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Woods Hole Coastal and Marine Science Center

2020 Annual Report

Circular 1487

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

Cover. Front—Wetlands play a key role in the coastal carbon cycle, removing carbon dioxide from the atmosphere during photosynthesis and releasing carbon dioxide and methane during respiration. The amount of methane emission is critical to determining how a wetland interacts with the global climate system. Here U.S. Geological Survey staff measure carbon dioxide and methane fluxes in a clear chamber in a *Phragmites* wetland in Mashpee, Massachusetts.

Back—The U.S. Geological Survey samples water within wetlands to understand which environmental drivers affect the carbon cycle and sediment accretion. Here Jennifer O'Keefe Suttles pumps water from a *Phragmites* wetland in Mashpee, Massachusetts, to analyze at the Woods Hole Coastal and Marine Science Center Geochemistry Lab.

Title page. The U.S. Geological Survey partners with the National Park Service to study ecosystem and sediment dynamics at the Cape Cod National Seashore, Wellfleet, Massachusetts. The Herring River estuary provides a natural laboratory for studying wetland dynamics behind structures that restrict tidal flow from Cape Cod Bay. *Phragmites* vegetation displaces salt marsh because of low salinities maintained by the current dike and is a source of methane to the atmosphere.

Woods Hole Coastal and Marine Science Center

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By Sara Ernst

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

U.S. Geological Survey, Reston, Virginia: 2021

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Suggested citation:
Ernst, S., 2021, Woods Hole Coastal and Marine Science Center—2020 annual report: U.S. Geological Survey Circular 1487, 36 p., https://doi.org/10.3133/cir1487.

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

ISBN 978-1-4113-4423-5

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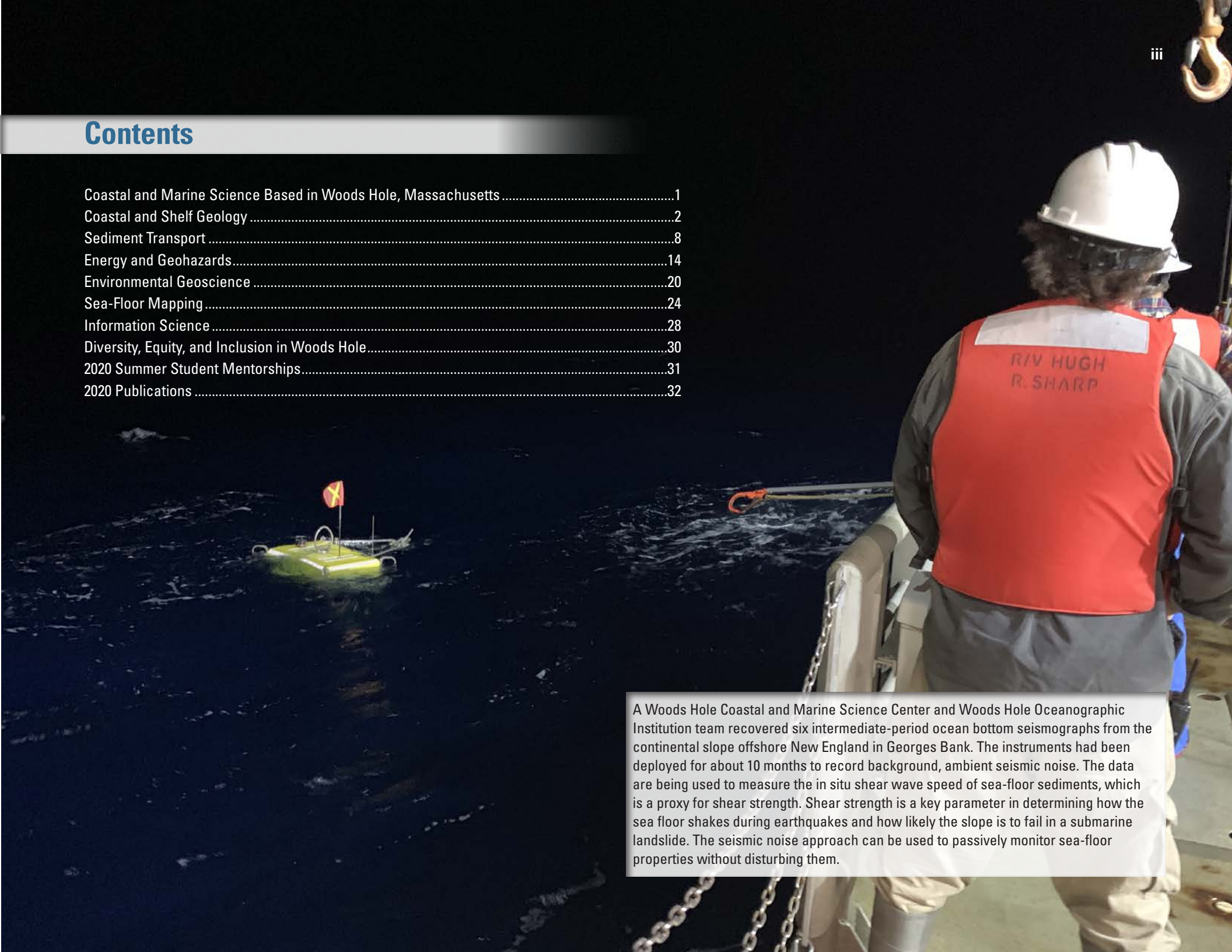


A Woods Hole Coastal and Marine Science Center and Woods Hole Oceanographic Institution team recovered six intermediate-period ocean bottom seismographs from the continental slope offshore New England in Georges Bank. The instruments had been deployed for about 10 months to record background, ambient seismic noise. The data are being used to measure the in situ shear wave speed of sea-floor sediments, which is a proxy for shear strength. Shear strength is a key parameter in determining how the sea floor shakes during earthquakes and how likely the slope is to fail in a submarine landslide. The seismic noise approach can be used to passively monitor sea-floor properties without disturbing them.

Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
square kilometer (km^2)	0.3861	square mile (mi^2)
kilogram (kg)	2.205	pound, avoirdupois (lb)

Abbreviations

AIM	Aerial Imaging and Mapping [group]
CCNY	City College of New York
CMHRP	Coastal/Marine Hazards and Resources Program
COAWST	Coupled Ocean-Atmosphere-Wave-Sediment Transport [modeling system]
ECS	extended continental shelf
ESA	Ecological Society of America
GPS	Global Positioning System
lidar	light detection and ranging
MATRIX	Mid-Atlantic Resource Imaging Experiment [cruise]
NOAA	National Oceanic and Atmospheric Administration
PDF	Portable Document Format
PEP	Partnership Education Program
QMS	Quality Management System
SEABOSS	Seabed Observation and Sampling System
SNC	State of Our Nation's Coast
SSF	Summer Student Fellowship
STEP–UP	Secondary Transition to Employment Program-USGS Partnership
UAS	unmanned aerial system
USGS	U.S. Geological Survey
WHCMSC	Woods Hole Coastal and Marine Science Center
WHOI	Woods Hole Oceanographic Institution

Collapsed arch in Guayanilla, Puerto Rico.

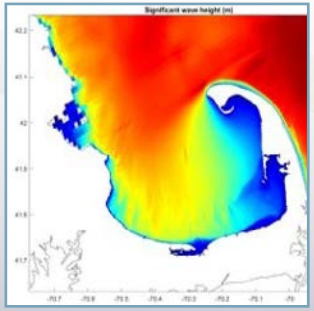
Coastal and Marine Science Based in Woods Hole, Massachusetts

The U.S. Geological Survey (USGS) Woods Hole Coastal and Marine Science Center (WHCMSC) 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 throughout the United States and in international waters 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), to characterize the coast 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.



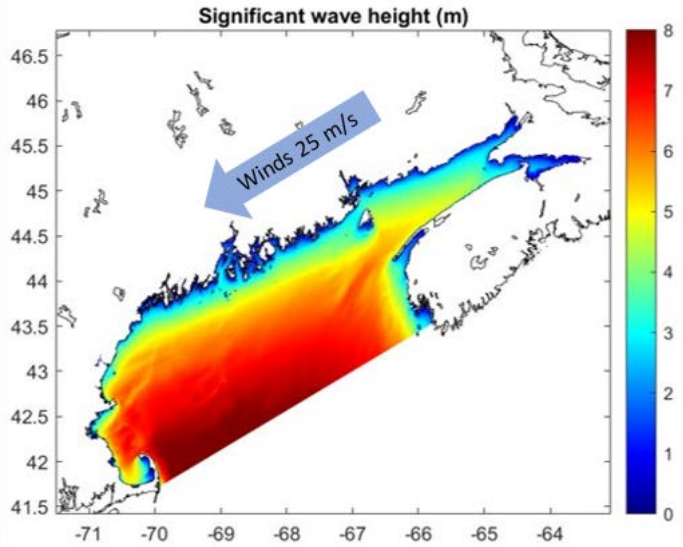
Shoreline Forecasting

A new Massachusetts shoreline was extracted from elevation data collected in 2018. This new shoreline was used to recalculate the rate of shoreline change across Massachusetts to identify areas of recurring coastal erosion. It was also used to test two methods of shoreline forecasting at several sites of varying morphological diversity throughout Massachusetts, including Cape Cod Bay. Both methods were used to forecast the location of the shoreline in 2018 by using data collected before 2008. These predicted locations were compared to the measured 2018 shoreline. The accuracy and predicted uncertainty of each forecast are being analyzed for a summary report.

Coastal Change Hazards and Sea-Floor Mapping Project: Massachusetts Integrated Coastal Studies

Highlights of 2020

The USGS, in partnership with the Commonwealth of Massachusetts, initiated the Massachusetts Integrated Coastal Studies project in 2018 to further research into the processes that control sediment movement in Cape Cod Bay. Through this multi-tiered research initiative, USGS 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 capabilities for predicting shoreline change. 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 2020

Sea-level rise will have a variety of future effects on the coast, including land loss from inundation and erosion; migration of coastal landforms and environments; increased water levels, 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 brings together multidisciplinary scientists from the USGS and other organizations to assess, model, and predict the effects of sea-level rise on the Nation's coasts. The project synthesizes information on coastal environments and uncertainties, as well as current knowledge of coastal processes, into an analytic framework for evaluating the likelihood of various sea-level-rise effects. Researchers with this project also work with decision makers and State, academic, and nonprofit collaborators and stakeholders to ensure that the research outcomes are applicable and useful to managers who face decisions about whether to avoid, mitigate, or adapt to future hazards.

Effect of Coastal Change on Seabeach Amaranth and Evaluating Coastal Bluff Vulnerability

National Park Service funding and collaboration supported the development and testing of probabilistic models to explore which geomorphic configurations most support favorable habitat for *Amaranthus pumilus* (seabeach amaranth, a threatened annual plant species) at Assateague Island National Seashore off the coast of Maryland and Virginia. Project staff also began providing coastal science expertise in collaboration with other Federal partners to develop a framework for evaluating the vulnerability of coastal bluffs to erosion along the Great Lakes.

Forecasting Barrier Island Characteristics and Piping Plover Habitat—Preliminary Results Presented

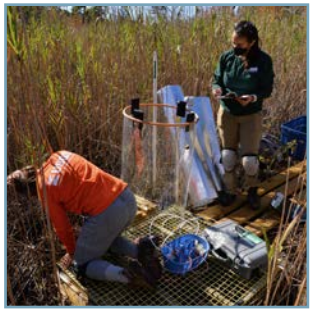
Integrated Bayesian belief networks are being used to forecast barrier island characteristics and associated piping plover habitat under several possible sea-level-rise scenarios at 21 study areas along the U.S. Atlantic coast (Maine to North Carolina). Preliminary results were presented by project staff at the U.S. Fish and Wildlife Service's Piping Plover Workshop, as well as to partners at the Parker River National Wildlife Refuge, Massachusetts, through a virtual presentation, which was followed by a site visit to explore observed changes to barrier islands and piping plover habitat and discuss ongoing management challenges in regard to model design and outcomes.

Index of Coastal Vulnerability to Sea-Level Rise

Driven by National Resource Preservation Project funding, the sea-level-rise project initiated an effort to revise the nearly 20-year-old Coastal Vulnerability Index, which assesses the susceptibility of the Nation's coast to sea-level rise. The framework for this approach is being developed in collaboration with a variety of USGS researchers and National Park Service staff to ensure that it is supported by the best available scientific information and that outcomes are useful and actionable.

American Geophysical Union Ocean Sciences

Project staff initiated, cochaired, and presented at a multidisciplinary session at the American Geophysical Union Ocean Sciences Meeting in February 2020, entitled "What's My Hazard: Meaningful and Actionable Coastal Science for Property Owners, Planners, and Practitioners," which examined how observational and modeling research into coastal hazards is developed, communicated, and applied to meet user information needs.



Operational Support

The AIM group completed two UAS collections of field data along the Potomac River in Maryland and the Jones River in Massachusetts. They also assisted the Remote Sensing Coastal Change project with field-data collections at the Head of the Meadow Beach in Massachusetts. A data release compiling data from 2018 is in progress.

Operational Capabilities

The AIM group worked toward securing a testing facility on the Joint Base Cape Cod, Massachusetts, in conjunction with the Woods Hole National Oceanic and Atmospheric Administration (NOAA) UAS team. They also obtained an emergency waiver from the Department of the Interior for conducting emergency UAS operations if a severe weather event occurs. Additionally, the group maintained flight proficiency and gear thanks to the emergency waiver granted through the Secretary of the Interior.

Technical Development

The group investigated and implemented mdEditor—a web application for authoring and editing metadata, for both projects and datasets—for International Organization for Standardization metadata creation. A related data release is in progress. Additionally, they began organizing a Global Positioning System (GPS)/geodesy workshop.

Leadership in UAS

The AIM group continues to lead the USGS North Atlantic and Appalachian Region UAS Capability Team, and a member of the group became a lead UAS instructor capable of hosting classes in the Northeast. The team also provided expertise to regional groups forming UAS operations, assisted and mentored UAS data collections and analyses for regional colleagues, and reviewed a data release for colleagues at the Ohio-Kentucky-Indiana Water Science Center.

Aerial Imaging and Mapping

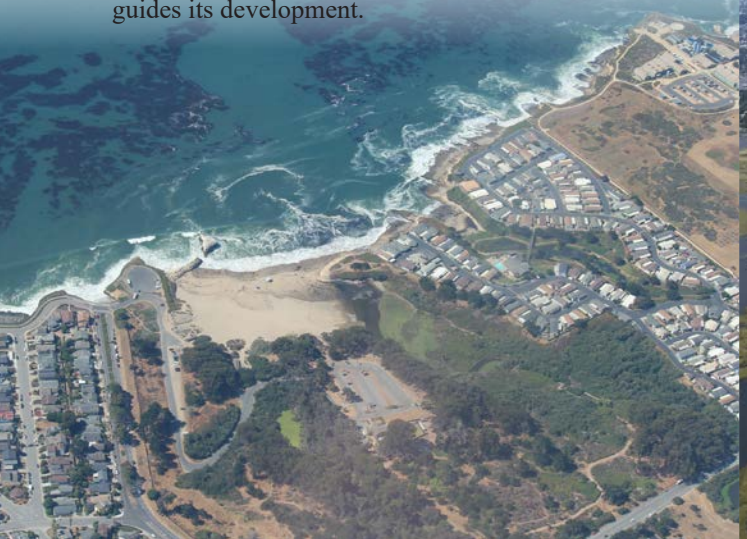
Highlights of 2020

Unmanned aerial system (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 its applications make UAS technology applicable to multiple scientific investigations. The WHCMSC Aerial Imaging and Mapping (AIM) group is developing the capability to provide operational remote-sensing support to coastal, estuarine, and lacustrine research using UAS technology. Group responsibilities include data acquisition, processing, and publication of UAS-collected data products and working collaboratively with the Department of Interior/USGS UAS operators to explore new UAS technology, sensor development, and new data acquisition techniques. Research supports the Remote Sensing Coastal Change project, the Coastal Change Hazards (CCH) programmatic focus, the national UAS project office, and other Bureau-wide remote-sensing projects. High-resolution imagery and elevation maps created from the remote-sensing data are used in change-detection studies (for example, to detect coastal erosion), hurricane damage assessments, and natural disaster responses, and the imagery and maps support situational awareness for emergencies. Collecting data remotely by UAS technology is an efficient and often safer alternative to collecting data by hand.

State of Our Nation's Coast

Highlights of 2020

State of Our Nation's Coast (SNC) is a project of the USGS Coastal and Marine Science Centers (in Woods Hole; St. Petersburg, Florida; and Santa Cruz, California) and two mission areas (Natural Hazards and Ecosystems) with several Woods Hole project leads. Its primary objective is to develop a comprehensive, online visualization tool that will be the outreach component of the USGS Coastal Change Hazards programmatic focus. The SNC vision is outreach focused, and the visualization tool is intended to serve as a mechanism of engagement to identify and meet stakeholder needs. The tool is based on concepts that received top endorsements from the 2018 Coastal Change Hazards working group meeting and is intended to provide an interactive national picture of past, current, and future coastal hazards (for example, coastal change and flooding), including those related to extreme events and sea-level rise. Outputs of the visualization tool are to be based on observations and on model predictions by the USGS and partners across the range of coastal geomorphic settings (for example, beaches, cliffs, estuaries, and coral reefs). The visualization web tool will be informed by an iterative process in which stakeholder feedback guides its development.



Series of Geonarratives on Coastal Change Hazards

Scientists and other staff within the SNC project created a series of geonarratives on coastal change hazards that can help viewers learn about coastal change and the related research conducted along the Nation's coasts. The overarching geonarrative, "Our Coasts," introduces the Nation's coastal environments and why it is crucial to understand the impacts and risks associated with coastal change. From there, other topics can be explored in more detail, such as barrier islands, coastal storms, shoreline change, forecasting coastal change, and the role of coral reefs in the coastal environment. Each geonarrative allows the user to learn more about how specific tools help people understand coastal hazards and the environmental drivers of these hazards and help decision makers to reduce risks along the Nation's coasts.

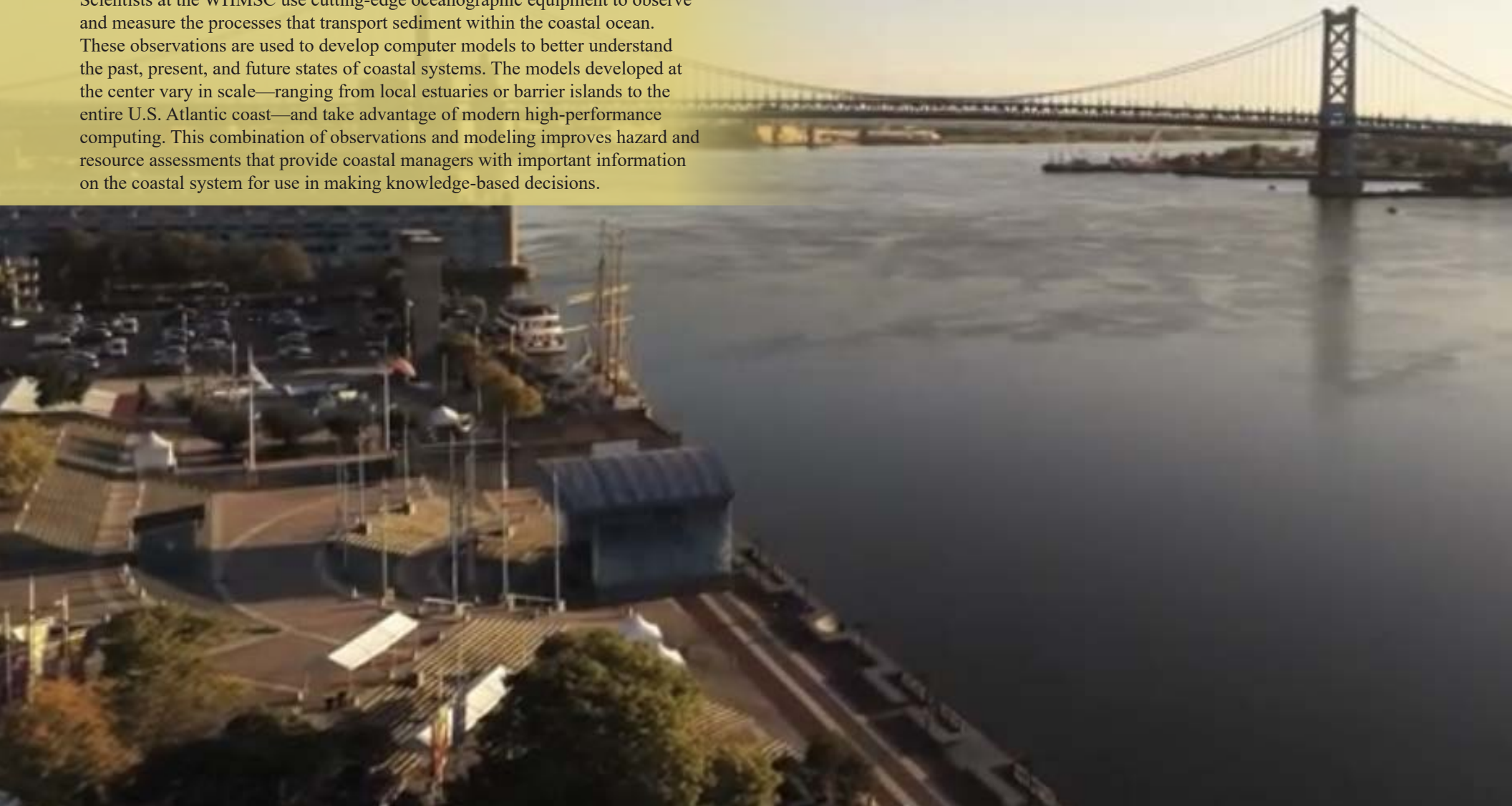
Stakeholder Engagement Workshops

SNC project leads planned, organized, and facilitated workshops in Oakland, California, in January 2020 and Falmouth, Massachusetts, in February 2020 to receive feedback from invited stakeholders on the coastal change hazards geonarratives and learn more about their needs, what tools they currently use and why, and any limitations of their current tools. Feedback was also received from stakeholders at the 2020 Alaska Marine Science Symposium and Social Coast Forum 2020. All feedback was synthesized and has been used to help determine the target audience and vision of the next SNC-project-developed product. More stakeholder engagement efforts are planned for the future.

Erika Lentz presenting at the east coast State of Our Nation's Coast stakeholder engagement workshop at the Waquoit Bay National Estuarine Research Reserve in Falmouth, Massachusetts, in February 2020.

Sediment Transport

Coastal systems are dynamic—they change constantly as a result of 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 help decision makers mitigate hazards, such as loss of infrastructure, tourism and recreational use, and effects on marine habitats. Scientists at the WHMSC use 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 use in making knowledge-based decisions.

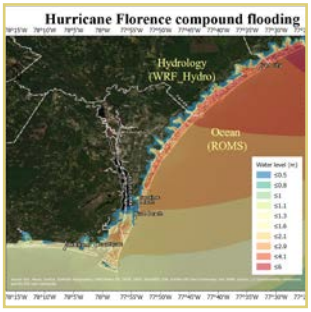


Predicting the Salt Front in Delaware Bay

Using the COAWST modeling system, the USGS is working to understand the mechanisms that control the salinity distribution in the Delaware estuary and drive salt water into the Delaware River. Results can help inform hazard guidance, emergency preparedness, and resource management of the Delaware estuary and improve understanding of salinity mixing in other estuarine environments.

Mixing of Salinity in the Hudson River Estuary

The Hudson River estuary is a multiuse waterway next to a heavily populated area. Salty ocean water mixes with fresh river water in the estuary at certain locations and times. The mixing of salt and other constituents in the water is important for water quality, health of aquatic species, and contaminant transport and makes it easier to locate freshwater intakes. Along with scientists from the Woods Hole Oceanographic Institution (WHOI), WHCMSC scientists studied where and when mixing occurs. These mixing processes also control transport of other tracers in the estuary, as well as helping us understand how changes to the estuary (like channel dredging or sea-level rise) will affect salt intrusion.



COAWST Advancement—Compound Flooding of Ocean and River Waters

Scientists advanced the COAWST modeling system to include the coupling of a hydrologic model that simulates routing of rainfall through the rivers with an ocean model that predicts wave and sea surge from storms. This model coupling is expected to improve flood forecasts.

Analyzed Sonar Images to Estimate Changes in Geomorphology in Matanzas Inlet

The changes in geomorphology of the sea floor can be estimated by using an imaging sonar to measure the movement of ripples. Scientists analyzed sonar images collected in 2018 in the nearshore zone in Matanzas Inlet, Florida. They began using machine learning algorithms, such as convolutional neural networks, that can identify optimal regions of interest within an image for tracking ripples. The next step is to apply the Canny edge detection algorithm with open-source Python packages to identify ripples and automate the process of finding ripple dimensions and ripple migration.

Cross-Shore and Inlets Processes

Highlights of 2020

Understanding the exchange of water, sediment, and biological particles between the inner shelf and back-barrier estuaries is critical 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.

Project tasks include (1) leading the development of the Coupled Ocean-Atmosphere-Wave-Sediment Transport (COAWST) modeling system; (2) identifying regional locations where shoreline change is dominated by cross-shore sediment processes; (3) investigating the processes that create new inlets (breaching) and the dynamics that control inlet stability and closure; (4) investigating controls on the exchange of flows and material transport through inlets, specifically the interaction of waves with the vertical structure of the currents on the sediment transport into the bay, ebb shoal effects, and sediment bypassing; and (5) communicating project findings through publications and outreach and by providing access to data and model results via the Coastal Change Hazards Portal.

Coastal Model Application and Field Measurements

Highlights of 2020

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 analytical 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.

Analysis of Differences in Bay-Shelf Transfers in Great South Bay

Scientists used the COAWST modeling system to analyze differences in bay-shelf transfers in Great South Bay and adjacent bays along the south shore of Long Island, New York, during normal and extreme (for example, Hurricane Sandy) conditions. The results demonstrate the need to include wave-enhanced friction contributions and geomorphic changes in the prediction of bay dynamics and bay-shelf exchanges, especially during large storms. Properly characterizing these exchanges supports informed decision making in the prediction of coastal flooding, hazard response, and changes in bay water quality.

Improvements for Modeling Sediment Transport Within COAWST

Using COAWST, scientists have simulated the effects of Hurricanes Sandy and Matthew on barrier island breaching, dune erosion, and inundation along the coasts of Fire Island, New York, and Matanzas Inlet, Florida, respectively. COAWST was improved to account for sediment transport from different types of waves and to include land characteristics. These improvements allow for exploration of critical conditions controlling local-scale changes during extreme events. Methods are being applied to forecast coastal change in advance of storms at selected locations, in partnership with the National Park Service and other local agencies.

Eight Missions Flown Over the Outer Banks

WHCMSC scientists worked with USGS colleagues to fly eight missions over the Outer Banks of North Carolina to collect high-resolution images. The imagery was used to assess damage to North Core Banks from Hurricane Dorian, to develop model grids for simulating morphologic change, and to improve photogrammetric techniques. The results were presented at the Ocean Sciences Meeting 2020 and the Geological Society of America 2020 Annual Meeting.

Critical Information Provided to the National Park Service

Days after Hurricane Isaias made landfall, the USGS processed imagery collected at North Core Banks in Cape Lookout National Seashore, North Carolina, by the National Geodetic Survey of the National Oceanic and Atmospheric Administration (NOAA). The topography of the affected coastline was compared with the topography before the storm and provided critical information to the National Park Service before assessment teams could be deployed on the ground.

Structure-From-Motion Imagery Entirely in the Cloud

A new workflow for processing structure-from-motion imagery entirely in the cloud was successfully demonstrated with NOAA emergency response imagery from Hurricane Laura. Images of the Chandeleur Islands in Louisiana were processed, and difference maps were generated in the USGS Cloud Hosted Solutions environment less than 12 hours after NOAA released the photos. Similar products were derived from the post-Hurricane Sally imagery of Gulf Islands National Seashore in Florida and Mississippi and delivered to the National Park Service as overlays suitable for viewing in Google Earth and similar software.

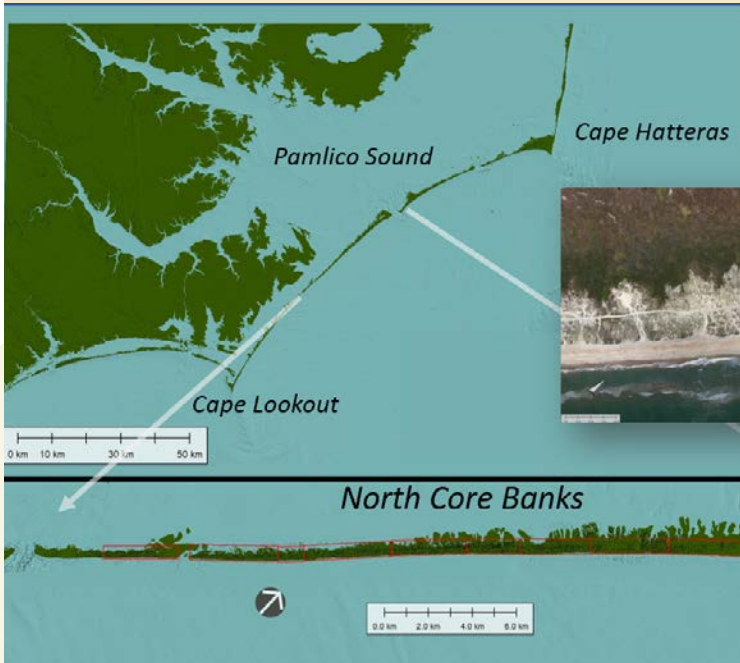
CoastCam Updates

The CoastCam network was shifted from a private cloud to the USGS Cloud Hosted Solutions network. Scientists translated image-rectification code—the code needed to convert oblique images to map views—from MATLAB to Python and completed proof-of-concept processing of CoastCam imagery on Cloud Hosted Solutions. Finally, scientists installed a meteorology station near a seal haulout about 1 kilometer north of the Head of the Meadow Beach parking lot in North Truro, Massachusetts. Data recorded at this station will eventually be streamed live on the web.

Remote Sensing Coastal Change

Highlights of 2020

The Remote Sensing Coastal Change project began in 2017 as a multicenter collaboration intended to advance USGS Coastal/Marine Hazards and Resources Program (CMHRP) applications of remote-sensing techniques to coastal change problems. The work at the WHCMSC has focused on rapid response to coastal events; advancing the capability to process imagery by using structure-from-motion photogrammetry (a technique that is used to create high-resolution digital models of surface elevation); developing USGS Cloud Hosted Solutions; and investigating the integration of machine learning into workflows. In past years, the focus was on processing imagery from unmanned aerial systems, but in 2020 the emphasis was on imagery obtained from light aircraft (an aircraft that has a maximum gross takeoff weight of 12,500 pounds).

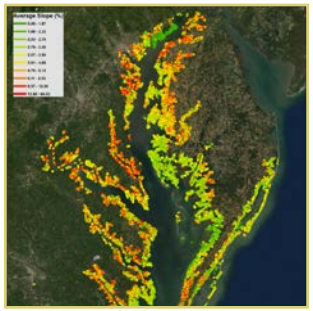


Estuarine Processes, Hazards, and Ecosystems

Highlights of 2020

Estuaries are dynamic environments where complex interactions between the atmosphere, ocean, watershed, ecosystems, and human infrastructure take place. They serve as valuable ecological habitat and provide numerous ecosystem services and recreational opportunities. However, they are modified by physical processes such as storms and sea-level rise, and effects of human activity such as nutrient loading threaten ecosystem function within estuaries. The Estuarine Processes, Hazards, and Ecosystems project collects basic observational data on these physical processes and anthropogenic effects, develops numerical models of these data, and applies models to understand the past, present, and future states of estuaries. Collaborative endeavors are led from the WHCMSC and include participation from other USGS offices, other Federal and State agencies, and academic institutions.

In 2020, the estuaries group participated in the National Aeronautics and Space Administration DEVELOP program and engaged with States and stakeholders such as the National Park Service, U.S. Fish and Wildlife Service, and the States of Massachusetts and New York. The group also published 12 peer-reviewed publications.



Assessment of the Chesapeake Bay Coastal System

Scientists worked towards an assessment of the vulnerability of the bay's coastal systems to coastal change, with a focus on marshes and submerged aquatic vegetation. They are assessing the current state of the coastal system through mapping and unvegetated to vegetated marsh ratio estimates and began evaluating the ability of bay marshes to migrate upland into adjacent forest in response to sea-level rise. The estuaries group worked to quantify the lateral vulnerability of the marshes to the action of waves and began conducting model simulations of hydrodynamics and vegetation conditions to determine the current health and predict the future evolution of the bay's seagrass beds.

Advanced COAWST Framework

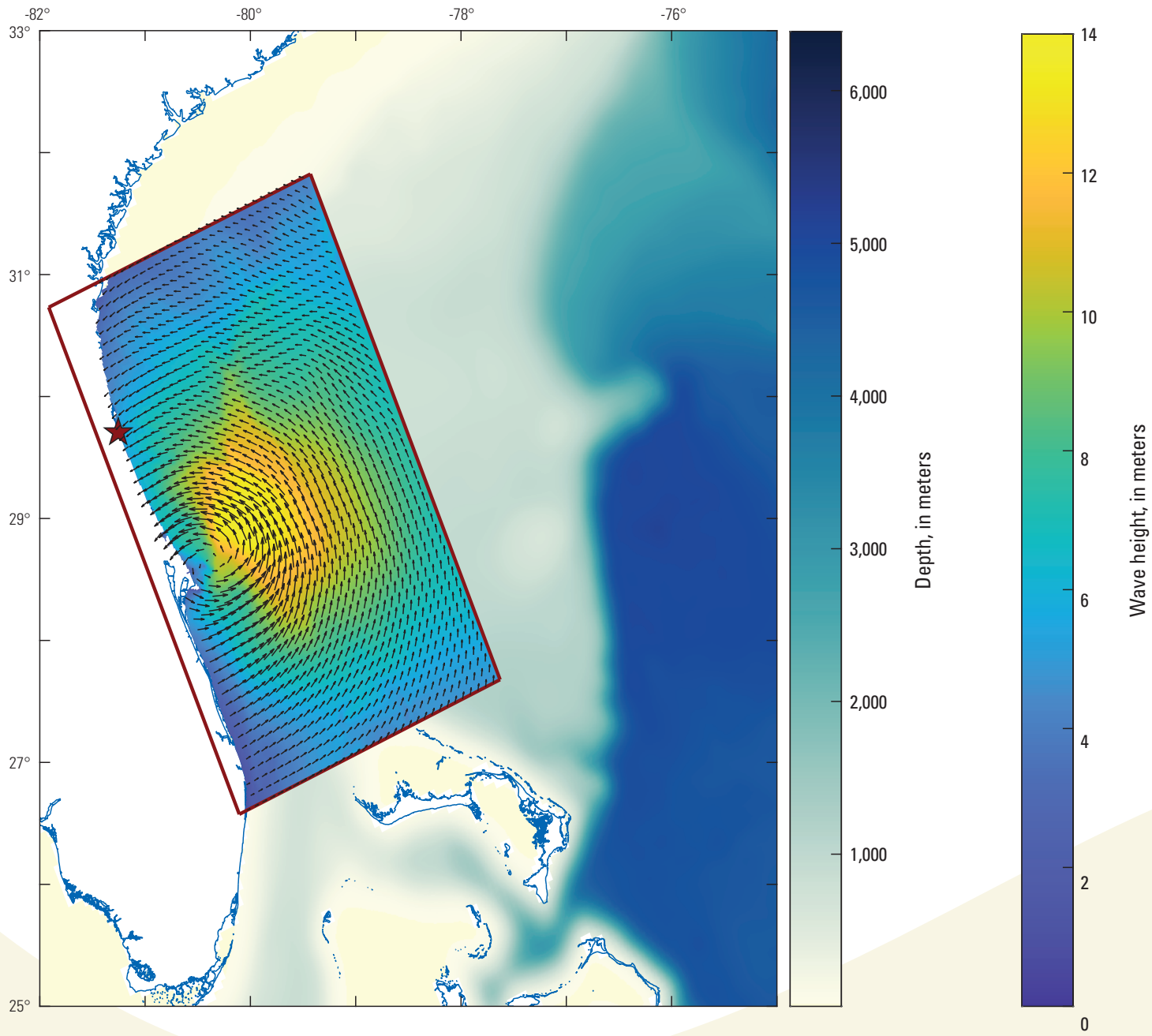
The estuaries group advanced the COAWST modeling framework to enable studying morphological evolution of salt marshes along the coast at temporal scales ranging from storms to decadal changes affected by sea-level rise. The group also implemented a method that accounts for vertical accumulation on the marsh platform to better represent marsh dynamics. A new seagrass growth model was developed and published.

Subterranean Estuary Dynamics

USGS scientists use scientifically oriented cave-diving techniques to deploy equipment developed to sample sharp chemical interfaces (reaction zones where important elemental transformations occur) within subterranean estuaries. In 2020, groundbreaking studies previously conducted along Caribbean coastlines were applied to the coastal aquifers beneath Florida's gulf coast in collaboration with the Woods Hole Oceanographic Institution.

Assessing Coastal Salt Marsh Potential To Survive Environmental Challenges

The ratio of open water to marsh vegetation—the unvegetated to vegetated marsh ratio, developed by WHCMSC scientists—is a robust metric of the state and trajectory of large areas of marsh and can help prioritize areas for conservation and restoration. The application of this metric has been completed or is ongoing at regional scales (for example, within national parks, wildlife refuges, Connecticut, Massachusetts, New York, and the Chesapeake Bay) and national scales. Numerous papers and data releases have resulted from this ongoing project.



Hurricane Matthew winds (arrows) and waves (colors) bearing down on the coast of Florida. Ocean depth is in the background. The red star indicates where a barrier island breach developed during the storm. This breach was modeled with the Coupled Ocean-Atmosphere-Wave-Sediment Transport (COAWST) system.

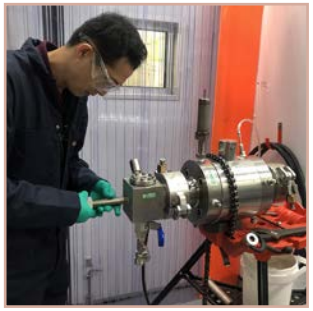
Energy and Geohazards

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 (ECS).

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. ECS. Further understanding of the resource potential of these vast areas in the Arctic, Atlantic, and Pacific Oceans can inform natural resource management and economic decision making.



Energy Resource Studies

Scientists started analyzing pressure cores retrieved from the northern Gulf of Mexico gas hydrates province during a U.S. Department of Energy-sponsored project in 2017. USGS researchers collaborated with various southern universities to conduct microbiological sampling from these pressure cores under high-pressure conditions. These studies provide clues about Earth's deep biosphere. Project scientists and engineers also designed new tools for analyzing pressure cores and acquired data on the reservoir properties of sediments that host gas hydrates offshore of India and Korea and completed an international multiyear collaboration focused on improving the predictive capability of models of gas hydrate reservoirs.

Global Gas Hydrates Database and Reviews of Natural Gas Hydrate Phenomena

For 30 years, the USGS Gas Hydrates Project has maintained a fully referenced database of locations where gas hydrate has been recovered or where geophysical data indicate that gas hydrate likely exists. In 2020, project scientists formally released a preliminary version of the database. The database has already been adapted by the Japanese national Methane Hydrate 21 Research Consortium project for use on Japanese- and English-language educational websites. The database release accompanied an invited Grand Challenge article written for the centennial celebration of the American Geophysical Union. The project also contributed to an international review of gas hydrates science for the United Kingdom's Royal Society of Chemistry.

U.S. Atlantic Margin Gas Hydrates

WHCMSC researchers publicly released the raw and processed seismic data from the Mid-Atlantic Resource Imaging Experiment (MATRIX). Project scientists also continued working with Woods Hole Oceanographic Institution staff on developing a new machine learning approach for identifying hydrate-related seismic features in the MATRIX data. The project began collaborating with the private sector to reprocess about 1,100 kilometers of late-1970s seismic data collected by WHMSC scientists on the southern New England margin. The goal of this research is to map gas hydrate indicators offshore of Long Island, New York, and the States of Connecticut, Rhode Island, and Massachusetts.

Gas Hydrates Project

Highlights of 2020

Naturally occurring gas hydrate is an ice-like combination of water and (usually) methane gas that forms in sediments below the sea floor and in areas of continuous permafrost when pressure and temperature conditions are appropriate. Gas hydrate is estimated to trap about one-sixth of the methane in the global system. The USGS Gas Hydrates Project includes scientists at the WHCMSC, the Pacific Coastal and Marine Science Center in Santa Cruz, California, the USGS Earthquake Science Center in Menlo Park, California, and the USGS Central Energy Resources Science Center in Denver, Colorado. Project scientists study the resource potential, global climate interactions, and geohazard implications of natural gas hydrates.

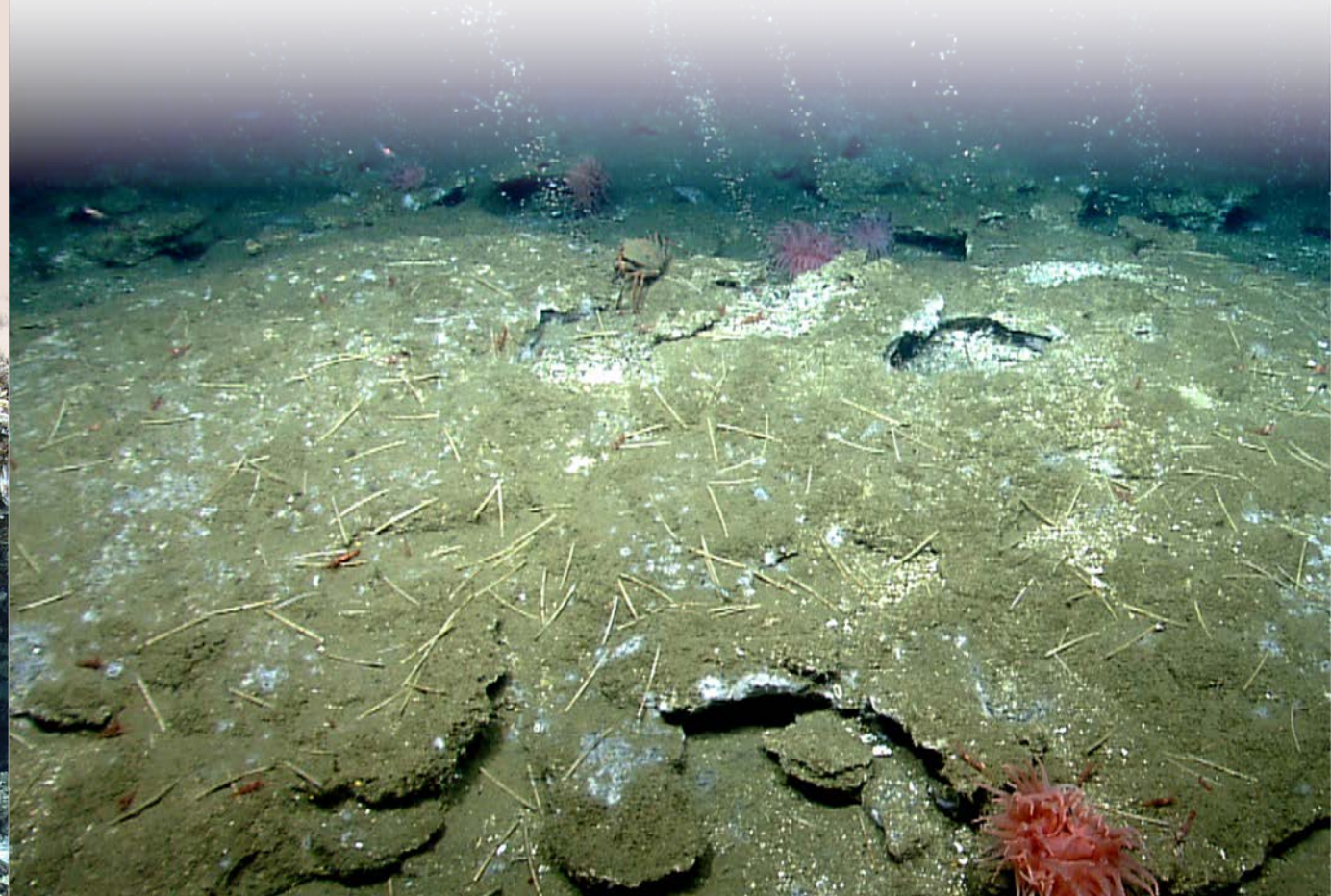
Biogeochemistry and Environmental Feedback of Gas Hydrate Systems

Highlights of 2020

USGS Gas Hydrates Project scientists address questions related to the production and fate of methane in evaluating the resource potential of gas hydrate and the environmental effects of methane released from the sea floor. The key to capability advances has been the development of analytical methods that enable critical measurements that have been used in domestic and international collaborations. Some investigations were conducted in gas-hydrate-bearing systems, and others were performed in proxy locations for settings where gas hydrate has been implicated with sea-floor methane discharge.

Instrument Development to Support Field and Lab Studies

Scientists, technicians, and engineers affiliated with the USGS Gas Hydrates Project in Woods Hole developed new geochemical instrumentation that makes it possible to conduct certain complex analyses in a field setting instead of taking samples back to the laboratory. The full patent application for the discrete sample-introduction module, which has supported USGS Gas Hydrates Project programs in the North Sea, Artic Ocean, and Baltic Sea during its development phase, was completed in September 2020. Staff also began development of an automated sample-introduction module to permit unattended analyses of methane and carbon dioxide concentrations and stable carbon isotopes from as many as 16 gas samples. In addition, an automated pressure-core sampler is being developed to quantify gas volumes contained in hydrate-bearing sediments in pressure cores and analyze gas composition during benchtop experiments that simulate production of methane from gas hydrate during its breakdown. These new instruments are expected to be first deployed in support the Alaskan North Slope hydrates pressure-coring project.



Multichannel Seismic-Reflection Profile Data Collected Offshore of Southwestern Puerto Rico

The USGS conducted a rapid-response, high-resolution multichannel seismic survey within the epicenter of the southwestern Puerto Rico seismic sequence, which started in December 2019. WHCMSC scientists surveyed 250 line-kilometers aboard the University of Puerto Rico's research vessel *Sultana*. Numerous faults were identified within the survey area and may help to define focal mechanism for the magnitude 6.4 earthquake on January 7, 2020. This research effort required assessments on site by USGS staff prior to the cruise to gauge earthquake damage and the feasibility of carrying out the study given the complicated logistics associated with seismic activity in the region.

Landmark 500th Volume of the Geological Society's Special Publication Series

A scientist working within the Marine Geohazards Sources and Probability project served as an editor and contributing author for the landmark 500th volume of the Geological Society of London's special publications series. This special volume focuses on underwater or subaqueous landslides with the overarching goal of understanding how they affect society and the environment. Geographically it covers almost the entire world and includes diverse geological settings, such as lakes, fjords, volcanic islands, and passive and active margins. The papers within this volume represent the latest results in underwater landslide research.

Deep SEARCH Sample and Data Analysis

DEEP SEARCH is a multiagency (USGS, Bureau of Ocean Energy Management, and the National Oceanic and Atmospheric Administration [NOAA]), multiyear interdisciplinary study of little-known deep-sea ecosystems of the U.S. mid- and south Atlantic. The DEEP SEARCH team finished 3 years of field work in late 2019. Overall, the team collected and processed more than 2,800 biological and geological samples from the sea floor and water column. In 2020, researchers from USGS and the other participating agencies began analyzing the samples and corresponding data. A final report detailing the study's findings and conclusions is expected in the coming years.

Marine Geohazards Sources and Probability

Highlights of 2020

The Marine Geohazards Sources and Probability 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;
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.

Extended Continental Shelf Project

Highlights of 2020

The USGS Extended Continental Shelf (ECS) Project supports the U.S. Department of State in delineating the outer limits of the U.S. ECS. The ECS is the region beyond 200 nautical miles from shore where coastal States (that is, nations) can exert their sovereign rights to explore, manage, or conserve 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, NOAA, and the U.S. Department of the Interior) provide guidance to the project for priorities in boundary delineation. The project is currently in the final 2 years of phase 3, in which the past two decades of data collection are being synthesized into documentation of proposed U.S. ECS outer limits.

There are seven core regions for which full documentation is underway. For five of these regions, the documentation includes major geologic contributions to the geologic framework (Arctic, Atlantic, Bering, Eastern Gulf of Mexico, and Marianas). The USGS also contributes to documentation for the other two regions, where the geologic framework and surficial geology analysis are the focus (Pacific/Mendocino and Western Gulf of Mexico). The USGS contributes to developing the documentation for noncore regions, for which documentation is underway for submissions to the United Nations Convention on the Law of the Sea that might be developed in the future (Hawai‘i, Gulf of Alaska, alternative Pacific/Mendocino, and Marianas-West).

Arctic Extended Continental Shelf

The USGS received the updated processing of about 15,000 kilometers of multichannel seismic data from the Geological Survey of Canada and loaded these data into a software package that generated seismic-interpretation imagery. Images from these data were incorporated into figures in the revised Arctic submission document to clarify basement (the interface between the top of the oceanic crust and the base of the sediment) in areas of thick sediment. The USGS Law of the Sea Artic submission document was reviewed by four former or current commissioners of the Commission on the Limits of the Continental Shelf and was revised according to their comments. The Arctic document may be further modified pending ongoing outer-limit delineation by other Arctic coastal States.

Atlantic Extended Continental Shelf

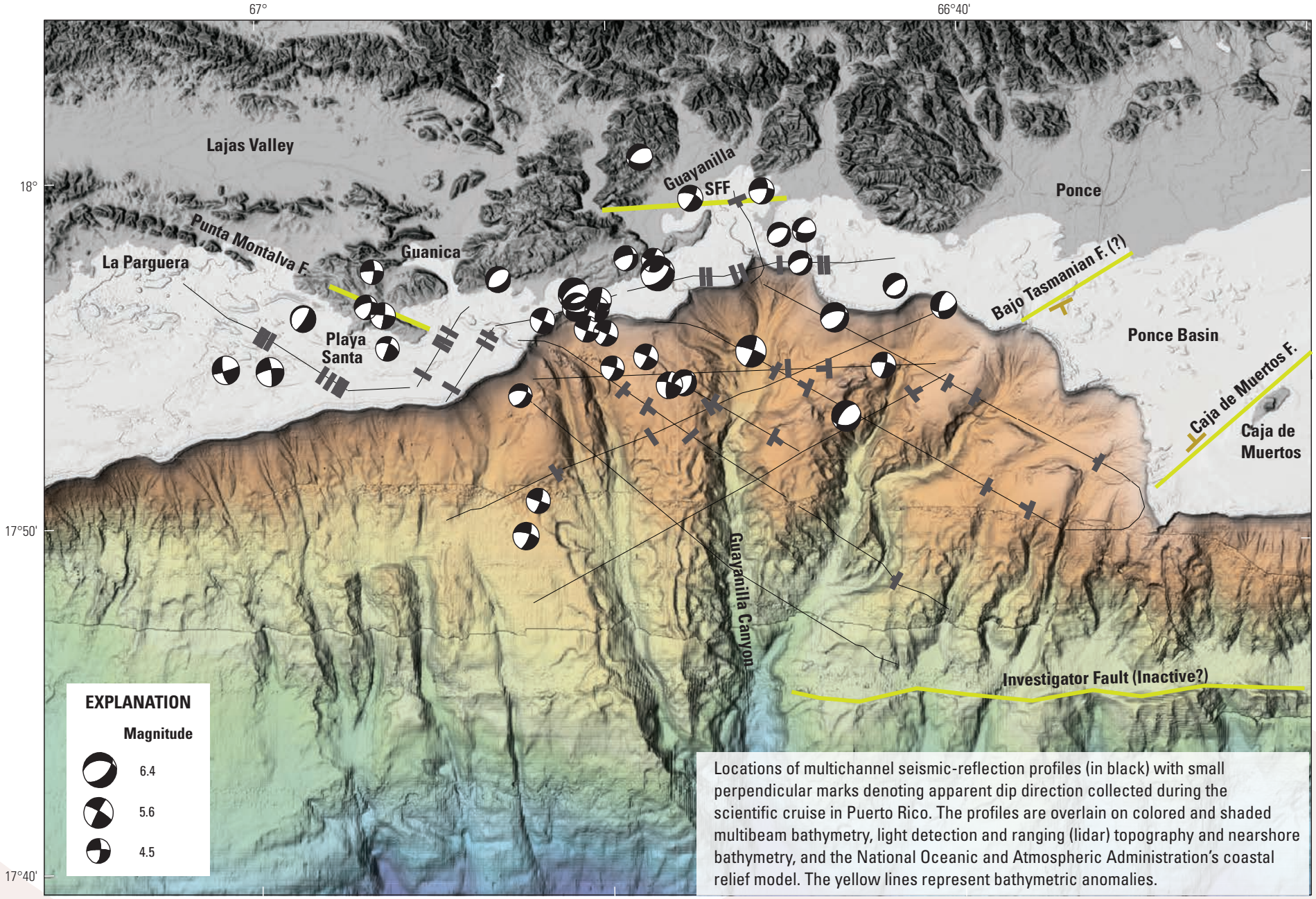
For the USGS Law of the Sea Atlantic submission, scientists at the center developed scripts and quality control processes for testing the accuracy of depth conversion of the seismic interpretations of the data collected in 2014 and 2015 and developed a methodology for using velocity data from these two Atlantic field programs to convert legacy seismic data to depth. The geologic framework of surficial processes was further refined to support ECS studies.

Eastern and Western Gulf of Mexico Extended Continental Shelf

The USGS Law of the Sea submission documents for the eastern and western Gulf of Mexico both proceeded through final layout, design, and creation in Portable Document Format (PDF). The USGS is involved in developing seismic data and metadata for part 3 of the eastern Gulf of Mexico submission, which can be used as a template for the other regions.

Other Project Activities

A new project annex agreement was negotiated with the Geological Survey of Canada regarding ECS field work, publications, and data sharing. The project annex extends the cooperation through 2030. Also, ECS studies are being recognized as part of the National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone, formally adopted by the White House in late 2020. The annual project review meeting was held remotely in June 2020 and included external reviewers from Japan, France, Chile, and Canada. The USGS annual report on the status of studies using ECS physical samples was completed.



Locations of multichannel seismic-reflection profiles (in black) with small perpendicular marks denoting apparent dip direction collected during the scientific cruise in Puerto Rico. The profiles are overlain on colored and shaded multibeam bathymetry, light detection and ranging (lidar) topography and nearshore bathymetry, and the National Oceanic and Atmospheric Administration's coastal relief model. The yellow lines represent bathymetric anomalies.

Environmental Geoscience

Our coasts include a range of environments that provide essential habitat for a variety of plants and animals. From wetlands to estuaries to coastal margins, these ecosystems deliver critical benefits and services to society. Research by the Environmental Geosciences group at the WHCMSC is focused on key ecosystem functions and drivers of ecosystem change. Knowledge gained through fieldwork and sample analysis 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 data, products, and decision support to Federal, State, and local organizations and individuals tasked with managing these vital ecosystems for future resilience. The Core Laboratories Project at the WHCMSC provides the analytical and technical infrastructure necessary to accomplish project objectives.

Guidance for Commonwealth of Massachusetts

The Environmental Geosciences group participated in the New England Blue Carbon Working Group, which provides the scientific foundation for the Blue Carbon Initiative by synthesizing current and emerging science on blue carbon and by providing a robust scientific basis for coastal carbon conservation, management, and assessment.

Continental United States and State-Level Mapping and Modeling

The Environmental Geosciences group began mapping managed wetlands and modeling climate impacts to wetlands of the continental United States and innovating methods for mapping human-built structures in the intertidal and coastal zone on a State level.

Data and Models for Herring River Estuary Restoration

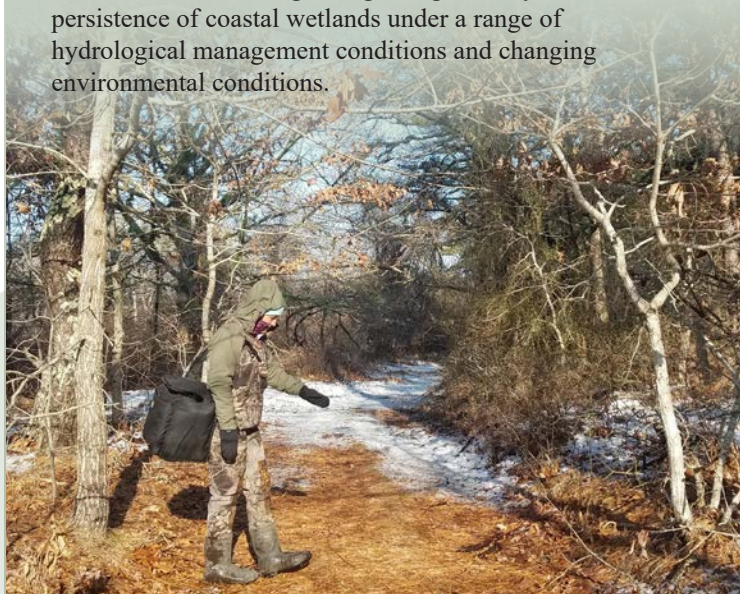
The Cape Cod National Seashore is progressing with restoration of the Herring River estuary in Massachusetts and will implement an adaptive management approach to restore hydrology incrementally while maximizing ecosystem and environmental benefits and minimizing negative economic and social effects. The USGS is providing data and models that predict how the diked landscape will respond to sea-level rise, how rapidly the landscape will change, and how these changes will either enhance or reduce ecosystem benefits. This summer, new field measurements were conducted to understand the production of methane within the wetland subsurface and associated methane fluxes out of the wetland. An eddy covariance tower is measuring methane and carbon dioxide fluxes very rapidly over a large marsh area. Samples collected throughout the year will provide the data needed to determine environmental drivers of methane production and flux in wetland systems.

Biogeochemical Drivers of Wetland Persistence and Feedbacks on Coastal Hazards

Highlights of 2020

Tidal wetlands provide critical services to society, including protection of infrastructure from coastal hazards and protection of 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. 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.

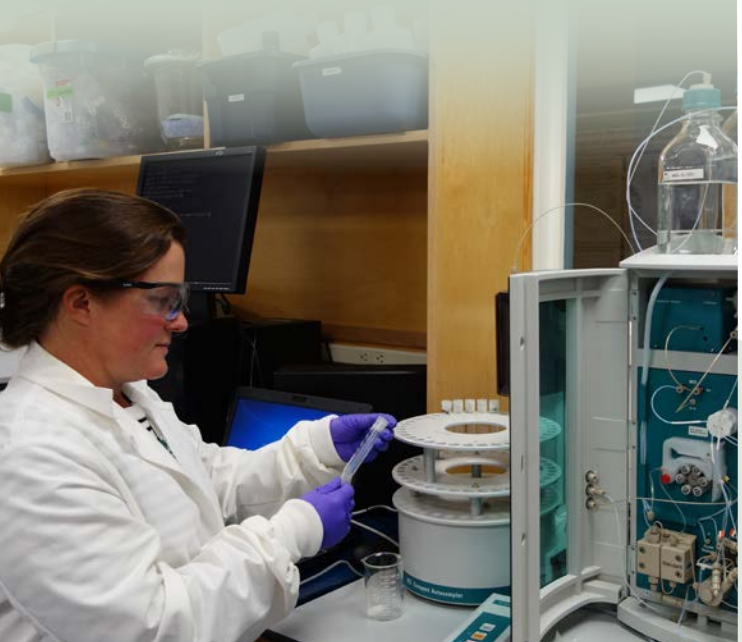


Analytical Laboratories

Highlights of 2020

The Core Laboratories Project is a research support service of the 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.

The Geochemistry Lab provides high-quality geochemical data through processing and analyses of groundwater, surface water, sediment, and gas samples for a wide array of dissolved nutrients, carbon, age (determined by radiochemical dating), and stable isotopes. The Sediment Lab supports a range of projects at the WHCMSC by providing data derived from grain size, mineralogy, suspended sediment, and sedimentary character analyses.

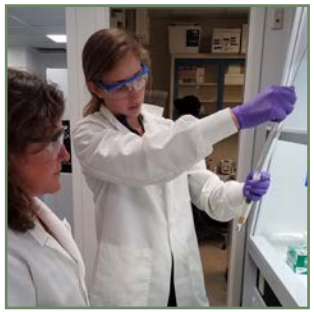


Geochemistry Lab: Project Support

The Geochemistry Lab continued to provide analyses in support of the Herring River Restoration project, the Great Barnstable Marsh project, and the Diked and Restricted Wetlands project. Carbon content of marsh sediments was measured to observe the effects of historical management actions on carbon storage dynamics and sustainability. Pore-water samples from these marshes were measured for dissolved carbon species, as well as methane and sulfide, to improve understanding of carbon cycling dynamics in affected wetlands.

Sediment Lab: Project Support

The Sediment Lab provided analytical data to the following projects, as well as to collaborators in the USGS Water Resources Mission Area: Massachusetts Integrated Coastal Studies; Estuarine Processes, Hazards, and Ecosystems; Office of Naval Research New England Mud Patch; Atlantic and Gulf of Mexico Submarine Landslides-Tsunami Hazards Project; and National Oceanic and Atmospheric Administration (NOAA)/USGS/Bureau of Ocean Energy Management DEEP SEARCH. The laboratory continued to expand and improve its facilities and analytical capabilities to support research at the center and throughout the USGS. New capabilities and methods are continually researched and incorporated into the laboratory.



Quality Management System (QMS) Pilot Implementation Project

The Sediment and Geochemistry Labs completed the QMS Pilot Implementation project by providing a hands-on peer review of the QMS requirements outlined for the Ecosystems, Natural Hazards, and Water Resources Mission Areas. The results and input from these laboratories, along with participating laboratories from across the USGS, contributed to the final rollout of the Bureau-wide QMS policies.

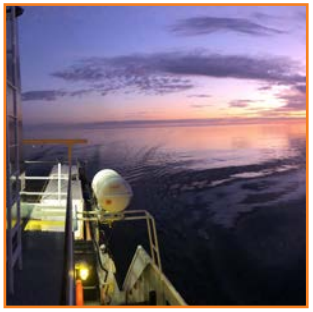
Woods Hole Oceanographic Institution/Massachusetts Institute of Technology Ph.D. student Sheron Luk analyses sediment carbon on an elemental analyzer.

Sea-Floor Mapping

The Sea Floor Mapping Group provides support for nearly every project at the center and works closely with the other two Coastal/Marine Hazards and Resources Program (CMHRP) science centers in St. Petersburg, Florida, and Santa Cruz, California. Working across diverse environments, the 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

Delmarva Regional Study

The study used seismic data collected by the USGS on the continental shelf of the Delmarva Peninsula (consisting of parts of Delaware, Maryland, and Virginia) and data collected in the Maryland Wind Energy Area to define the region's geologic framework. These results lay the groundwork for better understanding of Quaternary evolution and coastal vulnerability while delineating potential sediment resources (such as sand) and hazards to development (such as paleochannels). The project published a new article in "Marine Geology."



Massachusetts Sea-Floor Mapping Project

The Commonwealth of Massachusetts used the 2,940 square kilometers of sea-floor mapping data acquired by the Sea Floor Mapping Group between the State's borders with New Hampshire and Rhode Island to review the Massachusetts Ocean Management Plan, while the National Oceanic and Atmospheric Administration (NOAA) used the data to update the Nation's navigation charts.

New Jersey Coastal Evolution

The Sea Floor Mapping Group processed data from the previous year's mapping of the inner continental shelf in areas adjacent to Little Egg Inlet and the Edwin B. Forsythe National Wildlife Refuge in New Jersey. The high-resolution geophysical data will be used to create new maps of the geology and sediment distribution and to develop probabilistic models of the vulnerability of the system to storms, sea-level rise, and human activities on timescales relevant to resource managers (annual to decadal). The group also continued to coordinate with the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, New Jersey Department of Environmental Protection, and Stockton University by providing scientific information and consultation on a range of coastal hazards issues in the region.

Lake Superior Stamp Sands

The Sea Floor Mapping Group published high-resolution mapping data collected in 2018 to determine the distribution and thickness of historical mine tailings on the bottom of the lake. These data will be compiled with existing lidar, video, and sample data from other sources to produce geologic maps of the area, with a focus on deposits of stamp sands. The group continues to build on existing partnerships and is working closely with USGS colleagues at the Great Lakes Science Center to develop new methods to track the migration of mine tailings across the floor of Lake Superior.

Geologic Mapping: Links to Coastal Vulnerability and Hazards

Highlights of 2020

The objectives of the geologic mapping project are to characterize a region's resources and potential coastal hazards through understanding of the region's geologic framework. This work provides baseline datasets and derivative interpretive maps that offer a geospatial basis for scientific research and provide critical information to planners and decision makers who oversee the management of resources and mitigation of hazards in the coastal ocean. Also, 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 Delmarva regional study; (2) completing the Massachusetts sea-floor mapping project and preparing for the next phase (Massachusetts Integrated Coastal Studies); (3) a study offshore the Edwin B. Forsythe National Wildlife Refuge in New Jersey; and (4) Lake Superior stamp sands work.

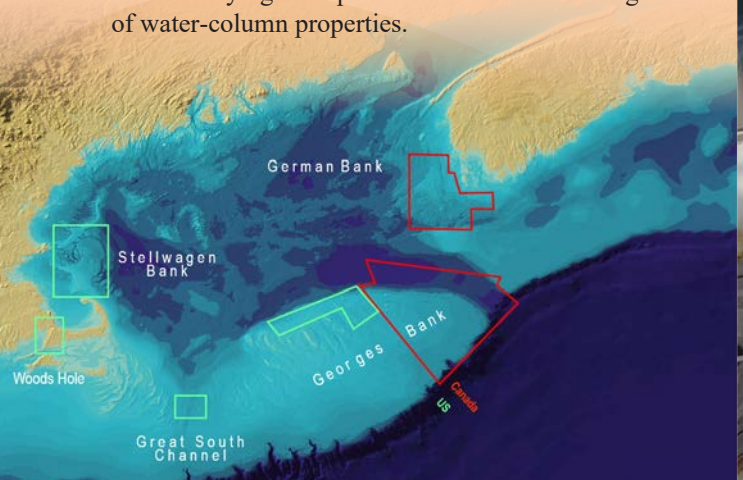
National Sea-Floor Mapping and Habitat Studies

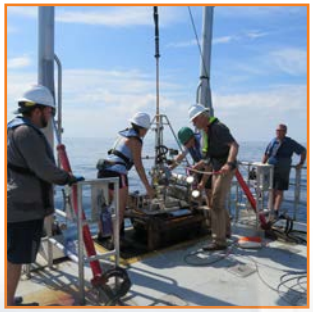
Highlights of 2020

The National Sea-Floor Mapping and Habitat Studies—Atlantic project has two objectives: to produce high-resolution geologic substrate maps of the seabed and to collaborate with NOAA and academic scientists to better understand the role geologic substrates play in determining the distribution and ecology of fishery species.

This project produces a series of online interpretive maps that show the distribution of geologic seabed substrates and processes in the Stellwagen Bank 20 miles offshore from Boston, Massachusetts, at a scale of 1:25,000. The maps serve as the template for a new approach to seabed mapping.

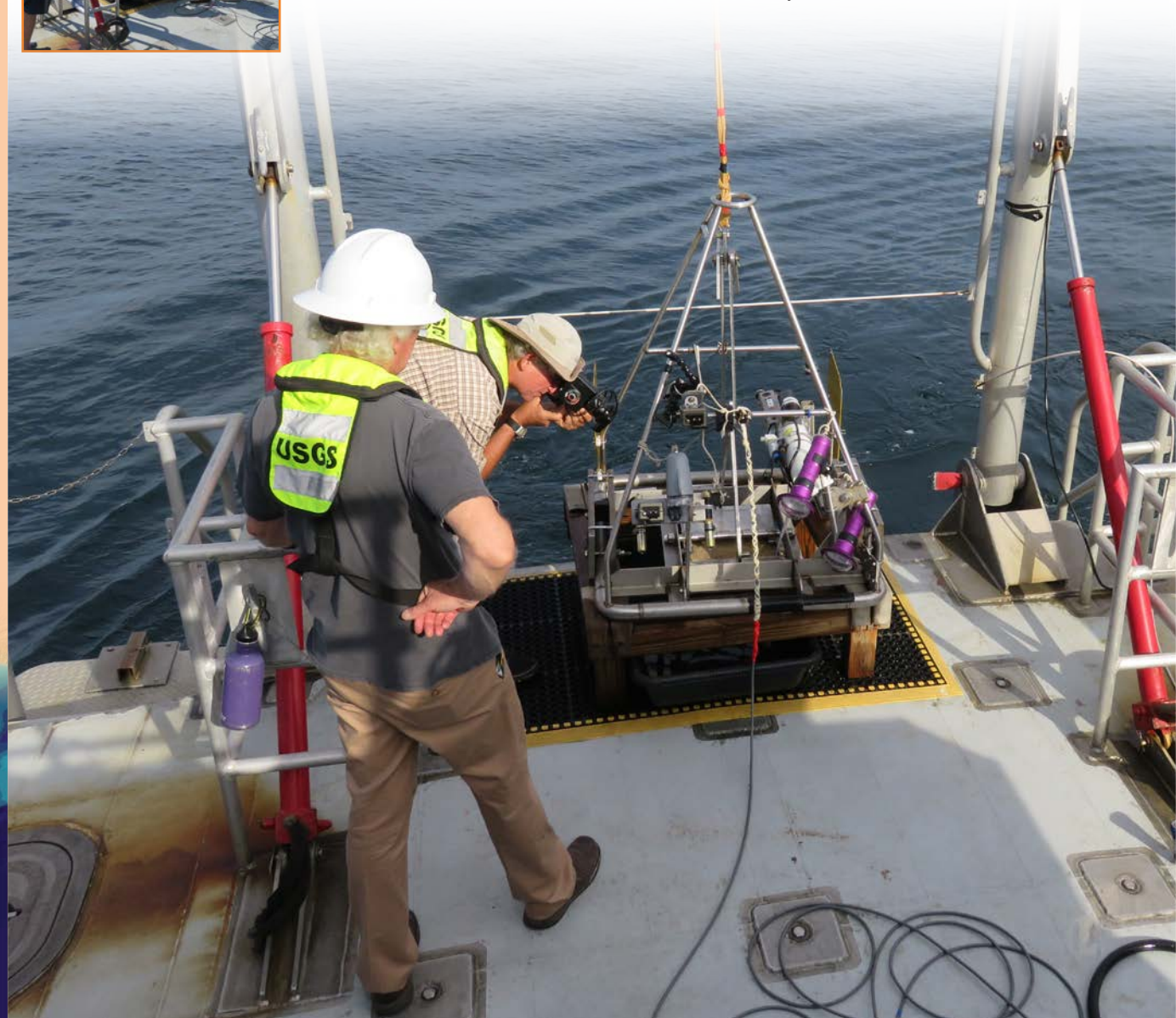
The maps provide a framework for scientific research in the region and for managing fishery resources and infrastructure. Stellwagen Bank is the principal habitat in the eastern Gulf of Maine for sand lance, a schooling fish that is the primary food resource for marine mammals, seabirds, and most of the bank's commercial fishery species—including cod, haddock, and tuna. Geologic substrate mapping can help 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.





Sampling Survey in Stellwagen Bank National Marine Sanctuary

In September 2020, the Sea Floor Mapping Group, working with other center staff, conducted a Seabed Observation and Sampling System (SEABOSS) survey in collaboration with NOAA and the Stellwagen Bank National Marine Sanctuary to acquire sea-floor samples, bottom video, and photographs within the sanctuary offshore of Massachusetts. This is part of a long-term sampling effort to map the seasonal distribution of sand lance within the sanctuary.



Wayne Baldwin and Eric Moore deploying a multichannel seismic streamer in Puerto Rico from the research vessel *Sultana* in March 2020.

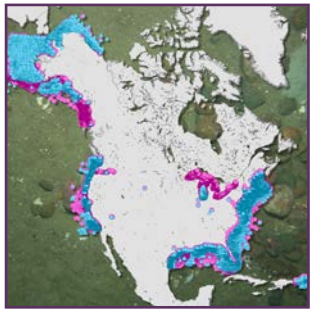
Information Science

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.

Additionally, members of this group produce physical and electronic information products, manage social media accounts, highlight research efforts by writing articles and social media posts, organize and participate in outreach activities, and maintain the center's web presence.

Improvements to Compass, the CMHRP Internal Data System

Compass maintains records and provides reports about CMHRP field activities, enables discovery of unpublished data via geographic or thematic queries, links publications to field activities, and allows users to develop and share data management plans for their project. Programmers on the Compass team made strides toward unifying the Compass code base and decreasing use of previous versions to create a more streamlined system. Transition to this new system has been facilitated by the data managers on the team, who improved the completeness, clarity, and consistency of the information contained in Compass. In addition to improving the quality of database products, this more consistent system can more easily integrate new field activities. Also, analysis of the problems detected in older records is guiding the team to further improve workflow and the forms used to collect data for planned research cruises or field activities.



Publications About the usSEABED Integrated Sea-Floor-Characterization Database

usSEABED is the collaborative product of the USGS, the University of Colorado, and other partners and provides integrated data from small and large marine research efforts by many entities—Federal and State agencies, local authorities, universities, and private and public consortiums. Data derived from the usSEABED database that were previously released as three USGS data series publications, which covered the U.S. Atlantic margin, the Gulf of Mexico and Caribbean regions, and the Pacific coast, were collected into a single USGS data release. In 2020, a data release was published that unifies the three publications and incorporates additional data and sources, including data from Alaska, Hawai‘i, and U.S. overseas territories, and provides revised output files that fix known errors and add known or inferred sampling dates. A report accompanies the data release and contains information on the methodology and products of the usSEABED database.

Data Management and Preservation

Highlights of 2020

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. Well-documented data that are easily accessed may be integrated readily into a new project or dataset.

Best practices of data management attempt to define, document, and use consistent standards and procedures. The goal is to provide the information resources needed for efficient program operations. Staff at the WHCMSC and the other Coastal/Marine Hazards and Resources Program (CMHRP) centers collaborate to provide consistency within data management activities.

Diversity, Equity, and Inclusion in Woods Hole

At the WHCMSC, we are committed to improving diverse representation and equity in science. We invest time and resources to identify and address blind spots and build an inclusive culture, and we strive to continually improve. Addressing systemic racism, microaggressions, and attitudes of apathy, skepticism, and resignation within the science community toward such efforts is crucial to the future vitality and viability of the USGS as an earth science agency serving the Nation.

The WHCMSC has long promoted diversity, equity, and inclusion in its many forms. In 2004, the six Woods Hole science institutions formed the Woods Hole Diversity Initiative and committed to attracting and retaining a more diverse workforce. The Woods Hole Diversity Initiative in turn established the Woods Hole Diversity Advisory Committee, made up of representatives from each organization, to recommend how the institutions can make the village of Woods Hole more diverse and inclusive. The committee plans events for Black History Month and Juneteenth, hosts community discussions, supports Gays, Lesbians, and Others in Woods Hole events, and much more.

In 2009, the Woods Hole Diversity Initiative started the Partnership Education Program (PEP)—a 10-week residential program primarily for college juniors and seniors from groups underrepresented in the marine and coastal sciences who want to gain practical, scientific experience. Additionally, our center started a partnership program with the City College of New York and the University of Puerto Rico in 2005 to place student interns at USGS centers across the country. The center also participates in the Secondary Transition to Employment Program-USGS Partnership (STEP–UP). Through this partnership, the USGS collaborates with school districts and other educational institutions to provide training experiences to students with disabilities.

In 2020, several WHCMSC staff members volunteered to represent the USGS Peer Support Worker program at our center. The center's Peer Support Workers worked with our staff to identify the highest priority training needs in topics such as unconscious bias, microaggressions, and bystander interventions.

2020 Diversity Activity Highlights

Overcoming Bias Seminar

The center's Peer Support Workers organized a 2-hour seminar on overcoming bias presented by Dr. Bruce Stewart, founder and chief executive officer of Small World Solutions, to learn more about the power of inclusive intelligence and culture. Dr. Stewart designed the seminar to provide strategies and structures for individuals, teams, and organizations to overcome the negative effect of unconscious biases.

National Hazards Mission Area Social Justice Lecture Series

Using hazards as a focal point, this series of five 60-minute seminars convened USGS staff interested in hazards and risk with experts whose research stands at the intersection of race and disasters for a set of structured discussions on race and social justice. Rob Thieler, Center Director of the WHCMSC, participated in a panel discussion and provided examples of USGS diversity activities.

Events Arranged by the Woods Hole Diversity Advisory Committee

The Woods Hole Diversity Advisory Committee organized numerous events in 2020. This year's theme for Black History Month was "African Americans and the vote." To celebrate, the committee organized a series of events, including a lecture by Dr. Daniel Black (professor of African American Studies, Clark Atlanta University; founder, Ndugu and Nzinga Rites of Passage Nation), titled "The Cost of the Vote," and a live performance by Cape Cod African Dance and Drum. Social justice educator Dr. Donique McIntosh, a social justice and diversity consultant, minister, and educator, gave a virtual lecture, titled "Freedom-Seeking," in celebration of Juneteenth. Nigel Golden (PhD Candidate at the University of Massachusetts Amherst; PEP alumnus, 2012) delivered the Ambrose Jearld, Jr., lecture, titled "Reducing Harm: A Politic to Address Institutional and Cultural Practices that Reduce Participation and Retention in STEM." Every summer, the lecture is given by an invited speaker on a topic related to diversity and inclusion.

2020 Summer Student Mentorships

Each summer, scientists at the center mentor students through programs such as the Woods Hole Oceanographic Institution (WHOI) Summer Student Fellowship (SSF), the Woods Hole Partnership Education Program (PEP), the City College of New York (CCNY)/City University of New York partnership, and the USGS/Ecological Society of America (ESA) Cooperative Summer Internship Program. Through these mentorship programs, students gain experience, advance skills, and interact socially and scientifically with their cohorts and the Woods Hole community. In the summer of 2020, owing to the global pandemic, these programs operated in a virtual capacity. The students worked at home, amidst their family members, using the equipment and software provided by their respective programs, and their Woods Hole mentors strived to provide them with a valuable experience, despite the distance and unique circumstances. Thanks to the creativity and dedication of these various internship programs and mentors, students across the country were still able to gain skills and experience valuable to advancing their education and their journeys to becoming scientists.

Tanjima Alam (CCNY)

- Research Mentor: Debbie Hutchinson
- Title: Sedimentary velocities and depth conversion of seismic reflection data from the deep-water Atlantic margin

Jose Cabral (PEP)

- Research Mentor: Chris Sherwood
- Title: Tracking the Nearshore Sandbar Morphology using Photogrammetry at Head of the Meadow Beach, Massachusetts

Hector Dominguez (PEP)

- Research Mentor: Meagan Eagle and co-adviser Kevin Kroeger
- Title: Nitrogen Cycling in groundwater mixing zones affected by topography and population density in Long Island, New York

Stephen Galindo (PEP)

- Research Mentor: Meagan Eagle
- Title: Nitrogen Cycling in the Yucatan Karst Subterranean Estuary

Sophie Kuhl (WHOI SSF)

- Research Mentor: Meagan Eagle and co-adviser Kevin Kroeger
- Title: Tidal Exports of Dissolved Organic Carbon from a Coastal Salt Marsh Complex

Jialin Li (WHOI SSF)

- Research Mentor: Chris Sherwood
- Title: Spatial and Temporal Nearshore Bar Dynamics Associated with White Shark Habitat

Liana Stachowicz (USGS/ESA program)

- Research Mentor: Meagan Eagle and co-advisor Sydney Nick
- Title: Mapping Managed Wetlands across the Contiguous U.S.

2020 Publications

Journal Articles (30)

Brankovits, D., and Pohlman, J.W., 2020, Methane oxidation dynamics in a karst subterranean estuary: Geochimica et Cosmochimica Acta, v. 277, p. 320–333, https://doi.org/10.1016/j.gca.2020.03.007.

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Data Releases (24)

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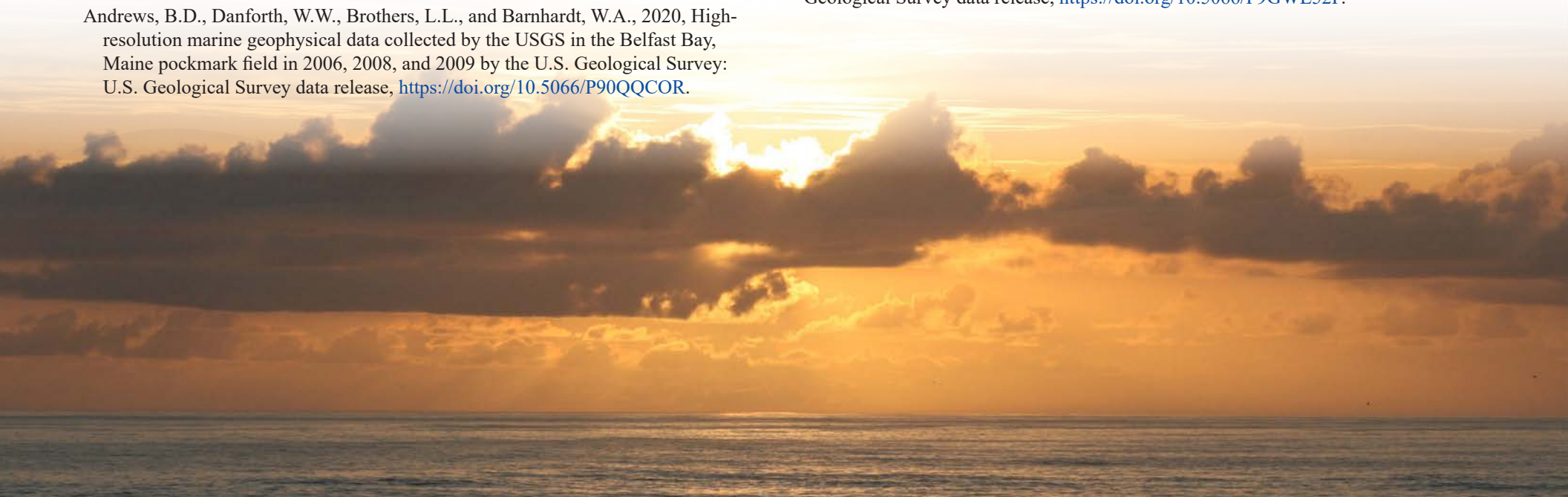

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Blog Posts (2)

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Book Chapters (2)

Mountjoy, J.J., Georgiopoulou, A., Chaytor, J., Clare, M.A., Gamboa, D., and Moernaut, J., 2020, Subaqueous mass movements in the context of observations of contemporary slope failure, *in* Georgiopoulou, A., Amy, L.A., Benetti, S., Chaytor, J.D., Clare, M.A., Gamboa, D., Haughton, P.D.W., Moernaut, J., and Mountjoy, J.J., eds., Subaqueous mass movements and their consequences—Advances in process understanding, monitoring and hazard assessments: London, The Geological Society, Special Publication 500, p. 1–12, https://doi.org/10.1144/SP500-2019-237.

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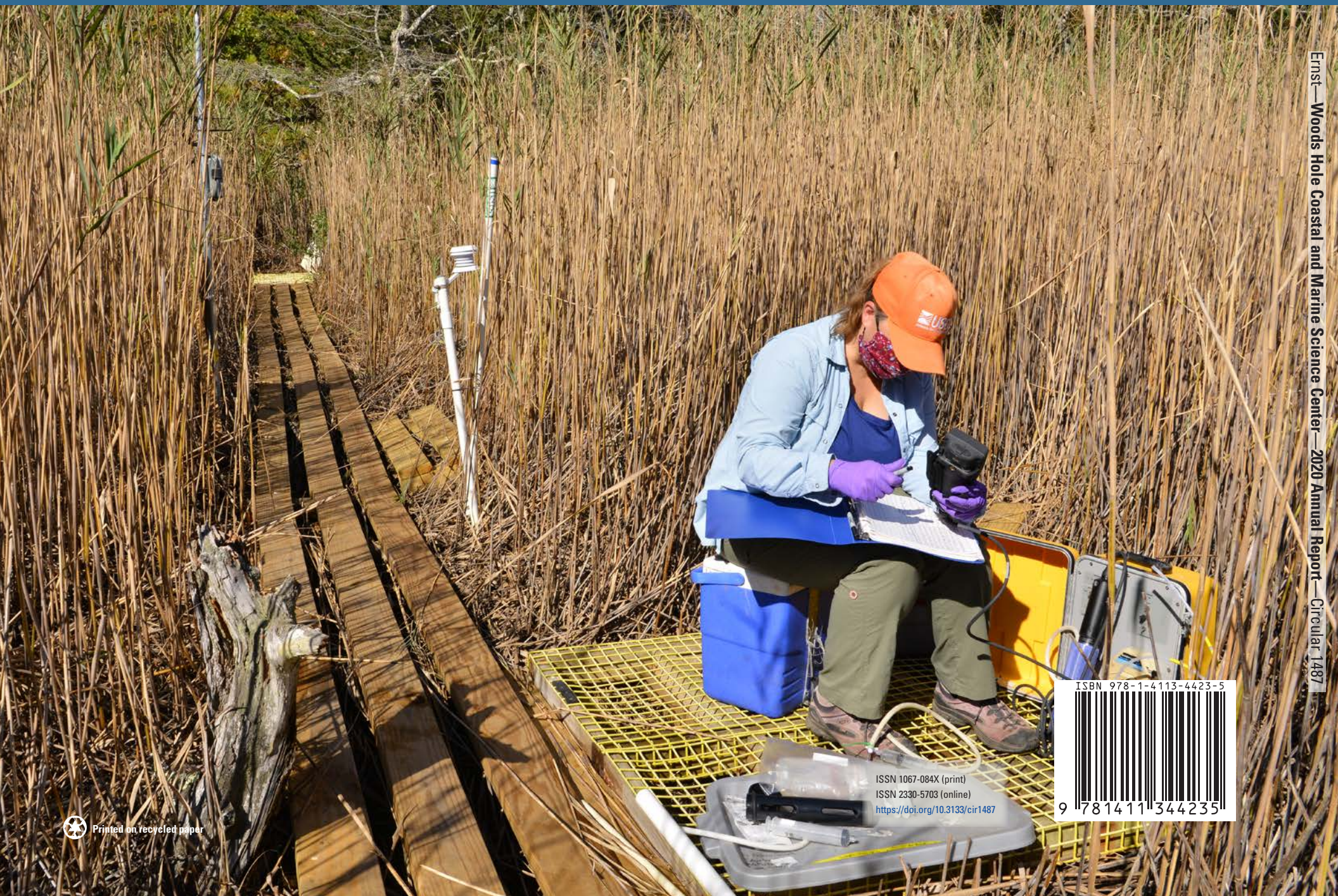
All photographs by the U.S. Geological Survey unless otherwise indicated.

Page number	Photograph credit	Photograph caption
15	Jennifer Glass, Georgia Institute of Technology	Dr. Junbong Jang, a geotechnical engineer, adjusts pressure core analysis instrumentation used to study hydrate-bearing sediments maintained at high pressures.
15	National Oceanic and Atmospheric Administration's (NOAA's) Office of Ocean Exploration and Research.	Gas hydrate (orange material) and gas bubbles near the sea floor in the northern Gulf of Mexico. Photograph obtained by remotely operated vehicle.
16	NOAA's Office of Ocean Exploration and Research	Icelike gas hydrates under capping rock encrusted with mussels on the sea floor of the northern Gulf of Mexico. Photograph obtained by remotely operated vehicle.
17	Courtesy of Eric Cordes, Temple University/NOAA/ROV Jason/2019, copyright Woods Hole Oceanographic Institution	Walls of Pamlico Canyon covered in brinsingid starfish, cup corals, and a diversity of other corals.
22	Sheron Luk, Woods Hole Oceanographic Institution/Massachusetts Institute of Technology	Adrian Mann, lab manager, analyzes pore water samples on an ion chromatograph.
24	NOAA's Office of Ocean Exploration and Research	Methane-derived authigenic carbonate rocks on the sea floor on the U.S. Atlantic margin.

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



Ernst—Woods Hole Coastal and Marine Science Center—2020 Annual Report—Circular 1487

ISBN 978-1-4113-4423-5

ISSN 1067-084X (print)
ISSN 2330-5703 (online)
https://doi.org/10.3133/cir1487

Printed on recycled paper