

# Coastal and Marine Science *of the* U.S. Geological Survey *in St. Petersburg, Florida*

General Information Product 214

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

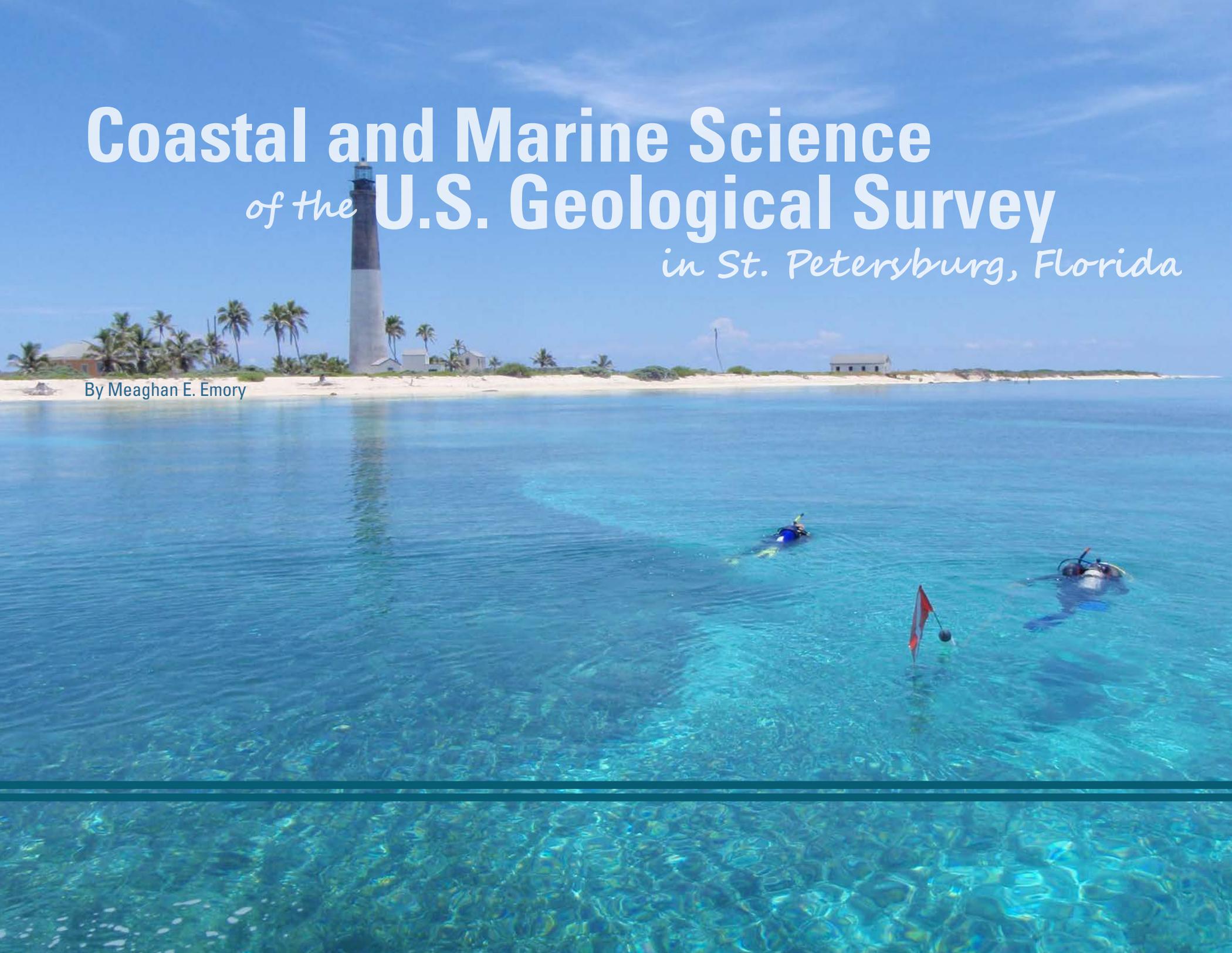
“As a U.S. Geological Survey (USGS) science center, the USGS St. Petersburg Coastal and Marine Science Center (SPCMSC) conducts coastal and marine research to ensure that our Nation has the information it needs to understand, protect, and restore coastal and ocean resources and the communities that depend on them. The center was established in 1988, with the support of the St. Petersburg business community and the University of South Florida, when just six USGS staff members began work in a temporary downtown location (a recently vacated podiatrist's office). Today, the SPCMSC occupies a renovated building that was originally constructed in 1925 and operated as a Studebaker dealership and repair shop. The current staff (of about 100) continues to work with the local community, including the University of South Florida's College of Marine Science and Tampa campus, Eckerd College, and the Florida Fish and Wildlife Research Institute, along with local networks such as the St. Petersburg Downtown Partnership, St. Petersburg Innovation District, and St. Petersburg Ocean Team, to solve local and global research challenges.

The current SPCMSC workforce has been shaped by more than three decades of evolution as the center has expanded its ability to perform research addressing coastal geology, coastal hazards, climate change effects, and biology and ecology. Our staff have been recognized internationally, at the highest levels of the Nation and the USGS, and by our research and applications partners for our dedication to scientific achievement and leadership, communication to the public, and delivering of applications that benefit the Nation. To name a few examples, our staff have received the Presidential Early Career Award for Scientists and Engineers, the Department of Interior's Meritorious Service Award, and the USGS Shoemaker Award for Communications Excellence. This dedication to our work and to those who benefit from it has continued despite challenges faced by our staff during the COVID-19 pandemic. I attribute much of our success to the close bonds that our staff members have built with each other and to their sense of purpose at work and in the community.

In addition to our local partnerships, the SPCMSC works with States on the Gulf of Mexico, Atlantic, and Pacific coasts, and other Federal agencies to support planning and response to storms, climate change, ecological threats, and human-caused disasters, such as the Deepwater Horizon oil spill. Examples of our work include development of new hazard warnings with the National Weather Service; forecasts of landscape and habitat change with the U.S. Army Corps of Engineers, National Park Service, U.S. Fish and Wildlife Service, and States; and delivery of data that are available to our partners and the general public. To those we have worked with to solve pressing challenges, thank you for engaging with us and helping us to demonstrate the value of our expertise and to set our priorities more effectively. To those who have not yet worked with us, we care about coastal challenges and ensuring that we lend our support effectively and equitably to a Nation with a diverse coastal population, diverse interests, and diverse objectives. With this brochure we invite you to engage with us so that we can work together to achieve these goals.

Nathaniel Plant  
St. Petersburg Coastal and Marine Science Center Director  
U.S. Geological Survey





# Coastal and Marine Science *of the* U.S. Geological Survey *in St. Petersburg, Florida*

By Meaghan E. Emory



## **USGS physical scientist collects beach elevation data to monitor coastal change**

Coastal Change Hazards researchers survey beach elevation at numerous locations along the U.S. coastline, such as this field site in Madeira Beach, Florida. Scientists use Global Positioning System (GPS) equipment to map the beach and study how coastal morphology changes over time, especially after extreme storms.

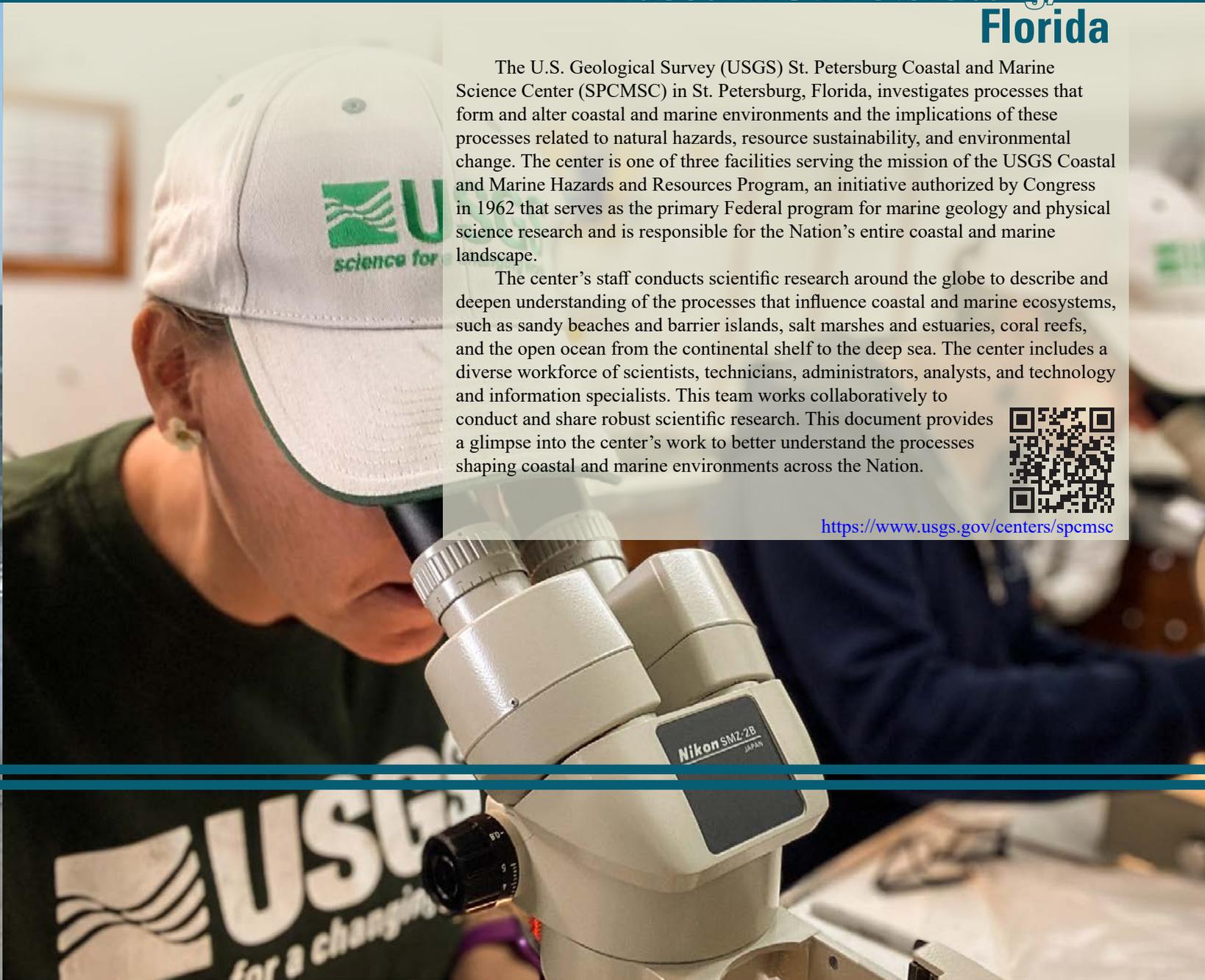
# Coastal and Marine Science Based in St. Petersburg, Florida

The U.S. Geological Survey (USGS) St. Petersburg Coastal and Marine Science Center (SPCMSC) in St. Petersburg, Florida, investigates processes that form and alter coastal and marine environments and the implications of these processes related to natural hazards, resource sustainability, and environmental change. The center is one of three facilities serving the mission of the USGS Coastal and Marine Hazards and Resources Program, an initiative authorized by Congress in 1962 that serves 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 conducts scientific research around the globe to describe and deepen understanding of the processes that influence coastal and marine ecosystems, such as sandy beaches and barrier islands, salt marshes and estuaries, coral reefs, and the open ocean from the continental shelf to the deep sea. The center includes a diverse workforce of scientists, technicians, administrators, analysts, and technology and information specialists. This team works collaboratively to conduct and share robust scientific research. This document provides a glimpse into the center's work to better understand the processes shaping coastal and marine environments across the Nation.



<https://www.usgs.gov/centers/spcmsc>



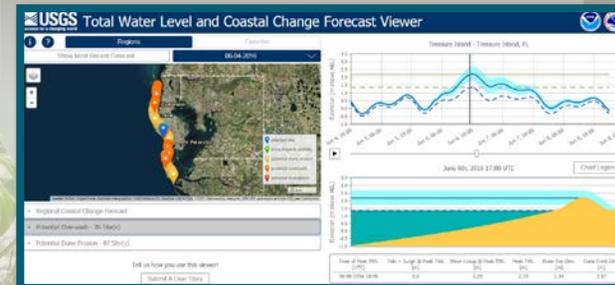
# Coastal Change Hazards

The Nation's coastlines are valuable and dynamic. In the United States, coastal areas are home to about 40 percent of the Nation's population and numerous species of wildlife, including shorebirds and nesting sea turtles. Extreme changes to the coast can pose risk to human lives, property, infrastructure, and wildlife habitats. The center's Coastal Change Hazards team seeks to understand the processes involved in coastal change and its associated hazards by integrating basic and applied research, technical capabilities and application development, and stakeholder engagement to ensure our research and products meet public needs. Research involves observing, modeling, and forecasting the effects of natural and human-driven coastal processes—such as erosion, sea-level rise, sediment transport, and coastal restoration and hazard mitigation actions—in diverse environments, from wetlands to barrier islands. Our scientists use methods such as light detection and ranging (lidar), satellite imagery, nearshore sea-floor mapping, and coastal elevation data collected on foot, to characterize the shape of our coasts and how they are shifting over time. Predictive modeling techniques are used to forecast how the coast will change in response to extreme events such as storms and persistent processes such as sea-level rise, along with how these changes may affect the availability and distribution of habitat for species of concern. This information is useful for informing strategies of species and habitat conservation for partners such as the National Park Service and the U.S. Fish and Wildlife Service. Technical capabilities allow us to display and share data and forecasts in publicly available online platforms for use by partners and stakeholders. Ultimately, the research, products, and engagement generated by the Coastal Change Hazards programmatic focus are used to inform coastal resource managers on how to help increase the resiliency of coastal communities and habitats.

## Total Water Level and Coastal Change Forecast Viewer

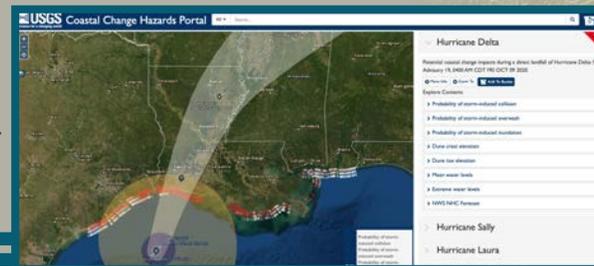
The Total Water Level and Coastal Change Forecast Viewer, a collaboration between the USGS and the National Oceanic and Atmospheric Administration, provides real-time predictions of elevated coastal water levels on sandy beaches that can threaten safety, infrastructure, or resources. The continuously operating model incorporates local beach characteristics and real-time wave data to provide hourly forecasts of water level for nearly 3,000 miles of the U.S. coastline.

<https://coastal.er.usgs.gov/hurricanes/research/twlvviewer/>



## Coastal Change Hazards Portal

The USGS Coastal Change Hazards Portal provides forecasts of coastal change at scales useful for local communities, regional managers, and decision makers. Users can explore the potential for storm-induced coastal erosion, forecasts of extreme water levels, historical shoreline change, and vulnerability to sea-level rise.

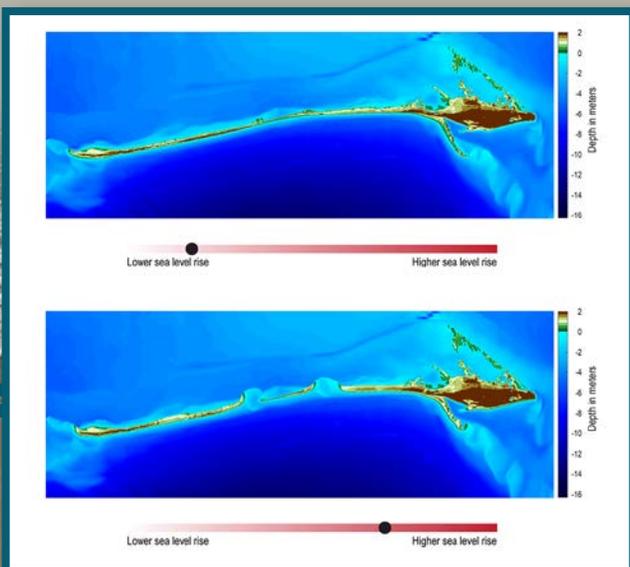


<https://marine.usgs.gov/coastalchangehazardsportal/>



## Dauphin Island Restoration Assessment

Supported by the U.S. Fish and Wildlife Service in collaboration with the State of Alabama, the U.S. Army Corps of Engineers, and other USGS partners, scientists at the SPCMSC investigate viable, sustainable options to protect and restore natural coastal resources and enhance coastal resilience. Hydrodynamic and morphological modeling are used to simulate the evolution of Dauphin Island, Alabama, under various restoration strategies in the face of increased storm frequency and sea-level rise.



## A breach in the coastline caused by a storm in a coastal community

Extreme changes to the coast can pose risk to human lives, property, and habitats. The SPCMSC Coastal Change Hazards team seeks to understand and forecast the processes and hazards related to coastal change, such as this breach from a storm in Rodanthe, North Carolina.

## Modeling Sediment Availability

The evolution of barrier islands can have important implications for coastal development and habitats. A combination of field and modeling approaches is used to quantify barrier island sensitivity to changes in sediment supply, such as erosion. Scientists at the SPCMSC collect field data on the shape and structure of barrier islands along with historical records such as aerial imagery and sediment cores. These data are used to create models of barrier evolution to help scientists infer and predict how barrier systems change over time in response to variations in sediment supply, sea-level rise, and storms.



## USGS research geologist labels a sediment core

This sediment core, obtained from a barrier island along the gulf coast of Central Florida, will be used to reconstruct the long-term geological history of the island. Studying barrier island evolution allows scientists to calibrate models to predict sensitivity of barriers to future changes in sea-level rise and sediment input.

# Sediment Dynamics

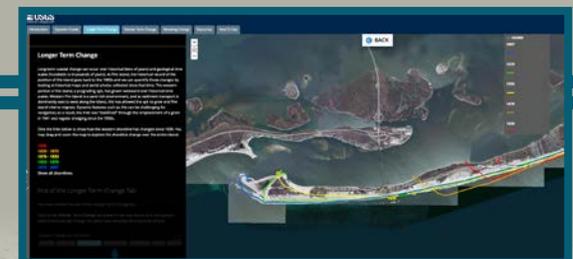
Sediments are the foundation of coastal systems, including barrier islands, marshes, and estuaries. Scientists at the SPCMSC study the dynamic links between erosion, sea-level rise, sediment availability and exchanges between coastal environments, and how sediment transport processes affect coastal evolution. Sediment dynamics research involves collecting shelf, nearshore, and wetland geomorphologic data by various methods, such as remote sensing (for example, lidar, satellite, and aerial imagery), modeling, and field-based methods (for example, boat-based geophysics and sediment sampling), which allow us to understand coastal evolution on scales from years to millennia. Ultimately, our understanding of sediment transport processes will allow us to develop models to both make predictions of future coastal vulnerabilities and resiliency, and evaluate restoration strategies in support of critical habitats and resources.

## Fire Island Geonarrative

This interactive, web-based product allows users to explore USGS research at Fire Island, New York. Fire Island is a 31-mile-long barrier island consisting of Fire Island National Seashore, State and county parks, and communities. For more than two decades, USGS scientists have been researching Fire Island's offshore, nearshore, and barrier island systems to better understand drivers of coastal change and evolution, particularly in response to storms.



<https://wim.usgs.gov/geonarrative/ficc/>

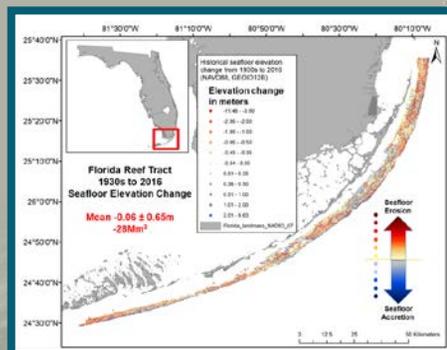


# Ocean Ecosystems

The ocean hosts numerous ecosystems that support and produce valuable marine resources. Scientists at the SPCMSC study oceanic systems, including the continental shelf, the open ocean, blue holes, and the deep sea. Much of our research focuses on coral reef ecosystems, which provide benefits such as coastal protection from storms, habitat for diverse marine life, and economic support through the tourism and seafood industries. Coral reefs have experienced substantial coral loss in recent decades due to climate change, disease, and human-related disturbances. Scientists at the center study the processes that have controlled reef growth and rates of erosion over the past 10,000 years to better understand the persistence of reefs in a changing ocean. Coral growth assessment studies help identify environmental and genetic variables that influence where corals can grow most successfully. This information is used by partners to make informed decisions on where to plant nursery-grown corals for reef restoration efforts.

## Sea-Floor-Elevation Change

Scientists at the SPCMSC study how sea-floor elevation is shifting simultaneously with sea-level rise. Reductions in height and complexity of sea-floor structure combined with sea-level rise can allow waves to break closer to shore and water levels to reach farther inland. As offshore ecosystems like coral reefs degrade over time because of physical and chemical erosion, coastal communities may be at increased risk to coastal hazards such as storm surge and waves. USGS scientists track and project changes in sea-floor elevation by using technology to create three-dimensional maps of marine ecosystems and developing models to better understand how the combined processes of sea-level rise and sea-floor erosion may influence coastal vulnerability.



## Coral Diseases

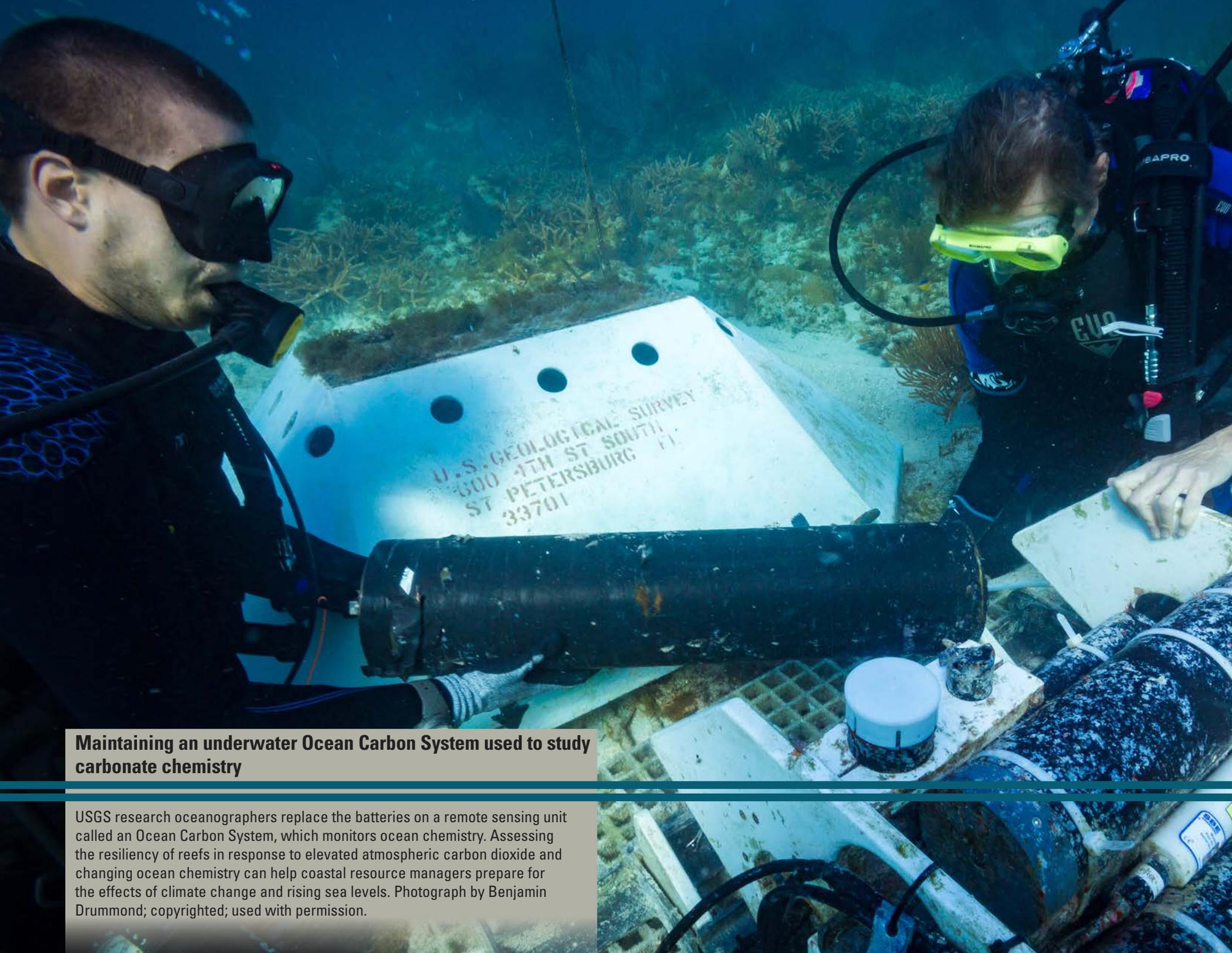
Scientists at the SPCMSC use genetic techniques to identify microbes—viruses and bacteria—in coral tissues. Some microbes are beneficial for corals, whereas others cause disease. Coral diseases are a major cause of reef degradation and coral mortality worldwide, so it is important to identify the microbes living on coral reefs to better understand their roles and how they may affect the health of these important ecosystems. Scientists at the center are currently working to identify the microbes associated with stony coral tissue loss disease—the effects of which are shown here.





## USGS marine biologist measures elkhorn coral in Dry Tortugas National Park

Scientists at the SPCMSC maintain the USGS coral-assessment network, a set of stations for monitoring coral calcification placed throughout the Florida Keys and the U.S. Virgin Islands to investigate growth rates across species and environmental gradients. This research can guide partners' restoration plans for species such as the threatened *Acropora palmata* (elkhorn coral), which is critical for building coral reefs. Photograph by Andréa G. Grottoli, The Ohio State University.



**Maintaining an underwater Ocean Carbon System used to study carbonate chemistry**

USGS research oceanographers replace the batteries on a remote sensing unit called an Ocean Carbon System, which monitors ocean chemistry. Assessing the resiliency of reefs in response to elevated atmospheric carbon dioxide and changing ocean chemistry can help coastal resource managers prepare for the effects of climate change and rising sea levels. Photograph by Benjamin Drummond; copyrighted; used with permission.

# Climate Change

## Paleoclimate Reconstruction

Innovative methods are used to measure climate variability, such as analyzing natural recorders, or proxies, of environmental conditions. These proxies include sediment and marine organisms such as plankton, clams, and corals—the chemistry of which reflects the environmental conditions where and when they were formed. To translate proxy data into environmental terms, measurements of

modern environmental variables are calibrated with the chemistry of modern proxies. These relationships are used to interpret proxies in geologic archives, such as sediment, shells, and reefs, that date back centuries to millennia.



Scientists at the SPCMSC study past and present changes in climate, along with the effects of a changing climate on coastal and marine systems. Investigating past changes in the environment helps us better understand the natural and anthropogenic factors that contribute to climate variability on interannual to millennial timescales. This understanding can aid in projecting future change. USGS scientists also investigate the effects of climate change, such as coastal and marine acidification. Ocean acidification is the decline of ocean pH driven by increases in atmospheric carbon dioxide and its absorption into the ocean. Acidification in coastal systems can also be driven by local effects, such as excess nutrients. The process of acidification can cause harmful effects to marine systems, including the dissolution of carbonate sediment and the shells and skeletons of marine organisms—including economically important shellfish in the seafood industry and ecologically important corals that support biodiversity. Careful monitoring and dedicated research are needed to prepare effective management and mitigation strategies for the effects of climate change, including increasing acidity, in our oceans.

## Ocean Acidification Studies

With Federal, State, and local partners, scientists at the SPCMSC work to understand how coastal and ocean acidification are changing ecosystems. The center's climate-grade Carbon Analytical Laboratory allows center scientists and partners to acquire precise measurements of ocean acidity. These measurements allow them to examine the processes and effects of acidification. The ocean carbon team's successes include quantifying the benefits of seagrass restoration for mitigating acidification in Tampa Bay, Florida, and discovering the first evidence of climate change refuges for corals within mangrove ecosystems in Virgin Islands National Park. Photograph by Benjamin Drummond; copyrighted; used with permission.



# Capabilities

An extensive inventory of vessels, tools, equipment, technology, and qualified personnel is required to collect the data needed for coastal and marine research. The Marine Operations group maintains the SPCMSC scientific diving program for underwater research; a fleet of research vessels and vehicles, including personal watercraft for shallow water access and all-terrain vehicles for navigation; and equipment for data collection, including geophysical survey gear for surveying below the sea floor, sonar systems for bathymetric mapping and habitat studies, and several core extractors for use in various environments. The team also manages the center's fabrication workshop for designing custom scientific equipment to meet the center's research goals. Laboratory capabilities at the center allow for the processing and analysis of the samples collected in the field. Specialized equipment in the center's 12 laboratories allows for processing, characterization, and dating of diverse sample types in the study of environmental change.

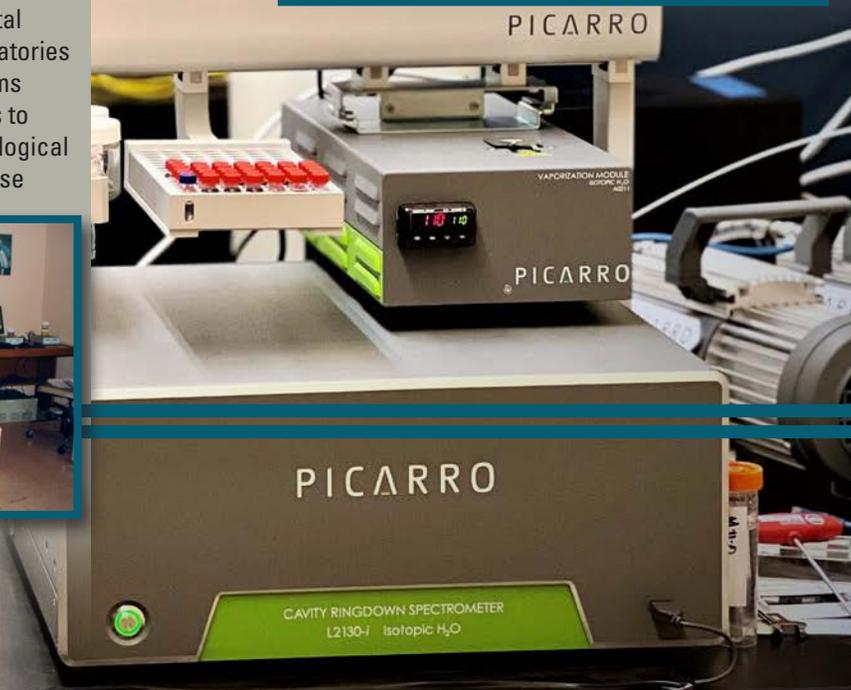
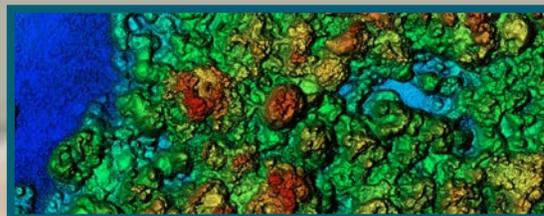
## Radiochemistry Laboratories

Radioactive isotopes are common in nature and emit particles that can be detected, quantified, and used to study environmental processes. The SPCMSC alpha and gamma spectroscopy laboratories use anthropogenic and naturally occurring radionuclides—atoms with unstable cores—in estuarine, wetland, and lake sediments to investigate sediment deposition and dynamics, reconstruct ecological histories, and identify sediment sources. Scientists also use these capabilities to detect radioisotopes of radium and radon as part of investigations of how groundwater discharge mixes with seawater in coastal areas.



## Sea-floor Mapping

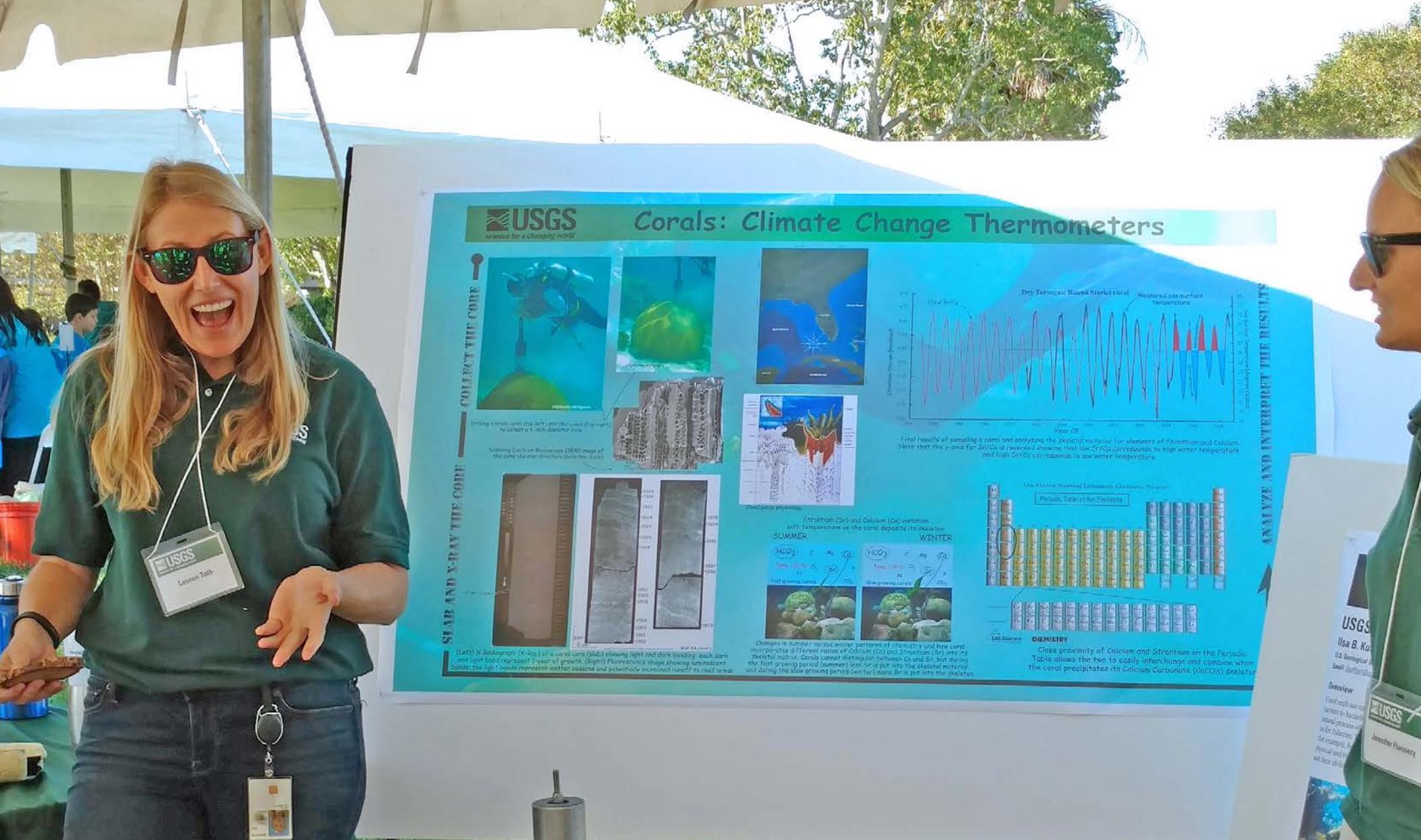
Efforts to map the sea floor help scientists at the SPCMSC understand the coastal geology and the topographic complexity of marine habitats. This understanding enables scientists to characterize the vulnerability of shorelines and coastal resources, document past and ongoing change, and predict future changes. Various remote sensing methods are used to map coastal and marine environments, including side-scan sonar, multibeam bathymetry, lidar, and the Structure-from-Motion Quantitative Underwater Imaging Device with Five Cameras (SQUID-5).





### Research vessel *Sallenger* and seismic sled used for subbottom surveying

A USGS team works off the research vessel *Sallenger*, one of several vessels at the center. The team prepares to launch a floating sled equipped with an EdgeTech SB-512i chirp system and single-beam sonar that enables subbottom and single-beam bathymetry surveying in shallow water, nearshore, and shoreface environments.



**USGS scientists share their enthusiasm for coral research at a local science festival**

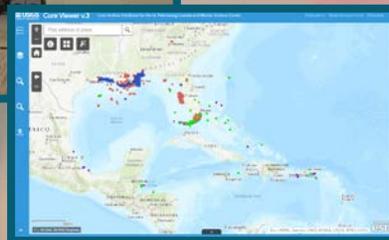
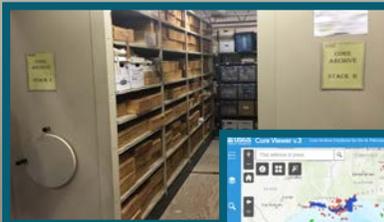
USGS staff members have participated in the St. Petersburg Science Festival for over a decade. Here, two center scientists discuss how coral and reef cores are used to study past climate change. This is one of many outreach efforts conducted by the center to share scientific coastal and marine discoveries with stakeholders, partners, and the community.



# Information Sharing

## Core Archive

The SPCMSC core archive houses a collection of nearly 3,000 cores collected by the center and Federal, State, and university partners. These cores have been sampled from diverse study areas including coral reefs, wetlands, beaches, and marine environments from around the world. The USGS and partners study these cores to understand the geomorphological and climatic history of the Nation's coastal and marine environments. The center's data management group maintains the USGS Core Viewer—a database of information on core samples in the archive, including the field collection site, archive storage location, associated publications, photographs, analytical results, and whether the core is still physically present in the archive.



<https://doi.org/10.5066/F7319TR3>



Thousands of partners and customers look to the USGS, which as part of its mission provides scientific information about the earth, for its natural science expertise and vast data holdings. Scientists at the SPCMSC conduct basic and applied research so that policy makers and the public have the understanding they need to enhance preparedness, response, and resilience in a changing world. Center staff share information by maintaining local, State, and national partnerships; managing and sharing data using state-of-the-art information technology; engaging with stakeholders and the scientific community; hosting and attending outreach events; and disseminating science news through our website, social media channels, interactive web products, and the Sound Waves newsletter.

## Media Coverage

The research and staff of the SPCMSC have been featured in numerous news articles, videos, documentaries, podcasts, and other media outlets. The center is dedicated to sharing findings with the public in a variety of ways to help inform stakeholders of the data and tools available from the USGS and communicating the value of coastal and marine research. Center staff have been featured in educational programming, Public Broadcasting Service (PBS) documentaries, podcasts, by national news outlets such as the Washington Post, USA Today, and the Associated Press, and by large local outlets such as the Miami Herald and Tampa Bay Times.





**Aerial photograph looking west along Dauphin Island, Alabama**

Dauphin Island, along Alabama's gulf coast, is vulnerable to coastal change. USGS models are used to simulate the evolution of Dauphin Island under various restoration strategies in the face of increased storm frequency and sea-level rise.

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

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment—visit <https://www.usgs.gov> or call 1–888–ASK–USGS. For an overview of USGS information products, including maps, imagery, and publications, visit <https://store.usgs.gov>.

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### **Cover. Vegetated dunes on Cocoa Beach, Florida**

A view looking north on Cocoa Beach toward the John F. Kennedy Space Center at Cape Canaveral. Coastal infrastructure and natural resources such as sediment and beach vegetation can all be affected by coastal change processes—a major area of study at SPCMSC.

### **Back Cover. USGS St. Petersburg Studebaker Building**

This historic brick Studebaker Building, originally built in 1925, was chosen as the location for the USGS St. Petersburg Coastal and Marine Science Center in the late 1980s. Many of the building's original features are kept intact to this day, including the Studebaker logos along the top of the building and the Studebaker distributor sign on the back of the building that is maintained in the spirit of preserving the building's history. The building was placed on the National Register of Historic Places on July 5, 1985, and the St. Petersburg Register of Historic Places in 1986.

For additional information, contact:

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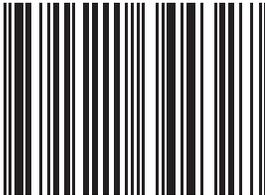
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