PROGRESS MADE IN IMPLEMENTING THE OCEAN AND COASTAL MAPPING INTEGRATION ACT 2014 – 2016

PRODUCT OF THE

National Science and Technology Council

December 2016

EXECUTIVE OFFICE OF THE PRESIDENT

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

WASHINGTON, D.C. 20502

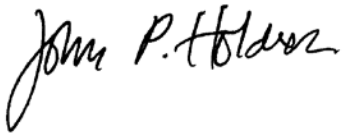
December 19, 2016

Dear Colleagues:

I am pleased to transmit to you *Progress Made in Implementing the Ocean and Coastal Mapping Integration Act: 2014–2016*, a report to Congress in response to requirements in the Omnibus Public Land Management Act of 2009 (P.L. 111-11), specifically the Ocean and Coastal Mapping Integration Act (P.L. 111-11, Title XII, Subtitle B). This legislation calls for "a report detailing progress made in implementing this subtitle." The report Appendix contains the full text of the reporting requirements.

The Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM) of the Subcommittee on Ocean Science and Technology, organized under the National Science and Technology Council; Committee on Environment, Natural Resources, and Sustainability, produced this report. In accordance with the Ocean and Coastal Mapping Integration Act, the IWG-OCM is enhancing coordination of ocean and coastal mapping to more effectively and efficiently provide stakeholders and the public with comprehensive geospatial information in these economically and environmentally important areas.

Sincerely,



John P. Holdren
Assistant to the President for Science and Technology
Director, Office of Science and Technology Policy

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The National Science and Technology Council (NSTC) is the principal means by which the Executive Branch coordinates science and technology policy across the diverse entities that make up the Federal research and development (R&D) enterprise. One of the NSTC's primary objectives is establishing clear national goals for Federal science and technology investments. The NSTC prepares R&D packages aimed at accomplishing multiple national goals. The NSTC's work is organized under five committees: Environment, Natural Resources, and Sustainability; Homeland and National Security; Science, Technology, Engineering, and Mathematics (STEM) Education; Science; and Technology. Each of these committees oversees subcommittees and working groups that are focused on different aspects of science and technology. More information is available at www.whitehouse.gov/ostp/nstc.

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The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976. OSTP's responsibilities include advising the President in policy formulation and budget development on questions in which science and technology are important elements; articulating the President's science and technology policy and programs; and fostering strong partnerships among Federal, State, and local governments, and the scientific communities in industry and academia. The Director of OSTP also serves as Assistant to the President for Science and Technology and manages the NSTC. More information is available at www.whitehouse.gov/ostp.

About the Subcommittee on Ocean Science and Technology

The purpose of the Subcommittee on Ocean Science and Technology (SOST) is to advise and assist on national issues of ocean science and technology. The SOST contributes to the goals for Federal ocean science and technology, including developing coordinated interagency strategies, and fosters national ocean science and technology priorities, including implementation of the National Ocean Policy.

About the Interagency Working Group on Ocean and Coastal Mapping

Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM) advises and assists the SOST on matters related to ocean and coastal mapping, including coordination of Federal activities on ocean and coastal mapping and other interagency activities as described in the Ocean and Coastal Mapping Integration Act of 2009 (P.L. 111-11, Title XII, Subtitle B).

About this Document

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Executive Summary

The Ocean and Coastal Mapping Integration Act of 2009 (OCMIA, P.L. 111-11, Title XII, Subtitle B) calls for intra- and interagency coordination of Federal ocean and coastal mapping programs. Section 12204 of the OCMIA states that the Subcommittee on Ocean Science and Technology (SOST), organized under the National Science and Technology Council Committee on Environment, Natural Resources, and Sustainability, shall transmit a biennial report to the Committees on Commerce, Science, and Transportation and Energy and Natural Resources of the Senate and the Committee on Natural Resources of the House of Representatives detailing the implementation of OCMIA.

The SOST's Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM) produced this report, which captures Federal ocean and coastal mapping activities from 2014 to 2016. The IWG-OCM is co-chaired by the United States Army Corps of Engineers, the National Oceanic and Atmospheric Administration, and the United States Geological Survey. The IWG-OCM coordinates a broad range of ocean and coastal mapping expertise and activities (from project planning and acquisition to data archive) across Federal agencies, as well as with states, tribes, local governments, and other contributing organizations. IWG-OCM agencies are heavily involved in mapping the United States coastal zone to support applications that range from shoreline mapping and nautical charting to regional sediment management, storm and flood vulnerability analysis, sea-level change, coastal-zone management, fishery management, and other coastal-science investigations.

Key accomplishments include progress in supporting efficient acquisition, management, and dissemination of data; improving mapping technologies; and pursuing other efforts to improve the Nation's ability to meet ocean and coastal mandates. A number of highlighted activities were made possible through one-time supplemental funding for the recovery effort after Post-Tropical Cyclone Sandy, (e.g., analysis and products developed from the mapping data acquired, continued coordination through the United States Federal Mapping Coordination site, and sand/gravel mapping data rescue and visualization). IWG-OCM agencies have expanded Federal interagency coordination with terrestrial mapping counterparts and broadened outreach to state, academia, and private sector partners through use of web-based planning tools to facilitate data acquisition, data access and data mining.

Introduction

The Subcommittee on Ocean Science and Technology (SOST), organized under the National Science and Technology Council Committee on Environment, Natural Resources, and Sustainability, established the Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM) in 2006 to facilitate the coordination of ocean and coastal mapping activities and avoid duplicating mapping activities across the Federal sector as well as with non-Federal mapping interests. Congress codified this coordination effort with the Ocean and Coastal Mapping Integration Act of 2009 (OCMIA, P.L. 111-11, Title XII, Subtitle B), which also established biennial reporting requirements to detail progress made in implementing OCMIA (see Appendix).

The IWG-OCM coordinates a broad range of ocean and coastal mapping expertise and activities (e.g., project planning and acquisition, data archiving) across Federal agencies and with states, tribes, local governments, and other contributing organizations. IWG-OCM agencies are heavily involved in mapping the United States coastal zone to support applications that range from shoreline mapping and nautical charting to regional sediment management, storm and flood vulnerability analysis, sea-level change, coastal-zone management, fishery management, and other coastal-science investigations. The United States Army Corps of Engineers (USACE), the National Oceanic and Atmospheric Administration (NOAA), and the United States Geological Survey (USGS) co-chair the IWG-OCM, which also includes members from the Bureau of Ocean Energy Management (BOEM), the United States Naval Oceanographic Office (NAVO), the United States Coast Guard (USCG), the United States Environmental Protection Agency (EPA), the United States Fish and Wildlife Service (USFWS), the National Park Service (NPS), the National Science Foundation (NSF), Federal Emergency Management Agency (FEMA), National Geospatial-Intelligence Agency (NGA), and the National Aeronautics and Space Administration (NASA).

This report, as required by Section 12204 of OCMIA, describes the diverse Federal ocean and coastal mapping programs and explains the efforts of the IWG-OCM to ensure effective intra- and interagency mapping coordination from 2014–2016. The report is organized into sections corresponding to the 13 subsections of OCMIA Section 12204.

Table 1 provides an overview of IWG-OCM progress made through 2016 on the 13 reporting requirements outlined in the OCMIA. Details on accomplishments made in the 2014–2016 reporting period are organized according to the reporting requirement subsection (i.e. Section 12204 (1)) for ease of reference.

Table 1. Summary of Ocean and Coastal Mapping Integration Act Implementation 2014–2016

Reporting Requirements, Section 12204	Updates on the Requirement Provided in this Progress Report Covering 2014–2016	More information on Page
(1) an inventory of ocean and coastal mapping data within the territorial sea and the exclusive economic zone and throughout the Continental Shelf of the United States, noting the age and source of the survey and the spatial resolution (metadata) of the data	U.S. Federal Mapping Coordination site (fedmap.seasketch.org) U.S. Interagency Elevation Inventory (NOAA, USGS, and FEMA) web-mapping resource: https://coast.noaa.gov/inventory/ Preparation of metadata guidance and vocabulary document for data discoverability in Data.gov and geoplatform.gov.	6

Reporting Requirements, Section 12204	Updates on the Requirement Provided in this Progress Report Covering 2014–2016	More information on Page
(2) identification of priority areas in need of survey coverage using present technologies	Gulf of Mexico Eastern Seaboard Alaska West coast estuaries, including Puget Sound Pacific Island territories Pearl Harbor Marine National Monuments in Pacific region	7
(3) a resource plan that identifies when priority areas in need of modern ocean and coastal mapping surveys can be accomplished	Resources and requirements for Federal ocean and coastal mapping data acquisition	9
(4) the status of efforts to produce integrated digital maps of ocean and coastal areas	Examples of integrated digital maps: NOAA topobathymetric Digital Elevation Models for tsunami modeling NOAA and USGS high-resolution regional topobathy Digital Elevation Models, sea level rise and coastal flooding impacts maps (https://coast.noaa.gov/slr/ NOAA incorporation of U.S. Army Corps of Engineers (USACE) and other external data to nautical charts California Seafloor Mapping Program map series	18

Reporting Requirements, Section 12204	Updates on the Requirement Provided in this Progress Report Covering 2014–2016	More information on Page
(5) a description of any products resulting from coordinated mapping efforts under this subtitle that improve public understanding of the coasts and oceans, or regulatory decision making	NOAA data and tools on Digital Coast: www.coast.noaa.gov/digitalcoast USGS Coastal Change Hazards Portal, with information on impacts of extreme storms and Nor'easters, shoreline change, and sea-level rise: http://marine.usgs.gov/coastalchangehazardsportal/ FEMA Flood Insurance Rate Maps identifying areas subject to high-risk flood hazards: https://wwwfema.gov/flood-insurance-rate-map-firm Other FEMA coastal flood risk products: https://wwwfema.gov/coastal-flood-risk-study-process The U.S. Extended Continental Shelf Project http://www.continentalshelf.gov/ USACE beach volume change maps Bureau of Ocean Energy Management offshore geophysical and geological mapping data in selected areas 3-8nm offshore the Atlantic coastline. The National Outer Continental Shelf Sand Inventory will be used for sand resource identification, resource planning and administration and coastal restoration/offshore dredging projects.	14
(6) documentation of minimum and desired standards for data acquisition and integrated metadata	Definition of quality levels for coastal topographic and bathymetric lidar developed for the National Coastal Mapping Strategy (NCMS)	16
(7) a statement of the status of Federal efforts to leverage mapping technologies, coordinate mapping activities, share expertise, and exchange data	Coordinating coastal mapping activities and sharing expertise via regional IWG-OCM Coastal Mapping Summits, Joint Airborne Lidar Bathymetry Technical Center of Expertise Annual Workshop, and IWG-OCM mapping coordination online tool Continue implementation of the national Coastal and Marine Ecological Classification Standard Coastal mapping data publication through NOAA Digital Coast, NOAA National Centers for Environmental Information, USGS National Map, USGS EarthExplorer, National Science Foundation project funding mechanism	18

Reporting Requirements, Section 12204	Updates on the Requirement Provided in this Progress Report Covering 2014–2016	More information on Page
(8) a statement of resource requirements for organizations to meet the goals of the program, including technology needs for data acquisition, processing, and distribution systems	Given current declining resources for mapping, Federal agencies are only able to map the sandy ocean coasts of the continental United States on a multi-decadal basis. Airborne lidar technology does not work in persistently turbid water areas where there is high absorption and scattering in the water column or in areas with low bottom reflectivity. There is a need for development of airborne acquisition technologies that excel in these environments.	9
(9) a statement of the status of efforts to declassify data gathered by the Navy, the National Geospatial-Intelligence Agency, and other agencies to the extent possible without jeopardizing national security, and make it available to partner agencies and the public	The U.S. Navy now releases Arctic submarine data as it is collected and processed in collaboration with research agencies and the marine research community. During 2014-2016, Submarine Arctic Science Program partners focused on delivering products from 2011, 2012, and 2014 cruises and publicizing data already released http://nsidc.org/scicex/data_inventory.html	18
(10) a resource plan for a digital coast integrated mapping pilot project for the northern Gulf of Mexico that will— (A) cover the area from the authorized coastal counties through the territorial sea; (B) identify how such a pilot project will leverage public and private mapping data and resources, such as the United States Geological Survey National Map, to result in an operational coastal change assessment program for the subregion	NOAA worked with the Northern Gulf Institute and the National Association of Counties to conduct a two-day Digital Coast workshop for the six coastal counties in Mississippi to help them share issues, identify common needs, and determine if data and tools available via the Digital Coast could help them increase their resiliency. High-resolution integrated topobathy elevation maps produced for Mobile Bay and coastal Louisiana. No additional updates since 2014 report	25
(11) the status of efforts to coordinate Federal programs with coastal state and local government programs and leverage those programs	Examples: Post-Tropical Cyclone Sandy mapping coordination Development of the NCMS USACE National Coastal Mapping Program annual planning USGS 3D Elevation Program Broad Agency Announcement, which provides information on how to partner with Federal agencies to acquire 3D elevation data.	18

Reporting Requirements, Section 12204	Updates on the Requirement Provided in this Progress Report Covering 2014–2016	More information on Page
(12) a description of efforts of Federal agencies to increase contracting with nongovernmental entities	IWG-OCM member agencies successfully executed multiple contracts for coastal surveys such as on the U.S. west coast, topobathymetric surveys of the Beaver Islands in Lake Michigan, and coastal imagery acquisition in MA for seagrass mapping. USACE executed 76 percent of its coastal mapping budget through contracts. Other examples include ocean and coastal mapping data acquisitions via the Coastal Geospatial Services Contract, such as a post-El Nino survey with costs divided between NOAA, USGS, and USACE.	25
(13) an inventory and description of any new Federal or Federally-funded programs conducting shoreline delineation and ocean or coastal mapping since the previous reporting cycle	No updates.	N/A

Inventory of Ocean and Coastal Mapping Data (OCMIA Section 12204 (1))

In 2009, participants in an IWG-OCM workshop identified certain mapping data essential to support research, management, and planning efforts in the ocean and coastal zone. These data include critical framework data layers for elevation below and above the water (e.g., bathymetry and coastal topography); imagery data describing surface characteristics such as land cover, built areas, and seafloor habitat; and geophysical data, such as seismic and shoreline data that describe the surface and subsurface of the seafloor. IWG-OCM agencies continue to focus on these framework datasets.

Building on interagency efforts from prior years, the National Oceanic and Atmospheric Administration (NOAA) is sustaining an online community (www.data.noaa.gov) that includes a curated inventory of ocean and coastal mapping data sets and provides other related information for the ocean and coastal mapping community. The IWG-OCM's long-term vision is to optimize tools in Data.gov to serve metadata to the ocean community while using the Federally-sanctioned National GeoPlatform Marketplace as the primary survey-planning tool. While this tool is in development, the IWG-OCM has created a U.S. Federal Mapping Coordination site using the SeaSketch platform as a foundation for collaboration (www.fedmap.seasketch.org). Information about planned mapping areas, proposed survey dates, primary contact, and data collection plans can be viewed, modified, and annotated, and the extents of existing data can be layered to highlight data gaps.

NOAA, USGS, FEMA, and USACE are keeping the U.S. Interagency Elevation Inventory (USIEI) (https://coast.noaa.gov/inventory/) up to date. The USIEI is a web-based resource for elevation data that complements Data.gov and the National GeoPlatform. It is a comprehensive, nationwide listing of known high-accuracy topographic data, including light detection and ranging (lidar), interferometric synthetic-aperture radar, and bathymetric data, including hydrographic surveys, multibeam data, and bathymetric lidar. Data sets shown in the USIEI are sourced from IWG-OCM agencies, states, academia, and other partners. The information provided for each elevation dataset includes attributes such as vertical accuracy, point spacing, and date of collection.

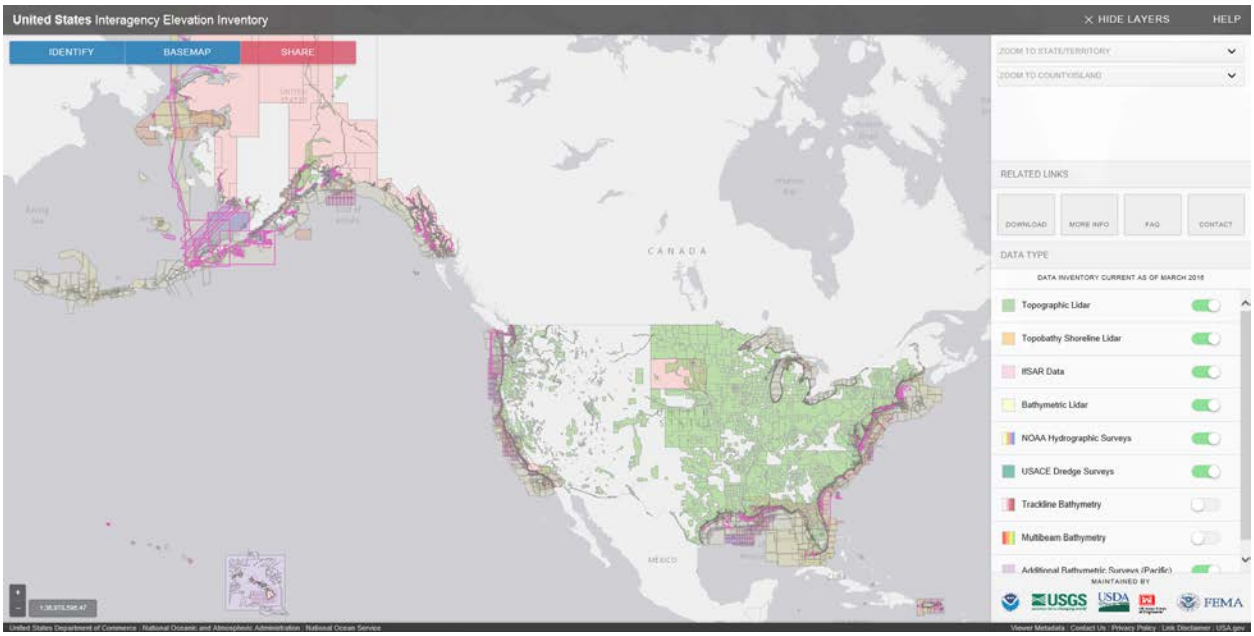

Figure 1. U.S. Interagency Elevation Inventory web interface allows the public to view available datasets and provides a link for data access.

Identification of Priority Survey Areas (OCMIA Section 12204 (2))

Ocean and coastal mapping data support the mapping applications required to meet the Nation's economic, natural-resource preservation, and management needs. The IWG-OCM has promoted increased interagency planning and coordination on ocean and coastal mapping to establish priorities, maximize limited resources, and produce data that can be used for multiple purposes.

To identify priority survey areas, IWG-OCM member agencies frequently sponsor workshops and meetings to engage with stakeholders, and use tools for interagency planning. For example, the IWG-OCM is currently convening a series of regional coastal mapping summits to identify opportunities for coordination of mapping activities, including an Alaska Coastal Mapping Summit and a Pacific Northwest Topobathymetric Models and Applications Workshop. The Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) partner agencies (USACE, NOAA, USGS, and NAVO) hold quarterly teleconferences and an annual face-to-face interagency meeting focused on interagency collaboration in prioritization, planning, and execution of coastal mapping activities. Individual agencies regularly collect priority mapping requirements from internal and external stakeholders to feed their planning processes (e.g., NOAA continually updates its Hydrographic Survey Priorities with input from maritime stakeholders, available at www.nauticalcharts.noaa.gov/hsd/NHSP.htm). The IWG-OCM co-chairs have also engaged with stakeholders through presentations and attendance at the Coastal Geotools Conference, Coastal States Organization meetings, and the American Shore and Beach Preservation Association 2015 annual meeting. The IWG-OCM will quickly set up additional mapping forums if a leveraging opportunity presents itself, upon request and for specific events (e.g., hurricane response).

Since its successful inception to coordinate East Coast data acquisition after Post-Tropical Cyclone Sandy, the U.S. Federal Mapping Coordination site has evolved to address mapping coordination across the entire Nation year-round, rather than just during emergency response and recovery situations. For

example, the USGS-led 3D Elevation Program (3DEP) has used the site for its 2015 and 2016 Broad Agency Announcement (BAA) process for topographic lidar acquisition. The BAA is a mechanism for state and other non-Federal entities to partner with Federal agencies to acquire high-quality topographic elevation data. The IWG-OCM uses the site to communicate and coordinate mapping plans, and updates the acquisition plans and data needs at least twice a year. The coordination site was used successfully at the JALBTCX Coastal Summit in June 2015 and the Alaska Coastal Mapping Summit in June 2016 to share information on acquisition plans and data needs, and to identify opportunities to combine efforts on areas of mutual interest. This coordination site is available to all interested parties, including Federal and state agencies, universities, and local governments. The IWG-OCM's goal is to ensure that ocean and coastal mapping data are collected efficiently and effectively, per the working group's goal to "map once, use many times."

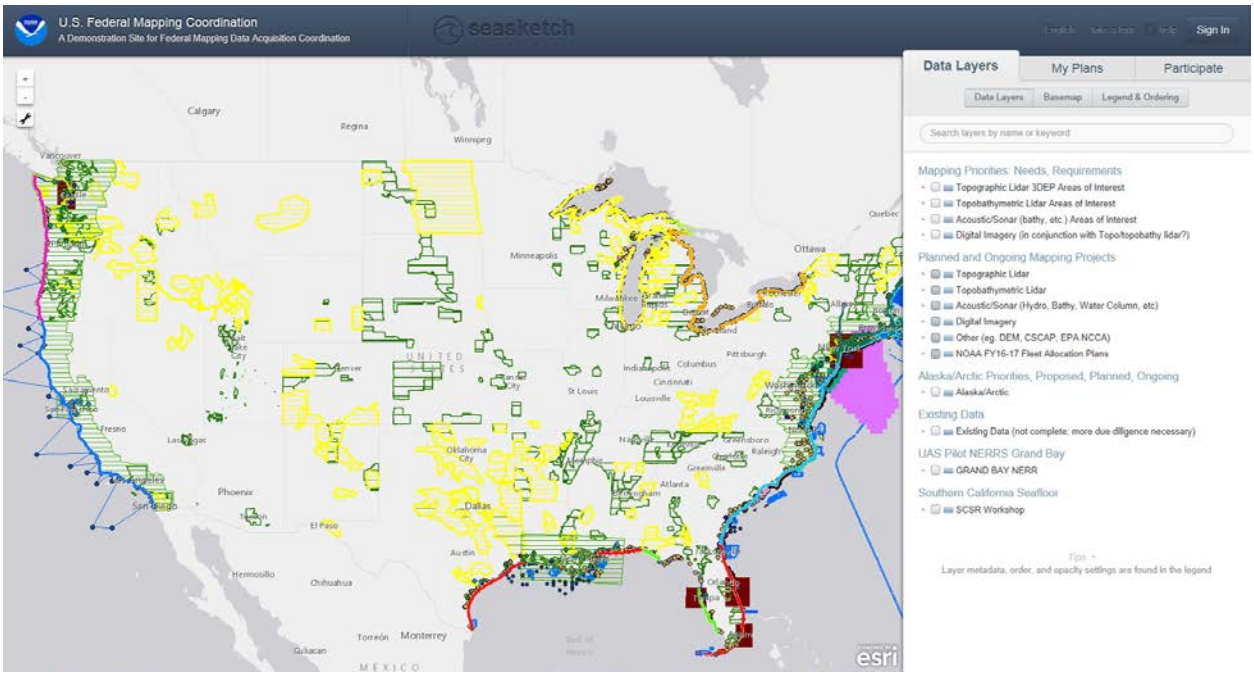

Figure 2. The U.S. Federal Mapping Coordination site uses the SeaSketch platform to provide transparent access to Federal planned and ongoing mapping, facilitating Federal, state, local, and general public input of requirements and plans for mapping data.

Specific priority survey areas in 2014–2016 included the Arctic region, the Post-Tropical Cyclone Sandy-impacted region, Chesapeake Bay, West Coast estuaries, and Puget Sound. The Alaskan Arctic region continues to be a priority because of the need for improved mapping and charting for safe navigation, accurate geodetic positioning, and support for sustained protection of key biological habitats, subsistence use areas, and vulnerable coastlines. The coastal and nearshore zones in the Post-Tropical Cyclone Sandy-impacted East Coast were prioritized to support coastal restoration activities, damage assessments, marine debris remediation, the development of updated flood maps and nautical charts, shoreline delineation, coastal geomorphology studies, and other needs as shared by Federal, state, and local government agencies.

USACE districts and local stakeholders, NOAA, and USGS have also identified coastal regions that are high priorities for lidar surveys, but are not covered by the USACE National Coastal Mapping Program (NCMP).

The NCMP is designed to provide high-resolution elevation and imagery data along sandy, outer coast shorelines of the United States in support of regional sediment management for USACE navigation projects. Priority regions not covered by NCMP include estuaries, sounds, and bays, as well as the Big Bend and Everglades coasts of Florida, the Florida Keys, and the rocky coastline of Maine. In Texas, USACE Galveston District has provided additional funding to survey dredge placement sites along the Intercoastal Waterway, and in Florida, USACE Jacksonville District is adding funds to survey around Lake Okeechobee.

The USGS Coastal National Elevation Database Applications (CoNED) project laid the groundwork in 2016 to create a topobathy model for the coastal zone of Oregon and Washington, including Puget Sound. In an effort to connect with the stakeholder community prior to project initiation, the USGS, NOAA, state partners, and others convened a workshop in June 2016 in Lacey, Washington. A central goal of the workshop was to identify science applications for elevation data in the Pacific Northwest and identify priorities for new data acquisition.

On the United States East Coast, many stakeholders have requested bathymetry data in the very shallow nearshore areas of the Chesapeake Bay, a need reinforced by NOAA's Hydrographic Survey Priorities document. On the United States West Coast, USGS, NOAA, and USACE partnered on USGS and NOAA contract vehicles to capture coastal and nearshore impacts of the late 2015 El Nino winter with topobathymetric lidar data. The USACE NCMP surveyed the entire United States West Coast in 2014 and 2015, providing a timely pre-event dataset against which the El Nino impacts could be quantified.

BOEM, USACE, and state stakeholders are collaborating to identify data gaps for sand resource evaluation. BOEM's Marine Mineral Program (MMP) is focused on a band 3 to 8 nautical miles offshore from Maine to Florida for geophysical analysis. BOEM is gathering multi-beam and backscatter data, chirp sub-bottom, side scan, and high resolution Digital Elevation Models (DEM) to support sand resource analysis for New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, and Florida. Nationwide, little is known about the character, quantity, and location of Outer Continental Shelf (OCS) sand resources, including areas where sand resources are needed and used most frequently along the United States Atlantic and Gulf coasts. A comprehensive sand resource inventory will allow the MMP to: meet BOEM's mandate as steward of all Federal mineral resources on the OCS; be proactive in meeting increasing demands for OCS resources and emergency needs as they arise; and be informed about location and character of sand reserves in order for BOEM to identify and manage multiple use conflicts.

Integrated Mapping Resources and Requirements (OCMIA Section 12204 (3 and 8))

Federal agencies have historically planned and conducted ocean and coastal mapping activities based on specific requirements, mandates, and available funding. Recognizing the need to improve coordination, the IWG-OCM continues to identify mapping requirements and resources across the Federal Government, as Table 2 illustrates. This work will continue to align standards, specifications, acquisitions, and multipurpose use of the mapping data.

New state-of-the-art multibeam mapping systems are enabling acquisition of more high-resolution data describing the coast, seafloor, and water column. Greater focus on procedures and training in survey planning, at-sea data acquisition, and post-processing techniques is helping to fully realize the maximum benefits from these systems. Recent topobathy lidar instruments have improved capabilities, such as the USACE Coastal Zone Mapping and Imaging Lidar. Emerging airborne lidar technologies, such as single photon counting lidar and Geiger-mode lidar, can efficiently acquire data at higher point densities.

Experimental work to derive bathymetry data from Landsat 8 satellite and other satellite systems such as WorldView-3 is ongoing. Landsat 8 is expected to be more useful for coastal and bathymetric mapping applications compared to previous Landsat satellites because of its improved signal-to-noise radiometric performance and the new short-wavelength blue spectral band (Figures 3 and 4). Stereo photogrammetry using imagery acquired from unmanned aerial systems (i.e., drones) is another emerging technology that is useful for low-cost repeat surveys of rapidly changing beaches, seacliffs, dunes, and other coastal features.

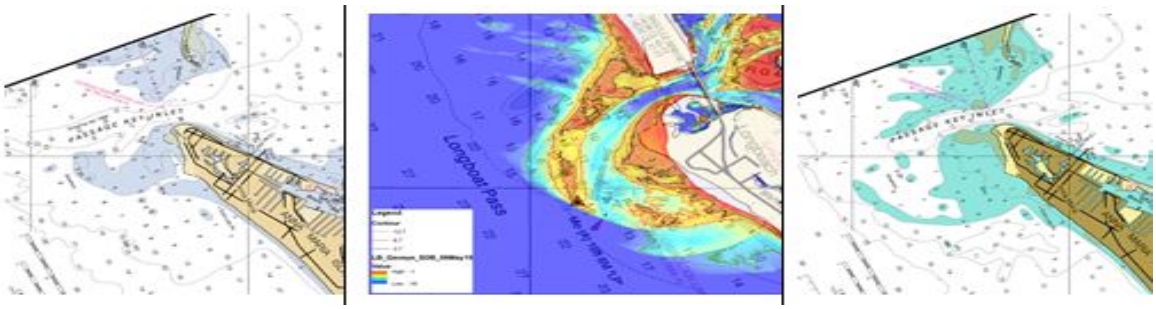

Figure 3. NOAA application of satellite-derived bathymetry for updates to NOAA's Passage Key nautical chart.

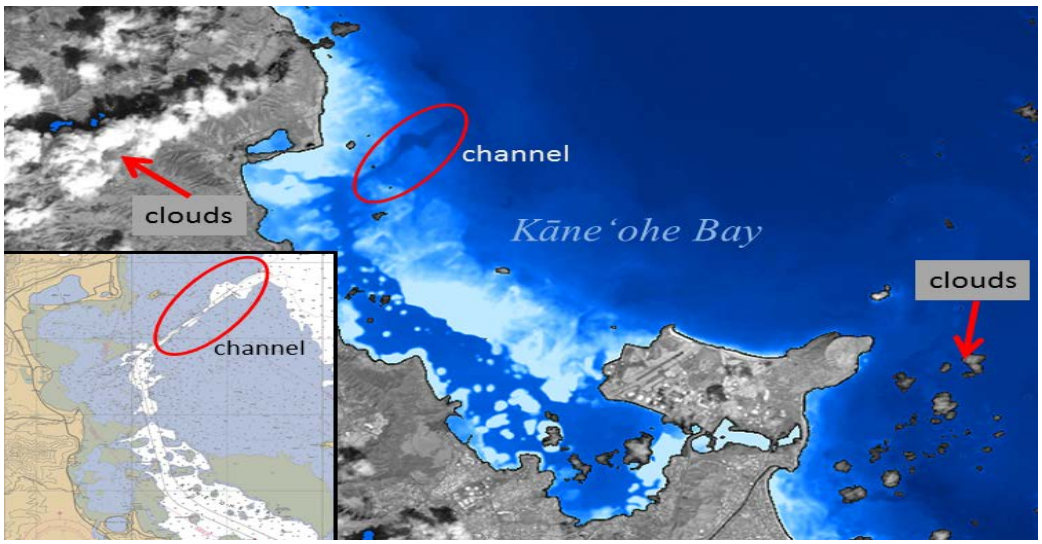

Figure 4. Example of USGS experimental Landsat-derived bathymetry for Kāne'ohe Bay in Oahu, Hawaii.

Ocean and coastal mapping data are made available to the public through several web-based data portals. NOAA's Digital Coast Data Access Viewer (www.coast.noaa.gov/dataviewer) is a user-friendly portal that provides public access to ocean and coastal data collected by NOAA, USGS, USACE's JALBTCX, state and county governments, and non-governmental organizations. This public accessibility effort is part of the larger Digital Coast platform (www.coast.noaa.gov/digitalcoast), which provides a full suite of coastal geospatial information resources to address coastal issues. NOAA's National Centers for Environmental Information (NCEI; https://www.ncei.noaa.gov/) provides a long-term archive for, and access to, the Nation's ocean and coastal data, including data collected by many government agencies,

universities, and non-governmental organizations. The USGS EarthExplorer (http://earthexplorer.usgs.gov/), the National Map (http://nationalmap.gov/), and the Coastal Change Hazards Portal (http://marine.usgs.gov/coastalchangehazardsportal/) also provide public access to coastal and ocean data, such as satellite imagery, lidar, land cover data, DEMs, and many other types of data frequently used by Federal, state, local, tribal, and foreign governments; industry; academia; and the general public. A joint project from NOAA and BOEM, the Marine Cadastre (www.MarineCadastre.gov) provides authoritative data to meet the needs of the offshore energy and marine planning communities.

Table 2. Major Federal Ocean and Coastal Mapping Data Acquisitions – Resources and Requirements

Agency	Mapping Category	Goal Statement	Data Acquired	Goal Acquisition	Actual Capability	Average cost
BOEM	Energy siting and resource extraction	Most of BOEM's seismic or bathymetric data is obtained from industry and is dependent on interest in particular areas that may be available for future resource development. Shoreline data is obtained from other bureaus (e.g., NOAA and USACE) or in conjunction with coastal states. Marine minerals: foster access to the Nation's offshore mineral resources	See Goal Statement	See Goal Statement	See Goal Statement	2D seismic $1/Linear Mile (LM); 3D $27–43/block Marine Minerals Program: Estimate $10K per vibracore, estimate 30 line miles per day at $1000K for 30 miles per day, mobilization, vessel, captain and crew, data analysis (varies by survey technology)
FEMA	Climate change and hazard resiliency	Maintain current coastal flood hazard maps developed during Fiscal Years 2008–2013 by reviewing and processing requests for modifications	Maintenance is typically driven by data submitted by local governments and property owners seeking revisions. NFIP maps are evaluated on a five year cycle	Assess maps every 5 years	Review maps every 5 years	$300–$500 per mile for assessing coastal flood hazard data

Agency	Mapping Category	Goal Statement	Data Acquired	Goal Acquisition	Actual Capability	Average cost
		to the flood hazard data, periodically assessing the flood hazard data for major changes affecting the currency of the data and responding to new priorities resulting from the Technical Mapping Advisory Council (TMAC) establish by recent National Flood Insurance Program (NFIP) reforms	to evaluate the methods used to develop them and look at changes in the physical or climatological environment since the last update. The TMAC is also expected to provide recommendations for new mapping related to future conditions flood hazards including the best available climate science and information on sea level rise			
NOAA	Navigation, transportation, and security	Re-survey hydrographic areas every 50 years and open shoreline every 10 years	Hydrography: acoustic and lidar Shoreline: photography and lidar	10,000 square nautical miles (SNM) per year 95,000 LM per year	3,000 SNM per year 3,100 LM per year	$18K/SNM; cost per linear nautical mile varies greatly by mission need and survey technology
NOAA	Climate change, hazard resiliency	Elevation data at 10-meterhorizontal/10-centimeterverti cal resolution for high hazard/ change areas	Hydrography, shoreline, and lidar in coordination with other programs	Complete initial products of priority areas, with focus on Alaska	Dependent upon partner capabilities	None identified, partner with other programs for ocean and coastal mapping data
NOAA	Ecosystem-based management	Consistently/ comprehensively map distribution of benthic habitats; cultural resources	Multibeam echosounder, side scan sonar, lidar ground truth, species surveys	Ocean and coastal mapping varies widely by region and fiscal year, goal is to map coastal U.S. with 15 meter resolution data	2 or more surveys/year plus coordination with partner programs	$400K–$1.2 M/year

Agency	Mapping Category	Goal Statement	Data Acquired	Goal Acquisition	Actual Capability	Average cost
NOAA	Climate change and hazard resiliency	Map coastal bathymetry, topography and geologic framework	Acoustic, lidar, satellite imagery	Accomplished through interagency partnerships; long-term plan does not exist	Limited to interagency partnerships	$100K/year
NOAA	Ocean exploration	NOAA, in partnership with Federal (USGS, BOEM) and state agencies (including the Mid-Atlantic Regional Ocean Council and others) collect deep water sonar and video and imagery data	Multibeam sonar, water column sonar, sub bottom sonar, ROV imagery	Provide scientific data for understanding deep water ecosystems with in U.S. Exclusive Economic Zone	Collected data within U.S. Exclusive Economic Zone: the submarine canyons from Canada-U.S. border to Virginia; in Puerto Rico including trench and several nearby canyons; in Gulf of Mexico canyons, salt domes, and Florida Escarpment, in several Pacific marine national monuments including on seamounts, ridges, guyots, and potential deep sea mining areas	Varies, dependent upon NOAA, BOEM and USGS needs
NPS	Ecosystem-based management	Map submerged and intertidal habitats and associated natural and cultural resources	Acoustic, lidar, satellite imagery	Accomplished through interagency partnerships; strategy for data acquisition being developed	Limited to interagency partnerships	Varies depending on need and map product
USACE	Navigation, coastal flood damage risk reduction, environmental restoration	Data is collected to inform science-based decision making for coastal project management	Bathymetric and topographic lidar, aerial photography and hyperspectral imagery, beach profiles, single and multibeam sonar	As required by project activities	Varies with technology	Varies greatly by mission need and survey technology

Agency	Mapping Category	Goal Statement	Data Acquired	Goal Acquisition	Actual Capability	Average cost
USACE	Regional sediment management	Data supports management of coastal navigation, flood damage risk reduction, and environmental restoration projects as a system	Bathymetric and topographic lidar, aerial photography and hyperspectral imagery	New data is available every 5 years	New data is available every 6 years	$6M/year for Actual capability
USGS	Resources and requirements span all mapping categories	Collect a wide array of data types to meet diverse the Department of the Interior requirements for geospatial information keyed to 1. agency science mission needs, 2. agency natural resource management mission needs, and 3. a diverse set of partnering opportunities	Acoustic, seismic, topographic lidar, bathymetric lidar, aerial imagery, satellite imagery	USGS programs maintain and continually update mapping acquisition plans		Varies greatly by mission need and survey technology

Integrated Mapping Projects and Results (OCMIA Section 12204 (5))

Many excellent ocean and coastal maps are produced through interagency coordination. Some examples detailed in this section include joint mapping projects that are used to produce integrated products such as the USGS National Assessment of Coastal Change Hazards, USACE after Post-Tropical Cyclone Sandy beach volume change analysis, updated nautical charts produced by NOAA, an interagency effort to map baseline habitat in Charleston Harbor, FEMA flood risk maps, and the NOAA-led U.S. Extended Continental Shelf Project. The availability of these products to the public and regulators through NOAA's Digital Coast, USGS EarthExplorer, the USGS National Map, and numerous other websites help improve public understanding of the ocean and coasts, and play a role in regulatory decision-making.

USACE, NOAA, and USGS map the coast to support their own missions, but also work in conjunction with each other to produce integrated products. Using USACE and USGS data sets, NOAA updates nautical charts for safe navigation and DEM development to aid coastal resilience in the future. USACE used data from the Post-Tropical Cyclone Sandy recovery to develop analysis procedures, publish web services depicting pre- and post-Tropical Cyclone Sandy beach volume change analysis in northern New Jersey and

western Long Island, and create new integrated topobathy products for Lakes Michigan and Ontario. This work was expanded using USACE NCMP datasets to the entire state of Florida and the United States Eastern Seaboard. The USGS National Assessment of Coastal Change Hazards uses lidar and other types of ocean and coastal geospatial data to map hurricane-induced coastal erosion, shoreline change, and vulnerability to sea-level rise. USGS research on storm-driven coastal change hazards has resulted in data and modeling capabilities to identify coastal areas that are vulnerable to severe erosion during hurricanes. In 2016 USACE conducted field surveys to support baseline habitat map development prior to the start of construction of the Charleston Harbor Deepening project in South Carolina. This project is a coordinated effort between the USACE Charleston District and state partners, including the South Carolina Department of Natural Resources and the South Carolina Ports Authority, to monitor environmental impacts. USACE is using satellite imagery and airborne lidar data collected by JALBTCX to assist with habitat mapping and monitoring.

State	Start Date	End Date	Baseline Length	Number of Transects	Average Shoreline Change Rate	Volume Density Rate	MHW Volume Density Rate	Above MHW Volume Density Rate
			km	n	ft/yr	cy/ft/yr	cy/ft/yr	cy/ft/yr
ME	10/19/2005	6/19/2010	62	633	(0.4)	13.5	0.7	0.6
NH	11/01/2005	6/20/2010	15	152	(1.0)	2.6	(0.5)	(0.5)
MA	11/11/2005	5/26/2010	381	3,834	(2.8)	(2.8)	(0.9)	(0.8)
NY	10/26/2005	8/13/2010	192	1,921	6.9	4.5	4.1	4.2
NJ	9/2/2005	8/28/2010	203	2,034	0.6	2.1	2.2	2.2
DE	9/3/2005	9/11/2010	44	440	5.1	3.9	4.1	4.2
MD	9/3/2005	8/2/2010	50	505	(4.3)	2.8	2.7	2.7
VA	9/8/2005	7/28/2010	183	1,835	7.2	3.1	3.4	2.9
NC_2009	9/28/2005	8/16/2009	272	2,725	3.9	0.6	(1.3)	0.2
NC_2010	9/28/2005	5/4/2010	236	2,369	0.2	2.7	2.5	2.5
SC	1/13/2006	5/4/2010	277	2,778	2.1	2.3	1.3	0.9
GA	1/13/2006	5/4/2010	145	1,452	(0.2)	4.2	3.0	2.8
FL-E	7/1/2004	5/4/2010	587	5,875	(2.7)	6.2	1.0	0.8
FL-W	6/1/2004	6/20/2010	298	2,998	7.7	19.3	2.3	2.4
FL-NW	6/1/2004	6/20/2010	346	3,461	(9.5)	4.6	(0.2)	(0.2)
Total/ Average			3,289	33,012	0.9	4.6	1.6	1.7

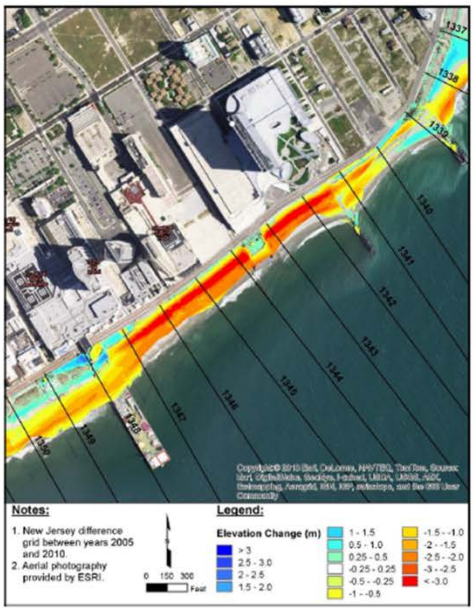

Figure 5. USACE National Coastal Mapping Program new standard product uses consecutive datasets to compute shoreline change and volume change. The table summarizes results for Maine through Florida. The graphic shows an excerpt of the elevation changes from which the table was generated. The changes depicted are from 2005 to 2010 for the area around Atlantic City, New Jersey. This product will be made available to public through web services, and updated with new datasets like those collected after Post-Tropical Cyclone Sandy.

FEMA recently initiated flood hazard studies for the Nation's coastal areas as part of its Risk Mapping, Assessment, and Planning (Risk MAP) effort. Risk MAP is the FEMA program that provides communities with flood information and tools they can use to enhance their mitigation plans and take action to better protect their citizens. In addition to the development of Flood Insurance Rate Maps, Risk MAP projects also offer a Flood Risk Report, Flood Risk Database, and other custom products. These studies have directly benefited coastal communities by increasing public awareness, improving mitigation planning, and encouraging mitigation actions. FEMA leverages data from partner IWG-OCM agencies, such as USACE and NOAA, and other sources to develop Risk MAP products. The Risk MAP progress website, www.riskmapprogress.msc.fema.gov, is updated quarterly and offers an interactive look at program progress across the country.

Another mapping coordination effort comes from the U.S. Extended Continental Shelf (ECS) Project. This project is a multi-agency collaboration to establish the full extent of the continental shelf of the United States, consistent with international law. The process to determine the outer limits of the United States ECS requires the collection and analysis of data that describe the depth, shape, and geophysical characteristics of the seabed and sub-sea floor. In 2015, NOAA-led teams completed two ECS-related cruises. The first was a 24.5-day survey along the United States Atlantic continental margin that acquired a total of 157,166 square kilometers of multibeam bathymetry. This was the eighth ECS survey along the United States Atlantic coast resulting in nearly complete coverage of the United States Exclusive Economic Zone (EEZ). This collection of data, shown in Figure 6, will be a valuable resource to support other marine research.

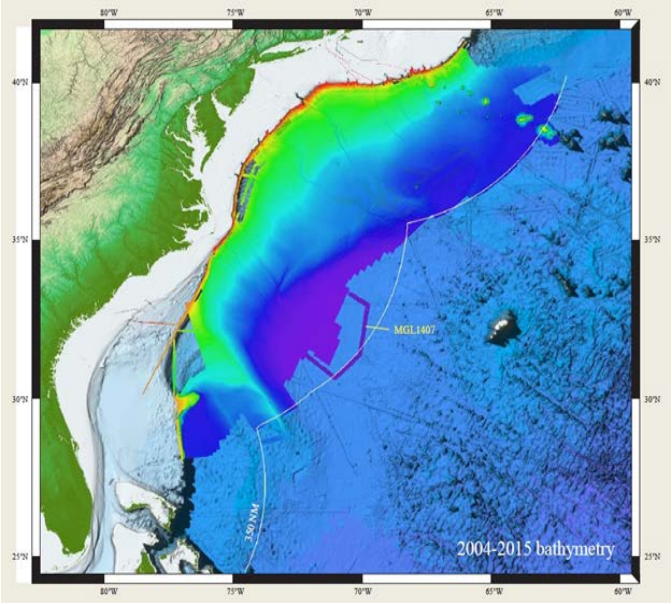

Figure 6. High-resolution multibeam bathymetry coverage along the United States Atlantic coast collected by NOAA for the United States ECS Project (2004–2015).

The second 2015 survey was conducted in the vicinity of Kingman Reef-Palmyra Atoll, where a total area of 164,200 square kilometers was mapped (excluding transits) during the 22 survey days. In early 2016, another survey was conducted in the Kingman Reef-Palmyra Atoll vicinity to collect 149,475 square kilometers of multibeam data. The ECS Project also continues to make significant progress in utilizing the EEZ mapping products to prepare materials and GIS products to support the analysis of potential areas of extended continental shelf, including areas in the Arctic. The ECS Task Force is led by the U.S. Department of State, with co-vice chairs from the Department of Interior and NOAA. Participants include the Executive Office of the President, USGS, the Joint Chiefs of Staff, United States Navy, and USCG, Department of Energy, NSF, EPA, BOEM, and the U.S. Arctic Research Commission.

Data and Documentation Requirements (OCMIA Section 12204 (6))

The IWG-OCM supports a “whole ocean” approach to management and planning, leveraging limited resources by identifying common mapping requirements across programs and agencies. Essential aspects of integrated ocean and coastal mapping include the abilities to: (1) acquire and process data for multiple uses; (2) generate products meeting differing requirements; (3) deliver data, derived products, and

supporting metadata in a way that enables integration; and (4) turn data in to relevant information supporting ecosystem-based decision-making. Modern data management and effective long-term stewardship enables the "map once, use many times" goal of the IWG-OCM, helping to reduce duplication of mapping efforts, facilitate cooperative mapping activities, and improve data accessibility.

The IWG-OCM has made progress towards documenting standards for lidar acquisition by building on the early success of JALBTCX in establishing consistent quality levels for coastal lidar, which provide a means of consistently comparing specifications across Federal agencies to facilitate coordination to meet cross-agency needs. The working group is close to the completion of a first National Coastal Mapping Strategy, which includes quality levels that specify vertical uncertainty (accuracy) and point density for bathymetric lidar surveys, similar to the approach taken by the USGS-led 3D Elevation Program for topographic lidar quality levels. This Strategy is meant to align Federal agencies on data collection and planning in shared interest areas, in addition to promoting proper stewardship of data collected in the shared coastal zone.

Lidar data stewardship ensures that the data are accurately described in standards-based metadata records to support Internet search and discovery tools. Lidar metadata records are currently generated in Federal Geographic Data Committee (FGDC) or International Organization for Standardization (ISO)-endorsed standards by Federal agencies and vendors who collect the data. These records are updated as the data are transferred to other agencies for dissemination and archiving, which occurs before the records are published to metadata portals such as Data.gov. NOAA, USGS, BOEM, and the University-National Oceanographic Laboratory System adopted common ISO metadata templates for the following ocean and coastal mapping metadata: cruise level; multibeam bathymetry; gravity; seismic; magnetic; and geologic samples. The IWG-OCM has also provided an updated metadata and vocabulary guidance document to the National Ocean Council Data and Information Working Group. The goal of metadata guidance is to improve data discovery and accessibility by promoting common standards across Federal agencies for comprehensive metadata records that include essential information for data evaluation and re-use.

NOAA's Ocean Exploration program, National Marine Sanctuaries, and the National Estuarine Research Reserve System continue implementation of the national standard for coastal and marine habitats, the Coastal and Marine Ecological Classification Standard (CMECS, www.coast.noaa.gov/digitalcoast/publications/cmecs) as feasible. Several state and tribal governments are currently using CMECs, and others have expressed interest. BOEM is requiring use of CMECS for alternative energy permitting and is using CMECS in its mapping programs to help identify Essential Fish Habitat. NOAA provides a CMECS cross-walk tool is online to aid users interested in updating previous classification work, as well as NatureServe's web interface for users to submit suggestions for improvement.

Current Ocean and Coastal Mapping Activities (OCMIA Section 12204 (4, 7, 9, and 11))

Integrated Digital Maps

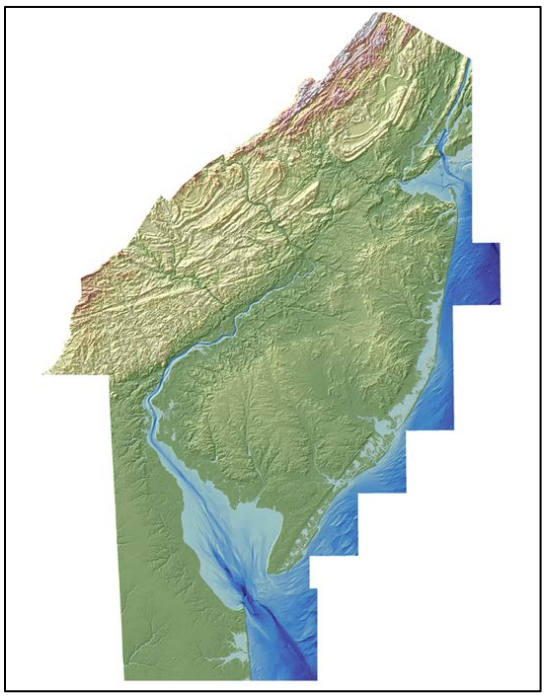

Figure 7. USGS Topobathymetric elevation model of New Jersey and Delaware.

Topobathy DEMs are a merged rendering of both topography (land elevation) and bathymetry (water depth) that provides a seamless elevation product useful for inundation mapping, as well as for other Earth science applications, such as the development of sediment-transport, sea-level rise, and storm-surge models. NOAA's NCEI and USGS collaborated on the development of a common methodology for creating integrated topobathy DEMs. This methodology has resulted in both a consistent, repeatable process to produce integrated, seamless topobathy data sets for coastal areas. A high-resolution (3-meter) integrated topobathy elevation model was produced in response to Hurricane Sandy by USGS National Geospatial Program (www.usgs.gov/ngpo) and NOAA's NCEI (www.ncei.noaa.gov) developed high resolution (1 meter) 3-D topobathymetric elevation models for the New Jersey/Delaware area, including the Delaware Estuary and adjacent coastline. The integrated 1-meter topobathymetric model for the Sandy-CoNED New England subregion has also been completed and is available at http://topotools.cr.usgs.gov/coned/hurricane_sandy.php. NOAA's NCEI developed a suite of DEMs of the United States Atlantic Coast impacted by the hurricane (http://www.ngdc.noaa.gov/mgg/inundation/sandy/sandy_geoc.html). These DEMs are the initial part of a planned framework for a seamless depiction of merged bathymetry and topography along United States coasts.

NCEI also developed a seamless mosaic of all topographic-bathymetric DEMs held by NCEI, including the newly-developed DEM tiles in the Sandy-affected areas. This mosaic, available as a web service (http://gis.ngdc.noaa.gov/arcgis/rest/services/DEM_SeaLevel/ImageServer), can be used in desktop programs, as well as web-based applications. The mosaic allows the user to get the actual elevation data values seamlessly across the underlying individual DEMs. This service also provides visualization (e.g., hillshade) of the seamless elevation from the nearshore land elevations through the United States EEZ.

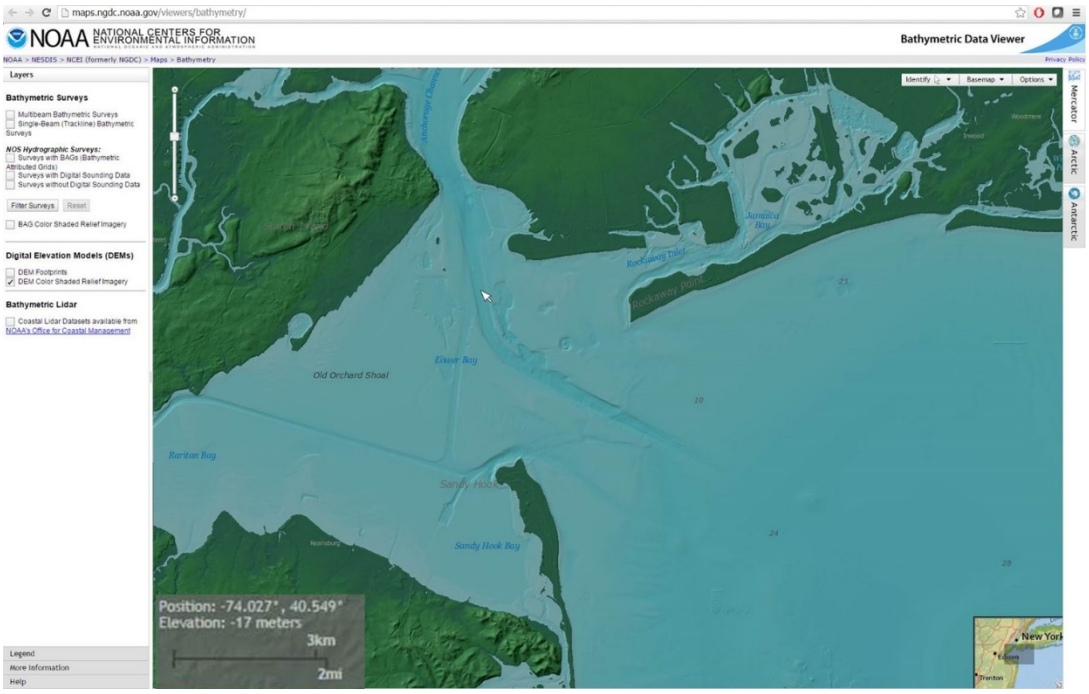

Figure 8. Screengrab of NCEI bathymetry map viewer (http://maps.ngdc.noaa.gov/viewers/bathymetry/) showing the DEM mosaic of Lower New York-New Jersey Harbor and Inner New York Bight, as well as the depth at the location of mouse pointer in the browser window (17 meters in Ambrose Channel).

A new high resolution topobathy DEM for Chesapeake Bay was completed in May 2016. These topobathy DEMs were developed using multiple topographic and bathymetric datasets, acquired on different dates by USGS, USACE, NOAA, and other organizations. The datasets include several new lidar surveys collected post-Hurricane Sandy over coastal areas. Comprehensive integrated onshore – offshore high-resolution topobathymetric data are essential for shoreline erosion analyses, emergency planning, disaster response, fisheries restoration, and land-use planning. NCEI also works with the World Data Service for Geophysics to compile integrated datasets for tsunami modeling as part of a long-term program to support tsunami warning centers, oceanographers, seismologists, engineers, and the general public. NCEI's topobathy DEMs are used in tsunami forecasting and modeling efforts to simulate tsunami generation, propagation, and inundation. NCEI makes the data available through a publicly accessible website: http://www.ngdc.noaa.gov/mgg/inundation/tsunami/inundation.html.

NOAA's Office of Coast Survey has a long standing partnership with the USACE and is already using USACE acoustic bathymetric survey data to update depth information on nautical charts for many channels, harbors, and entrances along the United States coastline. Traditionally, this survey data has been limited to hydrographic surveys performed from small boats using single-beam and multi-beam sonar. Plans for including USACE airborne lidar bathymetry data are also underway.

Post-Tropical Cyclone Sandy Work

Under the Disaster Relief Appropriations Act of 2013 (P.L. 113-2), BOEM received $13.6 million for Hurricane Sandy response for coastal resiliency studies and efforts. In 2014, 13 Atlantic coastal states received funding from BOEM, and each state is updating its maps and databases of offshore sand resources. In 2015, BOEM began the Atlantic Sand Assessment Project (ASAP) to survey and evaluate OCS sand resources within areas with little or no existing data from 3 to 8 nautical miles offshore from

Maine to Miami. BOEM is collecting offshore geophysical and geological mapping data and working with Federal, state, and academia partners on existing and new data analysis for Federal offshore sand resource evaluation and needs on the OCS. BOEM's MMP will integrate the data collected from the ASAP and state cooperative agreements with historical data MMP has gathered over the past 20-plus years that will support a National OCS Sand Inventory using a Marine Minerals Geospatial Information System that is in development. This system will maintain a repository of applicable offshore marine mineral data, and leverage available partner data to the maximum extent possible. The system will be used for sand resource identification, resource planning and administration, and coastal restoration/offshore dredging projects. BOEM is mapping bathymetry and conducting geophysical and geotechnical surveys by collecting magnetometer, chirp sub-bottom seismic, vibracores (sediment core obtained by vibrating a core sampler barrel into sediment), and grab samples. BOEM has included the locations of planned geophysical surveys in the United States Federal Mapping Coordination Site (fedmap.seasketch.org) to facilitate partnerships and cooperative agreements with states, other Federal agencies, universities, and industry. The geophysical data collected by BOEM will be archived at NOAA's NCEI. The vibracores collected from the reconnaissance level surveys were delivered to Lamont-Doherty Earth Observatory, Columbia University, in 2016. Lamont Staff is cataloguing the vibracores and will make them available to researchers.

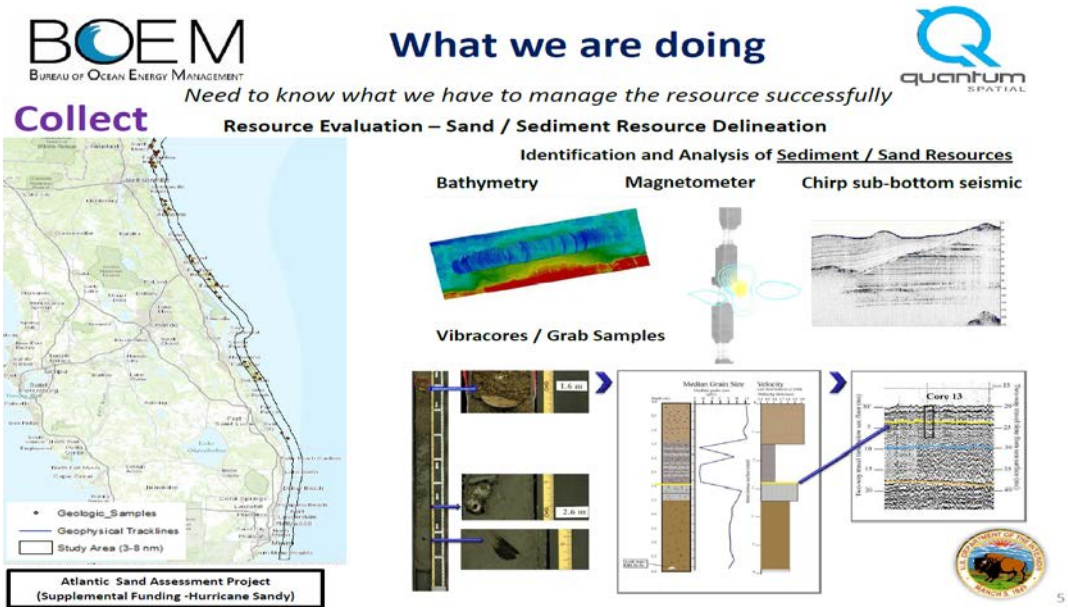

Figure 9. Data collection methods for offshore sand and sediment resource mapping for BOEM in 2015–2016.

NOAA's Integrated Ocean and Coastal Mapping (IOCM) Sandy project includes complementary grant-funded research and development and contract-funded test, evaluation, and production work addressing the topobathymetric lidar and acoustic sonar data collected in the aftermath of the storm. These data will be used to update nautical charts and create new habitat maps of the impacted region, along with assessing marine debris detection.

The NOAA IOCM Sandy team is focused on improving methods for interagency use of the data collected for multiple purposes, incorporating non-traditional data sources and technologies to nautical charting. The NOAA coastal composite bathymetry project has integrated multiple types of data to update coastal bathymetry. Barnegat Bay, New Jersey, was chosen as the initial pilot area to develop this approach to data integration. Multiple agencies and organizations shared data for the project including NOAA, USGS, USACE, and the New Jersey Department of Transportation. In areas with gaps in data coverage, satellite derived bathymetry was used to assess whether changes in morphology were likely, but not to replace soundings on the chart.

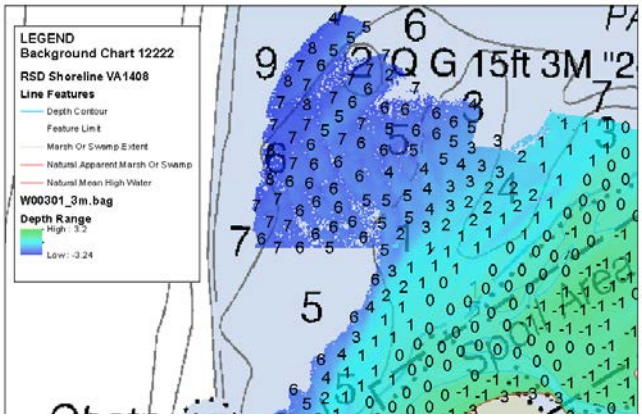

Figure 10. Example of lidar use to develop best practices for application to nautical charts.

Another project being carried out by the NOAA IOCM Sandy team is analyses needed to bring USGS interferometric data to nautical charts. This work has included coordinating data the NOAA ships need to collect based on the USGS acoustic data to meet minimum hydrographic needs for purposes such as investigating shoals and wrecks. Buzzard's Bay, Massachusetts, and the Delaware-Maryland-Virginia Peninsula, where the USGS has mapped a large area using interferometric sonar, are being used for this analysis. The Buzzard's Bay USGS data sets will result in at least three areas being submitted for consideration to be applied to update NOAA nautical charts.

NOAA's National Geodetic Survey acquired topographic and bathymetric (topobathy) lidar and imagery data along the United States East Coast from South Carolina to New York in accordance with its Scope of Work for Shoreline Mapping in support of Public Law 113-002, the Disaster Relief Appropriations Act of 2013. This airborne topobathy lidar elevation data and imagery are now available on NOAA's Digital Coast (http://coast.noaa.gov/digitalcoast/), covering approximately 2,654 square miles of impacted areas along the United States East Coast. Collection of Sandy topobathy lidar began November 2, 2014, and was completed July 27, 2014. Processing and reviewing of the data took a little over a year for the more than 32,000 flight-line miles, representing NOAA's largest topobathy lidar data collection to date. The bathymetric and shoreline data that is derived from this topobathy lidar will be used to update NOAA nautical charts.

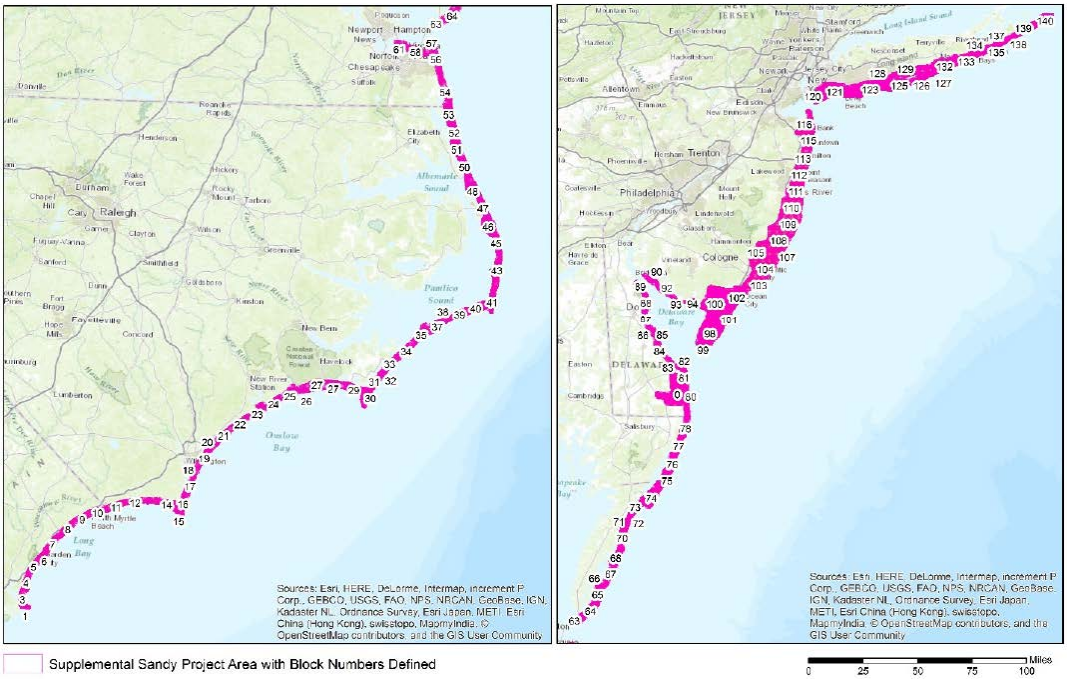

Figure 11. Topobathy lidar data collection by NOAA contractors in 2014.

Marine debris has been another focus area for the NOAA IOCM Sandy team. Nassau County, New York, supplied NOAA with its FEMA-funded debris identification and removal reports, allowing NOAA to chart possible remaining obstructions. From this effort templates and best practices were developed to share information between Federal agencies so that entities such as states and municipalities that receive Federal funds for debris identification and removal as a result of a disaster maintain records that are easily shareable and usable by the other agencies.

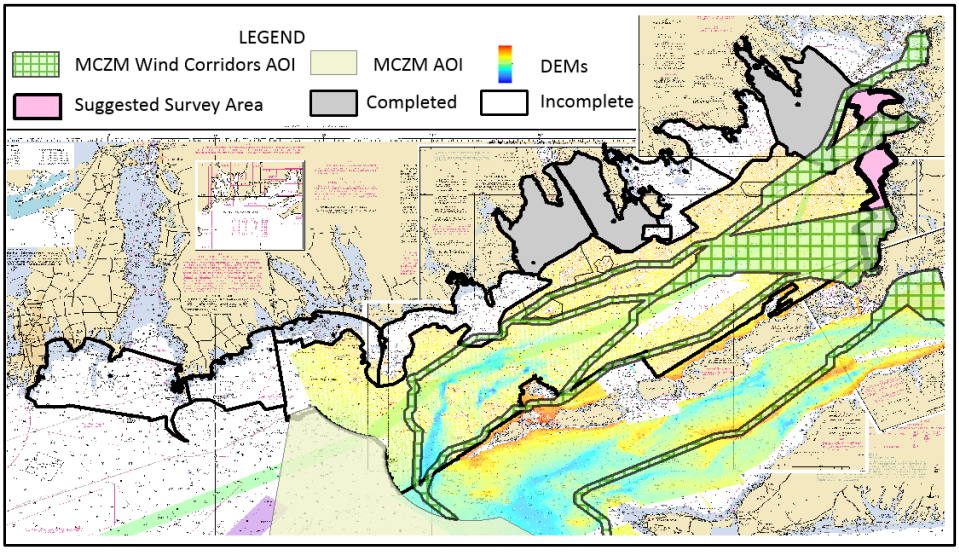

Figure 12. Example of coordination in real time between NOAA and stakeholders, taking into account existing data to "Map Once Use Many Times" for Buzzard's Bay, Massachusetts, in 2016 and 2017 surveys.

Leveraging Resources and Improving Coordination

The first draft of the NCMS incorporates comprehensive interagency plan for coordinated lidar, topography, and shallow-water nearshore bathymetry mapping of the coastal zone. It includes both mapping standards and data stewardship standards. The NCMS assesses the next steps needed to achieve the vision of the United States as a 3D Nation with comprehensive lidar elevation coverage, including whether there is sufficient interest in mapping United States coastal areas routinely through the judicious, efficient, and closely-aligned collection of lidar bathymetry and topography.

Recognizing the importance of coordinating activities and using consistent standards for coastal mapping, the IWG-OCM aligned the NCMS with 3DEP plans. 3DEP strives to systematically collect enhanced elevation data in the form of high-quality lidar data over the conterminous United States, Hawaii, and United States territories on an 8-year schedule. The IWG-OCM and 3DEP implementation teams are working to coordinate their project planning schedules to the extent possible and to maximize consistency between their respective initiatives in terms of data standards, survey specifications, and lidar quality level definitions.

In 2015–2016, JALBTCX partner agencies (USACE, NAVO, NOAA, and USGS) held quarterly teleconference and face-to-face meetings focused on interagency collaboration in planning and execution of coastal mapping activities. Additionally, these and other Federal and state agencies and other entities (academia etc.) coordinate coastal mapping planning and execution utilizing the U.S. Federal Mapping Coordination site (fedmap.seasketch.org).

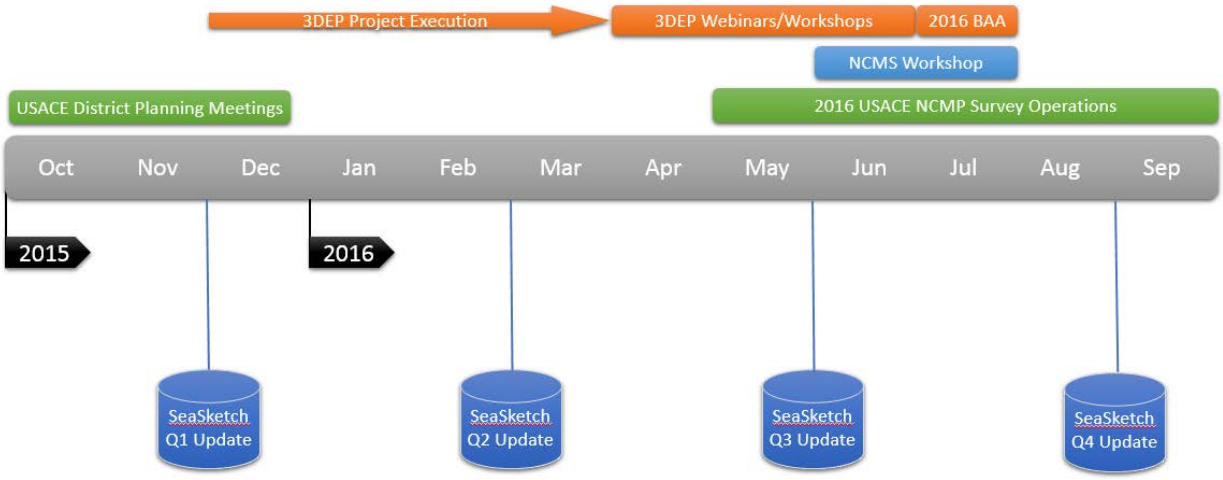

Figure 13. Fiscal Year 2016 Timeline for IWG-OCM U.S. Federal Mapping Coordination Site Updates, USGS 3DEP BAA process and execution, and USACE National Coastal Mapping Program planning and execution.

NSF supports ocean and coastal mapping projects by providing assistance awards in the form of grants and cooperative agreements, primarily to researchers in academia. Proposals for support of research that includes ocean and coastal mapping activities are peer reviewed according to the standards of the program of interest. The majority of support from NSF for ocean and coastal mapping is provided through programs in the NSF Division of Ocean Sciences (OCE). When OCE funds a research project where ocean and coastal mapping data are collected, awardees are required to follow the OCE Sample and Data Policy (www.nsf.gov/pubs/2011/nsf11060/nsf11060.pdf). This policy states, in general, that Principal Investigators are required to submit, at no more than incremental cost and within a reasonable time frame (but no later than two (2) years after the data are collected), the primary data, samples, physical

collections and other supporting materials created or gathered in the course of work under NSF/OCE grants to the appropriate Data Center.

The NSF OCE requirement for data submission may be satisfied through use of NOAA's NCEI, or other permanent accessible archive, as described in the Sample and Data Policy. In this way, data gathered with funding from the NSF are made available for unrestricted use, including scientific research and Federal, State, or Local regulatory uses.

FEMA attributes much of the success of the Risk MAP program to collaboration with the Cooperating Technical Partners (CTP) Program. The CTP Program is an innovative approach to creating partnerships between FEMA, National Flood Insurance Program communities, regional agencies, State agencies, tribes, and universities that have the interest and capability to become more active participants in FEMA flood hazard mapping initiatives. CTP Program participants are relied on to maintain up-to-date flood hazard maps and other flood hazard information.

Declassifying OCM Data

Federal agencies collect significant amounts of ocean data of a variety of types from United States and international waters, including data used for ocean and coastal mapping. Although as much of these data as possible are publicly released, some of these data cannot be released due to national security interests, the proprietary nature of the data, or other release restrictions. Executive Order 13526 (Classified National Security Information) of December 29, 2009, prescribes a uniform system for classifying and safeguarding national security information and for declassifying and publicly releasing classified information when data protection is no longer necessary. Several Federal agencies have programs that require collection and handling of classified ocean and coastal mapping and charting data, and declassification and release of that data when it becomes possible to do so.

United States Navy

The United States Navy collects high resolution global bathymetric data in support of operational United States, allied, and coalition military forces. While much of the Navy-collected mapping and charting data cannot be released, the Navy continues to dispense as much ocean data available as possible.

The Navy collected multibeam bathymetric data in the United States EEZ from offshore of the New England coast to Florida in 2004 and 2006 which is now declassified by the Navy in support of efforts to determine the limits of the United States continental shelf. In June 2006, the Navy agreed to release Arctic Ocean bathymetric data collected by submarines from 1993–2000 within the designated Science Ice Exercise (SCICEX) area in the Arctic Ocean. The Navy now releases Arctic submarine data as it is collected and processed in collaboration with research agencies and the marine research community. During 2014–2016, SCICEX partners focused on delivering products from 2011, 2012, and 2014 cruises and publicizing data already released (see http://www.onr.navy.mil/reports/FY15/agfetter.pdf). In 2008, the Navy worked with NOAA and the Governor of Washington State to remove a 1985 restriction by the Deputy National Security Advisor on NOAA prohibiting public release of some bathymetric data and products from United States waters by NOAA without the prior approval of the Department of Defense. That restriction was lifted in December 2008.

National Geospatial-Intelligence Agency

U.S. Code 10 U.S.C. § 451 authorizes the National Geospatial-Intelligence Agency (NGA) to prepare maps, charts, and nautical books required in navigation, and to have those materials published and furnished to navigators. 10 U.S.C. § 455 addresses public availability and exceptions to public release. NGA makes many nautical products and essential updates available to the public through its website

with conditions that allow commercial firms to reproduce hard copy publications. Releasable bathymetric data acquired by NGA are made available to the public through the NCEI.

Digital Coast Integrated Mapping Pilot (OCMIA Section 12204 (10))

As described in the 2009–2010 and 2014 IWG-OCM Reports to Congress, a Digital Coast Northern Gulf of Mexico resource plan was developed which included purchase and development of topographic and bathymetric data for the Northern Gulf of Mexico. Funds were not made available, however, for data acquisition. In lieu of this original plan, NOAA worked with the Northern Gulf Institute and the National Association of Counties (NACo) to conduct a two-day Digital Coast workshop for the six coastal counties in Mississippi to help them share issues, identify common needs, and determine if data and tools available via the Digital Coast could help the counties increase coastal resiliency.

Workshop participants included Digital Coast partners, NACo members from national and local offices, city planners, land trust executive directors, researchers, and private sector companies. The goals of the workshop were to identify key concerns and vulnerabilities, share natural hazards coping strategies, learn about resources available through the Digital Coast, and improve links to the Mississippi Digital Earth Model project.

Outcomes from the workshop indicated that the Mississippi coastal communities needed aerial imagery updated at 6-month intervals, improved coordination on data access issues, and experience challenges in post-event storm recovery. The participants were pleased to learn about the resources available via the Digital Coast and thought many could help address their needs. No additional changes or work has occurred on this project since the 2014 IWG-OCM Report to Congress. For purposes of reporting, this OCMIA Reporting Requirement has been completed.

Federal Contracting Policies (OCMIA Section 12204 (12))

The IWG-OCM agencies recognize that qualified commercial sources can provide competent, professional, and cost-effective ocean and coastal mapping services and expertise in support of diverse agency mapping missions. Each IWG-OCM agency has policies in place regarding collection contracts for ocean and coastal mapping data that are described in the 2009–2010 IWG-OCM Report to Congress. During the 2014–2016 reporting period, IWG-OCM member agencies successfully and efficiently contracted with multiple commercial sources for acquisition of ocean and coastal mapping data, including the notable acquisition of coastal lidar data and imagery in the aftermath of Sandy. In some cases, data acquisition began within a week of Sandy's landfall to support disaster recovery efforts and scientific studies of storm impacts.

NOAA is one agency with a long history of contracting for coastal and ocean mapping services. It is incumbent upon NOAA to maintain operational ocean and coastal mapping expertise. NOAA supplements its internal operational capacity by contracting for ocean and coastal mapping services when feasible. To better leverage its mapping resources, NOAA makes its coastal geospatial and hydrographic services contracts with private-sector companies available to state and local government entities that have a need for the services provided by these contracts and can provide adequate funding. This process facilitates increased synergy in planning and executing surveys of mutual interest. To foster improved end-data interoperability, NOAA references relevant Federal standards whenever appropriate in contracted projects.

Since 1998 NOAA has awarded over $450 million of task orders for hydrographic surveying services that provide data to update nautical charts and improve future storm surge models. This data is publicly

available at no cost, and supports a wide variety of integrated ocean and coastal mapping users. In 2014 NOAA awarded a new contract to eight firms to ensure it has the contracting capacity for future requirements in the near-term. The new contract has a $250 million program ceiling.

USACE also offers a good example of Federal mapping contracting. During the time period represented by this report, the JALBTCX executed over 80 percent of the funding it received for mapping through eight indefinite-delivery, indefinite-quantity survey and mapping contracts. The remaining funds were used for contract management, quality assurance and quality control of data, and development of new information products using ocean and coastal mapping data. Over 5,000 square miles of new elevation and depth measurements were taken of key coastal areas during the reporting period, including:

- Washington, Oregon, and southern California, including 29 Federal navigation channels and 63 coastal navigation structures, and the aforementioned Federal priority areas;
- Northern California and Florida Gulf Coast, including 25 navigation channels and 48 coastal structures;
- Baseline data and imagery for navigation projects in USACE New England District (Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine) 67 projects in total; and
- NGA leveraged JALBTCX sensor capability in USACE and NAVO to acquire data on the Great Bahamas Bank.

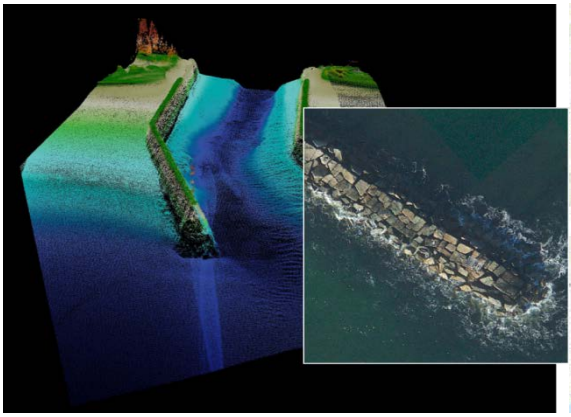

Figure 14. USACE navigation project at Wells Harbor, Maine. Background image is lidar point cloud color-coded by elevation (blue-water, tan-green land elevations). Foreground inset image is 5-cm resolution image clip of navigation structure.

Figure 15. USACE survey of Nisqually Wildlife Refuge for USGS. Because the survey was performed in conjunction with USACE National Coastal Mapping Program activities along the outer coast of Washington, USGS saved on the cost of mobilization and USACE benefitted from having a secondary survey site when survey operations were precluded by weather or water quality on the coast.

The Maritime Domain of NGA mostly supports ocean and coastal mapping in areas outside United States territorial waters. In support of the United States Navy, NGA does limited nautical charting inside United States territorial waters. NGA produces and maintains the electronic digital nautical chart over United States territorial waters and the Global Port Infrastructure Data over United ports. Approximately 95 percent of digital nautical chart production and all updating are done through contracts.

The Way Forward

The IWG-OCM agencies remain committed to advancing the goals of OCMIA and integrated ocean and coastal mapping. The partners will continue to expand interagency coordination through multiple avenues, including using web-based planning tools for greater collaboration on data acquisition planning, and interagency agreements for shared data acquisition and simplified contracting. Priorities include advancing best practices and standards for ocean and coastal mapping, and promoting the transfer of data to national archives. The IWG-OCM also plans to continue building stronger links to national and regional planning bodies such as the 3DEP Working Group and states to work towards coordination of mapping data acquisition, particularly lidar and acoustic data. IWG-OCM agencies will also leverage the National Coastal Mapping Strategy, when completed, into an outreach tool to encourage adherence to a minimum set of established standards and partnerships across Federal and state governments, academia, and other non-governmental organizations. Next steps for the NCMS include expanding beyond the current focus on topobathy lidar to include other types of coastal geospatial data such as hydrographic surveys. Progress on these actions and other OCMIA mandates will be relayed by the IWG-OCM in its next Report to Congress in 2018.

Appendix

Ocean and Coastal Mapping Integration Act

Below is the section of the Ocean and Coastal Mapping Integration Act (Subtitle B) that is relevant to the biennial reporting requirement.

SEC. 12204. BIENNIAL REPORTS.

No later than 18 months after the date of enactment of this Act, and biennially thereafter, the co- chairmen of the Committee shall transmit to the Committees on Commerce, Science, and Transportation and Energy and Natural Resources of the Senate and the Committee on Natural Resources of the House of Representatives a report detailing progress made in implementing this subtitle, including—

(1) an inventory of ocean and coastal mapping data within the territorial sea and the exclusive economic zone and throughout the Continental Shelf of the United States, noting the age and source of the survey and the spatial resolution(metadata) of the data;

(2) identification of priority areas in need of survey coverage using present technologies;

(3) a resource plan that identifies when priority areas in need of modern ocean and coastal mapping surveys can be accomplished;

(4) the status of efforts to produce integrated digital maps of ocean and coastal areas;

(5) a description of any products resulting from coordinated mapping efforts under this subtitle that improve public understanding of the coasts and oceans, or regulatory decision making;

(6) documentation of minimum and desired standards for data acquisition and integrated metadata;

(7) a statement of the status of Federal efforts to leverage mapping technologies, coordinate mapping activities, share expertise, and exchange data;

(8) a statement of resource requirements for organizations to meet the goals of the program, including technology needs for data acquisition, processing, and distribution systems;

(9) a statement of the status of efforts to declassify data gathered by the Navy, the National Geospatial-Intelligence Agency, and other agencies to the extent possible without jeopardizing national security, and make it available to partner agencies and the public;

(10) a resource plan for a digital coast integrated mapping pilot project for the northern Gulf of Mexico that will—

(A) cover the area from the authorized coastal counties through the territorial sea;

(B) identify how such a pilot project will leverage public and private mapping data and resources, such as the United States Geological Survey National Map, to result in an operational coastal change assessment program for the sub region;

(11) the status of efforts to coordinate Federal programs with coastal state and local government programs and leverage those programs;

(12) a description of efforts of Federal agencies to increase contracting with nongovernmental entities; and

(13) an inventory and description of any new Federal or federally funded programs conducting shoreline delineation and ocean or coastal mapping since the previous reporting cycle.

Abbreviations

3D	Three Dimensional
3DEP	3D Elevation Program
BOEM	Bureau of Ocean Energy Management
CMECS	Coastal and Marine Ecological Classification Standard
CTP	Cooperating Technical Partner
DEM	Digital Elevation Model
FGDC	Federal Geographic Data Committee
FEMA	Federal Emergency Management Agency
IWG-OCM	Interagency Working Group on Ocean and Coastal Mapping
JALBTCX	Joint Airborne Lidar Bathymetry Technical Center of Expertise
K	Thousand
Lidar	Light Detection and Ranging
LM	Linear Mile
NACo	National Association of Counties
MAP	Mapping, Assessment, and Planning
NAVO	Naval Oceanographic Office
NCMP	United States Army Corp of Engineers National Coastal Mapping Program
NCMS	National Coastal Mapping Strategy
NFIP	National Flood Insurance Program
NCEI	National Centers for Environmental Information
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NSF	National Science Foundation
NSTC	National Science and Technology Council
OCE	National Science Foundation Division of Ocean Sciences
OCMIA	Ocean and Coastal Mapping Integration Act
OCS	Outer Continental Shelf
OSTP	Office of Science and Technology Policy
Risk MAP	Federal Emergency Management Agency Risk Mapping, Assessment, and Planning Program
Sandy	Post-Tropical Cyclone Sandy

SNM	Square Nautical Mile
SOST	Subcommittee on Ocean Science and Technology
STEM	Science, Technology, Engineering, and Mathematics
TMAC	Technical Mapping Advisory Council
USACE	United States Army Corp of Engineers
USIEI	United States Interagency Elevation Inventory
USGS	United States Geological Survey