historically provided environmental guidance and review for survey and removal operations after hurricanes in the United States and has established best practices to ensure hydrographic surveying is as efficient as possible and minimize the collateral harm caused by removal actions. NOAA is working with all relevant stakeholders to revise existing best practices to reflect the regional environments and challenges associated with the marine debris in the Sandy-affected regions.

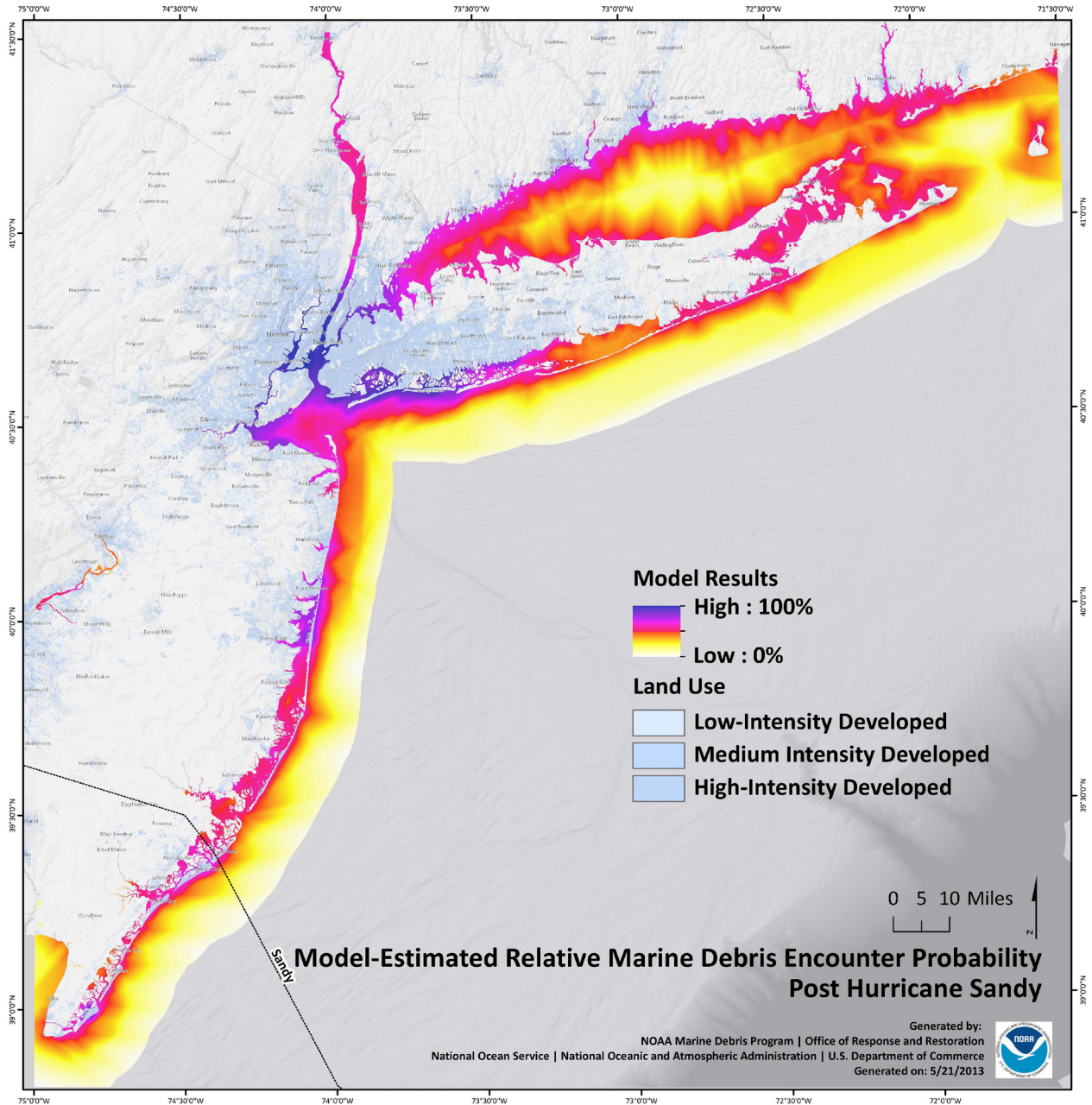


Figure 1: Graphic output of a model-estimated relative marine debris encounter probability.

NOAA has worked with Research Planning, Inc. (RPI) to update an existing marine debris dispersion model (Figure 1) created for the Gulf of Mexico coast after Hurricane Katrina to be relevant and specific to the Sandy impact areas. The model predicts spatial differences in density of marine debris after Sandy made landfall by statistically relating those differences to other available data sets, such as the location

of damaged infrastructure, wind speeds, storm surges, distance to land, and water depth. The model will assist prioritization of areas for future hydrographic surveys and ultimately marine debris removal, using debris aggregation probability predictions as a basis for prioritization. The extent of this effort includes coastal areas along the Atlantic Ocean including Delaware, New Jersey and New York City from the Long Island Sound into Connecticut.

In an attempt to efficiently use limited resources, federal and state agencies are coordinating new mapping efforts through an online planning tool to eliminate redundant surveys and produce information that will be used to create products vital to coastal resource managers and safe navigation. Specifically, NOAA is conducting shallow water hydrographic surveys in areas impacted by Sandy from North Carolina to Maine that will be combined with bathymetric and topographic shoreline LiDAR (a remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light) and used to update nautical charts and supply valuable spatial data to decision makers in the coastal zone.

NOAA is updating its current Environmental Sensitivity Index (ESI) Maps to areas impacted by Sandy, which will be used as planning aids and during future coastal hazard events. ESI enhancements will also leverage the relevant survey data, LiDAR shoreline and aerial imagery collected in this effort, as mentioned above.

Specific to marine debris, NOAA-funded surveys will be used to detect and classify submerged marine debris in areas affected by Sandy. NOAA and its partners are conducting analysis of pre-storm and post-storm imagery to build a rough baseline of impacts with emphasis on the Atlantic seaboard, New York Harbor, Long Island Sound and Barnegat Bay. As new survey data become available throughout the region, local, state and federal partners will begin prioritizing debris items for removal and developing debris disposal options. NOAA will also develop documents that describe best practices for removal of debris (e.g., boats, tanks, construction debris) from sensitive habitats. NOAA will assist regional partners

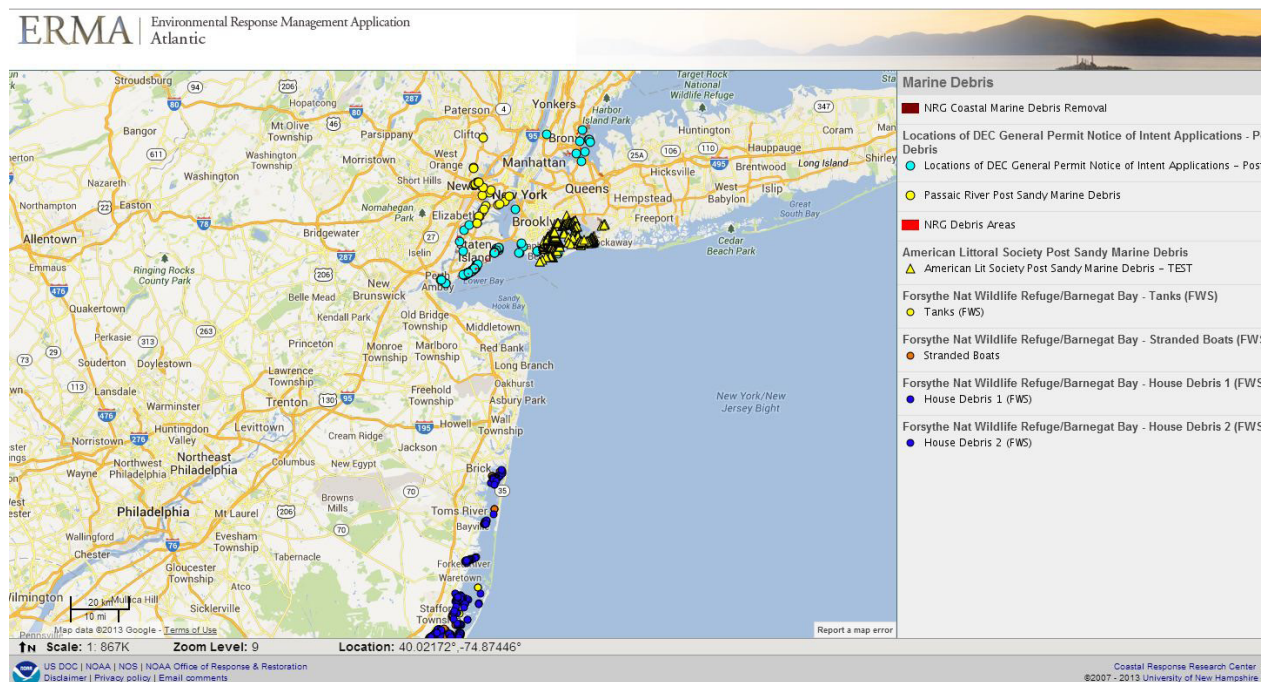


Figure 2: NOAA's Environmental Response Management Application (ERMA) used to display environmental data and present a common operational picture for Sandy-related spatial data.

Photo Credit: U.S. Fish & Wildlife Service



Figure 3: Aerial view of debris at Edwin B. Forsythe National Wildlife Refuge left by Sandy

Photo Credit: U.S. Fish & Wildlife Service



Figure 4: These derelict vessels at Edwin B. Forsythe National Wildlife Refuge were washed away from a nearby marina during Sandy.

to develop contingency plans for severe marine debris events on the East Coast resulting from natural disasters in the future.

NOAA, through its partnership with the Integrated Ocean and Coastal Mapping (IOCM) Production Center at the University of New Hampshire, will work with marine debris mapping experts to process sonar and LiDAR data to identify submerged marine debris objects. Information about detected items, such as location, size, density and clearance from the water's surface will then be loaded into NOAA's Environmental Response Management Application (ERMA), a geographic information system used to produce maps, graphics, and spreadsheets that will be important information as regional partners determine removal prioritization (Figure 2). As these data are being gathered, NOAA will develop a list of best practices and standard operating procedures (SOPs) for processing the various data types to identify submerged marine debris. These SOPs will be used in future sonar and LiDAR debris detection processing efforts.

EPA continues to support FEMA and work closely with federal agencies and the states of New Jersey and New York to protect the public's health and the environment through multiple activities. Since Sandy made landfall, EPA worked to assess damage and respond to environmental concerns. EPA assessed the condition of drinking water and wastewater facilities, helped to get several damaged wastewater treatment plants in New Jersey up and running, evaluated conditions at hazardous waste sites and assisted in the collection of debris and household hazardous waste. EPA also continues to provide information to the public about cleaning up after flooding, mold, and the safe disposal of household hazardous waste.

In May 2013, the EPA announced that it will provide grants of \$340 million to New York and \$229 million to New Jersey for improvements to wastewater and drinking water treatment facilities impacted by Sandy. The funding will help storm-damaged communities in both states as they continue to recover from the damage.

The USFWS has been responding to significant damage on coastal national wildlife refuges (NWRs) in North Carolina, Virginia, Maryland, Delaware, New Jersey, New York (Long Island), Connecticut, and Rhode Island. These impacts include damaged buildings and visitor facilities, washed out roads and parking lots, damage and loss of coastal protection structures (e.g. bulkheads, levees, dunes), and severely degraded wildlife habitat. Below are some short summaries of the significant debris issues faced by these refuges.

The entire 47,000-acre Edwin B. Forsythe NWR, located near Atlantic City, NJ, was directly impacted by Sandy (Figures 3 & 4). The storm surge washed over the refuge, leaving a 22-mile wide path of damage and debris. A USFWS-operated helicopter conducted aerial surveys following the storm and documented large amounts of debris on beaches, in sensitive salt marsh habitats, and far into some forested areas several miles from any waterways. Debris includes downed trees, lumber, appliances, glass, drums of unknown contents, trash, and at least 176 boats that were washed from nearby marinas. Some of the derelict boats and other debris are leaking fuel and other contaminants and may present hazards to refuge staff, visitors, and wildlife. Debris on the deCamp Wildlife Trail is obstructing stream flow and preventing some marine organisms from moving between the salt marsh and open water.

The Chincoteague NWR on the Eastern Shore of Virginia received debris in parking lots, roadways, trails, and the refuge's administrative and housing areas. A large amount of debris also remains on the public

access beach that is used by over a million visitors during the summer months.

Sandy deposited debris in environmentally sensitive marsh areas along 6.5 miles of USFWS coastal lands within the Long Island NWR Complex, which includes Wertheim, Target Rock, Oyster Bay, Seatuck, and Conscience Point, and Lido Beach NWRs (Figure 5). The debris includes refrigerators, propane tanks, and boats. Some debris may be hazardous or contain contaminants that could pose risks to refuge visitors and refuge staff conducting management activities.

The Stewart B. McKinney NWR in Connecticut received large amounts of shoreline debris by storm floodwaters. Some debris poses significant contaminant issues.

At the Rhode Island NWR Complex, debris must be removed from 5,000 feet of shoreline in order to return the areas to conditions suitable to provide feeding and resting areas for thousands of shorebirds, wading birds, and waterfowl.

Photo Credit: U.S. Fish & Wildlife Service



Figure 5: Aerial view of debris at Edwin B. Forsythe National Wildlife Refuge left by Sandy.

The USFWS's Region 5 has estimated that debris removal from these impacted refuges will cost approximately \$23 million. A debris removal effort is in progress to eliminate serious safety hazards and potential liability to the USFWS and return these refuges to their pre-hurricane condition. However, this task will be difficult and expensive considering that some impacted areas are only accessible by boat or are in remote marshes and forests. Debris removal activities may also further impact sensitive habitats and disturb nesting birds and other wildlife.

Sandy impacted 23 National Park System units on the Atlantic Coast with over 2,200 miles of shoreline. The NPS mobilized quickly to assess damage from heavy winds, tidal surge, high waves and flooding, and to protect and restore damaged park resources. Critical infrastructure systems, facilities and historic sites sustained heavy damage, including buildings, roads, docks, bulkheads, parking lots, water, sewer, electrical, and mechanical systems, particularly in the New York – New Jersey Bight where the storm made landfall. Sandy deposited thousands of tons of debris on park shorelines and sensitive wildlife habitats including beaches, back bays and wetlands. Marine debris ranged from automobile tires and plastics to damaged or destroyed buildings, infrastructure, and recreational vessels. Some NPS park units also experienced extreme beach erosion and the deterioration of natural shoreline features, including dunes that provide storm protection. NPS removed marine debris and repaired and restored heavily visited areas in time to reopen for the Memorial Day weekend and the summer season, including the

Statue of Liberty and access to recreation beaches in several parks. However, long-term removal, restoration and repair efforts continue. Examples of parks impacted by debris include:

Gateway National Recreation Area (NY-NJ) – Significant impacts at Gateway National Recreation Area include common marine debris as well as damaged or destroyed housing and infrastructure near shorelines.

For example, at the fishermen’s access in Jamaica Bay, NY, a deck from a private residence washed hundreds of feet inland onto the parking lot road (Figure 6). On April 27, 2013, over 700 volunteers collected 80 tons of debris at Sandy Hook, NJ. Since the first post-Sandy volunteer project on December 1, 2012, more than 1,700 volunteers have dedicated 6,250 hours to restore numerous parts of the park.

Photo Credit: National Park Service



Figure 6: Residential deck and other debris - Gateway National Recreation Area, Jamaica Bay, NY.

Fire Island National Seashore (NY) – There is damage to the natural dune landscape and breaches to barrier islands along the seashore’s 94 miles of coastline. In addition to restoring and monitoring natural resources, extensive debris cleanup and repair has been necessary to restore many recreational areas, including beaches, boardwalks, and access to these areas (Figure 7).

Assateague Island National Seashore (MD-VA) – Automobile tires washed onto the seashore beaches (FIGURE 8). The barrier island sustained heavy flooding and overwash, which deposited sand and debris onto park roads and parking lots and damaged visitor facilities. Assateague Island National Seashore had previously installed movable, solar-powered bath houses and a parking lot with a low-impact, clamshell surface to reduce vulnerability to storms. Before Sandy’s onset, NPS biological technicians and staff from the Marine Animal Rescue Program at the National Aquarium in Baltimore saved two live hatchlings and 160 eggs from a loggerhead sea turtle nest for incubation at the Animal Rescue Center.

Cape Hatteras and Cape Lookout National Seashores (NC) – Seashores on the Outer Banks of North Carolina sustained damage from tidal flooding and overwash from Sandy to beaches, facilities and to Portsmouth Village, an historic fishing village at Cape Lookout National Seashore listed on the National Register of Historic Places. Marine debris deposition included typical debris as well as portions of damaged or destroyed residences and piers that washed into the ocean along Cape Hatteras.

The USCG and EPA have addressed vessels that pose a pollution threat or a hazard to navigation and the USACE have addressed vessels that are in federally maintained channels. Under certain circumstances, FEMA is funding removal and disposal of eligible disaster-generated debris. But there are many vessels and debris items that do not meet the requirements for removal by those agencies. Removal of marine debris in areas not controlled by federal regulations can be performed by contractors, fishers, and/or commercial boat operators, which will create economic opportunities for local businesses. NOAA

typically partners with these groups to provide technical expertise and coordination for removal activities.

Photo Credit: National Park Service



Figure 7: Debris stacked for removal - Fire Island National Seashore.

Photo Credit: National Park Service



Figure 8: Automobile tires on beach - Assateague Island National Seashore.

SANDY DEBRIS REMOVAL EFFORTS IN AFFECTED STATES

One of the most pressing needs when addressing human-related marine debris dispersion caused by a major storm is to assess and verify debris locations. Knowing where high densities of marine debris are likely to be found greatly assists in developing survey priorities and in planning for debris removal. Models that predict marine debris densities may also be very useful to federal and state managers in dealing with marine debris.

Many data points of debris items throughout Connecticut, Delaware, New Jersey and New York have been identified in the time since Sandy made landfall. Some of those debris items have been removed, but a great deal are still on land, stranded in marshes, or remaining submerged below the water's surface. Federal, state and local agencies continue to locate debris and track items found in disparate spatial data platforms, but it is very challenging to know where concentrations of debris exist due to the lack of a source of centralized information. NOAA has the experience and opportunity to provide this service of centralizing marine debris information, which will improve the overall efficiency of prioritization and removal of the debris.

The challenge that a Significant Marine Debris Event of this nature poses, due to the widespread range of impact, is the different ways in which debris mitigation and remediation occur within and among the states hardest hit. Some states, such as New Jersey, are addressing marine debris issues through a single state agency, whereas others such as New York are addressing debris through many different state, city, and county agencies. In addition, land ownership and management within the coastal zone of the impact area is very diverse. Multiple federal and state agencies hold or manage significant areas of shoreline, as do private organizations. Generally, with some exceptions, the parties with jurisdiction over a coastal area have the authority to determine how or whether to proceed if marine debris is found in that area. For example, the agency or private landowner would have the authority to decide who can access the land to survey or clean up marine debris and what equipment or methods may be used. Anyone considering or planning a marine debris response action, such as a debris removal operation, must know who has jurisdiction over the land where the debris is located, must secure any required permits, and must coordinate with the land owner or manager prior to entry and removal operations.

SUMMARY

This document was developed as a comprehensive resource summarizing federal progress and involvement related to this effort as of June 2013. It seeks to describe coordination and planning between federal, state, local, and tribal agencies and organizations by describing the actions of federal agencies that are currently involved in Sandy marine debris issues. It is important to note once again that this information is only a snapshot in time. Activities and efforts described in this report are ongoing and changing rapidly.

To date, federal agencies have undertaken a variety of actions related to marine debris in preparation for removal activities, from mapping to site visits and surveys to public outreach. Field observations from monitoring sites, aerial surveys, citizen science reports, and other sources also add to the understanding of the issue of Sandy debris along U.S. shores. Continued coordination is essential, and it is imperative that we continue to approach this issue by understanding and addressing the problem as a whole. To do this, all relevant federal agencies will continue to address the problem in partnership with state and local organizations.

