



Coastal and Marine Science of the **U.S. Geological Survey**

in Woods Hole, Massachusetts

General Information Product 191

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

“*The preservation and health of the Nation’s coastal and marine environments depend on well-informed management of risks posed by natural hazards and on the conservation and sustainable use of natural resources. The Woods Hole Coastal and Marine Science Center of the U.S. Geological Survey (USGS) supports science-based decision making by Federal, State, and local policymakers to meet these challenges.*

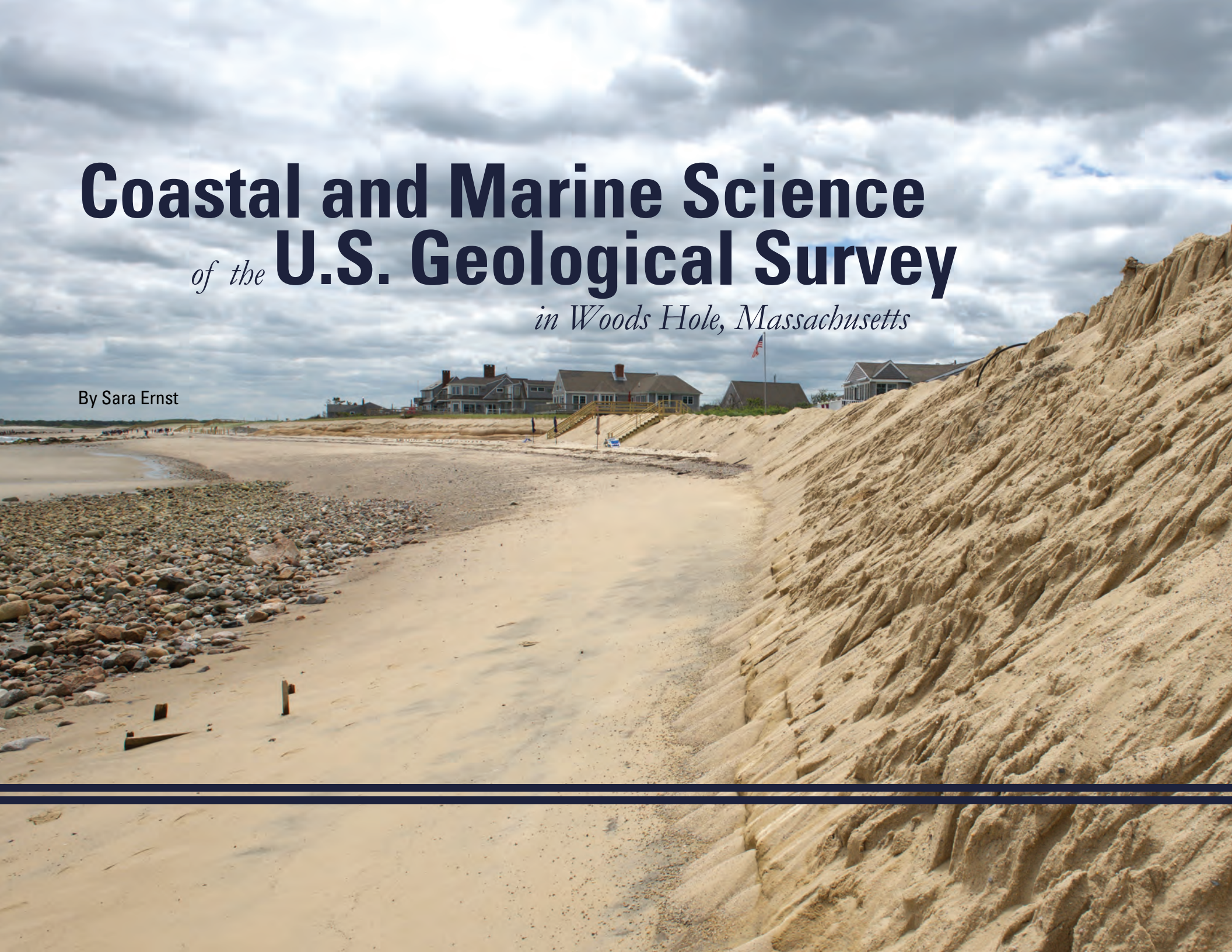
We are strategically located in Woods Hole, Massachusetts, a world-renowned center for the study of earth and ocean science, where we belong to a vibrant scientific community. We have well-established expertise and an international reputation in fields like marine geology and geophysics, oceanography, environmental geochemistry, energy, geohazards, and informatics. Our staff works collaboratively with local institutions such as the Woods Hole Oceanographic Institution, the Marine Biological Laboratory, the Northeast Fisheries Science Center of the National Oceanic and Atmospheric Administration, the Sea Education Association, the U.S. Coast Guard, and the Woods Hole Research Center. Our center has a long history of collaborating in research, teaching, training, and technology transfer with other Federal and State agencies, academic institutions, and international entities.

As part of the national USGS program in coastal and marine science, we work in the Atlantic, Pacific, and Arctic Oceans; in the Gulf of Mexico; and in myriad estuaries and inland waterways, including the Great Lakes. We also work extensively in our own coastal backyard along the Mid-Atlantic and New England coast. Our cooperative work with the Massachusetts Office of Coastal Zone Management, for example, has for decades provided data, knowledge, and tools used to characterize the State’s shoreline and coastal waters and to guide their sound management. We can adapt the concepts and approaches developed in these efforts to other coastlines, estuaries, and large lakes that are critical to the communities and livelihoods of millions of Americans.

Our center provides expertise and capabilities that directly respond to needs of resource managers, decision makers, and the public across the Nation’s coast and submerged lands. We are passionate about our mission, and our commitment makes great science happen.”

Rob Thieler
Woods Hole Coastal and Marine Science Center Director
U.S. Geological Survey





Coastal and Marine Science of the **U.S. Geological Survey** *in Woods Hole, Massachusetts*

By Sara Ernst

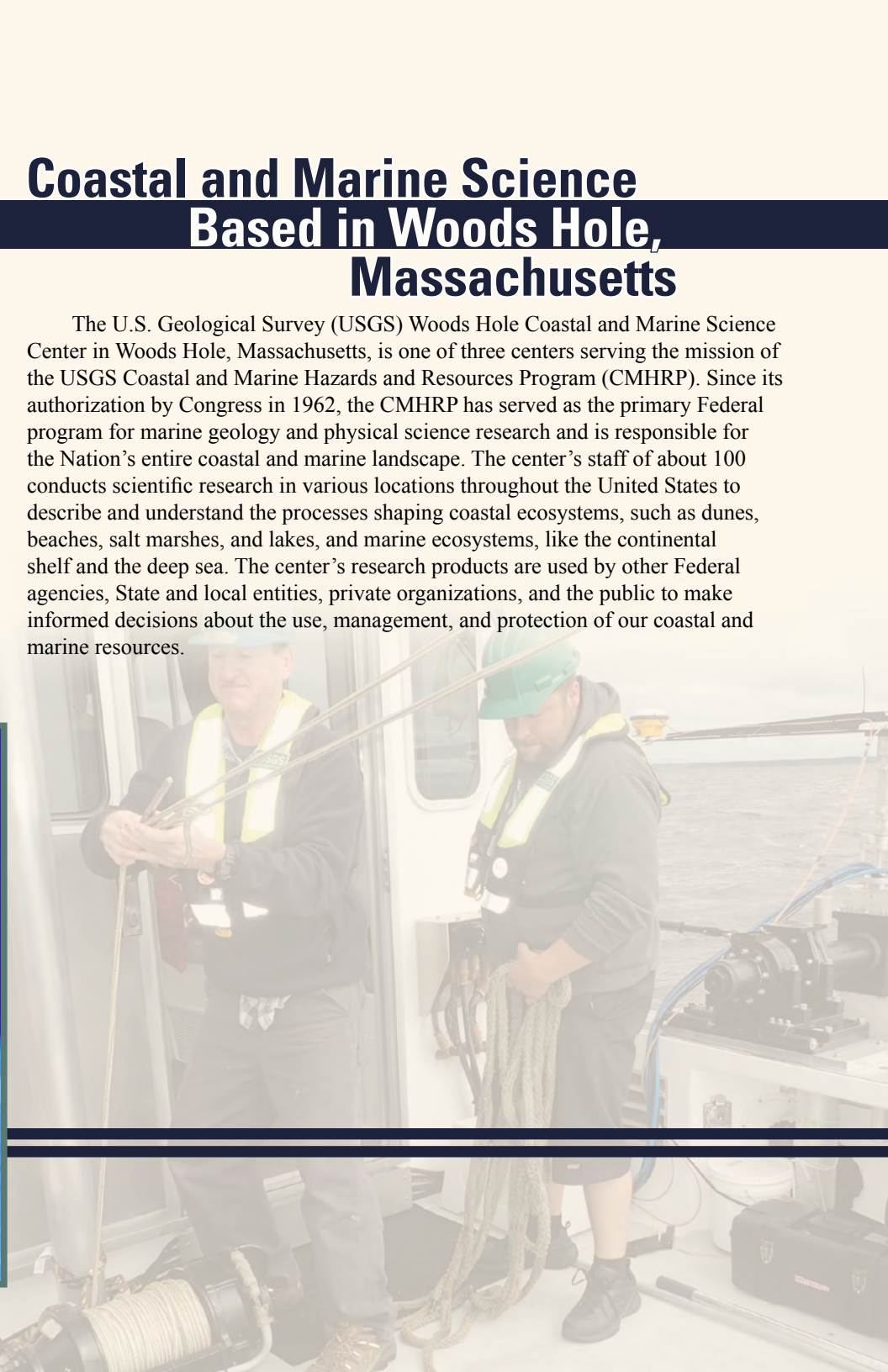


USGS drone collects photographic imagery to produce rapid, low-cost, detailed maps of coastal environments

The center's Aerial Imaging and Mapping (AIM) group uses drones mounted with various high-resolution optical and high-precision Global Positioning System (GPS) systems to map the topography and collect shoreline imagery in coastal environments. This work supports studies of coastal erosion, short- and long-term changes to coastal environments, sediment transport and storm response, habitat classification, biomass mapping, and marsh stability.

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 and 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.

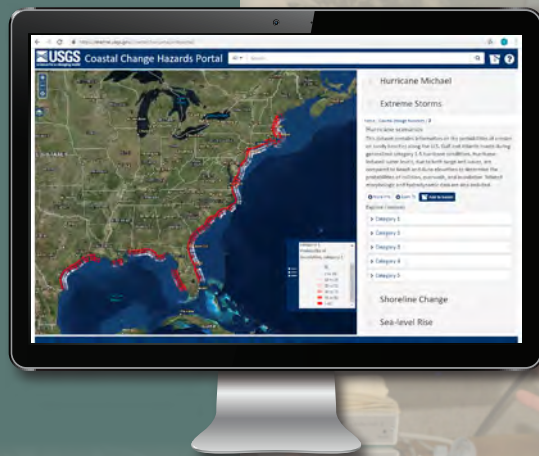


Coastal and Shelf Geology

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. The center's Coastal and Shelf Geology group conducts mapping, modeling, and data analysis to describe and improve our understanding of the geology underlying these environments and the processes that shape them. 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 and are used to improve forecasts of coastal change and identify hazards in areas vulnerable to storms, chronic erosion, and sea-level rise.

Coastal Change Hazards Portal

The USGS Coastal Change Hazards Portal provides access to USGS data, products, and tools. Users can view areas vulnerable to storm-induced coastal change, long-term shoreline change, and sea-level rise. This tool assesses the likelihood of erosion from storms and long-term sea-level rise.



<https://marine.usgs.gov/coastalchangehazardsportal/>





Photograph by Josh Seibel, U.S. Fish and Wildlife Service

Juvenile piping plovers at a nest site

Interdisciplinary USGS scientists conduct research and develop tools to identify suitable coastal habitats for species of concern, such as the piping plover, under a variety of sea-level-rise scenarios. The center developed an open-source smartphone application called iPlover that standardizes the collection of biogeomorphic information at piping plover nest sites on coastal beaches and simplifies other data-acquisition challenges.



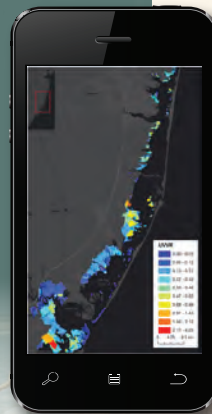
USGS oceanographer measures water and sediment movement

In collaboration with other organizations and USGS offices, the center developed the unvegetated to vegetated marsh ratio (UVVR) 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.

Sediment Transport

Estuarine Processes, Hazards, and Ecosystems

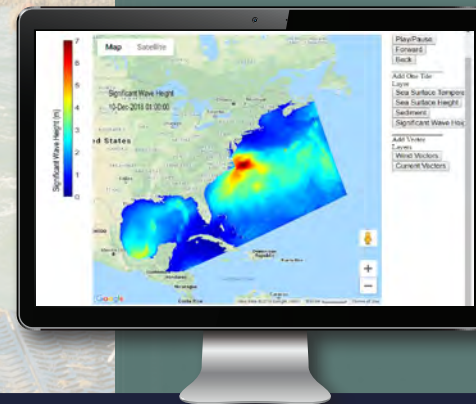
The health of estuaries and wetlands largely determines how well they protect coastal communities against storms and sea-level rise. Scientists and technicians at the center investigate the processes that control marshes and estuaries through research combining field observations with numerical modeling and deliver new decision-making tools for coastal managers.



https://www.usgs.gov/centers/whcmssc/science/estuarine-processes-hazards-and-ecosystems?qt-science_center_objects=0#qt-science_center_objects

Coastal systems 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. Predicting how the coast will respond to these forces can mitigate hazards and their effects, such as losses of infrastructure, declines in tourism and recreational use, and effects on marine habitats. Scientists at the center use oceanographic equipment to observe 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 apply to systems that vary in scale, ranging from local estuaries and 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 and helps coastal managers to make knowledge-based decisions.

Predictive Modeling of Coastal Systems



The Sediment Transport Group created the coupled ocean-atmosphere-wave-sediment transport (COAWST) modeling system, an open-source tool that produces comprehensive predictive models for investigating the dynamic effects of storms on coastal environments. The model is widely used throughout the United States and internationally.

<https://woodshole.er.usgs.gov/project-pages/cccp/public/COAWST.htm>

Energy and Geohazards

Energy and geohazards research at the center is focused on three themes: gas hydrates (naturally occurring ice-like substances 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.

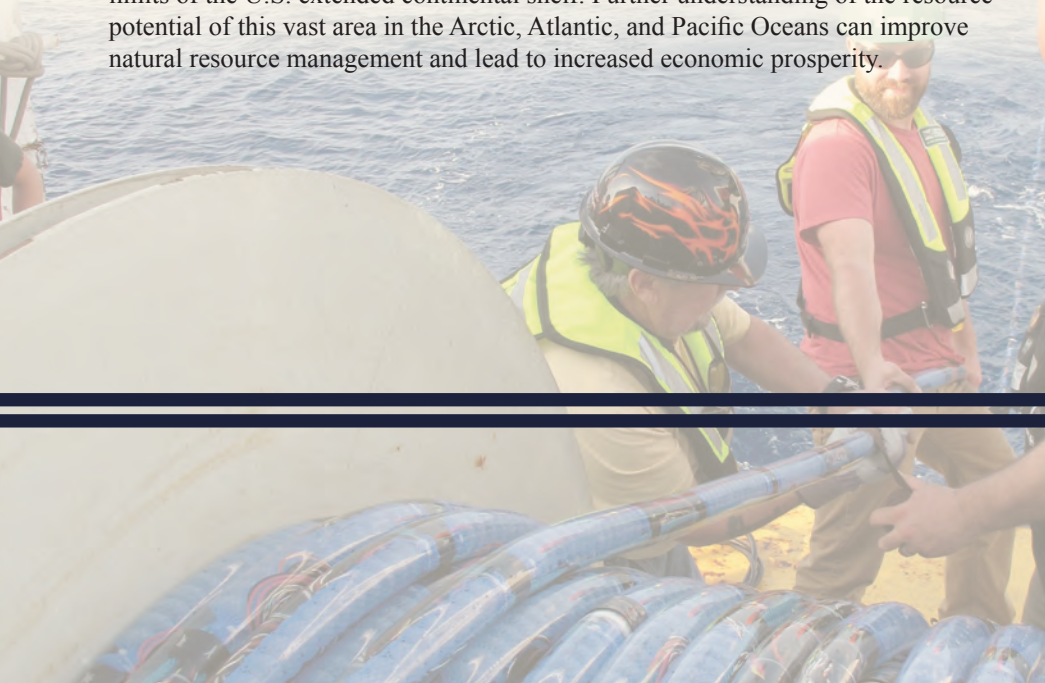
Scientists in the USGS Natural Hazards and Energy and Minerals Mission Areas work together to study the formation and distribution of gas hydrates in nature, the potential of hydrates as an energy resource, and the possible environmental effects of gas hydrates when they break down and release methane (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 hydrate research for more than three decades.

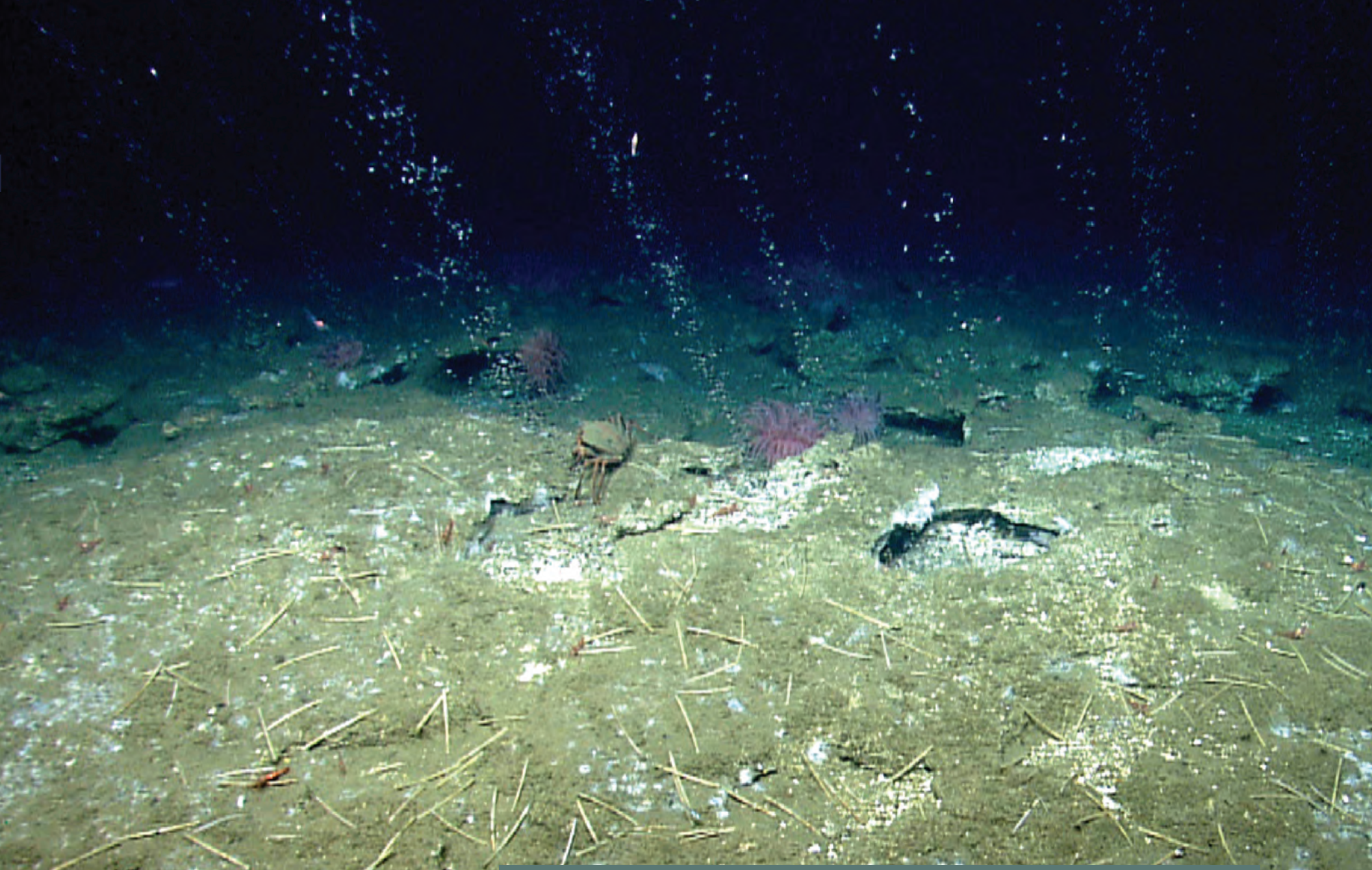
Underwater earthquakes can generate tsunamis that are hazardous to coastal communities. Scientists at the center study the recent history of underwater earthquakes and tsunamis and evaluate the future potential for such events and their probable effects on a regional basis. Their research results are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

The USGS 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 this vast area in the Arctic, Atlantic, and Pacific Oceans can improve natural resource management and lead to increased economic prosperity.

Facilities and Laboratories

The Energy and Geohazards group relies primarily on the center's Sea Floor Mapping group to acquire field data that support its scientific mission. Researchers also use laboratory facilities to analyze sediment cores to support research at the center and in other parts of the USGS. Gas hydrates studies rely on an advanced pressure-core facility to process sediments containing methane hydrate and on a geotechnical laboratory to determine reservoir properties. The Ocean Bottom Seismometer facility provides instrumentation to support the group's research and collaborative studies with the USGS Earthquake Hazards and Volcano Hazards Programs.





Methane bubble streams emanating from the sea floor on the northern U.S. Atlantic margin

To reduce uncertainty in estimated global emissions of methane (the most common gas present in gas hydrate) from the sea floor, the USGS designs and carries out field programs and participates in expeditions to study seep distribution, integrated gas flux, and the processes controlling methane leakage.

Research Partner for Restoration Efforts

The 1,000-plus-acre Herring River estuary was once one of the most productive salt marsh systems in the Northeast. Together with the 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 USGS provides data and products related to wetland stability, elevation change, and persistence in the Herring River estuary for current and future management scenarios.



USGS scientist collects groundwater from coastal wetlands

Scientists at the center study the role of groundwater in delivering nitrogen, carbon, phosphorus, and various greenhouse gases to coastal ecosystems. Studies are particularly focused on how groundwater discharge is related to declines in estuarine water quality and to changes in coastal ecosystems resulting from climate change.



Environmental Geoscience

Coasts include a range of environments that provide essential habitat for a variety of plants and animals. From wetlands to estuaries to coastlines, 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 field work 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. The group provides data, products, and decision support to Federal, State, and local organizations and individuals tasked with managing these vital ecosystems to support their future resilience.

Specialized Tool Development

The Environmental Geoscience group applies standard methods and specialized capabilities developed at the USGS for the collection, analysis, and interpretation of water, air, gas, and sediment samples acquired in diverse settings. These tools support field-based research aboard ships and in estuaries, wetlands, coastal waters, and Arctic lakes. This research yields information about nutrients, toxic metals, stable isotopes, organic matter, and the origins and concentrations of gases in air and water.

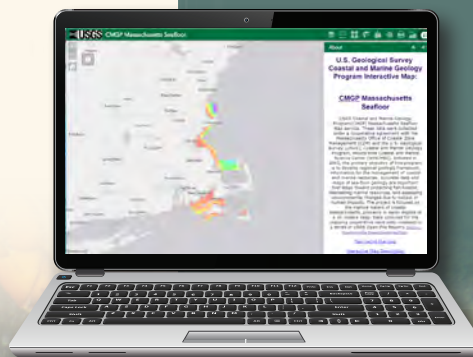


Sea-Floor Mapping

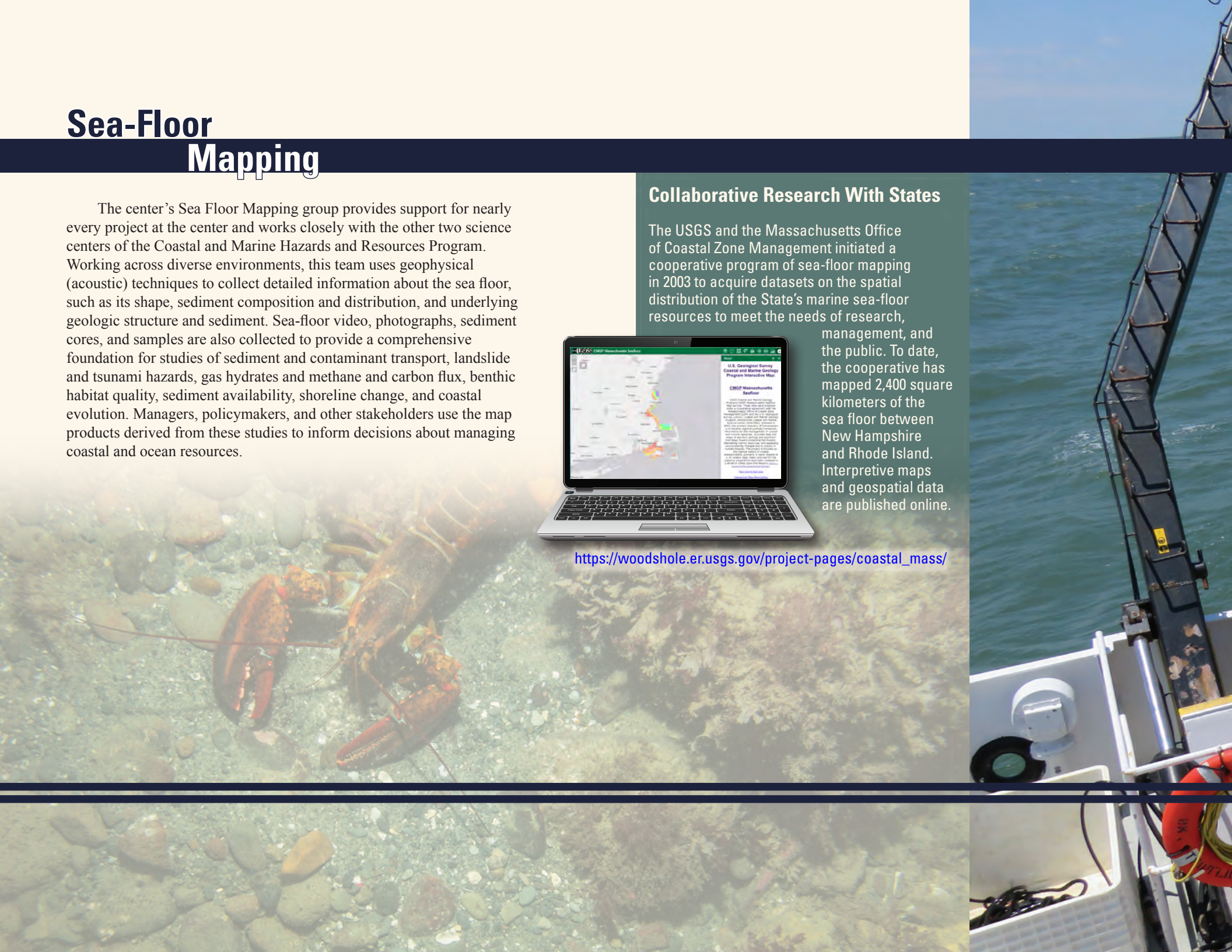
The center's Sea Floor Mapping group provides support for nearly every project at the center and works closely with the other two science centers of the Coastal and Marine Hazards and Resources Program. Working across diverse environments, this team uses geophysical (acoustic) techniques to collect detailed 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 decisions about managing coastal and ocean resources.

Collaborative Research With States

The USGS and the Massachusetts Office of Coastal Zone Management initiated a cooperative program of sea-floor mapping in 2003 to acquire datasets on the spatial distribution of the State's marine sea-floor resources to meet the needs of research, management, and the public. To date, the cooperative has mapped 2,400 square kilometers of the sea floor between New Hampshire and Rhode Island. Interpretive maps and geospatial data are published online.



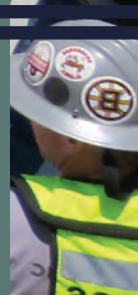
https://woodshole.er.usgs.gov/project-pages/coastal_mass/





USGS scientists deploy sea-floor mapping equipment

The center's Sea Floor Mapping Group uses technological devices to map the shape of the sea floor (depth), distribution of sediments on the sea floor, and geologic structure and sediments beneath the sea floor. This mapping allows scientists to define the geologic framework of a region and study its influence on coastal and shelf evolution and behavior; identify mineral, sand, and gravel resources; identify potential hazards; and determine the influence of geology on sea-floor habitats, resources, and ecology.





USGS research geologist is interviewed by media

Interviews with media outlets are one way the center educates the public on research topics and informs decision makers of tools and methods created by the USGS to aid in coastal and marine resource management.

Information Science

Education and Outreach

Center staff use numerous platforms, such as social media, newsletters, traditional news outlets, and community outreach events, to enhance awareness and understanding of Coastal and Marine Hazards and Resources Program research and to connect the public, resource managers, policymakers, and other stakeholders with the information and tools necessary to make informed decisions.



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 interested individuals or organizations in understanding their data needs and locating useful data.

Web Presence

The web team develops websites and content that provide accurate, detailed, and up-to-date information about center research activities and news.



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

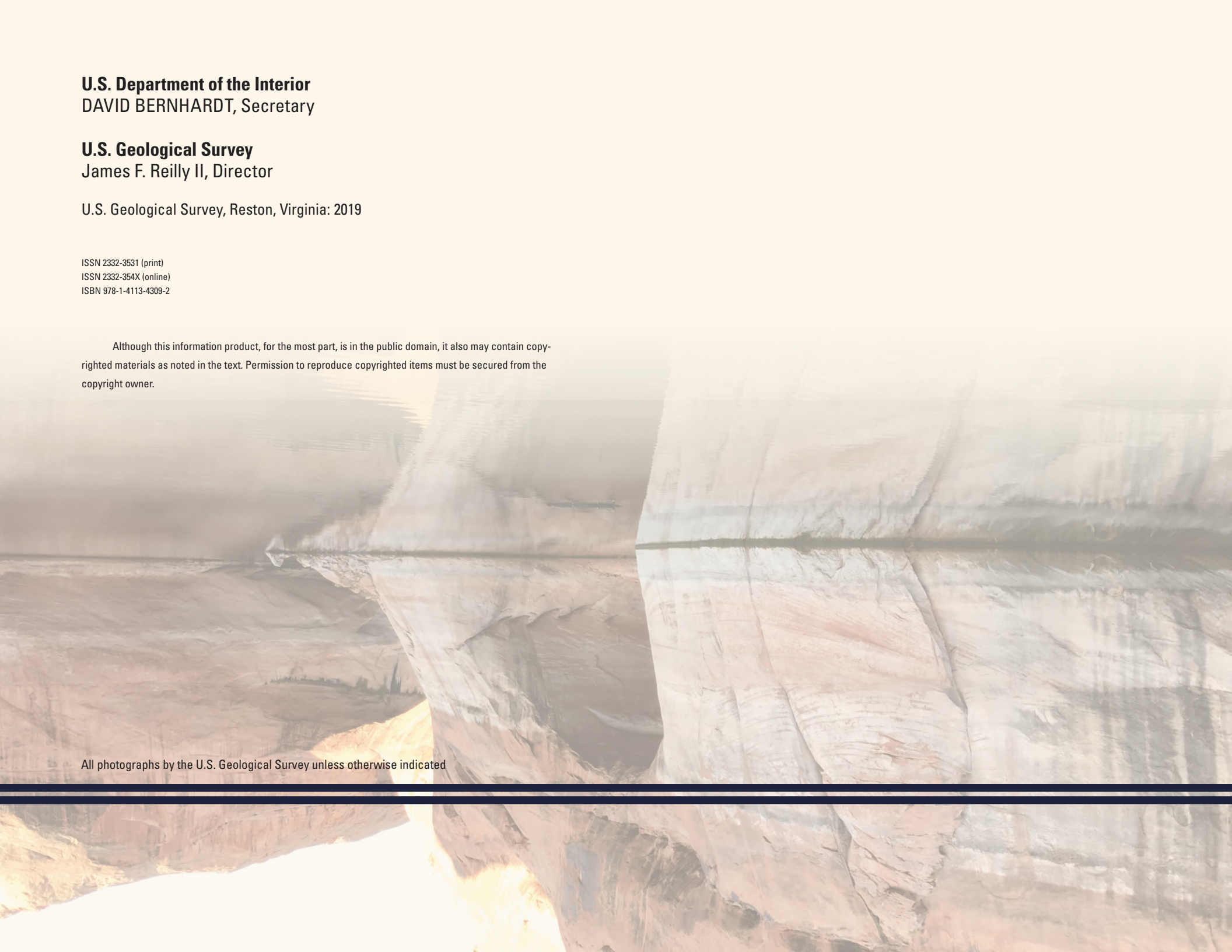
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James F. Reilly II, Director

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