REPORT TO THE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION OF THE SENATE

AND

THE COMMITTEE ON NATURAL RESOURCES OF THE HOUSE OF REPRESENTATIVES

2012 Report to Congress

on

NOAA's Integrated Ocean and Coastal Mapping Initiative

Prepared by:

The National Oceanic and Atmospheric Administration

United States Department of Commerce

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REPORT TO THE COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION OF THE SENATE and THE COMMITTEE ON NATURAL RESOURCES OF THE HOUSE OF REPRESENTATIVES

2012 Report to Congress on The National Oceanic and Atmospheric Administration's Integrated Ocean and Coastal Mapping Initiative

This report is an update to the 2010 Report to Congress on the National Oceanic and Atmospheric Administration's (NOAA) Integrated Ocean and Coastal Mapping Initiative, responding to requirements in the *Omnibus Public Land Management Act of 2009* (P.L. 111-11), and specifically the *Ocean and Coastal Mapping Integration Act* (P.L. 111-11, Title XII, Subtitle B) (hereafter, "Act"). The Act directs NOAA to "…develop and submit to the Congress a plan for an integrated ocean and coastal mapping initiative within the National Oceanic and Atmospheric Administration" (see Appendix 2 for the full text of the reporting requirements as contained in Section 12205 of the Act).

Executive Summary

Accurate mapping of the Nation's coastal watersheds, adjacent oceans, and Great Lakes is critical to meeting economic, security, environmental, and societal needs. NOAA has a suite of programs that acquire, manage, and distribute robust mapping data for the ocean and coastal zone. These programs support NOAA's stewardship and economic missions, as well as other coastal and ocean requirements. With more than 50 percent of the U.S. population and economic activity occurring along the coast, accurate maps and charts are vital to protect life and property, support healthy and resilient coastal communities, provide for safe and efficient marine transportation, and inform smart economic decisions regarding public and private infrastructure.

NOAA recognizes the importance and value of integrating mapping activities, both within the agency and with its Federal, State, Tribal, local, and non-governmental partners. In accordance with the Act, NOAA continues to enhance its coordination of ocean and coastal mapping in order to more effectively and efficiently provide stakeholders and the public with comprehensive geospatial information. Included are those who acquire ocean and coastal geospatial data, use these data, or depend on derivative mapping products and services developed from these data.

This report provides an update on NOAA's progress in implementing efficient, comprehensive ocean and coastal mapping and the multi-year effort to enhance the integration and coordination of derivative mapping products. Selected success stories provide examples of specific mapping efforts since the last report. In addition, the report includes updated descriptions of NOAA's ocean and coastal mapping programs and efforts to ensure effective interagency mapping coordination, support efficient management and dissemination of data, and improve mapping technologies.

Introduction

As defined in the Act, ocean and coastal mapping is the acquisition, processing, and management of physical, biological, geological, chemical, and archeological characteristics and boundaries of ocean and coastal areas, resources, and sea beds using a variety of mapping technologies. The NOAA Integrated Ocean and Coastal Mapping (IOCM) program implements planning, acquiring, documenting, managing, integrating, and disseminating these data and derivative products in a manner that permits easy access to and use by the greatest range of users. NOAA is adopting these practices throughout its mapping programs with the philosophy of "map once, use many times." This philosophy is also reflected in the concepts of efficient government as promoted by the National Ocean Policy.

IOCM involves at least three primary tasks: 1) coordination and collaboration between mapping organizations within NOAA and other agencies to avoid duplication of effort and maximize survey time; 2) end-to-end data management to provide an efficient system to assure that all data collected is consistently processed and provided to the national archive centers; and 3) maximum use and re-use of the total archive of mapping data to consistently produce the products that were originally intended, as well as the innovative re-use of data to produce additional products to serve national needs. IOCM requires intra- and inter-agency coordination with a focus on streamlining operations, reducing redundancies, improving efficiencies, developing common standards, and stimulating innovation and technological development.

This report provides an update from the initial 2010 Report on NOAA's progress in implementing integrated ocean and coastal mapping. Table 1 provides a status check on specific activities proposed in the 2010 report. IOCM accomplishments within NOAA have depended on innovative use of resources contributed by the NOAA offices involved in a variety of small projects. Selected projects and activities are described in more detail under "IOCM Accomplishments," grouping accomplishments under the broad categories of "Coordination and Collaboration," "End-to-End Data Management," and "Maximum Use and Re-Use." Example successes include a fisheries water-column survey that discovered a seafloor hazard to navigation, which was quickly included on the corresponding nautical chart. Other highlights include the first interagency data inventory portal for ocean and coastal mapping data, a suite of collaborative field programs from across NOAA, the development of metadata standards, the Rolling Deck to Repository (R2R) program with the academic fleet and within NOAA to improve data flow from ship to the data archive centers, and numerous examples of data re-use. Finally, sections of the 2010 Report are updated in Appendix 1.

The Act calls for NOAA to provide a schedule for submission to Congress of periodic progress Reports on plan implementation. NOAA provides these Reports on a biennial basis, with the next Report to be delivered by April 1, 2014.

Progress in Implementing the NOAA Integrated Ocean and Coastal Mapping Initiative

"…set forth a timetable for implementation and completion of the plan…"

Resourcing the *Ocean and Coastal Mapping Act's* mandates will enable NOAA to execute the actions needed to enhance integration and move to more fully coordinated ocean and coastal mapping. As summarized in Table 1 below and more fully described in the following "IOCM Accomplishments," NOAA and its partners are making progress in realizing the goals of IOCM. While the timeframe (proposed in the 2010 Report to Congress) may change depending on available resources, NOAA is committed to the actions listed in Table 1:

Table 1: Progress in Implementing the IOCM Initiative

Action	2012 Progress Report	< 2 Years	2-5 Years	> 5 Years
Planning and Coordination:				
1. In partnership with the Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM) and the NOAA IOCM Coordination Team, conduct annual NOAA and/or interagency OCM planning and coordination workshops.	Workshops conducted in 2010 and 2011 (topics included: planning, data management, data inventory, NOAA Rolling Deck to Repository). Results include recommended procedures and standards. Examples in "IOCM Accomplishments."	●	●	●
2. Develop integrated inventories of existing data.	Prototype Ocean and Coastal Mapping (OCM) Inventory integrates elevation data from NOAA, United States Army Corps of Engineers (USACE), United States Geological Survey (USGS), Bureau of Ocean Energy Management (BOEM), and Environmental Protection Agency (EPA).	●	●	●
3. Conduct regional mapping requirements workshops to ensure the capture of Federal, State, and regional requirements with coastal states and regional ocean governance councils.	Leverage other regional workshops and work with related interagency efforts.		●	●
4. Improve resources to allow more robust interagency coordination of data acquisition activities with the IWG-OCM.	Prototype OCM Inventory will aid coordinated planning.	●	●	●

Action	2012 Progress Report	< 2 Years	2-5 Years	> 5 Years
5. Develop standard operating procedures for documenting and providing for discovery of planned survey activities.	Evaluating best way to access planning data in prototype OCM Inventory; on-going development of standard documentation and procedures.	●	●	
Data Acquisition:				
1. Define new standard operating procedures for NOAA Rolling Deck Repository (R2R).	Shipboard Geophysical Data Stewardship policy approved and implemented. Oceanographic Data policy is in development.	●	●	
2. Implement NOAA R2R.	R2R policies are being implemented by NOAA; phased implementation at Data Centers underway; R2R for seafloor mapping standards implemented with OMAO's Data Management System (DMS) as an Operations Manual.		●	
3. Develop a plan for supporting the acquisition of shallow-water bathymetry	NOAA has a plan and is currently working with inter-agency government and academic partners to fully develop a shallow-water bathymetric light detection and ranging (LiDAR) system capable of bridging the current technology gap. Operation of this system is expected to begin during the summer of 2012.	●	●	
4. Complete the development of a common specification for airborne light detection and ranging (LiDAR) data coastal mapping and charting.	Collaborated with Federal partners on the development and release of common LiDAR Survey Specifications Matrix. On-going progress on specifications, standards, and survey practices, including first operational use of USACE LiDAR for NOAA National Shoreline.	●		
5. Develop or adopt a common specification for the acquisition of acoustic bathymetry.	NOAA IOCM Sea Floor Mapping Standard completed and in NOAA's Office of Marine and Aviation Operation's (OMAO) Data Management System (DMS) Operation Manuals; shared with OCM partners.	●		

Action	2012 Progress Report	< 2 Years	2-5 Years	> 5 Years
Data Management:				
1. Identify and adopt standards and practices applicable to IOCM data.	New OCM International Standards Organization (ISO) metadata adopted by IWG-OCM and academia partners; ongoing as new standards needed.	●	●	●
2. Develop consistent practices and guidance for applying metadata standards to ocean and coastal mapping data.	IWG-OCM common metadata vocabulary in development; R2R implementation pending.	●	●	●
3. Develop new technologies and techniques for improved data processing and analysis.	Continual progress and developments being made; examples follow in "IOCM Accomplishments."	●	●	●
4. Provide guidance and implement standard operating procedures for end-to-end data management.	Shipboard Data Stewardship policies are being developed for end-to-end data management; Data Centers follow Open Archive Information System (OAIS); discovery and delivery based on open standards, assessment underway.		●	
Data Integration:				
1. Develop integrated web-map inventories of existing OCM data.	The prototype OCM Inventory includes data from 5 federal repositories. Web Mapping Inventory has been built and is being evaluated.	●	●	
2. Develop or adopt common data delivery formats.	Working with academia and partner agencies to develop common data delivery format from multiple industry sensor formats.		●	
Data Dissemination:				
1. Improve discovery and delivery of data.	OCM Inventory, NOAA R2R, advances in web services, and improved metadata standards are continually advancing discovery and delivery of data.	●	●	
2. Implement approved practices and standards for IOCM data and metadata.	Metadata standards developed and adopted by OCM partners; OMAO is instituting all approved policies and standards to NOAA fleet and contracts.	●	●	

IOCM Accomplishments

Building on successful projects begun early in the conceptual stages of IOCM, the community has initiated new projects resulting in better science, collaboration, and products for the Nation. The following successes highlight recent efforts to maximize the benefit of OCM.

Coordination and Collaboration

NOAA is improving planning and coordination to ensure efficient and appropriate data acquisition.

Planning and Coordination Workshops

Under the auspices of the IWG-OCM, planning and technical workshops were held to maximize collaboration in survey planning, data acquisition, and data access and management. Workshops resulted in the concrete examples of improved inter- and intra-agency collaboration detailed below. Two workshops were held in 2011 focusing on the OCM Inventory work flow, data producers, and technical tools. The Inventory was prototyped in 2011 and is currently under review using elevation data and planning information as a test suite. Recommendations from the review will be used to initiate improvements to ensure utility of the Inventory, both for coordinated planning and for data discovery.

Standards and Best Practices Developed

NOAA, working with partner agencies, developed standard operating procedures for documenting and providing for discovery of planned survey activities through common metadata. Metadata for OCM Cruises, Bathymetric Data, Seismic Data, and Geologic Samples were all developed jointly with the IWG-OCM and academic partners. Standard metadata and vocabularies to address the data types are being developed. NOAA's Geophysical Shipboard Data Stewardship Policy was implemented through the Office of Marine and Aviation Operations. This policy details the workflow and responsibilities to ensure data collected are well planned, described, and delivered to the archives in an efficient manner. The Shipboard Oceanographic Data Stewardship policy is currently in development.

NOAA also completed the IOCM Seafloor Mapping Standard document, providing guidelines based on the International Hydrographic Organization's (IHO) Order 1 standard for the collection and processing of seafloor mapping data. Adherence to these guidelines will allow bathymetric products from diverse surveys to be used for multiple mapping purposes. NOAA is collaborating with partners in the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) to exchange and further refine common specifications for airborne LiDAR.

NOAA recently completed two documents guiding development of the agency's habitat science program, with habitat mapping identified as a key requirement. These documents describe how improved habitat science can improve fisheries management through incorporation of habitat information into stock assessments and through enhancing the information base for Essential Fish Habitat (EFH) designations. The Marine Fisheries Habitat Assessment Improvement Plan identifies programmatic needs, including habitat mapping. *The Habitat Assessment Prioritization*, awaiting approval for release, implements components of the Plan by describing a method for establishing regional priorities for habitat

assessments. These regional priorities will inform decisions about mapping needs within regions. Maps and descriptions of EFH, as well as information on the steps that Fishery Management Councils have taken to minimize the impact of fishing on EFH, are available on NOAA's Essential Fish Habitat Mapper.

NOAA/BOEM/USGS Collaboration

NOAA's Office of Ocean Exploration and Research (OER) is partnering with BOEM and USGS on a number of deep-water exploration projects. The collaboration started in the Gulf of Mexico focusing on chemosynthetic communities and deep sea corals, and the newest project focuses on deep communities in canyons along the mid-Atlantic seaboard. The study areas for these projects are correlated with information needs associated with future management of off-shore resources and the outer continental shelf. These projects are multi-year and include detailed multi-beam mapping of potential study sites followed by exploration with remotely operated vehicles (ROVs). Data acquired during projects is processed to benefit both NOAA and its partners.

Prototype OCM Inventory: Discovery of and Access to Ocean and Coastal Mapping Data

The Prototype OCM Inventory seamlessly combines information from multiple Federal data archives to provide users with a one stop source for ocean and coastal mapping data. This new technology will improve data discovery and accessibility and encourage data reuse. The Inventory also includes information about planned surveys to help reduce redundant survey efforts and facilitate cooperative mapping. The OCM Inventory prototype currently provides centralized access to hydrographic and topographic data from NOAA, USGS, EPA, BOEM, and USACE and has already shown potential for promoting efficient use and collection of OCM data. Current challenges to the goal of increasing the positive impacts of the Inventory include implementation of controlled metadata vocabularies, upgrading Federal data archives to enable modern stewardship and data delivery practices, and establishment of a permanent, sustainable Inventory location.

Marine Debris Mapping

Figure 1: Satellite image of marine debris from the March 2011 Japan tsunami

Following the devastating Tohoku, Japan, tsunami in March 2011, much of the debris in the inundation zone washed into the ocean. NOAA utilized satellites, aerial surveillance, and ocean circulation models validated by ship reports to track the massive debris fields (Figure 1). Heavier materials sank closer to shore, while buoyant materials created debris fields identified in satellite imagery and aerial photos of the waters surrounding Japan. Winds and ocean currents scattered the debris, so months later it is no longer recognizable in satellite imagery. Models predict some of the debris may reach U.S. coasts. NOAA and its Federal and non-Federal partners are working together to collect data and to assess the debris and possible impacts based on sound science. From Hurricanes Katrina and Rita, NOAA developed practices to conduct seafloor surveys to identify and map marine debris using side scan sonar and other technologies. These techniques can now be rapidly employed to provide survey information to the U.S. Coast Guard

(USCG), Federal Emergency Management Agency (FEMA), and other stakeholders to assist with debris removal.

Mobile Bay Collaborative Mapping Project

Several NOAA offices joined forces to execute a collaborative mapping project in the Mobile Bay region of the Gulf of Mexico. This project established a foundation for a new circulation model, which provided input for oil spill prediction models; contributed to more accurate modeling of storm surge, coastal inundation, and sea-level rise; and will improve harmful algal bloom forecasts. As a component of this project, a series of bathymetric surveys were conducted in order to provide contemporary hydrographic data for application to the circulation model and to update nautical charts and products. In addition to the products created and updated from the mapping portion of the project, several tidal and current prediction tables were updated with the information gained from the installation of ancillary tidal support measuring equipment for mapping activities.

Coastal Georgia Collaborative Mapping Project

The U.S. coastline is experiencing significant population growth, putting increasing pressure on the region's natural and economic resources. Much of this growth is occurring in low lying areas that are vulnerable to the effects of coastal inundation. High resolution elevation data provides the accuracy to model the potential extent of inundation, giving coastal communities a powerful tool to identify where they are most at-risk. In 2009, a consortium of coastal cities, counties, educational institutions, state and Federal agencies, and private-sector organizations worked together to acquire high resolution elevation data for over 4500 square miles of coastal Georgia. This partnership, led by the Coastal Regional Commission of Georgia, worked with USGS, FEMA, and NOAA to develop a common specification for data acquisition. As a result, data obtained through the consortium meets the minimum standards for several specifications: the National Geospatial-Intelligence Agency (NGA) Minimal Delivery Specifications for LiDAR, FEMA Specifications for Flood Hazard Mapping, and Florida Division of Emergency Management's LiDAR Standards. This effort ensures that the resultant products will be of greatest utility to all parties involved and maximizes the consortium's return on investment. The high resolution elevation data collected as part of this effort is highly valuable for economic planning and infrastructure development and improvements. Access to the processed data sets is provided through the Digital Coast Data Access Viewer.

NOAA/USACE Shoreline Mapping Collaboration

NOAA and USACE each have defined coastal mapping responsibilities. USACE's coastal mapping requirements support regional sediment management, construction, operations, and regulatory functions in the coastal zone. NOAA maps the National Shoreline, which is used to update nautical charts, and which serves as a baseline for cadastral (boundary) applications in matters of private, State, and Federal property ownership, waterway responsibilities, and mineral rights. Using in-house and contract assets, NOAA annually maps between two and three percent of the U.S. shoreline. The active partnership between NOAA and USACE has led to: common specifications for certain source data; sharing of data, tools, and workflows between the two organizations; and productive research collaboration on coastal remote sensing technologies and techniques; all of which are increasing efficiency in both agencies.

Interagency Coastal LiDAR Collaboration

JALBTCX, the Joint Airborne Lidar Bathymetry Technical Center of Expertise, is an example of a highly-successful IOCM interagency collaboration. As part of the Center's activities, member agencies NOAA, USACE, and the Naval Oceanographic Office (NAVO), and participating agency USGS have been collaborating for a number of years on developing coastal mapping technology and common standards. This work recently allowed NOAA to begin using USACE-collected LiDAR data and NOAA's vertical datum transformation utility, VDatum, for mapping the National Shoreline depicted on NOAA nautical charts. An initial demonstration project conducted in California in 2011 resulted in new mapped shoreline extending from the southern end of San Diego County (border with Mexico) to the northern end of Ventura County, with data meeting the needs of both USACE and NOAA. The next steps in this project will include continuing the shoreline extraction from LiDAR data up the California, Oregon, and Washington coasts. At the same time, JALBTCX partner agencies are now using NOAA LiDAR data and imagery in their programs, including recent projects in which the USGS used NOAA-collected LiDAR in assessing coastal storm impacts. These collaborative projects already show increased efficiency for the partner agencies, and further JALBTCX success stories are anticipated.

Long Island Sound Collaborative Mapping Project

In 2011, the Long Island Sound (LIS) Program (State of Connecticut, State of New York, Connecticut and New York Sea Grant, and the U.S. EPA) requested NOAA's assistance in providing management and technical expertise, data acquisition, and product development for LIS. Through a State, Federal, and academic partnership, NOAA is leading the LIS seafloor mapping project to provide products and capabilities to meet the various partnership requirements as set out by the LIS Executive Committee. Nautical charting data collected by NOAA in 2012 will also provide information needed to map seafloor habitats. Conversely, data collected by other parties through LIS Program funding will meet NOAA nautical charting requirements. NOAA's engagement in the project has made the coordinated planning, management, identification of priorities, and design of products possible.

Collaborative Research and Charting in the Eastern Bering Sea

Three branches of NOAA are working together to conduct coordinated fish-habitat research and nautical charting in the eastern Bering Sea. This partnership is using innovative technology to acquire data that are simultaneously applicable to multiple agency mandates. The resulting organizational efficiencies maximize the benefits from skilled personnel and specialized NOAA vessels. New technology that was purpose-built for fish-habitat research (Figure 2) has increased the efficiency of survey operations, thereby reducing costs and the time required to complete missions. The broad swath coverage of the integrated bathymetric subsystem may also improve the efficiency of

Figure 2: Long-range side scan sonar system for fisheries research.

hydrographic reconnaissance in the Arctic and provide a safer alternative to launch-based surveying in shallow water areas. Furthermore, protocols for concurrent ground-truth and survey operations have been developed that also increase survey-vessel productivity. A rigorous field experiment (the FISHPAC project) planned on *Fairweather* in summer 2012 will directly compare five different sonars to identify the most cost-effective system for acquiring the diverse seafloor data needed to improve existing fish-habitat models.

Strategic partnerships promote timely delivery of high-quality products. OMAO has created a cross-over shore billet for a NOAA Corps Officer to provide hydrographic expertise at the Alaska Fisheries Science Center (AFSC) and ensure that the acquired bathymetric data meet international standards for charting. An interagency agreement with the Naval Undersea Warfare Center (Keyport, WA) provides access to specialized electronic equipment and skilled operators for sea trials and survey operations.

Leveraging Research Assets with Mission Priorities

NOAA's *Okeanos Explorer* explores the Earth's ocean for the purpose of discovery and the advancement of knowledge. NOAA leverages these research assets with mission priorities in several ways, including contribution of expertise and collaborative mapping support. Examples include contributions towards the Gulf of Maine Mapping Initiative (GOMMI), support of National Marine Sanctuaries, and the Extended Continental Shelf Task Force and Gulf of Mexico mapping. GOMMI is a U.S.-Canadian partnership of government and nongovernment organizations to conduct comprehensive seafloor imaging, mapping, and biological and geological surveys. This initiative involved partnerships with NOAA, the IOCM Processing Center, and the State of Massachusetts. From 2008 through 2011, NOAA partnered with other Federal and State agencies to map large portions of Olympic Coast, Cordell Bank, and the Gulf of the Farallones, in support of Marine Sanctuaries. Another effort with NOAA involvement, the Extended Continental Shelf (ECS) Task Force, an interagency coordinating body headed by the U.S. Department of State, directs the interagency program to determine the limits of our continental shelf in accordance with international law. To date, the U.S. ECS program, through a multi-agency effort, has mapped more than 20,000 linear kilometers of seismic data and more than 1.8 million square kilometers of seafloor in the Atlantic, Pacific, Gulf of Mexico, and Arctic. This includes 2010 surveys of the Mendocino and Necker Ridges. Also in 2010, NOAA demonstrated the capability to detect and map deep water gaseous seeps in the water column. The Gulf of Mexico expedition was a partnership involving the NOAA Ship *Pisces* and representatives from NOAA, BOEM, and the University of New Hampshire (UNH).

Gravity for the Redefinition of the American Vertical Datum (GRAV-D)

The National Spatial Reference System (NSRS) is a consistent national coordinate system that specifies latitude, longitude, height, scale, gravity, and orientation throughout the Nation, as well as how these values change with time. Horizontal positions can be quickly determined using GNSS (Global Navigation Satellite System, which includes GPS and foreign satellites) receivers, but high accuracy vertical positions are more difficult. To improve the accuracy and accessibility of heights (roughly height above sea level) NGS began the GRAV-D project (Gravity for the Redefinition of the American Vertical Datum) in 2007. The end result will correct errors up to two meters to provide about three centimeter accuracy where possible and, according to a 2009 socio-economic study, provide an estimated $4.8 billion in benefits. GRAV-D is currently focusing on airborne gravity surveys over the U.S. and its territories to fill in data gaps and assist with combining terrestrial and satellite gravity data. The project

also includes long-term monitoring of gravity changes and partnerships for terrestrial surveys. As of January 2012, GRAV-D has flown 15.8% of the total target area, including large areas of Alaska, the Gulf of Mexico, and the Great Lakes. The completion of GRAV-D is critical for updating the International Great Lakes Datum (IGLD). Several NOAA programs have partnered to update IGLD, provide new tools for its use, and test the agreements between ocean circulation models and gravity-based heights. The project is expected to be complete in 2022.

Deep-Sea Coral Mapping

In 2011, NOAA and partners completed a 3-year mapping and research initiative off the Southeast U.S. that mapped 1,480 square miles of seafloor off Florida and Georgia and discovered and characterized significant new deep-sea coral habitats. This information is being provided to the South Atlantic Fishery Management Council to refine its coral protection actions while allowing sustainable fisheries to thrive. On the West Coast, the Program's mapping and research is contributing to the Pacific Fishery Management Council's work to review the designation of EFH for ground fish and management actions associated with these habitats.

End to End Data Management

NOAA is providing an efficient system to assure that all data collected are consistently processed and provided to the national archive centers.

NOAA's Rolling Deck to Repository

The NOAA Rolling Deck to Repository (R2R) project aims to ensure that data collected aboard NOAA ships (a multi-million dollar annual investment of public funds) are efficiently documented, preserved, and accessible for long-term use. By coordinating across line offices, programs, and projects, NOAA can streamline the delivery of data to the archive and make them available to the stakeholders who depend on environmental data for decision making, habitat management, hazard mitigation, and research. Largely based on the Academic Fleet R2R program funded by the National Science Foundation, the NOAA R2R project provides coordination, facilitation, and support for the NOAA programs that already have primary responsibility for their ship-based data management activities. NOAA is implementing R2R in stages, focusing initially on geophysical data. In 2010, NOAA approved and adopted new Geophysical Data Stewardship Policies through OMAO. This policy establishes the standard operating procedures regarding data handling from planning through collection and archive. Combined with the ongoing standardization of metadata, data are efficiently acquired, described, archived, and inventoried for future discovery and use. Next steps include developing and implementing an Oceanographic Data Policy, expanding R2R to other OCM data, and ensuring the National Data Centers are ready to manage and deliver the full suite of ocean mapping data in a robust and consistent manner.

Metadata Standards Supporting Discovery and Use of OCM Data

Clear, standard metadata are essential to the discovery, use, and re-use of ocean and coastal mapping data and products. If we know where OCM data has already been collected and enough information about its

quality, we can determine what, if any new data we need. This leads to smart planning that saves time and resources. Standard metadata underlie the success of the OCM Inventory and improve discovery of and access to OCM data. NOAA, working with several U.S Federal agencies and academic science data centers, has developed common metadata standards for many OCM data. These metadata standards were developed to support the U.S. Extended Continental Shelf (ECS) project and NOAA R2R and make data easier to manage and more useful to more people. Common, well developed metadata enables data integration, fosters collaboration, and avoids costly duplication. Challenges remain in finalizing the metadata vocabularies for the primary OCM data streams, fully implementing standards for archived data, and supporting adoption of the metadata across NOAA.

NOAA's IOCM Data Processing Center

A critical aspect of the success of IOCM is processing mapping data originating from a wide variety of platforms and organizations in a consistent manner according to the latest standards. NOAA obtains this consistency for charting by operating two Hydrographic Processing Centers at Norfolk and Seattle that adhere to well established International Hydrographic Organization (IHO) mapping standards. Non-charting data being provided through IOCM will be more heterogeneous and will require the use of innovative methods to derive consistency from the data, such as those being developed by the IOCM processing center. In 2007, The NOAA/ Center for Coastal and Ocean Mapping/ UNH Joint Hydrographic Center (CCOM/JHC) established the IOCM processing center in a new purpose-built wing of their facility. Having NOAA personnel processing IOCM data co-located with the world-class expertise at UNH seemed the best path to attaining the goals of IOCM. Since 2008, two OER physical scientists have been stationed at the IOCM processing center with their primary role to support NOAA's *Okeanos Explorer* Program, but with a secondary role to contribute toward IOCM activities. Since the establishment of this team, OER scientists have contributed to the processing of data sets collected by other offices/organizations to be assimilated into archive centers. The cross pollination of ideas between the JHC staff and other NOAA line offices has been of significant benefit to both. In 2010, NOAA assigned a NOAA Corps Officer to the JHC to work with CCOM/JHC researchers in developing improved data processing tools for the adaptation of NOAA hydrographic survey data to other non-traditional uses, such as habitat mapping. As a result, a new seafloor backscatter data processing tool is being added to the workflow at the Seattle and Norfolk hydrographic processing centers. What is critically needed now is both additional staffing of the IOCM processing center by other NOAA offices to better integrate IOCM activities and increase staff work capacity as well as identification of additional projects to which IOCM staff can contribute**.**

MAXIMUM USE AND RE-USE OF DATA

NOAA is improving data integration, discovery, and delivery to ensure maximum return on investment from existing data.

R2R Increasing OCM Data Available for Re-use

Following the successful pattern pioneered by the U.S. academic research fleet R2R Data Pipeline and Standard Products initiative, development of NOAA R2R will follow a phased implementation plan over several years, with routine cataloging and delivery of data to the National Data Centers as the top priority. As a result of both increased mapping and improved delivery to the archive, NOAA increased the amount of seafloor elevation data (bathymetric and hydrographic) available on-line by 168 terabytes (Tb) in the last two years (Figure 3). Over 200 Tb of seafloor relief data is available on-line with data discovery through the OCM Inventory, NOAA standards-based web map services, and integrated web map viewers. As R2R continues to be implemented, for both NOAA and the academic research fleet, data available from NOAA's National Data Centers will continue to increase.

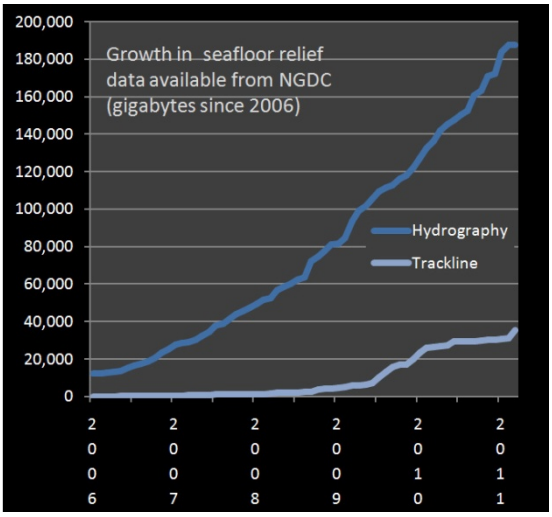

Figure 3: Increase in gigabytes of bathymetric and hydrographic data available from NGDC for re-use from 2006 to 2011.

Mapping the Water Column

CCOM/JHC developed software tools for the extraction and visualization of water column data from multibeam sonars, expanding application of these data to other fields. Working with private sector partners, these tools have been refined and commercialized for operational use. NOAA took advantage of these tools to detect and map a major methane plume off the coast of California while combining ocean exploration mapping with mapping for the U.S. Extended Continental Shelf Program (Figure 4). The methane plume mapping and resulting analysis set the stage for a joint multi-office, cross-NOAA effort to use the water column sonar visualization for tracking gas seeps and detecting perturbations in the water column associated with the Deep Water Horizon (DWH) oil spill. The use of NOAA sonars to detect gas and JHC-developed software to visualize gas in the water column was instrumental in establishing the integrity of the Macondo well and recognized as a key technology tool at the highest levels of the DWH response effort.

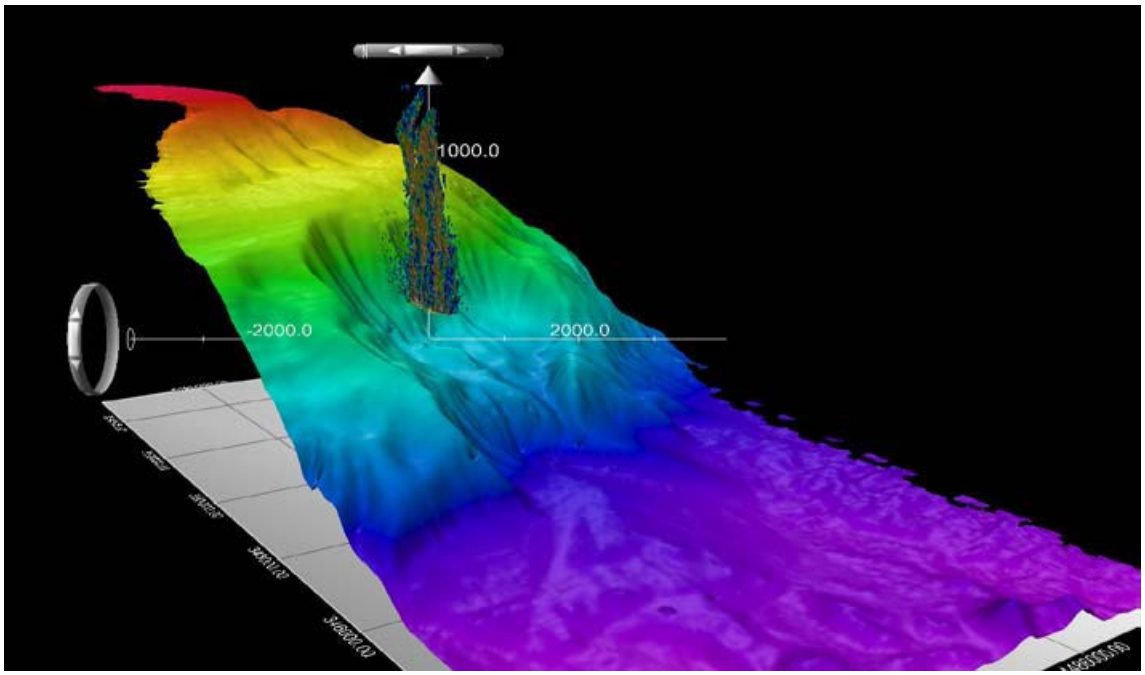

Figure 4: Methane seep and seafloor relief mapped off California by NOAA Ship Okeanos Explorer

U.S. Caribbean Mapping Project

The primary focus of this collaborative effort has been to fill informational gaps in high priority areas. These gaps include the identification of EFH through mapping of seafloor topography, coral reef habitats, fish distribution (biomass and abundance), and identification of fish spawning aggregation sites. In addition, information collected during these missions is used to support other NOAA mandates for safe navigation of maritime commerce and to provide basic data for engineering, scientific, and other commercial and industrial activities such as navigational charting updates; identification of shipwrecks, derelict fishing gear, and maritime archeology detection; incidence of coral disease and bleaching; and invasive species identification, including lionfish. As a direct result of this project, NOAA has developed pioneering capabilities to discern seafloor habitat types using semi-automated discrimination methods using one or a combination of remote sensing technologies (e.g., LiDAR, multibeam, satellite imagery). We have also exploited additional capabilities of ship-board sonars to map distributions of reef fishes not before possible. These advanced capabilities allow NOAA to rapidly provide spatial informational products to resource managers to improve their time-sensitive decision-making abilities. This project is a collaborative effort of NOAA, the NOAA/UNH CCOM/JHC, the Department of Interior (DOI), Department of Defense (DOD), Territorial Governments (U.S Virgin Islands and Puerto Rico), and academic institutions (University of the Virgin Islands and University of Puerto Rico).

Processing Data to Support Multiple Mandates

Working with the Alaska and Northeast Fisheries Science Centers, the IOCM processing center and CCOM/JHC researchers developed software applications that allow for the simultaneous acquisition of water column data, bathymetry, and seafloor backscatter during standard NOAA National Marine Fisheries sonar operations (Figure 5). These tools enable NOAA, while conducting biomass surveys, to collect data that both support mapping fisheries habitats and obtaining bathymetry for nautical charting purposes. Working with NOAA's Office of Coast Survey, JHC developed data processing tools and a data processing workflow for generating charting data from the bathymetry, including a methodology for obtaining and evaluating unconventional sound speed data for sounding corrections. These tools have resulted in the processing and submission of bathymetry from the NOAA Ship *Oscar Dyson* for nautical charting, and in the process, discovering and charting a dangerous rocky shoal via a Notice to Mariners. This effort is now extended to include NOAA Data Centers to test archive and delivery of the data. Similar collaborations to the one described above resulted in new tools and methodology to process multibeam backscatter data for additional non-navigation needs. NOAA ships have collected backscatter along with bathymetry (Figure 6), supporting NOAA's charting mission, habitat mapping projects, and coral reef habitat studies.

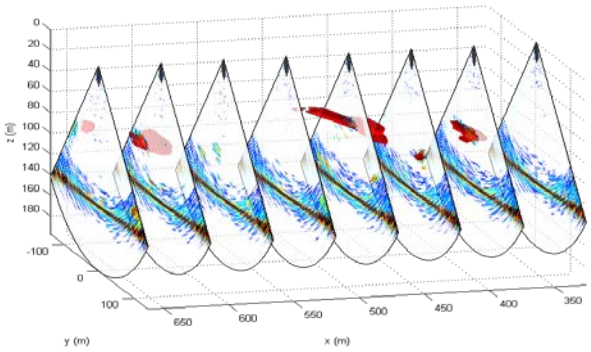

Figure 5: Along track multibeam sonar display of simultaneous acquisition of water column data, bathymetry, and seafloor backscatter from Fisheries water column survey.

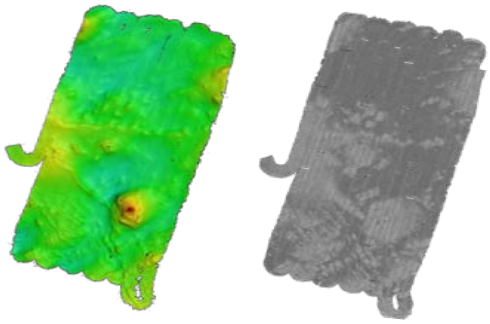

Figure 6: Graphical display of difference between multibeam bathymetry data (left) and multibeam backscatter return (right) from a NOAA Fisheries water column sonar system.

Multi-use of Remote Sensing Data

A major goal of IOCM is expanding the use of ocean and coastal geospatial data, including exploiting data collected for nautical charting to simultaneously generate new geospatial data products for coastal management and science. NOAA is currently applying this concept not only to sonar data acquired from ships, but also to aerial imagery, LiDAR data, and other types of remote sensing data. An initial IOCM pilot project aimed at demonstrating this concept was undertaken by NOAA's National Geodetic Survey (NGS) in the North Carolina Outer Banks. This pilot project generated 1500 km^2 of LiDAR data and ortho-imagery extending from Cape Hatteras to Virginia Beach and encompassing the Currituck Banks National Estuarine Research Reserve (NERR). The procedures developed in this pilot project have since been incorporated into NGS' production workflows, resulting in new, multi-use data products—LiDAR point clouds and high-resolution ortho-images—that are being disseminated via the Coastal Service Center's Digital Coast web portal. In FY11, NGS delivered over 50 high-resolution ortho-image mosaics for coastal areas, as well as LiDAR point clouds for several coastal and emergency response projects.

These new IOCM remote sensing data products are directly supporting a range of coastal management and science applications, while the source data continue to be used to map the National Shoreline and update NOAA nautical charts.

Digital Elevation Models from Diverse Data Serve Multiple Purposes

NOAA builds high-resolution, coastal digital elevation models (DEMs) to support tsunami forecast and warning efforts and inundation modeling. Bathymetric and topographic data collected for other purposes – such as NOAA hydrographic surveys for nautical charting, LiDAR surveys flown to map the coastline, and multibeam swath sonar surveys conducted by the academic fleet – are reused in the development of these DEMs. The DEMs seamlessly integrate diverse data to most accurately portray the morphology of the coastal zone and serve as a common base-layer for many integrated mapping activities. DEM development is coordinated with and supports State tsunami hazard mitigation and community preparedness efforts including coastal processes such as storm-surge and sea-level rise. The Alabama Department of Environmental Management used a DEM of Mobile Bay developed for tsunami inundation modeling to model water quality. This water-quality model merged elevation, salinity, and tidal influence factors to help differentiate between coastal estuarine and inland freshwater environments to help

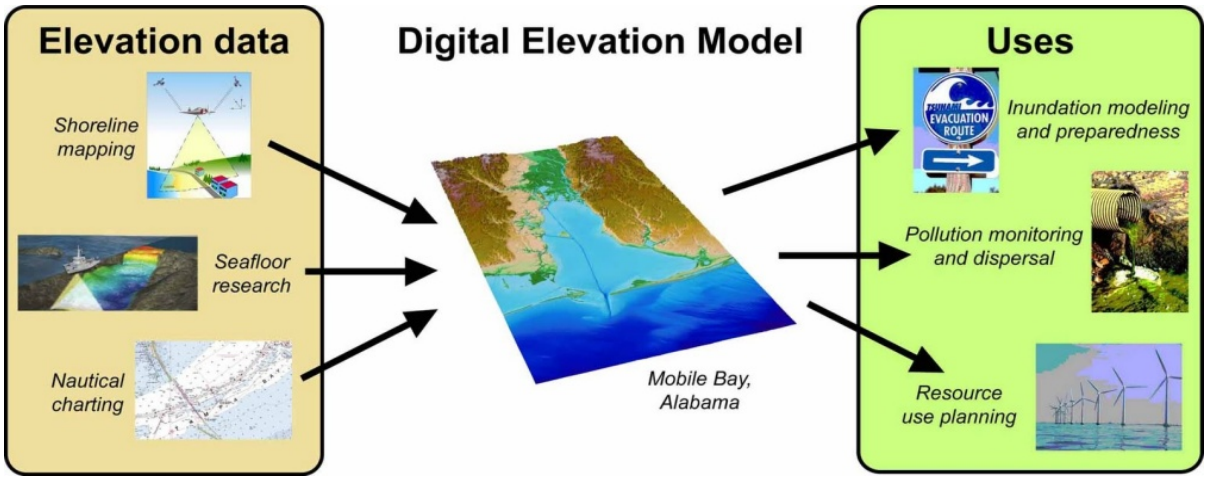

Figure 7: OCM Elevation data are re-used to generate coastal DEMs used for many purposes.

determine acceptable levels of point pollutant discharge. The main challenge in developing accurate, coastal DEMs to meet NOAA's needs is realistically portraying the seafloor relief in areas that lack high-quality data, especially in the critical near-shore zone. IOCM can help remedy this problem by integrating data needs into the survey planning process

WHERE DOES IOCM GO NEXT?

Despite great progress, there is still much to do to implement and realize the benefits of IOCM. Coordination of field programs and multi-use of ships to maximize resources will require ready access to past, current, and planned project information on a routine basis. Given that capability, when data shows that a particular plan should be modified to improve the "bang for the buck" by adding, subtracting, or combining efforts, a mechanism to authorize the modification and possible augmentation of planned field

efforts must be established. This will assure that changes can be implemented routinely. In End-to-End Data Management, the NOAA R2R initiative must be implemented with mapping standards and procedures developed, approved, and provided to the fleet. The IOCM center at JHC needs to expand to provide consistent data processing for non-hydrographic data, and the data archives must be prepared to handle the data inflow, deliver data to users in appropriate forms and formats, and provide tools to the IOCM coordination team to assure accurate and timely information on where data exist or will exist. To ensure data are acquired in a manner supporting multiple uses, shipboard technicians require training in the proper use of sonar systems and IOCM standards. At the same time, NOAA must maintain a flexible approach to applying these skills to unforeseen events. For example, Hurricane Katrina, tsunami preparedness following the Sumatran Earthquake, and the Deep-Water Horizon oil spill are all incidents that required NOAA to produce new and unforeseen products from our data holdings and expertise. Areas such as climate change, ecosystem management, development of coastal areas, and coral reef decline are ongoing NOAA priorities that will benefit from the efforts of the IOCM program.

APPENDIX 1: UPDATE OF SELECTED SECTIONS OF THE 2010 NOAA REPORT TO CONGRESS

1. <u>NOAA's Ocean and Coastal Mapping Programs:</u>
"…identify and describe all ocean and coastal mapping programs within the agency [NOAA]..."

NOAA envisions an informed society that understands the role of the oceans, coasts, and atmosphere in the global ecosystem and uses that understanding to make the best social and economic decisions. The agency is pursuing four interrelated and mutually supportive long-term goals, of which three require a coordinated and integrated approach to ocean and coastal mapping.

1. Climate adaptation and mitigation – an informed society anticipating and responding to a changing climate and its impacts.
2. Sustainable and resilient fisheries, habitats, and species – natural habitats and biodiversity protected and restored and fisheries sustained within healthy and productive ecosystems.
3. Sustainable coastal communities and economies – environmentally and economically sustainable oceans, coasts, and Great Lakes communities and ecosystems.

In addition, the Administration has identified high-priority objectives for the Nation to pursue in implementing a National Ocean Policy. These objectives include three that relate specifically to OCM: 1) Strengthen and integrate Federal and non-Federal ocean observing systems, sensors, data collection platforms, data management, and mapping capabilities into a national system, and integrate that system into international observation efforts; 2) Adopt ecosystem-based management as a foundational principle for the comprehensive management of the ocean, our coasts, and the Great Lakes; and 3) Strengthen resiliency of coastal communities and marine and Great Lakes environments and their abilities to adapt to climate change impacts and ocean acidification.

The following programs describe NOAA's primary ocean and coastal mapping activities in support of NOAA goals and National objectives:

Marine Resource Management

Coral Reef Mapping – NOAA's Coral Reef Conservation Program (CRCP) strategy includes creating digital maps and characterizations of all U.S. coral reef habitats using best available data to support coral reef monitoring and assessment; natural and socioeconomic research and modeling; outreach and education; and management and stewardship. Bathymetric and benthic (ocean bottom) habitat mapping are fundamental components of ecosystem-based coral reef management, together providing data required to develop an accurate inventory of the extent and condition of coral reefs throughout U.S. States and Territories. The CRCP ensures that all data acquisition and processing meet NOAA's nautical charting standards, and that the locations of mapping activities are consistent with charting priority areas so that multiple NOAA objectives are met with each activity. CRCP's Coral Reef Information System then provides access to products from NOAA coral reef research, monitoring, and management.

Deep-Sea Coral Mapping – Extensive deep-sea coral communities are believed to exist off many of the Nation's marine coasts and may be a key to the recovery and sustainability of economically-important species and the well-being of ocean systems. The NOAA Deep Sea Coral Research and Technology Program, established by the *Magnuson-Stevens Fishery Conservation and Management Reauthorization Act*, has begun to map and characterize these habitats in the U.S. EEZ and to submit this information to Regional Fishery Management Councils for their EFH designations and fisheries management actions. Conducted under the auspices of the CRCP, deep-sea coral mapping is designed to build on and complement existing mapping efforts and to provide information to improve the management of these biologically diverse ecosystems.

Essential Fish Habitat Mapping – The *Magnuson-Stevens Fishery Conservation and Management Act* requires that NOAA: 1) designate Essential Fish Habitat (EFH; i.e., areas that are necessary to fish for their basic life functions and life stages) for managed species in fisheries management plans, 2) minimize fishing impacts on EFH to the extent practicable, and 3) consult with Federal action agencies (including NOAA) for actions that may adversely affect EFH. Each of these actions requires high-quality maps of the benthic environment coupled with accurate habitat classifications and detailed knowledge of the species and life history stages that make use of the environments. Regulations require that EFH designations be updated at least every five years. Benthic mapping and associated biological observations are carried out in response to needs articulated by eight Regional Fishery Management Councils and six Regional Fisheries Science Centers. Mapping activities typically involve collaboration and partnerships. At present, many projects are implemented because of specific needs or opportunistically as resources are identified. Surveys generally are carried out by NOAA vessels, but when opportunities allow, NOAA collaborates with sister Federal and State agencies to update EFH information.

Chesapeake Bay Habitat Assessments – NOAA performs assessments throughout a range of Chesapeake Bay benthic habitats including historic oyster bottom, sturgeon spawning grounds, and habitat areas of particular concern. The approach entails pre- and post-restoration acoustic seafloor mapping of benthic habitats, coupled with biological assessments that include identification of the spatial and temporal distributions of target species and associated species-habitat interactions. Resulting geodatabase products are based on high-resolution spatial datasets of bathymetry and backscatter amplitudes. Underwater video and sediment grab samples ground-truth these data. NOAA habitat assessments directly support collaborative native oyster restoration.

Coastal Change Analysis Program – NOAA's Coastal Change Analysis Program (C-CAP) produces a nationally standardized database of land cover and land change information for U.S. coastal regions. These products provide inventories of coastal intertidal areas, wetlands, and adjacent uplands with the goal of monitoring these habitats by updating the land cover maps every 5 years. C-CAP products highlight what changes have occurred in the coastal landscape, providing data used for land use planning and habitat assessment. C-CAP is coordinated with the USGS through the Multi-Resolution land Characteristics Consortium (MLRC) and provides the coastal component to the National Land Cover Database.

Marine Debris Mapping – NOAA supports a national and international effort to research, prevent, and reduce the occurrence of marine debris and to protect and conserve the Nation's natural resources, oceans,

and coastal waterways from the impacts of marine debris. To that end, NOAA develops best practices for locating derelict fishing gear, assesses the impacts of derelict fishing gear on habitat and species, monitors the amount of marine debris in the environment, and investigates the use of remote sensing technologies for detecting marine debris. Side scan sonar has been used in detecting derelict crab and fishing traps in Alaska; Puget Sound, Washington; the Chesapeake Bay; and along the West Coast. In the Caribbean, side scan sonar is use to aid in marine debris detection and instruct effective removal strategies. The NOAA Marine Debris Program and Office of Coast Survey collaborate to maximize the beneficial outputs to the American public from seafloor surveys.

Environmental Sensitivity Index Mapping – NOAA produces Environmental Sensitivity Index (ESI) maps of coastal resources at risk from spilled oil or other hazardous materials releases. An ESI map systematically compiles local information for coastal shoreline sensitivity, biological, and human-use resources. The maps identify sensitive resources before a spill occurs so that protection priorities can be established and cleanup strategies designed in advance.

Exploration

Ocean Exploration and Research (OER) Program- NOAA explores the Earth's oceans for the purpose of discovery and the advancement of knowledge, using state-of-the-art technologies including multibeam mapping systems, autonomous underwater vehicles and remotely-operated vehicles. OER focuses on end-to-end management of the data collected on the missions, working with NESDIS' National Data Centers to provide long-term data archive and access. Exploration projects leverage government and non-government resources to focus the best undersea assets and scientific minds on ocean exploration through mapping expeditions to unknown or poorly known ocean areas, features, and habitats.

U.S. Extended Continental Shelf (ECS) Mapping – The U.S. is engaged in a multi-agency effort under the direction of the U.S. Extended Continental Shelf Task Force to gather and analyze data in order to determine the outer limits of our ECS following criteria contained in Article 76 of the United Nations Convention on the Law of the Sea. The process requires the collection and analysis of data that describes the depth, shape, and geophysical characteristics of the seabed and sub-sea floor and thickness of the underlying sediments. This data includes bathymetry, seismic profiles, bottom cores, and magnetic and gravity data. The U.S. ECS Task Force is an interagency coordinating body headed by the U.S. Department of State. Participants in this Task Force include: NOAA, USGS, Executive Office of the President, Joint Chiefs of Staff, U.S. Navy, USCG, Department of Energy, National Science Foundation, EPA, BOEM, and the Arctic Research Commission. NOAA leads the bathymetric data acquisition and processing activities of the Task Force, archives and manages all geophysical data and information, and provides leadership and support to the analysis of data required to determine the extent of the U.S. ECS.

Nautical Charting

Nautical Charting Program - NOAA's mandate to produce nautical charts (traditional paper charts, raster charts, and electronic navigational charts) includes most of the Nation, with a suite of over 1,000 charts encompassing the U.S. coasts, Great Lakes, and territories. Nautical charts provide detailed information on water depth, natural features of the seabed, surface and sub-surface navigational hazards such as

wrecks and obstructions, aids to navigation, information on tides and currents, and man-made structures such as harbors, buildings, and bridges, all of which are critical for the safe and efficient navigation of surface vessels. The nautical chart is a working document used to plan voyage transits and plot courses for navigators to follow. The coastal waters of the United States are in a constant state of change: channels are dredged and sometimes re-routed; aids to navigation are established, relocated, or removed; new wrecks and obstructions are discovered; natural shoaling occurs in many areas; and new berthing facilities are constructed in the Nation's ports and harbors. In order for all mariners to transit safely, it is imperative that these changes be reflected on NOAA's nautical charts as soon as practicable.

Hydrographic Survey Program – Hydrographic surveys support nautical charting, dredging, beach erosion and replenishment studies, coastal zone management, and offshore resource development. While surveys primarily measure and record water depth, they can also determine the nature of sea floor material. These determinations have implications for anchoring, dredging, pipeline and cable routing, and benthic habitat characterization.

Shoreline Mapping and Shoreline Change Analysis Program – NOAA's Coastal Mapping Program surveys coastal regions to provide the Nation with an accurate, consistent, up-to-date shoreline. This National Shoreline serves many purposes, including nautical chart production, official U.S. boundary determination, coastal change analysis, and support of a variety of coastal management and science applications. NOAA's mapping activities are conducted using aerial photography, high resolution satellite imagery, and LiDAR, using both NOAA and contracted private sector assets. NOAA's Coast and Shoreline Change Analysis Program analyzes shoreline feature changes in the major 175 U.S. port cities by comparing recent high-resolution satellite imagery or aerial photography with existing NOAA raster and electronic nautical charts. Shoreline changes are noted and used to aid in updating nautical charts. Shoreline mapping priorities are driven by nautical chart production and national shoreline update schedules.

Mapping Support Infrastructure

National Spatial Reference System - The National Spatial Reference System (NSRS) is the consistent national coordinate system in use by Federal civilian mapping agencies. It specifies latitude, longitude, a variety of heights, gravity, and scale/orientation relative to international reference frames. NOAA has the authority to define, maintain, and provide access to the NSRS. The NSRS consists of a variety of elements, including: a consistent, accurate, up-to-date National Shoreline; the Continuously Operating GPS Reference Stations (CORS) network; and a model of the gravity field over the U.S. The CORS network is the primary method by which user's access up-to-date coordinates, as each station collects GPS data continuously, is monitored for movement, and NOAA provides tools for accurate positioning within the United States relative to CORS. NOAA is embarking on the Gravity for the Redefinition of the American Vertical Datum (GRAV-D) project which will improve access to the vertical datum. The gravity-based vertical datum resulting from this project will improve surveying and mapping accuracies from current errors of 40 cm to 2 m, to an accuracy of 1-2 cm relative to the NSRS.

National Water Level Observation Network - The National Water Level Observation Network (NWLON) is a national network of long term water level stations and data management infrastructure that serves as a water level datum reference system for the Nation. Managed by NOAA, NWLON consists of

210 long-term, continuously operating water level and associated meteorological stations throughout the U.S. and its territories. The tide and water level datums derived from the NWLON have traditionally been important primarily for navigation and shoreline boundary purposes. NWLON data is the foundation for reference stations for NOAA's tide prediction products, and provides the controls in determining tidal datums for all short-term water level stations. NWLON and short-term water level data and products also support the NOAA Tsunami Warning System, hydrographic surveys, shoreline mapping, the NOAA Storm Surge Warning System, and the Physical Oceanographic Real-Time Systems (PORTS®). NWLON data is used in coastal planning, wetland monitoring, marsh restoration, storm surge modeling, evacuation route planning, emergency preparedness, and hazardous materials response.

National Current Observation Program – NOAA collects tidal current information at over 70 locations each year to provide the basis for predictions in the U.S. Tidal Current Tables. Tidal current data is used by spatial modelers to both run and validate their circulation models. Knowledge of currents is important for building coastal structures, determining the fate of oil spills, and determining larval transport.

CoastWatch Program – Two significant environmental events, a harmful algal bloom (HAB) off the coast of North Carolina and a severe mammal die-off of more than 700 bottlenose dolphins in the mid-Atlantic coast, prompted Federal and State officials to explore near real-time satellite data sources for monitoring the coastal waters. In 1987, NOAA CoastWatch was formed to provide access to multiple satellite remote sensing data and products, including ocean color, sea surface temperature, and surface winds. These products support a variety of ocean and coastal mapping efforts. Biologists utilize ocean color radiometry data as well as derived chlorophyll-a and total suspended matter/turbidity products to identify runoff plumes and blooms and also to predict HABs. Mariners use ocean surface vector winds to help ensure safe navigation.

Ship and Aircraft Operations – NOAA ships and aircraft, civilian crew, and commissioned NOAA Corps Officers support ocean and coastal mapping programs including hydrographic surveying in support of nautical charting, EFH mapping, ocean exploration, tsunami and storm-surge inundation modeling, and shoreline mapping. The platforms and mapping sensors enable NOAA to maintain government expertise in the knowledge, skills, and abilities necessary to both conduct and evaluate the performance of ocean and coastal mapping functional elements such as installation and operation of water level equipment, horizontal positioning, and improvements in data acquisition and processing methods.

Ocean and Coastal Mapping Contracting – The NOAA Ocean and Coastal Mapping Contracting Policy was promulgated in December 2009 and describes a strategy for expanding contracting with non-governmental entities in order to take advantage of private-sector mapping capabilities. NOAA recognizes that qualified commercial sources can provide competent, professional, and cost-effective mapping services and expertise to NOAA in support of its diverse mapping missions. In the interest of furthering scientific knowledge and public and environmental safety, NOAA’s responsibility for executing its ocean and coastal mapping missions is manifest and non-delegable, and it is incumbent upon NOAA to maintain operational mapping core capabilities. Subject to appropriations, NOAA supplements its operational capacity by contracting for ocean and coastal mapping.

2. Establishing Mapping Priorities and Partnerships:

"…establish priority mapping programs … across all missions of [NOAA]…"

Pursuant to various statutory mandates, NOAA has the authority and responsibility to establish national priorities and promote multi-sector management of coastal resources at local, state, regional and national scales. NOAA's unique responsibilities and management mandates include:

1. Nautical charting and related hydrographic and geospatial services for safe and efficient marine commerce;
2. Stewardship and protection of trust resources;
3. Systematic observation and monitoring;
4. Protection and restoration of critical coastal and marine habitats;
5. Mitigation of impacts of coastal hazards on life and property;
6. Research to address priority issues; and
7. Delivery of and decision-maker access to relevant science, tools, products, and services to manage multiple and often competing ocean and coastal resource uses.

NOAA and other Federal and State agencies historically have established individual mapping priorities and data acquisition plans based in large part on their specific mandates, responsibilities, available technologies, and resource levels. In 2004, a National Research Council (NRC) report, *A Geospatial Framework for the Coastal Zone – National Needs for Coastal Mapping and Charting*, concluded that

> "any activity that involves multiple Federal, State, and local agencies, academic researchers, and the private sector has the potential for redundancy and overlap of effort…In the areas of coastal zone mapping and charting, the large number of agencies involved, their differing histories, the breadth of their mandates, and the complexity of the task offer ample opportunities for redundancy and inefficiency."

Although the individual program and agency approach to establishing mapping priorities remains largely in place today, NOAA has made considerable progress over the past several years to coordinate mapping activities with those of other Federal, State, and regional interests. Ensuring that all relevant agencies are aware of existing data through accurate web-map inventories and of each other's planned data acquisition activities is an important aspect of improved coordination.

Intra- and interagency coordination takes place through the efforts of the NOAA IOCM Coordination Team (see Section 6) and the Subcommittee on Ocean Science and Technology's Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM), which NOAA co-chairs with USGS and the USACE. In partnership with the Federal Geographic Data Committee's (FGDC) prior Geospatial One-Stop (GOS) effort (which was phased out in October 2011 and has been migrated to geo.data.gov), the IWG-OCM has made great strides in increasing the registration of ocean and coastal mapping metadata that facilitates the discovery of available data, thus preventing additional resources from being expended to acquire data that is readily available. The IWG-OCM is working on developing a prototype Ocean and Coastal Mapping Inventory, to improve discoverability of ocean and coastal mapping data.

The development of partnerships and the leveraging of Federal, State, and non-governmental mapping resources are imperative to meeting the ocean and coastal geospatial data needs of the Nation. The Act requires Federal mapping agencies, in coordination with affected coastal States, to establish a program to develop a National ocean and coastal mapping plan for the Great Lakes and coastal State waters, the territorial sea, the EEZ, and the continental shelf of the U.S (Section 12202 of the Act). This plan will require considerable cooperation among Federal agencies, coastal States, regional ocean governance councils, and other mapping interests. As outlined in the Draft January 2012 "National Ocean Policy Implementation Plan", Federal agencies plan to use the prototype Ocean and Coastal Mapping Inventory to develop a National Ocean and Coastal Mapping Plan.

3. <u>Cooperative Technological Research and Development Activities:</u>
"…encourage the development of innovative ocean and coastal mapping technologies and applications …"

NOAA has benefited greatly from research and development partnerships with Federal agencies, universities, non-governmental organizations, and private sector partners. To fill identified gaps in its ocean and coastal mapping capabilities, NOAA will continue to explore opportunities to establish additional partnerships.

Existing research and development partnerships:

NOAA-University of New Hampshire Joint Hydrographic Center – The Joint Hydrographic Center (JHC) is a research and education partnership between NOAA's Office of Coast Survey and UNH. The Center conducts applied research and development in hydrographic science and ocean mapping. The academic partnership concept of the Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) also offers a valuable mechanism for effective, albeit indirect, NOAA liaison with private industry. The university partner is able to enter into agreements with industry to collaborate on research and development, to use the latest industry-provided equipment and software, and to license commercial application of new technological developments. These partnerships ensure that the private sector ocean mapping community is contributing to, as well as benefiting from, new technology developed through JHC.

Joint Airborne LiDAR Bathymetry Technical Center of Expertise – The Joint Airborne LiDAR Bathymetry Technical Center of Expertise (JALBTCX) conducts operations, research, and development in airborne LiDAR bathymetry and complementary coastal remote sensing technologies. These activities support the coastal mapping and charting requirements of the USACE, the U.S. Naval Meteorology and Oceanography Command, USGS, and NOAA. JALBTCX staff includes engineers, scientists, hydrographers, and technicians from the organizations. JALBTCX research and development supports and leverages work in government, industry, and academia to advance airborne LiDAR for coastal mapping and charting technology and applications. In addition, the JALBTCX partner agencies work together on requirements and mapping plans to leverage joint capabilities and increase efficiency.

Cooperative Institute for Ocean Exploration, Research, and Technology – The Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT) is a consortium led by the Harbor Branch Oceanographic Institute at Florida Atlantic University. The University of North Carolina-Wilmington is the co-managing partner. Limited partners are SRI International and the University of Miami. NOAA's OER is CIOERT's primary NOAA partner. CIOERT conducts research and activities under four main themes**:** 1) development of advanced underwater technologies**,** 2) exploration and research of frontier regions of the eastern continental shelf and beyond, 3) improved understanding of deep- and shallow-water coral, and 4) outreach and education.

NOAA-Navy Unmanned Surface Vehicle Development – NOAA, in partnership with the Naval Surface Warfare Center (NSWC), is exploring the feasibility of developing unmanned surface vehicles (USVs) to support hydrographic survey and other seafloor mapping operations. This is an important component of NOAA's goal to further develop technology and the operational capabilities of USVs and use them as a "force multiplier" for acquiring hydrographic data. NOAA is developing a USV concept of operations (CONOPS) and detailed technical requirement for integrating USVs into NOAA's existing hydrographic survey operations. Once the CONOPS and technical requirements are developed, NOAA, through an agreement with NSWC, will develop and demonstrate a prototype USV system in 2012 based on the proposed CONOPS and technical requirements. NSWC's extensive experience with USV technology development and design and NOAA's expertise in hydrographic data acquisition lend themselves to this cooperative partnership.

In addition to facilitating innovation at cooperative and joint research institutes, NOAA has a vibrant internal research and innovation capability.

4. <u>Best Practices in Data Acquisition Standards, Processing and Delivery:</u>
"Document available and developing technologies, best practices in data processing and distribution …"

The 2004 NRC report, *A Geospatial Framework for the Coastal Zone*, recommended that all thematic and other value-added products adhere to predetermined standards to make them universally accessible and transferable, and that all sources should supply digital data accompanied by appropriate metadata. An aspect of this recommendation requires the development of minimum data acquisition and metadata standards to ensure that data acquired in support of particular requirement can be used to support a range of additional requirements.

Data Standards - Interagency efforts continue to develop common specifications for airborne coastal mapping and charting data. A multi-year NOAA-led effort to develop a national habitat classification standard continues to progress and was submitted to the FGDC in January 2012. Further efforts are being developed to ensure that data acquired by any government funded program or agency can be used to support multiple Federal, State, and regional applications regardless of the project's original intent. NOAA's IOCM Sea Floor Mapping Standard provides a common mapping standard for all seafloor mapping efforts undertaken by NOAA, and other parties are showing interest in adopting the document.

Common Specifications for Airborne Coastal Mapping and Charting Data – Federal agencies are building consensus on and agreeing to use a set of common LiDAR specifications for coastal mapping. NOAA and its partners at JALBTCX hosted a pair of summits: one was organized for the five Federal agencies with mandates for coastal mapping and charting (USACE, USGS, FEMA, NOAA, and Navy), and the other included members of academia and the private sector with a focus on application-driven requirements for coastal LiDAR mapping. These summits allowed agencies to understand their counterpart's requirements, identify areas for developing common survey specifications, and build consensus on priorities.

Habitat Classification Standard –The habitat classification standard describes the nature of biological, physical, chemical and geological features identified during habitat mapping efforts. Utilizing commonly understood and accepted terms to delineate habitats is a prerequisite for coastal and ocean governance activities such as planning for climate change, dealing with hazards, and sustainably managing coastal and ocean resources. In 2010, the Coastal and Marine Ecological Classification Standard (CMECS) underwent a 120-day public comment period (August to December), as advertised in the *Federal Register*, as well as an extensive extramural peer review. A revised version that addresses the comments and suggestions received though these processes was submitted to the FGDC in January 2012, with endorsement of CMECS possible as early as spring 2012.

Data Acquisition and Metadata Standards – Through the IOCM efforts, NOAA initiated a review of its marine data acquisition procedures. NOAA evaluated the OER Program's data acquisition and on-board data description model for potential fleet-wide application. NOAA is also developing and identifying metadata best practices, including the applications of consistent vocabularies for a variety of marine data. NOAA is the national archive and integration center for marine geophysical data. In support of the interagency U.S. ECS project, NOAA, in partnership with USGS, BOEM, and the Academic Fleet, developed common metadata templates for cruise-level, seismic, and bathymetric data description. NOAA will continue to develop common templates in order to improve the discovery, sharing, and use of geophysical data collected at sea. In addition, NOAA's Environmental Data Management Committee recently issued a NOAA Procedural Directive on Data Documentation (Metadata) as a guide for all NOAA programs and staff.

Ensuring the Preservation of Data – To ensure stewardship and access to marine geophysical and oceanographic data, NOAA has established a collaborative "rolling deck to repository" (R2R) project to build an enterprise-wide system to transfer data from the ships to the NOAA Data Centers for eventual long-term archive and distribution. This secure process is similar to the R2R system recently approved by the National Science Foundation for the Academic fleet. NOAA's National Geophysical Data Center (NGDC) and National Oceanographic Data Center (NODC) are two of the final repositories for the NOAA and the Academic Fleet R2R data.

Inventory and Access to Ocean and Coastal Data – The NOAA Line Office and Data Centers, through standards-based web services built on robust archives, support dynamic, integrated inventories of ocean and coastal mapping data, providing information on the location, date, type, and source of data, as well as access to the data. These inventories can be augmented with additional data sources and incorporated into management tools to improve prioritization of areas requiring surveys. NOAA was a lead participant in

the efforts of the National Ocean Council (NOC) to develop the ocean.data.gov portal called for in the National Ocean Policy framework documents. Ocean.data.gov was developed collaboratively by the 15 agencies and departments represented on the NOC. This new, virtual community provides one-stop shopping for a wide range of data from these agencies. In some cases, this is the first time that the data have been readily accessible through the Web. NOAA's NGDC has created an additional prototype Ocean and Coastal Mapping data portal that combines the data archives and planning resources of several these Federal agencies. Portal users are presented with a seamless, one stop source for ocean and coastal mapping data. The portal currently includes hydrographic and topographic data from NOAA, USGS, and USACE, and also interfaces with Environmental Protection Agency map services.

Integrated Digital Elevation Models and Maps of the Ocean and Coast – NOAA and other Federal Programs are building coastal digital elevation models (DEM) at regional (U.S. territorial waters) and higher (community) resolution scales. Coastal DEMs, maps and images are a common base-layer for many integrated modeling and mapping activities. By the end of 2012, NOAA will have completed more than ninety 10-meter resolution integrated DEMs. Coordinated development of the DEMs benefit from comprehensive inventories of existing and planned topographic and bathymetric surveys. Dynamic spatial inventories, including detailed metadata records, help partners determine when and where to develop DEMs based on best available data. When completed, the DEMs themselves are part of the inventory and available for others to reuse for purposes beyond the original requirement.

Products Resulting From Improved Coordination – As a result of coordination and *American Recovery and Reinvestment* Act (ARRA) funding in 2009, NOAA acquired additional hydrographic data and generated new products from existing data, supporting uses beyond navigation and charting. One beneficiary is a multi-agency habitat assessment and risk reduction effort in Louisiana. By coordinating efforts and requirements, NOAA rapidly delivered products and services that significantly improved the storm surge modeling for the eastern Gulf of Mexico, including New Orleans. These products also supported sea-level rise studies, habitat restoration, and tsunami inundation efforts underway in the region.

Digital Coast -The Digital Coast is a constituent-driven platform, providing access to geospatial data, tools, training, and information for the coastal resource management community. National organizations formed the Digital Coast Partnership to address coastal management issues. The Digital Coast website supports both highly technical and management level audiences through an integrated approach, allowing users to download data and also see and learn how the data are used in analysis tools and in decision-making across the country. Data access is facilitated through the Data Access Viewer. To date, this delivery mechanism has provided access to over 2 terabytes of IOCM-related LiDAR and ortho-imagery collected by USGS and NOAA's National Geodetic Survey.

New Approaches to Ocean Mapping Data Processing - The research and development themes of the UNH/NOAA JHC include the development of new approaches to ocean mapping data processing and to data visualization, presentation, and management. The Center's efforts have improved hydrographic and ocean mapping data processing efficiency and quality. The Combined Uncertainty and Bathymetry Estimation (CUBE) data processing algorithm, which reduces manual multibeam data processing time by orders of magnitude, has been incorporated into most commercial ocean mapping data processing

software. Hydrographic organizations around the world have also adopted the algorithm. Similarly, the GEOCODER seafloor backscatter processing technology has been commercialized in multiple software packages and is now widely used to produce seafloor character maps. Ongoing development is aimed at achieving additional improvements in NOAA's ability to derive multiple mapping products from its ocean mapping data and ability to disseminate IOCM data to a wider variety of end users.

This approach to data processing is critical to NOAA's IOCM efforts as well as to coastal and marine spatial planning and ecosystems-based management. The NOAA IOCM effort has the potential to provide a solid base for acquiring and delivering geospatial data to support integrated management approaches and efficient use and re-use of data. With a successful IOCM program, the Nation will realize the full benefits of the substantial data collection investment made at Federal, State, university, and local levels.

5. <u>Training, Technology, and Other Critical Resources:</u>
"…identify training, technology, and other resource requirements … to support a coordinated ocean and coastal mapping program"

With intra- and interagency planning and coordination, overlapping agency mission requirements can be better integrated, prioritized, and managed in order to maximize the Federal investments in ocean and coastal mapping. Many Federal, State, and private-sector customers rely on coastal, seafloor, and water column mapping data, and demand for this data is growing exponentially. Resourcing the *Ocean and Coastal Mapping Integration Act's* mandates will allow NOAA to execute the needed coordination, provide the necessary technical support, reduce the potential for duplication of effort, ensure easy access to accurate and real-time data, and directly target currently unrealized efficiencies.

Training - One of the primary challenges with IOCM is the shortage of trained personnel to support data acquisition and processing, particularly in programs other than nautical charting and hydrography. An IOCM training center, co-located with JHC, would provide a much-needed mechanism for training NOAA and other agency staff on the theory and operation of advanced seafloor and water column mapping sensors. The addition to the NOAA fleet of new fisheries survey vessels equipped with state-of-the-art multibeam mapping systems requires that shipboard personnel be trained in survey planning, at-sea data acquisition and processing practices, and post-processing techniques, in order to fully realize the maximum benefits from these systems. Training in consistent data acquisition, processing, and data/metadata management practices is critical in order to utilize and generate useful and reliable products. The training center would work closely with NOAA's ocean and coastal mapping programs to ensure delivery of generalized ocean and coastal mapping skills and knowledge, as well as program-specific curricula. The center would also utilize NOAA metadata experts and trainers to facilitate a comprehensive training program.

While the objective of data acquisition, processing, and management training is to improve NOAA's in-house capabilities, training to support the end-users' application of this data is equally important. Expanded geospatial training is needed to enable the ocean and coastal decision makers to integrate new data into their decision-support tools.

Technology – Ocean and coastal mapping technologies continue to evolve, enabling acquisition of more high-resolution data describing the coast, seafloor, and water column. These advancing technologies can provide an initial data management challenge, but also offer the potential to better enable accurate and automated data descriptions. NOAA is implementing technology to automatically harvest information about data directly from the on-board observing systems, providing essential documentation to enable immediate and long-term use of the data. Also, NOAA's involvement in programs such as R2R and Integrated Ocean Observing Systems (IOOS) has further advanced capabilities for capturing and transporting sensor and platform characteristics and data processing and quality information along with the data. JHC continues to advance new technologies in data collection and data processing.

A technology example is autonomous underwater vehicles (AUV). These are unmanned, self-propelled marine vehicles that operate without any physical connections to a ship or an operator, show significant promise for providing new survey and mapping capabilities. AUVs have been a part of NOAA's hydrographic survey technology development testing program since 2003. There is considerable potential in AUVs for hydrographic surveying and emergency response, as well as benthic habitat mapping and sea bottom characterization. NOAA has successfully demonstrated the use of an AUV equipped with side scan sonar to conduct operational surveys to detect submerged obstructions and hazards to navigation. In 2012, NOAA will take delivery of a bathymetric mapping AUV equipped with multibeam sonar and will evaluate if AUV-based depth measurements can meet stringent nautical charting standards. However, much is still needed to successfully transition AUVs to a fully operational technology, including safe and efficient launch and recovery systems aboard NOAA ships and small craft, training, and a support infrastructure.

Data Management Infrastructure - NOAA made important strides with the OCM Geoportal to improve data discovery, the R2R framework and the Geophysical Shipboard Policy to improve data delivery to the archive, and adoption of several OCM standards that will improve data management capabilities. However, NOAA still lacks aspects of the data and data management foundation needed to ensure long-term access to and use of mapping data and products. Key among these are implementing the capacity to archive, integrate, and deliver data via common or standard formats; sustain integrated data inventories; and implement rigorous metadata with controlled vocabularies to ensure proper use of data. Without these capabilities, data collection investments are at risk due to lack of archive or are processed for single purpose use only.

It is critical that all data are collected by trained personnel, processed to appropriate standards, described to enable long-term understanding, and archived and delivered in a secure and integrated environment that supports easy access and planning.

Data acquisition – There are significant, documented, yet unmet, national ocean and coastal mapping data requirements. These requirements range from high-resolution LiDAR topography and shallow-water bathymetry – both of which are needed for sea level rise mapping and improved storm surge modeling – to seafloor habitat mapping for EFH analyses, coral reef mapping, and coastal and marine spatial planning. Since no single Federal agency's resources can meet these needs, a coordinated national ocean and coastal mapping program is required.

Addressing challenges such as those described in the text above will improve the efficiency and cost-effectiveness of NOAA's mapping efforts; however, a significant need remains for more extensive program-related, fundamental mapping activities required to carry out NOAA missions. The need for basic data collection far exceeds that which can be accomplished using savings associated with greater operational coordination and more efficient processing, interpretation, and distribution of collected information. In order for NOAA's mapping programs to meet present and future mandates, resources for basic mapping, coordination, and infrastructure all must be addressed.

6. <u>Centralized Coordination of Data Acquisition and Management:</u>
"…identify a centralized mechanism or office for coordinating data collection, processing, archiving, and dissemination…"

NOAA has a coordination team to implement IOCM. In addition to this team, NOAA has established data processing, archival, and dissemination processes and centers to ensure maximum use of NOAA data assets. As part of the process to improve collection and management of mapping data, NOAA's R2R project initiated a new fleet procedure for stewardship of marine geophysical data that defines the roles and responsibilities for all non-nautical charting survey vessels (nautical charting vessels already adhere to this procedure). Implementing this new procedure, along with existing NOAA Administrative Orders describing collection and management of geospatial data, will significantly strengthen NOAA's capability to coordinate, process, preserve, and disseminate ocean and coastal mapping data. The approaches to improved coordination and re-use of data are described below in greater detail.

Data Acquisition Activities:

1. Define new standard operating procedures for geophysical and oceanographic data stewardship on NOAA ships (NOAA R2R).
2. Implement geophysical and oceanographic data stewardship procedures (NOAA R2R).
3. Develop a plan for supporting the acquisition of shallow-water bathymetry.
4. Complete the development of a common specification for airborne LiDAR coastal mapping and charting.
5. Implement a common specification for the acquisition of acoustic bathymetry and backscatter.

NOAA IOCM Coordination Team – The key to coordinating NOAA's diverse ocean and coastal mapping activities, including data acquisition, processing, archiving and dissemination, is robust dialogue between NOAA mapping programs and external stakeholders. To facilitate internal coordination activities, NOAA established the NOAA IOCM Coordination Team under the governance of the NOAA Ocean and Coastal Council (NOC-C). The NOC-C established the Team to promote an integrated approach to ocean and coastal mapping, to facilitate communications and coordination within NOAA's diverse mapping community, and to develop IOCM-related policies for review and endorsement by the NOC-C. NOAA offices and programs that participate on the Team are:

National Ocean Service

- Office of Coast Survey
- Center for Operational Oceanographic Products and Services
- National Geodetic Survey

- Joint Hydrographic Center (Office of Coast Survey)
- National Centers for Coastal and Ocean Science
- Office of National Marine Sanctuaries
- Office of Ocean and Coastal Resource Management
- Office of Response and Restoration
- Coastal Services Center
- Special Projects Office
- Coral Reef Conservation Program
- Marine Debris Program
- Integrated Ocean Observing System Program

National Marine Fisheries Service
- Office of Science and Technology
- Office of Habitat Conservation
- Alaska Fisheries Science Center

Office of Oceanic and Atmospheric Research
- Office of Ocean Exploration and Research
- Climate Program

National Environmental Satellite, Data, and Information Service
- National Geophysical Data Center
- National Oceanographic Data Center/National Coastal Data Development Center

NOAA Office of Marine and Aviation Operations

National Weather Service
- Tsunami Program

NOAA IOCM Data Management – Essential aspects of the NOAA IOCM program include establishing an IOCM Data Processing Center and developing a 21st century data management infrastructure. Modern data management supports dynamic inventories of existing data, ensures effective long-term stewardship, enables coordinated planning, and delivers data and products for multiple requirements.

The following activities are initial examples of the potential benefits that can be realized with an adequately resourced and functional NOAA IOCM program. Strengthened IOCM coordination, investments in data acquisition, product development, management, and delivery will yield overall cost savings as the benefits of "map once, use many times" are realized. Essential next steps include a fully staffed IOCM data processing center; data centers able to ingest, archive, and deliver data and products based on common web services and standards; and development of tools to support planning, research, and management.

IOCM Data Processing Center **–** In the absence of dedicated funding to support an IOCM data processing center (Center), NOAA is co-locating personnel from multiple line offices to enable innovation and expand adoption of common processing methods and capabilities. For example, NOAA's OER has

placed two physical scientists at JHC to ensure appropriate processing of data and enable innovative product development. OER scientists have contributed to processing of data sets collected by other NOAA and non-NOAA offices to be assimilated into archival centers, including Gulf of Maine Mapping Initiative data sets that have been collected under auspices of coordination between Federal, State and academic institutions.

As envisioned by the IOCM data processing center concept of operations, seafloor and water column mapping data acquired by NOAA, other Federal and State agencies, and academic institutions would be sent to the Center. The Center would be co-located with the NOAA/UNH CCOM/JHC. It would develop and maintain IOCM standards, specifications, and metadata standards for mapping data and utilize JHC's strengths to develop new technology and techniques for improved data processing and analysis. The Center would accept mapping data from a variety of sources, manage this data with advanced data systems, and produce quality-assured products that support both navigation and non-navigation uses. The data would be archived and distributed by NOAA's Data Centers.

NOAA Data Centers – NOAA has three National Data Centers and several centers of scientific data expertise. The primary ocean and coastal data centers are the National Oceanographic Data Center (responsible for data describing the water column), and the National Geophysical Data Center (responsible for data describing the physical shape and composition of the seafloor and lakebeds). Processed data and products would go from the IOCM Data Processing Center to the appropriate national repository for long-term archive and distribution. Centralizing archive and distribution through the data centers takes advantage of the investment in archive infrastructure and ensures complete inventories of NOAA ocean and coastal mapping data for planning purposes. Importantly, it would provide the broader research and resource management communities with greater public access to data that would otherwise be lost.

APPENDIX 2: OCEAN AND COASTAL MAPPING INTEGRATION ACT

OMNIBUS PUBLIC LAND MANAGEMENT ACT OF 2009 (P.L. 111-11); TITLE XII, SUBTITLE B – OCEAN AND COASTAL MAPPING INTEGRATION ACT, SECTION 12205 (A) AND (B)

(a) IN GENERAL.—Not later than 6 months after the date of enactment of this Act, the Administrator, in consultation with the Committee, shall develop and submit to Congress a plan for an integrated ocean and coastal mapping initiative within the National Oceanic and Atmospheric Administration.

(b) PLAN REQUIREMENTS.—The plan shall—

(1) identify and describe all ocean and coastal mapping programs within the agency, including those that conduct mapping or related activities in the course of existing missions, such as hydrographic surveys, ocean exploration projects, living marine resource conservation and management programs, coastal zone management projects, and ocean and coastal observations and science projects;

(2) establish priority mapping programs and establish and periodically update priorities for geographic areas in surveying and mapping across all missions of the National Oceanic and Atmospheric Administration, as well as minimum data acquisition and metadata standards for those programs;

(3) encourage the development of innovative ocean and coastal mapping technologies and applications, through research and development through cooperative or other agreements with joint or cooperative research institutes or centers and with other non-governmental entities;

(4) document available and developing technologies, best practices in data processing and distribution, and leveraging opportunities with other Federal agencies, coastal States, and non-governmental entities;

(5) identify training, technology, and other resource requirements for enabling the National Oceanic and Atmospheric Administration's programs, vessels, and aircraft to support a coordinated ocean and coastal mapping program;

(6) identify a centralized mechanism or office for coordinating data collection, processing, archiving, and dissemination activities of all such mapping programs within the National Oceanic and Atmospheric Administration that meets Federal mandates for data accuracy and accessibility and designate a repository that is responsible for archiving and managing the distribution of all ocean and coastal mapping data to simplify the provision of services to benefit Federal and coastal State programs; and

(7) set forth a timetable for implementation and completion of the plan, including a schedule for submission to Congress of periodic progress reports and recommendations for integrating approaches developed under the initiative into the interagency program.