

Scientific Support Teams for Pollution Response

The Office of Response and Restoration (OR&R) embedded scientific support coordinators in U.S. Coast Guard Incident Command Centers to assist hazardous materials response efforts in areas impacted by all three hurricanes. The office tracked thousands of vessels with the potential to leak fuel, oil, or other hazardous materials. The office also provided guidance on marine debris and vessel salvage, classified potential targets using aerial imagery, provided environmental consultations for marine debris, and coordinated with local responders.

OR&R also deployed its Environmental Response Management Application, or ERMA®. This online mapping tool integrates key information to provide a common operating picture and situational awareness in the areas impacted by the hurricanes.

Rebuilding and Recovery

The Office for Coastal Management hosts the online Digital Coast platform, providing coastal communities with information and resources including LIDAR, elevation, and land cover data as well as risk and vulnerability assessments. This office is working with state coastal management programs, research reserves, and Sea Grant programs to identify additional needs and opportunities for programmatic and environmental permitting assistance that could hasten short- and long-term recovery.

Through its Ecological Effects of Sea Level Rise Program, the National Centers for Coastal Ocean Science is funding research to develop a modeling tool to predict how barrier islands and sand dunes function and recover following storms. This will improve evaluations of how these natural and managed islands recover from storms and change through time under different sea level rise and management scenarios. The goal is to better inform coastal communities on how to maximize the ecological and societal benefits of these habitats.

Hurricane Irma passed directly through the Florida Keys, impacting Office of National Marine Sanctuaries facilities and vessels. NOS staff embarked on a collaborative effort to evaluate natural resources and joined with other federal and state agencies to assess vessels posing environmental and navigational hazards.

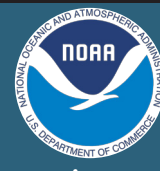
Field crews from the Center for Operational Oceanographic Products and Services continue to assess the damage to NOAA's water level stations throughout the impacted areas and provide minor repair where possible. The office is also providing extreme water level data to NOAA's National Weather Service to support refining their models and forecasts and help determine high water mark information.

Looking Ahead

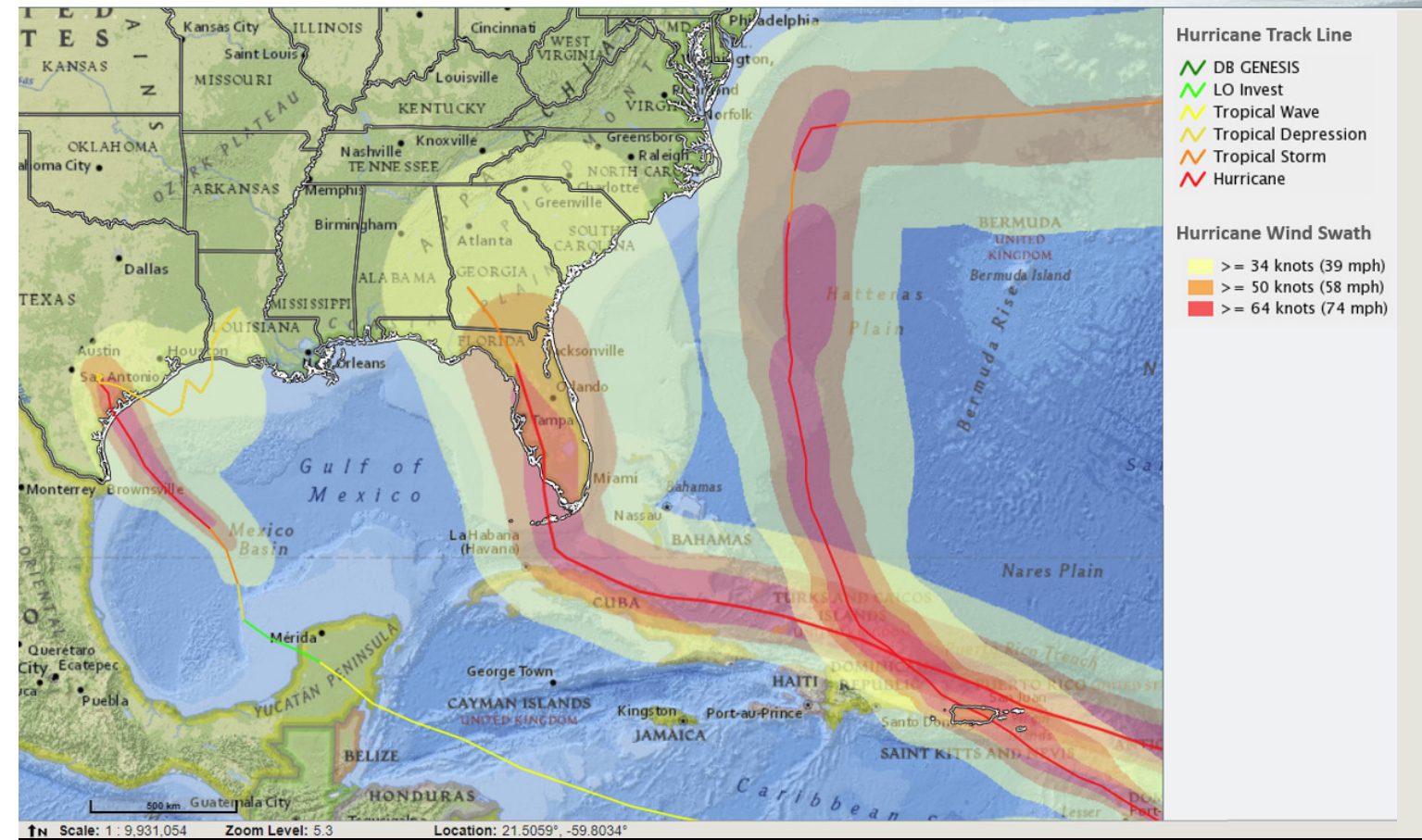
Following these storms, Hurricane Nate brought rain, wind, and damage to the central Gulf Coast. With the potential for additional storms throughout the 2017 hurricane season, NOS stands ready to respond as needed. Details about potential future response activities will be posted on the NOS website.



NOAA Ship *Thomas Jefferson* delivered supplies to the National Weather Service at the U.S. Coast Guard small boat pier in San Juan and provided equipment to repair the NOAA tide gauge station. The vessel then traveled to Ponce, Roosevelt Roads, and Bahia de Puerca on the island's southern shores, where Office of Coast Survey hydrographers conducted surveys to locate hazards to navigation and help the ports resume operations.



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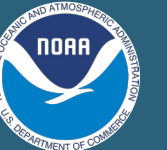
The Environmental Response Management Application (ERMA®), an online mapping tool that provides a common operating picture for emergency responders and decision makers, shows the wind swaths and tracks of Hurricanes Harvey, Irma, and Maria.

Hurricanes Harvey, Irma, and Maria:

The National Ocean Service Helps Communities Prepare, Respond, and Recover

On August 9, NOAA issued its 2017 hurricane season outlook update. Forecasters predicted a higher likelihood of an above-normal season and they increased the predicted number of named storms and major hurricanes. In the following weeks, three major hurricanes—Harvey, Irma, and Maria—impacted the United States. The impacted communities are just starting to recover from storms that resulted in tragic loss of life and billions of dollars in damage.

Before, during, and after these storms—as with all major hurricanes that impact the United States—the National Ocean Service (NOS) provides products, tools, and services to help emergency responders, coastal planners, individuals, and businesses make decisions to save lives, protect property, and mitigate damage.



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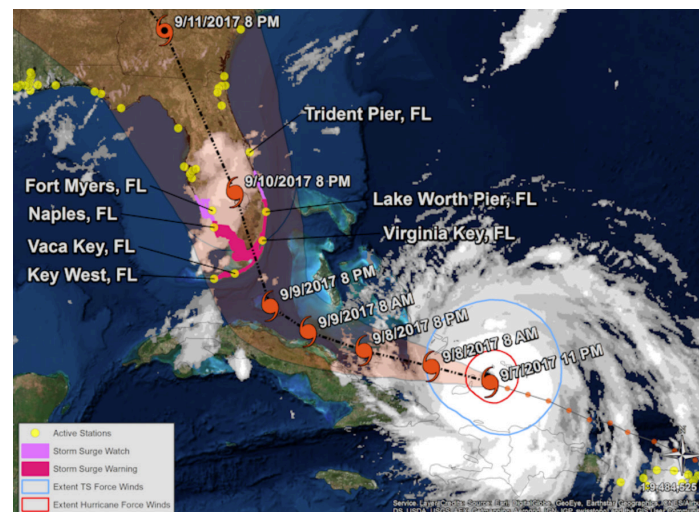
Preparing for Hurricanes

The Office for Coastal Management provided the elevation models and sea level rise data needed to develop storm surge forecast maps. Along with the Office of Response and Restoration, they also held disaster planning workshops to help organizations develop disaster response plans. Hurricane Harvey dealt a severe blow to Texas's Mission-Aransas research reserve, for instance, but the preparation efforts paid off and helped protect staff, reduce damages, and expedite post-storm response efforts. The Center for Operational Oceanographic Products provided water level information to NOAA's National Weather Service in advance of the storms to support storm surge forecasts.

Near Real-time Oceanographic and Meteorological Observations

The Center for Operational Oceanographic Products and Services provided its Storm QuickLook product before and during Hurricanes Harvey, Irma, and Maria. QuickLook provides a synopsis of near real-time ocean and weather observations at specific water-level stations affected by a tropical storm. The office's hurricane-hardened stations ensured that this real-time information was available when most needed.

The U.S. Integrated Ocean Observing System (IOOS®) worked closely with its Caribbean (CARICOOS), Gulf of Mexico (GCOOS), and Southeastern U.S. (SECOORA) regional associations to provide ocean observations before, during, and after all three storms with equipment such as high-frequency radars and gliders. Data collected by these regional associations helps to improve future hurricane forecasting.



Storm QuickLooks provide near real-time ocean and weather observations.

Coordinating Response Efforts

Before Hurricane Harvey made landfall, NOS dispatched a coastal advisor to FEMA's National Response Coordination Center. This expert helped FEMA to coordinate delivery of NOS services to support responses to Hurricanes Harvey, Irma, and Maria. Throughout the duration of these storms, the Office of Response and Restoration also led daily calls on the coordination of preparedness and response efforts. The office is home to the NOAA Gulf of Mexico Disaster Response Center in Mobile, Alabama, which hosts trainings, drills, and workshops with and for partners while enhancing NOAA's coordination and emergency planning to conduct an organized and effective response.



Damage to facilities at the Mission-Aransas National Estuarine Research Reserve following Hurricane Harvey.

Aerial Imagery for Damage Assessment

As soon as weather permitted, the National Geodetic Survey (NGS) began aerial survey missions to assess damages to areas affected by the hurricanes. The data and images NGS collected were rapidly processed and provided to emergency and coastal managers, often within hours of collection. The information was used to develop recovery strategies, facilitate search-and-rescue efforts, identify hazards to navigation and HAZMAT spills, locate errant vessels, and provide documentation necessary for damage assessment.

Hurricane Harvey

From August 27 - September 3, 2017, NGS collected 25,560 images covering more than 16,000 square kilometers of Texas that included Corpus Christi and Back Bay areas; Houston and suburbs; Galveston; Liberty; and Beaumont.



NOS collected more than 65,000 images following Hurricanes Harvey, Irma, and Maria. This image shows St. John, U.S. Virgin Islands.

Hurricane Irma

From September 11 - 18, 2017, NGS collected 23,915 images covering more than 5,800 square kilometers of impacted area including the Florida Keys, Naples, Fort Myers, Jacksonville, and Tampa in Florida as well as Savannah, Georgia, and Charleston, South Carolina.

Hurricane Maria

From September 22 - 26, 2017, NGS collected 15,373 images covering more than 1,900 square kilometers that included Puerto Rico and the U.S. Virgin Islands.

Hydrographic Surveys to Reopen Ports

As the storms approached, the Office of Coast Survey (OCS) regional navigation managers were embedded at U.S. Coast Guard Incident Command Centers to coordinate post-storm surveys and other support. Immediately following the hurricanes, OCS navigation response teams (NRTs) and the mobile integrated survey team (MIST) provided emergency hydrographic services for affected port areas. These emergency response teams use echo sounders to detect submerged obstructions and areas of shoaling that pose hazards to the delivery of emergency supplies and maritime commerce. The U.S. Coast Guard relies on these quick-response surveys to make decisions on reopening ports.

Hurricane Harvey

OCS surveyed the Texas ports of Corpus Christi and Seadrift/Matagorda and provided survey support toward the reopening of ports in Houston and Galveston. The Office of National Marine Sanctuaries provided the R/V *Manta* as a vessel of opportunity for MIST survey operations.

Hurricane Irma

OCS surveyed and supported the reopening of ports in Tampa, Miami, and Key West, Florida.

Hurricane Maria

OSC deployed the MIST and NOAA Ship *Thomas Jefferson* to the Caribbean. As of October 13, 2017, 14 locations and 19 port facilities were surveyed to support port reopenings in Puerto Rico and the U.S. Virgin Islands.

The Center for Operational Oceanographic Products and Services supported these efforts. For example, during Hurricane Irma, the office provided updates on the operations of water level gauges and tide coordination for emergency hydrographic surveys conducted within Miami, Tampa, Key West, and Savannah.



View of the first fuel ship entering the Port of Tampa after Hurricane Irma, taken by a NOAA navigation response team surveying the area.