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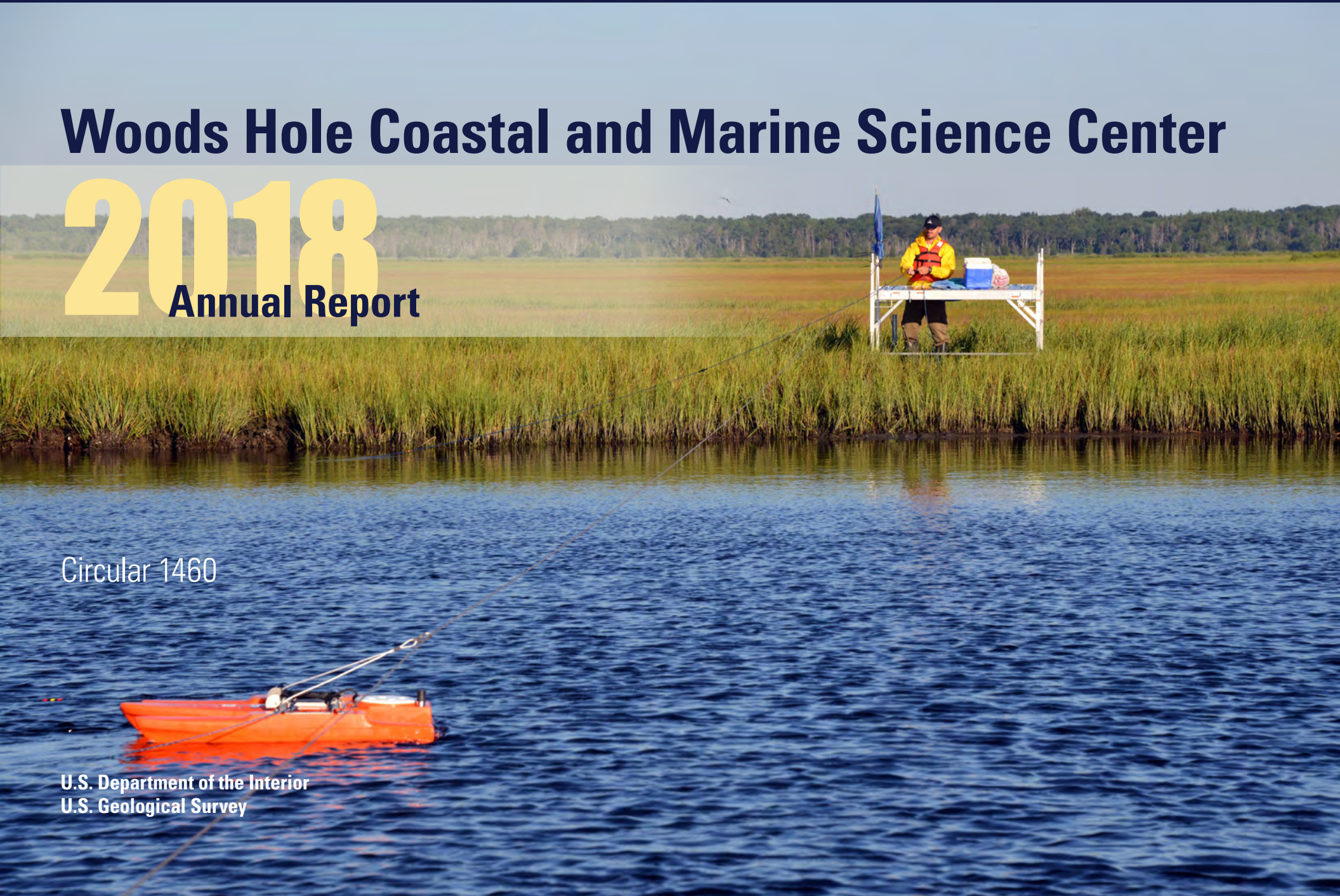
Woods Hole Coastal and Marine Science Center

2018 Annual Report



Circular 1460

U.S. Department of the Interior
U.S. Geological Survey

Cover. Front—U.S. Geological Survey (USGS) scientist Zafer Defne measures water and sediment movement at Edwin B. Forsythe National Wildlife Refuge, New Jersey. In collaboration with other organizations and USGS offices, the Woods Hole Coastal and Marine Science Center developed the unvegetated to vegetated marsh ratio for land managers to use in estimating the potential vulnerability of coastal wetlands. The estimates are based on sediment supply and the ratio of open water to vegetation. The center's field studies validated the results of the new method.

Back—Admiring the sunset while mapping the Massachusetts sea floor.

Woods Hole Coastal and Marine Science Center

2018 Annual Report

By Sara Ernst

Circular 1460

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DAVID BERNHARDT, Secretary

U.S. Geological Survey
James F. Reilly II, Director

U.S. Geological Survey, Reston, Virginia: 2019

Suggested citation:
Ernst, S., 2019, Woods Hole Coastal and Marine Science Center—2018 annual report: U.S. Geological Survey Circular 1460, 36 p., https://doi.org/10.3133/cir1460.

ISSN 1067-084X (print)
ISSN 2330-5703 (online)

ISBN 978-1-4113-4338-2

Contents

Abbreviations

AIM	Aerial Imaging and Mapping [group]
BCE	Beach Change Envelope
BOEM	Bureau of Ocean Energy Management
CDI	Community for Data Integration
CMHRP	Coastal/Marine Hazards and Resources Program
COAWST	coupled ocean-atmosphere-wave-sediment transport [modeling system]
ECS	extended continental shelf
IRIS	Incorporated Research Institutions for Seismology
ISO	International Organization for Standardization
lidar	light detection and ranging
MATRIX	Mid-Atlantic Resource Imaging Experiment [cruise]
NOAA	National Oceanic and Atmospheric Administration
PCB	polychlorinated biphenyl
RSCC	Remote Sensing Coastal Change [project]
SLR	sea-level rise
UAS	unmanned aerial system
USGS	U.S. Geological Survey
UVVR	unvegetated to vegetated marsh ratio

Coastal and Marine Science Based in Woods Hole, Massachusetts

The U.S. Geological Survey (USGS) Woods Hole Coastal and Marine Science Center in Woods Hole, Massachusetts, is one of three centers serving the mission of the USGS Coastal/Marine Hazards and Resources Program (CMHRP). Since its authorization by Congress in 1962, the CMHRP has served as the primary Federal program for marine geology and physical science research and is responsible for the Nation's entire coastal and marine landscape. The center's staff of about 100 conducts scientific research in various locations throughout the United States to describe and understand the processes shaping coastal ecosystems, such as dunes, beaches, salt marshes, and lakes, and marine ecosystems, like the continental shelf and the deep sea. The center's research products are used by other Federal agencies, State and local entities, private organizations, and the public to make informed decisions about the use, management, and protection of our coastal and marine resources.

Coastal and Shelf Geology

Shifting shorelines are the most visible result of a constantly changing coastal system that extends from shallow estuaries, across wetlands and beaches, and into adjacent ocean waters.

Our Coastal and Shelf Geology group conducts mapping, modeling, and data analysis to better understand and describe the underlying geology and processes that shape these environments. The group applies modern technologies, such as high-resolution mapping systems and unmanned aerial systems (drones/optics), to characterize the coast both above and below the water. Detailed maps of the coastal landscape are created from this research that improve forecasts of coastal change and identify hazards in areas vulnerable to storms, chronic erosion, and sea-level rise.

Determining Major Storms

Historical buoy and storm data are used to identify major storms offshore of Massachusetts. Since October 2018, our scientists have used this information to create model grids across the region to simulate waves formed by storms with winds.

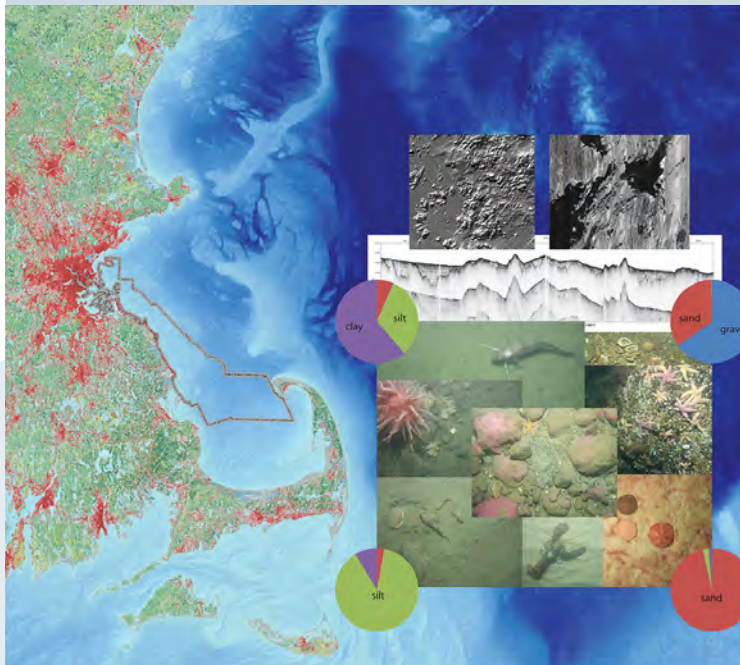
Shoreline Forecasting

Several sites of varying morphological diversity throughout Massachusetts, including Cape Cod Bay, are being selected to provide in-depth analysis and validation of a predictive method of shoreline position forecasting. Three variations of the shoreline forecasting models will be compared and tested against simulated and measured shoreline positions.

Massachusetts Integrated Coastal Studies

Highlights of 2018

To further our understanding of the processes that control sediment movement in Cape Cod Bay, the USGS, in partnership with the State of Massachusetts, initiated the Massachusetts Integrated Coastal Studies project in 2018. Through this multi-tiered research initiative, our scientists are developing and applying a coupled ocean-wave-sediment transport model for the bay at different scales by using our coupled ocean-atmosphere-wave-sediment transport (COAWST) modeling system. Planned work includes comprehensive sea-floor mapping of the bay, numerical modeling of coastal processes and their effects on coastline stability, and improved shoreline change assessments with new shoreline-change predictive capabilities. This work can help coastal zone managers better understand how, where, and why sediment is transported in western Cape Cod Bay.



Sea-Level Rise Hazards and Decision Support

Highlights of 2018

Sea-level rise (SLR) will have a variety of future impacts on the coast, including land loss from inundation and erosion; migration of coastal landforms and environments; increased water elevation, inland extent, and duration of storm-surge flooding; wetland losses; changes in coastal groundwater movement in relation to land; and effects on human development, infrastructure, and social systems. This project synthesizes information on coastal environments and uncertainties as well as our current knowledge of coastal processes into an analysis framework that evaluates the likelihood of various SLR impacts.

Using this analysis framework, the project is exploring the role of land cover diversity as an indicator of how adaptable a coastal site is to SLR, as well as habitat availability and change for species of concern to the U.S. Department of the Interior.

Piping Plovers

Piping plovers (*Charadrius melodus*) are a federally protected species and serve as a key indicator species for other shorebirds; their well-being indicates habitat quality and the likelihood other shorebirds will be successful in that area. Habitat data, collected with a smartphone app during the 2016 breeding season, were published in 2018 and are being used to predict the probability, based on the shape and form of coastal features, that an area will support piping plover habitat. Three papers related to these topics are in review.

Migration to Open-Source Software

The SLR project began the migration of our probabilistic (Bayesian) approach from proprietary to open-source software through funding obtained from a Community for Data Integration (CDI) proposal. The migration will enable models to run more rapidly, facilitate incorporation of new datasets, including updated sea-level-rise scenarios, and has the potential to leverage cloud computing avenues currently being pursued by our center to generate predictions on the fly. The migration is also necessary to facilitate development of a front-end interactive capability for users who want to explore how different inputs affect the model predictions. A beta version of the migration is complete, and we anticipate finalization and code publication in the coming years.

National Climate Assessment

Project staff contributed to the U.S. Global Change Research Program's fourth National Climate Assessment by

- synthesizing SLR research, projections, and predicted impacts to the region for the "Northeast" chapter,
- providing data, references, and illustrations, and
- providing a case study highlighting plover habitat availability research.

These contributions are reflected in the final publication, released in November 2018.

Web-Based USGS Tool

In partnership with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Global Change Research Program, we developed a web-based USGS tool to provide geospatial access and information on updated SLR scenarios released in a 2017 NOAA technical report; final products included a data viewer and accompanying geonarrative that were released in 2018.

Beach Change Envelope

Project researchers published a new metric to evaluate, compare, and track storm impacts and recovery, called the Beach Change Envelope (BCE). The BCE was used to track upper beach elevation change to assess storm impacts and recovery on Fire Island, New York. Four distinct upper beach morphologies were identified and linked to key phases of beach recovery. Using the BCE, researchers also developed a model that can reliably hindcast both storm response and recovery, with results published in a 2018 journal article.

Geophysical Surveying of the Nearshore Zone

Following a sediment coring and ground-penetrating radar survey in 2016, a rigorous field campaign which included extensive geophysical surveying, or mapping, of the nearshore zone of the sea floor was completed at Fire Island in 2018. The data collected can be used to provide maps of nearshore bottom features that describe the geology or the material that make up the features, as well as the geomorphology (or the shape or form) of the features. These maps improve our understanding of sediment availability and can be used to improve the models used to predict coastal behavior.

Shorebird Coastal Habitat Mapping

We mapped the availability of post-storm, evolving coastal habitats used by piping plovers and other shorebirds on Fire Island. Information learned through this work is being included in an upcoming update to the piping plover recovery plan by the U.S. Fish and Wildlife Service.

Fire Island Coastal Change

Highlights of 2018

Although we have a good understanding of how our coasts respond to storms, we are still trying to understand how long the effects of these storms persist on beaches and dunes. This information is critical to coastal resource managers considering the best ways to enhance coastal resiliency to future storms and sea-level rise. The Fire Island Coastal Change project, a cross-center collaboration between our center and the USGS St. Petersburg Coastal and Marine Science Center, has enhanced our understanding of coastal vulnerability and resilience by mapping nearshore sediment availability, monitoring breach evolution, and measuring the recovery of beaches after Hurricane Sandy.

The Woods Hole Coastal and Marine Science Center's Aerial Imaging and Mapping unmanned aerial systems pilots, Emily Sturdivant (left) and Elizabeth Pendleton (right) working the night shift in Hawaii at the Kīlauea Volcano site.

Plum Island Temporal Study

Field operations in the Plum Island study were focused on Plum Island estuary and Parker River National Wildlife Refuge, Massachusetts. Aerial surveys over 3 years (February/March 2017, 2018, and 2019) assessed marsh stability by measuring the amount of slumping happening along the banks of the tidal channels.

Great Marsh Data Collection

At Great Marsh, Barnstable, Mass., the AIM group was involved in a multidisciplinary study involving wetland scientists, sediment transport modelers, and the U.S. Army Corps of Engineers. Multiple datasets were collected from different sources. Light detection and ranging (lidar) and hyperspectral data were collected by aircraft and compared to digital elevation models and orthophotographs produced by using structure-from-motion natural color and multispectral imagery collected by UAS flights as well as a handheld spectrometer used for ground validation. These data can be used to classify vegetation, model elevation, compare the lidar data to the sea-floor mapping data, and to compare ditched with unditched mosquito marsh habitat (shallow channels are sometimes used to drain mosquito habitat and let in fish that feed on mosquito larvae).

Mount Kīlauea Volcanic Eruption

The AIM group provided operational support to the USGS Hawaiian Volcano Observatory and the Federal Emergency Management Agency at Mount Kīlauea in Hawaii. Our drone pilots provided 24-hour real-time (and near-real-time) eyes in the sky to help monitor and map the volcanic eruption.

Other Operations

Other 2018 field operations took place at Sage Lot Pond, Mass.; Town Neck Beach, Sandwich, Mass.; Taunton, Mass.; and Duck, North Carolina.

Aerial Imaging and Mapping

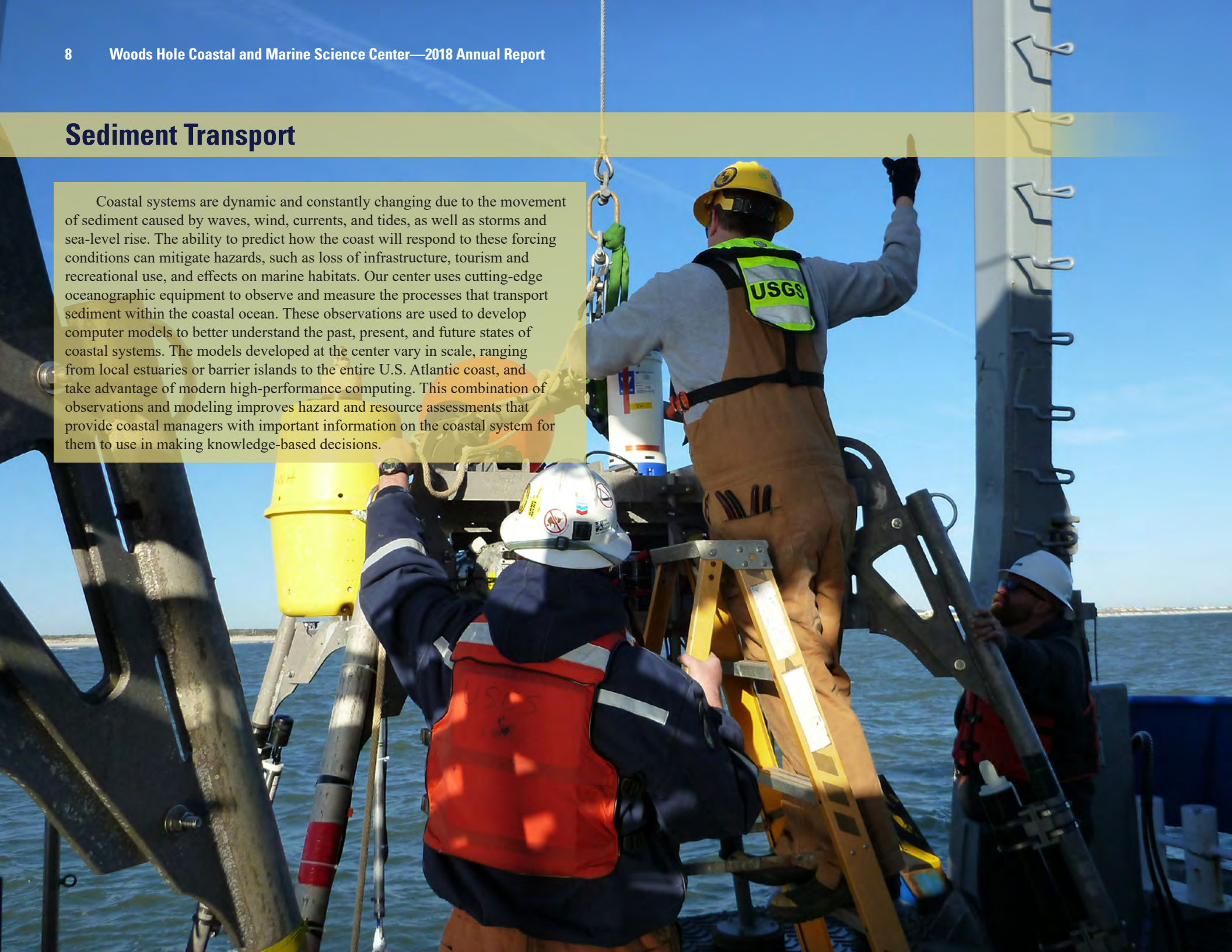
Highlights of 2018

Our Aerial Imaging and Mapping (AIM) group provides unmanned aerial system (UAS) services to support the wise use and protection of coastal and offshore resources and also inform policies and decisions that prepare us for extreme events, natural hazards, and climate change. UAS technology provides a rapid and low-cost solution for mapping coastal environments and assessing short- and long-term changes. The interdisciplinary nature of the data collected and the breadth of applications make UAS technology applicable to multiple scientific investigations.

The AIM group continues to lead the northeast region UAS working group, exploring new research applications and developing UAS platforms and data-processing methods to facilitate USGS publication of UAS data. Also, the AIM group hosted various national training classes and became coaches assisting the National Unmanned Aircraft Systems Project Office in basic UAS training classes.

Sediment Transport

Coastal systems are dynamic and constantly changing due to the movement of sediment caused by waves, wind, currents, and tides, as well as storms and sea-level rise. The ability to predict how the coast will respond to these forcing conditions can mitigate hazards, such as loss of infrastructure, tourism and recreational use, and effects on marine habitats. Our center uses cutting-edge oceanographic equipment to observe and measure the processes that transport sediment within the coastal ocean. These observations are used to develop computer models to better understand the past, present, and future states of coastal systems. The models developed at the center vary in scale, ranging from local estuaries or barrier islands to the entire U.S. Atlantic coast, and take advantage of modern high-performance computing. This combination of observations and modeling improves hazard and resource assessments that provide coastal managers with important information on the coastal system for them to use in making knowledge-based decisions.



Inlet Seafloor-Sediment Response to Winter Storms

From January 24 to April 13, 2018, our scientists deployed underwater instruments offshore of Matanzas Inlet near St. Augustine, Florida, to collect data tracking the response of sea-floor sediment to winter storms where inlets connect ocean and inland waters. These data are now being processed, and the results can be used to better understand the effects of storms on the movement of sediment near inlets.

New Capabilities Added to COAWST

As part of a funded effort from the Office of Naval Research, we added three new capabilities to our coupled ocean-atmosphere-wave-sediment transport (COAWST) modeling system. The first accounts for how waves change shape asymmetrically as they move into shallow water along the coast. This alters the net sediment movement across the sea floor. Secondly, we enhanced the sediment routines on the barrier island that account for sand slumping onto the beach when strong waves directly hit dunes. Thirdly, the model can now account for changes in the type of land cover across the area of interest when determining sediment movement. This allows effects of land type, such as vegetation, paved surfaces, or structures, to limit the movement of the sediment during storms. Each of these additions has enhanced our capability to predict coastal response.

COAWST Applications

We applied COAWST to several targeted areas: Fire Island for Hurricane Sandy (2012), Matanzas Inlet for Hurricane Matthew (2016), and North Carolina for Hurricane Florence (2018). Results were shown at several conferences (Ocean Sciences Meeting, February 2018, Portland, Oregon; Office of Naval Research Project Meeting, Monterey, California, May 2018; American Geophysical Union Fall Meeting, Washington, D.C., December 2018). Several publications are in review.

Cross-Shore and Inlets Processes

Highlights of 2018

Understanding the exchange of water, sediment, and biological particles between the inner shelf and back-barrier estuaries provides critical information for determining extreme water levels, the formation and maintenance of inlets, barrier-island evolution, and pollutant and larval transport. These connections are controlled by cross-shore processes including wave-driven inner-shelf and nearshore processes, dune overtopping, breaching, transport through existing and new inlets, and estuarine circulation. The Cross-Shore and Inlets Processes project objectives are to further our understanding and increase our ability to predict the evolution of the form and shape of the coast from estuaries to the continental shelf.

Estuarine Processes, Hazards, and Ecosystems

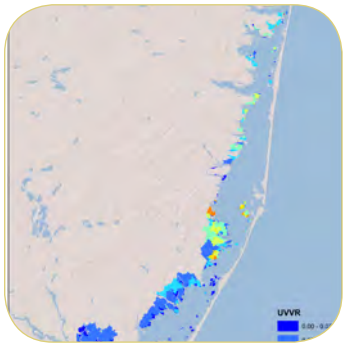
Highlights of 2018

Several interdisciplinary projects aim to collect basic observational data on estuarine processes, develop numerical models of these processes, and apply the models to understand the past, present, and future states of estuaries. Wetland synthesis efforts produce geospatial data layers to evaluate dynamics and change in these critical environments.

Study sites include Ogunquit, Maine; West Falmouth Harbor, Mass.; Great South Bay, N.Y.; Jamaica Bay, N.Y.; Barnegat Bay, New Jersey; Chincoteague Bay, Maryland/Virginia; Blackwater National Wildlife Refuge, Md.; and tidal wetlands along the Pacific coast.

Estuarine and Wetland Storm Response

Instrument data collection and modeling studies in Chincoteague Bay and Barnegat Bay investigated how estuaries respond to storms. Our scientists improved existing methods for collecting time-series data and enhanced our models that predict how an estuary will respond to changes in conditions. The results of our data collection and models have provided critical knowledge about estuarine and wetland storm response that inform larger scale studies now underway.

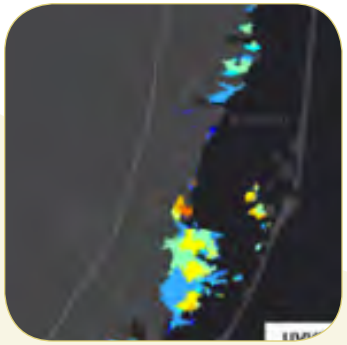


Edwin B. Forsythe National Wildlife Refuge Wetland Synthesis Geonarrative

With contributions from five different USGS groups, our scientists are developing an interactive, web-based geonarrative for the Edwin B. Forsythe National Wildlife Refuge (New Jersey) wetland synthesis, a collaborative product arising from Hurricane Sandy projects. The geonarrative will include multiple data layers that display how various aspects of this salt marsh complex are changing, such as marsh condition, salinity, and sediment. This product will enable vulnerability analysis and correlation/causation analyses.

Expansion of the Wetland Synthesis

Our scientists are working to expand the wetland synthesis beyond the Edwin B. Forsythe National Wildlife Refuge in New Jersey. The expansion includes four national parks—Assateague Island National Seashore in Maryland and Virginia, Cape Cod National Seashore in Massachusetts, Fire Island National Seashore in New York, and Gateway National Recreation Area in New Jersey—as well as Parker River National Wildlife Refuge in Massachusetts, Plum Island LTER in Massachusetts, and the entire State of New York. Geonarratives will be produced for each location, with geospatial products included where applicable.



Wetland Vulnerability

To advance our open-water assessment methodology, our scientists are working to formalize the unvegetated to vegetated marsh ratio (UVVR) as an index. This opens avenues for developing consistent methodology and nationally updating UVVR at a high resolution.

Cohesive Sediment Incorporated into COAWST

Ongoing improvements are being made to the sediment-transport components of the coupled ocean-atmosphere-wave-sediment transport (COAWST) modeling system. Treatments for cohesive sediment (mud) have been added, and the model has been applied to shelf and estuarine environments where cohesive sediment dynamics are important for studying the chemical composition of the sediments and recording storm events.

Mapping Sandwich Town Neck Beach

Since 2016, our scientists have mapped Town Neck Beach in Sandwich 14 times to capture seasonal variability of the beach and morphology changes after nor'easters. The latest measurement was taken in March 2018. These data show that Town Neck Beach lost 86 percent of the nourished berm, an important part of the back beach, over three winters. The beach also lost sand. Only sand deposited inland by overwash during high-energy storm events has accumulated.

Palos Verdes Shelf

The Palos Verdes continental shelf near Los Angeles is a Superfund site contaminated with legacy DDT and polychlorinated biphenyls (PCBs). One of the enduring questions is whether DDT will degrade naturally in the shelf sediments. Our scientists collaborated with USGS geochemists and, using field data obtained over several decades, developed a model to forecast the decay of DDT in the area.

Coastal Model Application and Field Measurements

Highlights of 2018

This project supports the development and application of open-source coastal models with several objectives:

1. improve the code of numerical sediment-transport models by implementing new or improved algorithms;
2. obtain measurements of coastal ocean processes to test and verify models;
3. develop new instruments or analysis techniques to collect these measurements; and
4. develop software tools and standards to facilitate analysis, comparison, and visualization of observations and models.

Study sites are selected for characteristics needed for model development and testing, as well as to address issues of national or regional importance.

Remote Sensing Coastal Change

Highlights of 2018

The Remote Sensing Coastal Change (RSCC) project began in 2017 as a multicenter collaboration intended to advance USGS Coastal/Marine Hazards and Resources Program applications of remote-sensing techniques to coastal change problems. The project has a technical focus on adapting instruments and methods from other fields to support the USGS mission. Two early, major components have been the use of drones and manned aircraft for collecting imagery and the use of structure-from-motion photogrammetry for measuring topography. We are incorporating satellite and underwater imagery into sea-floor mapping and investigating the use of drones for measuring bathymetry, waves, and river discharges. A new direction in the project is the use of machine-learning techniques, particularly deep neural networks, for classifying coastal imagery and detecting coastal change.

Lake Ontario Coastline Mapping

The RSCC project team worked together with the center's Aerial Imaging and Mapping group to map several parts of the Lake Ontario coastline in upstate New York in 2017. Data products from that fieldwork were published in 2018.

Evaluation of Oblique Images Before and After Hurricane Matthew

RSCC researchers from the center and the USGS Pacific Coastal and Marine Science Center collaborated to evaluate oblique images taken by NOAA before and after Hurricane Matthew (2016). We found that these images are suitable for making elevation maps that have enough precision to evaluate storm-induced changes.

A 3DR Solo quadcopter collecting imagery at Chimney Bluffs State Park in New York. Using photogrammetric techniques, a three-dimensional surface model was created to provide elevation data.

Energy and Geohazards

Energy and geohazards research at the center is focused on three themes: gas hydrates (naturally occurring ice-like deposits made of water and gas), earthquake and tsunami hazards, and the sea floor beyond 200 nautical miles from shore, known as the extended continental shelf.

USGS scientists work together to study the formation and distribution of gas hydrates in nature, the potential of hydrates as an energy resource, and the possible environmental effects of gas hydrates when they break down and release methane (a potent greenhouse gas) into sediments, the ocean, or the atmosphere. The USGS works closely with other Federal agencies on implementing national gas hydrate research priorities and has been a leader in gas hydrates research for more than three decades.

Underwater earthquakes can generate tsunamis that cause hazards for coastal communities. Scientists at the center study the recent history of underwater earthquakes and tsunamis and evaluate the future potential and probable impacts of such events on a regional basis. Their research results are used in evaluations of earthquake risk zoning, public disaster education and preparedness, and engineering and building codes.

The Energy and Geohazards group also works with other Federal agencies to explore and define the limits of the U.S. extended continental shelf. Further understanding of the resource potential of these vast areas in the Arctic, Atlantic, and Pacific Oceans will improve natural resource management and promote economic prosperity.

Mid-Atlantic Resource Imaging Experiment (MATRIX) Cruise

In August 2018, researchers acquired multichannel seismic data to image the distribution of gas hydrate and shallow gas on the U.S. Atlantic margin. With support from the U.S. Department of Energy and the Bureau of Ocean Energy Management (BOEM), scientists acquired 2,000 kilometers of marine seismic data and imaged gas plumes emitted by sea-floor methane seeps, further detailing geology and gas distribution beneath a subset of the more than 500 sea-floor methane seeps first discovered in 2014. The MATRIX data, which filled a large gap where no modern seismic data had been acquired on this margin, can also support future USGS research on submarine slides, sedimentation patterns, and margin evolution.

Geochemistry

Researchers analyzed gas samples from the Indian National Gas Hydrate Program drilling expedition in 2015 and from permafrost-associated hydrate reservoirs on the Alaskan North Slope, where the USGS is working with partners on drilling programs designed to lead to the first-ever long-term methane production test from gas hydrates. Scientists also finished analyses to determine the methane source for samples obtained during a 2015 cruise to study the sea-floor gas seeps that are widespread on the U.S. Atlantic margin.

From July 24 to July 29, 2018, USGS Gas Hydrates Project scientists took measurements at the methane seep on Dogger Bank in the North Sea as part of the German-led SeSOM (applying semi-autonomous subsea optical monitoring for methane seepage studies in the North Sea) project.

Physical Properties of Hydrate-Bearing Sediments

The project's scientists expanded laboratory capabilities for analysis of hydrate-bearing sediments to include more sophisticated instrumentation in the Hydrate Pressure Core Analysis Laboratory and a full suite of devices and models suitable for convenient use on a lab workbench in the physical properties laboratory. The project's staff also continued their focus on how fine sediments interfere with the extraction of methane from gas hydrates during production and how borehole logs can be used to better characterize gas hydrate reservoirs.

Gas Hydrates

Highlights of 2018

The USGS Gas Hydrates Project focuses on the study of natural gas hydrates in deepwater marine systems and permafrost areas. The project has three primary goals:

1. evaluate methane hydrates as a potential energy source;
2. investigate the interaction between methane hydrate destabilization and climate change at short and long time scales, particularly in the Arctic; and
3. study the spatial and temporal connections between submarine slope failures and gas hydrate dynamics.

The Gas Hydrates Project conducts multi-disciplinary field studies, participates in national and international deep drilling expeditions, and maintains a laboratory program focused on hydrate-bearing sediments.

Marine Geohazards Sources and Probability

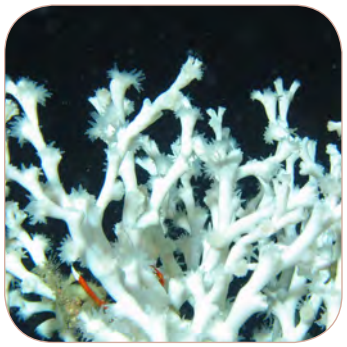
Highlights of 2018

The Marine Geohazards Sources and Probabilities project has three primary objectives:

1. quantify marine hazards, such as earthquakes, landslides, tsunamis, and volcanoes in marine and coastal environments by using geological and geophysical data, interpretations, and models, and develop the technologies and methodologies needed to do so;
2. understand the underlying processes of these marine hazards to inform hazard estimations; and
3. develop reliable deterministic and probabilistic estimates of the hazards to be used by engineers and policymakers.

Dead Sea Fault Imaging

In April 2018, our scientists imaged the deep structure of the Dead Sea fault in Israel to improve earthquake assessment and understanding of how continents stretch and rift. Enhanced understanding of the fault can also help identify resources like water, which are commonly stored in reservoirs of sedimentary rocks along such plate boundaries. The data are currently being processed and analyzed. A copy of the data has been archived with the Incorporated Research Institutions for Seismology (IRIS) Data Management Center, a public, open-access archive.



DEEP SEARCH 2018

In collaboration with NOAA and BOEM, our researchers participated in DEEP SEARCH 2018, a 15-day voyage to learn more about the natural resources of the deep ocean off the U.S. southeastern coast from Virginia to Georgia. During this voyage, researchers discovered discontinuous deep-sea coral reefs in a zone stretching over 50 miles long, 160 miles off the coast of Charleston, N.C. The goal of the project is to discover new, vulnerable habitats and make them priorities for BOEM's management plan for the area in case it is opened for drilling.

Georges Bank Ocean Bottom Seismometer Deployment

Our scientists deployed broadband ocean bottom seismometers (designed to record seismic data generated by earthquakes) in Georges Bank, a large area off the coast of Massachusetts, to study the shear strength of sediments which might fail in a submarine landslide.

Bering Sea Extended Continental Shelf

The USGS developed the geologic background chapter, finalized sediment thickness values, and created associated seismic images for inclusion in the document being prepared by the ECS Project Office to explain the U.S. position on its ECS boundary in the Bering Sea. Following external review by experts in Law of the Sea criteria, the USGS is revising its chapter, as well as completing associated information about the data used in the ECS document and making recommended revisions to the ECS Project Office for final map making.

Eastern Gulf of Mexico Extended Continental Shelf

A draft document with USGS contributions on framework geology, sediment thickness points, and surficial geology for the eastern Gulf of Mexico was submitted to the ECS Executive Committee in 2018. After favorable review by external experts, the Executive Committee selected the eastern Gulf of Mexico to be the first ECS region for which a full report package (all text, figures, data, metadata, appendixes, and supporting documentation) would be completed.

Other Regions of Extended Continental Shelf

Revisions to USGS ECS documentation for the Arctic region were completed in 2018. This product is undergoing internal USGS technical review in 2019 in preparation for completing the full documentation package. Preliminary work was completed on both the Atlantic and Pacific regions of ECS. An additional small region of ECS was added to the project (Northern Mariana Islands) and can be used in boundary negotiations with Japan in the future.

Other Nations

The USGS participated in U.S. Department of State-Bahamas preliminary boundary discussions in May 2018, including a discussion of potential ECS overlaps between the United States and the Bahamas.

Extended Continental Shelf

Highlights of 2018

The USGS Extended Continental Shelf (ECS) Project supports the U.S. Department of State in identifying the outer limits of the U.S. ECS. Within its extended continental shelf, a coastal nation can exercise its sovereign rights to manage, preserve, or exploit nonliving and sedentary living resources. The United Nations Convention on the Law of the Sea specifies the criteria and conditions under which nations justify their outer limit boundaries. The USGS uses geologic framework studies and estimates of sediment thickness in its ECS studies. The ECS Interagency Task Force and its Executive Committee (consisting of the U.S. Department of State, the National Oceanic and Atmospheric Administration, and the U.S. Department of the Interior) provide guidance to the project for priorities in boundary delineation. The project is currently in phase 3, in which the past 10 years of data collection are being synthesized into documentation of proposed ECS outer limits.

Environmental Geoscience

Our coasts contain a wide range of environments that provide essential habitat for a variety of plants and animals. From wetlands to estuaries to coastal margins, these ecosystems deliver many critical benefits and services to society. Research by the Environmental Geoscience group at the center is focused on key ecosystem functions and drivers of ecosystem change. Knowledge gained through fieldwork is used to model and map the effects of changing environmental conditions caused by sea-level rise and climate change, as well as the effects of expanding coastal infrastructure on critical ecosystems. This work provides valuable data, products, and decision support to Federal, State, and local organizations and individuals tasked with managing these vital ecosystems for future resilience.

Herring River Estuary

The 1,000-plus-acre Herring River estuary in Wellfleet, Mass., was once one of the most productive salt marsh systems in the Northeast. Together with local communities, the National Park Service aims to create a resilient coast by restoring tidal flow and salt marsh habitat and by returning herring runs to the Herring River. As a research partner, the Environmental Geoscience group provides data and products on wetland stability, elevation change, predicted vegetation change, and persistence of this altered and managed environment, under present-day conditions and in the future, under various management scenarios.

New England Salt Marsh Study

In New England, salt marshes were extensively ditched many decades ago to promote drainage to reduce mosquito populations. In partnership with the Waquoit Bay National Estuarine Research Reserve and other local managers, such as the Cape Cod Mosquito Control Project and the U.S. Fish and Wildlife Service, our scientists study the persistence of these marshes, as well as their elevation gain following sea-level rise, to provide data for managers seeking to update their hydrologic management strategies.

Terrestrial-Aquatic Lateral Fluxes

Tidal exchange between wetlands and the adjacent estuary is an important pathway for movement of nutrients and carbon. Through dense in-place measurements of water flux and physical chemistry across a range of coastal wetlands, we explore the magnitude of flux as well as important physical and biological drivers. Funded by the Ocean Carbon and Biogeochemistry program within the U.S. Carbon Cycle Science Program, in addition to support from USGS programs, we are leading synthesis activities among agencies and universities to deliver an estimate of lateral carbon flux across the contiguous United States. This will be the first analysis of its kind.

Biogeochemical Drivers of Wetland Persistence and Feedbacks on Coastal Hazards

Highlights of 2018

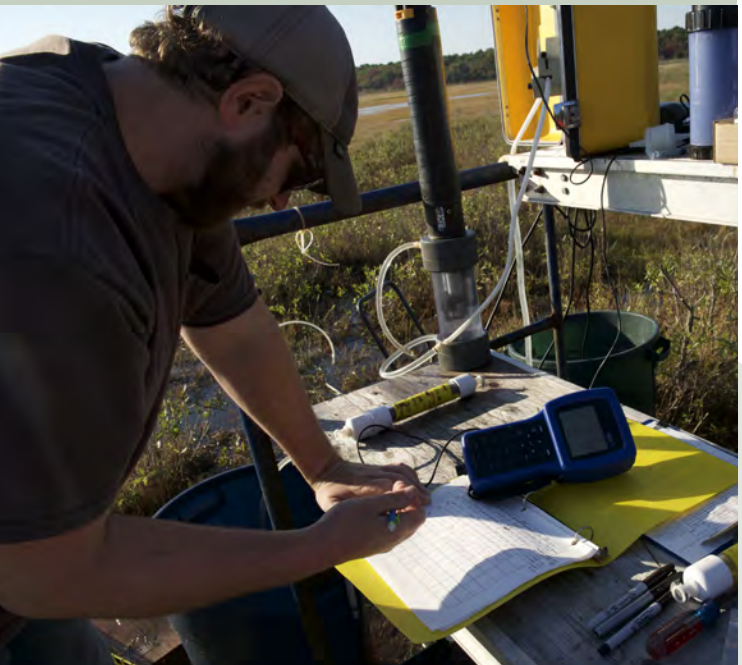
Tidal wetlands provide critical services to society, including protection of infrastructure from coastal hazards and habitat for economically important species. A large fraction of U.S. tidal wetlands, however, has been lost or degraded during recent centuries as a result of human actions, largely related to development and use of coastal lands. Feedback and interactions among natural and human influences have altered the stability and persistence of coastal wetlands. Decisions regarding hydrological management can alter the balance of organic-matter production and retention, and thus management actions can either promote wetland resilience or cause catastrophic loss of elevation, putting coastal infrastructure at increased risk of flooding or storm damage.

Results from the Biogeochemical Drivers of Wetland Persistence and Feedbacks on Coastal Hazards project provide guidance to Federal (National Park Service, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers), State, local, and private land owners and managers regarding stability and persistence of coastal wetlands under a range of hydrological management conditions and changing environmental conditions.

Analytical Laboratories

Highlights of 2018

The Core Laboratories Project is a research support service of our center, providing analytical and technical infrastructure and supporting a range of projects associated with coastal biogeochemical processes, coastal groundwater, climate-hydrates, and sedimentology. Support includes technician time, as well as the procurement of general equipment and consumables needed to operate and maintain the analytical spaces and instrumentation. Laboratory methods and techniques are continually refined and developed to meet project objectives and to provide new capabilities.



Measuring Magnetic Susceptibility in Sediment Cores

Sediment Lab personnel developed technology and methods for measuring magnetic susceptibility in sediment cores, using a magnetic susceptibility loop to measure whole cores and using a point sensor for split cores. They also developed a core-mounted camera system and a deep-water multicoring system to enhance sample-collection operations at sea.

Characterization of the "Mud Patch" of the Southern New England Shelf

The USGS component of the National Oceanographic Partnership Program's DEEP SEARCH project continues to provide our Sediment Lab with sample analyses for the joint-effort sediment-coring program in the Mud Patch on the southern New England shelf. Sediment cores, long narrow tubes containing sample soil deposits, are used to tell us about the history of an area. Grain-size analyses, sediment core descriptions, mineral identification and analyses, X-ray imaging, and carbonate content analyses performed in the lab are contributing to a complete characterization of the Mud Patch.

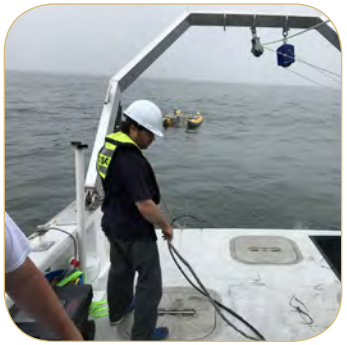
More Sample Analyses

The Sediment Lab prepared and analyzed samples for the USGS Gas Hydrates project, Stellwagen Bank habitat mapping program, tsunami hazards assessment project, Coastal Massachusetts mapping project, Long Island Sound mapping project, and Sediment Transport program.

USGS personnel and collaborators from the Marine Biological Laboratory and Waquoit Bay National Estuarine Research Reserve building research infrastructure at a salt marsh field site.

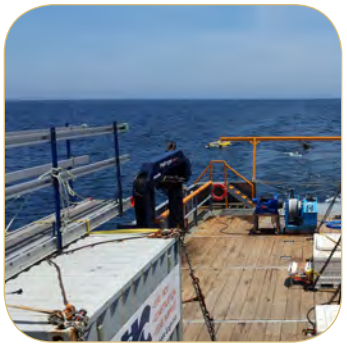
Sea-Floor Mapping

Our Sea Floor Mapping Group provides support for nearly every project at the center and works closely with the other two CMHRP science centers. Working across diverse environments, our technical team uses acoustic geophysical techniques to collect detailed information about the sea floor, such as its shape, sediment composition and distribution, and underlying geologic structure and sediment. Sea-floor video, photographs, sediment cores, and samples are also collected to provide a comprehensive foundation for studies of sediment and contaminant transport, landslide and tsunami hazards, gas hydrates and methane and carbon flux, benthic habitat quality, sediment availability, shoreline change, and coastal evolution. Managers, policymakers, and other stakeholders use the map products derived from these studies to inform coastal and ocean resource-management decisions.



New Jersey Study

Our scientists conducted high-resolution geophysical mapping of the inner continental shelf in the Edwin B. Forsythe National Wildlife Refuge. Data are to be used to create new maps of the geology and sediment distribution and develop models of the system's vulnerability to storms, sea-level rise, and human activities, such as the use of offshore sand for beach and dune restoration, on management timescales (annual to decadal).



Delmarva Regional Study

The Delmarva Peninsula, which includes parts of Delaware, Maryland, and Virginia, is a 220-kilometer-long headland, spit, and barrier island complex that was significantly affected by Hurricane Sandy. We continue to work collaboratively with the Bureau of Ocean Energy Management, State agencies, and other regional stakeholders to better understand their coasts and continental shelves and help them use the many USGS data releases and published papers. We prepared a map of sediment texture and manuscripts on paleochannels intended for release in the coming years.

Lake Superior Stamp Sands

Large amounts of waste material from copper mining, called "stamp sands," were dumped into Lake Superior at many locations in the early 20th century. We conducted high-resolution geophysical mapping to determine the distribution and thickness of historical mine tailings on the bottom of the lake to develop a framework for scientific research and provide baseline information required for resource management within the coastal zone of northern Michigan. We collected approximately 370 kilometers of instrument data to map the lake bottom and collected sediment samples at 17 stations. These data will be compiled with existing lidar, video, and sample data to produce geologic maps of the area, with focus on stamp sands.

Geologic Mapping: Links to Coastal Vulnerability and Hazards

Highlights of 2018

The objectives of the geologic mapping project are to characterize a region's resources and identify potential coastal hazards by understanding the region's geologic framework. This work provides baseline datasets and derivative interpretive maps that provide critical information to planners and decision makers who oversee the management of resources and mitigation of hazards in the coastal ocean. Geologic mapping project scientists conduct scientific analysis and develop cutting edge methodologies to examine these data and later communicate their results to the scientific community and the public.

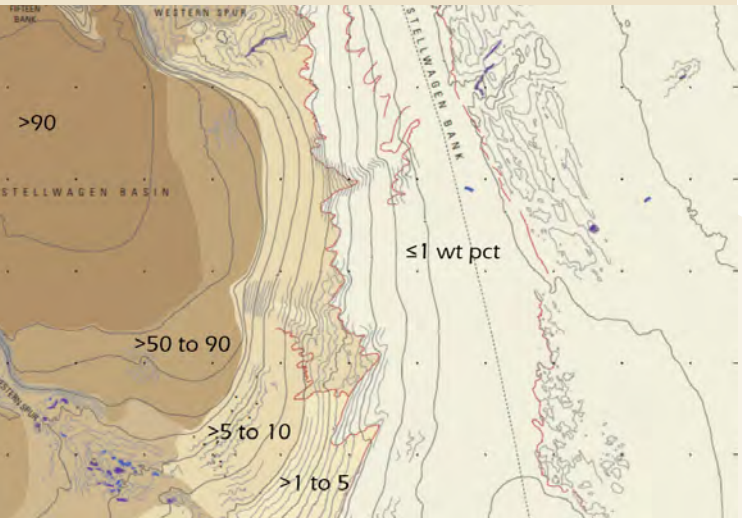
Currently the project consists of several tasks: (1) a study offshore Forsythe, N.J.; (2) a Delmarva regional study; (3) Lake Superior stamp sands work; and (4) completing the Massachusetts geologic mapping project and preparing for the next phase (Massachusetts Integrated Coastal Studies [MICS]).

National Sea-Floor Mapping and Habitat Studies

Highlights of 2018

Federal and State governments are responsible for managing the coastal and offshore region of New England. This project produces a series of online interpretive maps that show the distribution of geologic seabed substrates and processes in the Stellwagen Bank region, located 20 miles offshore from Boston, Mass., at a scale of 1:25,000.

The maps provide a framework for scientific research in the region and for managing fishery resources and infrastructure. Stellwagen Bank is the principal habitat in the eastern Gulf of Maine for sand lance, a schooling fish which is the primary food resource for marine mammals, seabirds, and most of the bank's commercial fishery species, including cod, haddock, and tuna. Geologic substrate mapping will determine the extent of suitable habitat for the species and provide a basis for assessing the size of the sand lance population and identifying its dependence on seasonal changes of water-column properties.



Photograph by Mandy Lindeberg, NOAA

Sand Lance Samples and Imagery

In collaboration with scientists of NOAA's Stellwagen Bank National Marine Sanctuary, cruises to survey the seasonal distribution of sand lance on the bank were conducted in May, July, and November of 2018. Researchers collected samples and imagery of sand lance and seabed sediment and recorded the water-column properties. Sand lance were found to be concentrated on the southern part of the bank. All cruise data are compiled, archived, and published online in field activity data reports.

Onboard Stockton University's research vessel *Petrel* to map the sea floor of Little Egg Inlet in the Edwin B. Forsythe National Wildlife Refuge, New Jersey.

Information Science

Data collected for analysis by USGS scientists are in demand by scientists at other agencies and universities, resource managers and policymakers at Federal, State, and local levels, and the public. The Information Science group at the center is responsible for managing and maintaining the scientific data, ensuring that they are readily available in a variety of formats and online systems. The group also assists stakeholders in understanding their data needs and locating useful products.

USGS Coastal and Marine Geology Data Catalog

The USGS Coastal and Marine Geology Data Catalog was released in 2018. This catalog makes it easier to find CMHRP research data. It offers more than 4,000 datasets through a geographical search interface using both an interactive map and lists of place names. The lists of place names also offer filtering by keyword, data source, and author.

Samples Repository

An updated collections management plan for the Samples Repository was published that provides an overview of the facilities, describes the types of samples preserved and managed there, and details the procedures that ensure the preservation and usefulness of the samples for future research. Each sample in the repository is required to have accompanying metadata, which identify samples and scientific collections. The metadata are then formatted into a collections inventory database. The collections inventory database was published as a USGS data release in 2018 and is available online through the Samples Repository's inventory search interface.

USGS Thesaurus

Metadata reviewers of the three CMHRP science centers worked with the USGS Thesaurus Team to enhance the USGS Thesaurus so it can be used to better categorize coastal and marine science data. The team worked to improve the usefulness of the controlled vocabulary in helping people outside the USGS find, understand, and obtain scientific information pertinent to their needs, as well as improving the ease of use for USGS scientists who are applying the vocabulary terms.

Data Library

Through the STEP–UP Program, an individual began working with us to rescue paper navigation data from the Data Library and get track charts and printed maps in the Data Library digitized and into Esri or GeoJSON formats. The STEP–UP Program works with individuals of differing abilities to provide job skills and training in a safe environment.

Data Management and Preservation

Highlights of 2018

As a permanent resource, the data USGS collects and uses are vital. Good data management enables sharing and reuse of data, and it reduces data redundancy and costs in terms of time and money.

An advantage of good data management lies in data integration. Well-documented data that are easily accessed may be integrated readily into an existing project or dataset, reducing redundant work and adding value.

Data-management best practices attempt to define and document consistent standards and procedures. The goal is to provide the information resources needed for efficient program operations. Staff at Woods Hole work collaboratively with the other CMHRP centers to provide consistency within data management activities

Bureau-Wide Activities – Community for Data Integration

Highlights of 2018

The Community for Data Integration (CDI) is a group in which members can expand their expertise on all aspects of working with scientific data. The CDI focuses on opportunities to share information across disciplines and organizational structures, invigorating cross-boundary communication. The CDI is funded and led by the U.S Geological Survey, but it is open to all who generate, use, and communicate about scientific information.

The CDI's purpose is to

1. advance understanding of earth systems through enhanced use of data and information and associated tools and techniques;
2. provide a forum for people doing work with data integration to come together and learn how to do their job better; and
3. advance overall USGS capabilities with data and information by increasing the visibility of the work of many people throughout the USGS.

To support many of the innovative ideas in the community, the CDI supports community collaboration that forms around common interests, helps address challenges, and identifies solutions that enable data-integration efforts. The CDI annually holds a competitive proposal process to award seed funds for projects that focus on data integration for interdisciplinary research, innovative data management, and advanced technology.

ISO Metadata Content Specifications

A group of 26 metadata specialists held the International Organization for Standardization (ISO) Metadata Standards Workshop in 2018 to propose content specifications to help USGS scientists in authoring metadata records.

Metadata are crucial for any use or reuse of data; no one can responsibly reuse or interpret data without metadata that explain how and why the dataset was created, where it is geographically located, and details about the structure of the data.

Participants used and refined a process for defining discrete modules of metadata content that can be combined to create metadata specifications appropriate for many types of scientific data the USGS produces. This method ensures consistency across the Bureau while enabling flexibility to create metadata that is appropriate for specific datasets.

Participants agreed to continue working on four initial modules: basic, lineage, biology, and geospatial.

Neil Ganju, a Woods Hole Coastal and Marine Science Center oceanographer, sharing science at the Woods Hole Science Stroll outreach event.

2018 Publications

Journal Articles (37)

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All photographs by the U.S. Geological Survey unless otherwise indicated.

For more information about this report, contact:

Director, Woods Hole Coastal and Marine Science Center
U.S. Geological Survey
384 Woods Hole Road
Quissett Campus
Woods Hole, MA 02543–1598
WHSC_science_director@usgs.gov
(508) 548–8700 or (508) 457–2200
or visit our website at
https://www.usgs.gov/centers/whcmsc

Publishing support provided by the Pembroke Publishing Service Center
Editing by Jonas Casey-Williams
Design and layout by Susan L. Meacham

USGS

Ernst—**Woods Hole Coastal and Marine Science Center—2018 Annual Report**—Circular 1460

ISSN 1067-084X (print)
ISSN 2330-5703 (online)
https://doi.org/10.3133/cir1460

ISBN 978-1-4113-4338-2

Printed on recycled paper