USGS
science for a changing world

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

in Santa Cruz, California

General Information Product 225
Version 2.0, January 2024

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

“Welcome to the Pacific Coastal and Marine Science Center!

We are one of three science centers that serve the mission of the Coastal and Marine Hazards and Resources Program, the primary Federal marine geology and physical science research program focused on the Nation’s coastal and marine landscape.

Our portfolio of coastal and marine projects in the Pacific Ocean provides the scientific information necessary to sustainably manage coastal and marine resources, to prepare for natural hazard events such as landslides and tsunamis, and to build resilience in coastal communities vulnerable to the effects of climate change, as well as storms, flooding, and risks to groundwater resources.

The Nation’s demand for societally relevant coastal and marine science has never been greater, and we invite you to explore some of our ongoing Pacific Coastal and Marine Science Center activities in these pages.”

Peter Swarzenski
Pacific Coastal and Marine Science Center
Director (Acting)
U.S. Geological Survey

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By Peter Pearsall

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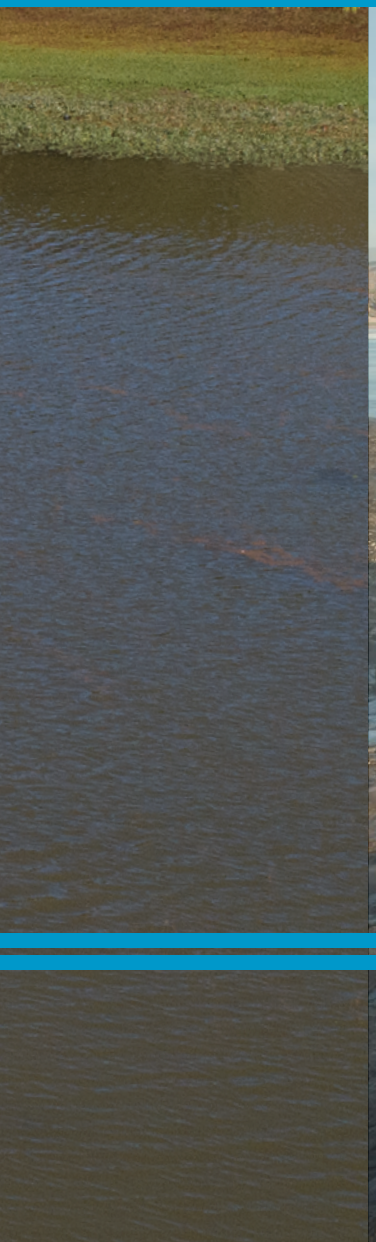
Collecting sediment cores at Searsville Lake

Scientists and engineers from the USGS Pacific Coastal and Marine Science Center (PCMSC) and Stanford University conduct sediment coring operations off the *Hadai* research vessel at Searsville Lake, near the San Andreas Fault in Stanford, California. Several projects at PCMSC involve core collection efforts in lakes and coastal marshes to better understand the effects of past earthquakes and tsunamis. By studying this geologic record of past activity, scientists can help to mitigate the risks of future geohazards. Photograph by Nona Chiariello, Stanford University.

Coastal and Marine Science in Santa Cruz, California



More than 120 million people—about 40 percent of the United States' population—live in a county bordering an ocean or the Great Lakes. As coastal populations continue to increase, more people, infrastructure, and ecosystems will be threatened by storms, tsunamis, sea-level rise, and other coastal hazards. Growing worldwide demand for natural resources will also increase our dependence on the products and services provided by coastal and marine environments.

The USGS Pacific Coastal and Marine Science Center (PCMSC) studies western U.S. coastal and offshore areas, including Alaska, Hawai'i, and other Pacific islands. Its staff of geologists, geophysicists, oceanographers, and geographers conduct research, monitor processes, and deliver products to help managers make more informed policy decisions.

https://www.usgs.gov/centers/pcmsc

Coastal Change Hazards

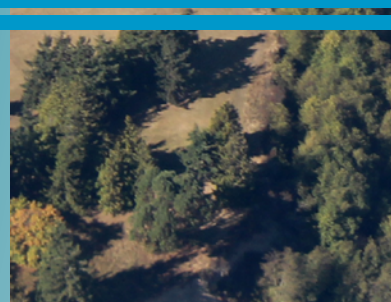
PCMSC science provides the knowledge and understanding needed to sustain U.S. coastal areas and ensure they are safe, accessible, and productive into the future. To address constantly changing and adapting coastal landscapes, the U.S. Geological Survey (USGS) conducts a wide range of research and monitoring efforts along our coasts.

At PCMSC, scientists make detailed seafloor maps of offshore geology to identify faults and underwater landslides that may cause tsunamis. Researchers develop computer models of shoreline change and sea-level rise. Understanding that powerful storms can destroy critical infrastructure and coral reefs that provide protective coastal barriers, PCMSC staff produce science that helps vulnerable coastal communities develop strategies to become more resilient.

Project:
Remote Sensing Coastal Change

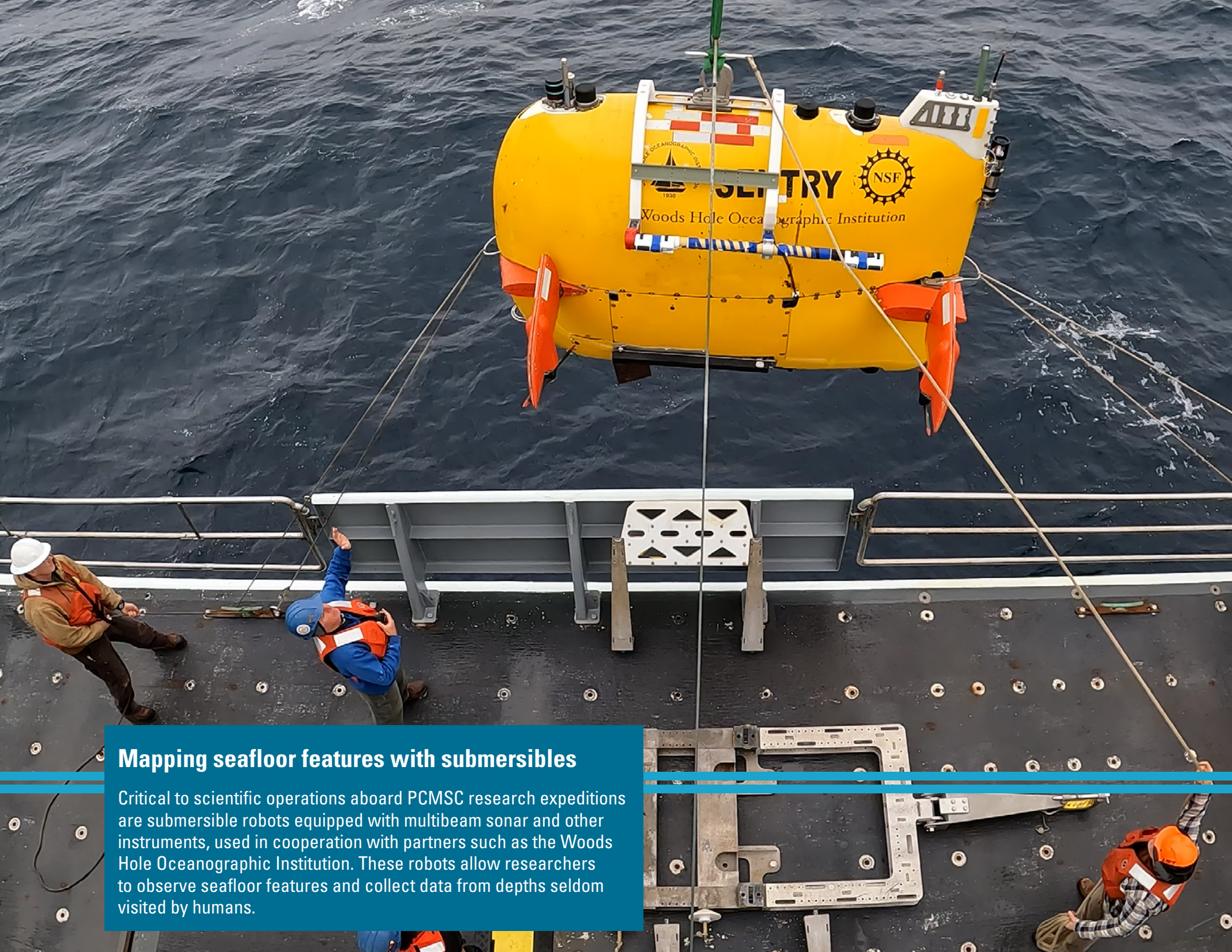
Remote-sensing technologies—such as aerial photography, satellite imagery, structure-from-motion photogrammetry, and light detection and ranging (laser-based surveying)—can be used to measure coastal change along U.S. shorelines. Quantifying coastal change is essential for calculating trends in erosion, evaluating processes that shape coastal landscapes, and predicting how the coast will respond to future storms and sea-level rise—all critical needs for U.S. coastal communities.

https://www.usgs.gov/centers/pcmsc/science/remote-sensing-coastal-change



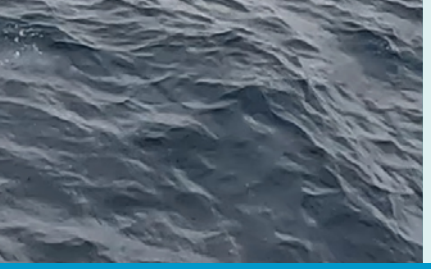
Elwha River mouth, post-dam removal

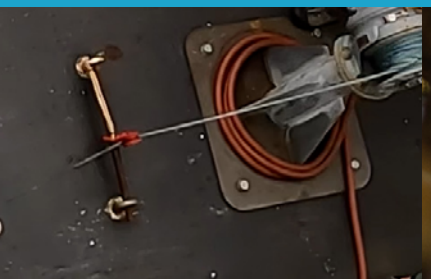
Two large dams on the Elwha River in Washington State were incrementally removed to restore river functions to this important salmon-bearing river. During early stages of the removal project, hundreds of thousands of tons of fine-grained sediment (mostly silt and sand), trapped for decades behind the dams, were released and deposited at the river mouth and in the Strait of Juan de Fuca.



Mapping seafloor features with submersibles

Critical to scientific operations aboard PCMSC research expeditions are submersible robots equipped with multibeam sonar and other instruments, used in cooperation with partners such as the Woods Hole Oceanographic Institution. These robots allow researchers to observe seafloor features and collect data from depths seldom visited by humans.





Ocean Resources

PCMSC scientists study seabed mineral occurrences, such as nodules, ferromanganese crusts, and sulfide chimneys at deep-ocean geothermal sites. Metals from such sites could be vital to U.S. energy and manufacturing needs, including emerging sustainable-technology applications. This work is part of a broader effort to better understand the mineral and energy resources within the U.S. Exclusive Economic Zone, which extends 200 nautical miles from the U.S. shoreline.

Project: Global Marine Mineral Resources

The Global Marine Mineral Resources project focuses on deep-ocean minerals within the U.S. Exclusive Economic Zone. This research concerns the setting, genesis, and metal-enrichment processes of mineral deposits, the relations between marine minerals and deep-sea biota, and the potential geochemical footprint of any seafloor mining.

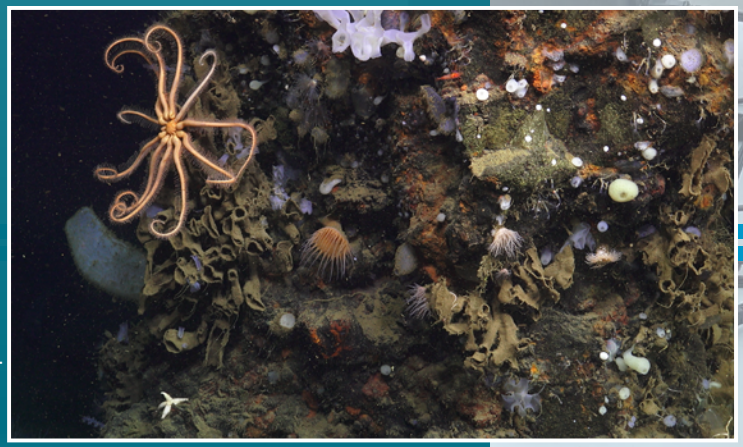
https://www.usgs.gov/centers/pcmsc/science/global-marine-mineral-resources

Coastal and Ocean Ecosystems

Researchers at PCMSC study geologic and oceanographic processes that create and maintain habitats for coral, clams, crabs, salmon, and other ocean and estuary inhabitants. PCMSC research on currents, suspended sediment, and groundwater chemistry, for example, helps assess natural and human influences on the health of coral reefs and other coastal and marine ecosystems. High-resolution seafloor mapping allows scientists to characterize seabed sediment types and identify seafloor features characteristic of hydrothermal systems and other deep-sea habitats.

Project: EXPRESS

EXPRESS, or Expanding Pacific Research and Exploration of Submerged Systems, is a multi-year, multi-institution cooperative research campaign to investigate deep-sea areas of California, Oregon, and Washington, including the continental shelf and slope. EXPRESS data and information are intended to guide wise use of living marine resources and habitats, inform ocean energy and mineral resource decisions, and improve offshore hazard assessments.



https://www.usgs.gov/centers/pcmsc/science/express-expanding-pacific-research-and-exploration-submerged-systems

Installing instruments on Ofu Island to detect groundwater plumes

As part of the Coral Reef Project, PCMSC scientists conduct geophysical and geochemical research to address questions about coastal groundwater-to-reef flow and coral reef health in American Samoa. The goal is to inform management decisions related to planning and implementing activities in priority watershed-coral reef systems.

Measuring erosion along Alaska's Arctic coast

The Arctic region is warming faster than anywhere else in the Nation. Understanding the rates and causes of coastal change in Alaska is needed to identify and mitigate hazards that might affect the region's people and ecosystems.

Climate Change Impacts

From sea-level rise and high-tide flooding to accelerated erosion and intensifying storms, climate change poses significant risks to coastal ecosystems. PCMSC scientists help coastal communities better understand climate change impacts, inform emergency responses, and provide insights to improve resilience and preserve coastal resources in the future. Researchers use on-the-ground field work, high-resolution data, and modeling to help communities understand and respond to changes in coastal landscapes.

Project: Coastal Climate Impacts

The impacts of climate change and sea-level rise around the Pacific and Arctic Oceans can vary tremendously. Thus far, the majority of national and international impact assessments and models of coastal climate change have focused on low-relief coastlines that are not near seismically active zones. Furthermore, the degree to which extreme waves and wind will add further stress to coastal systems has also been largely understudied. By working to refine this area of research, the PCMSC aims to help coastal managers and inhabitants understand how their coasts will change.

https://www.usgs.gov/centers/pcmsc/science/coastal-climate-impacts

Collecting sediment cores in West Coast lakes

The relatively undisturbed sediments of lakes along the Pacific coast preserve a seismic record dating back thousands of years, offering insights into the timing and intensity of regional seismic activity.

Offshore Hazards

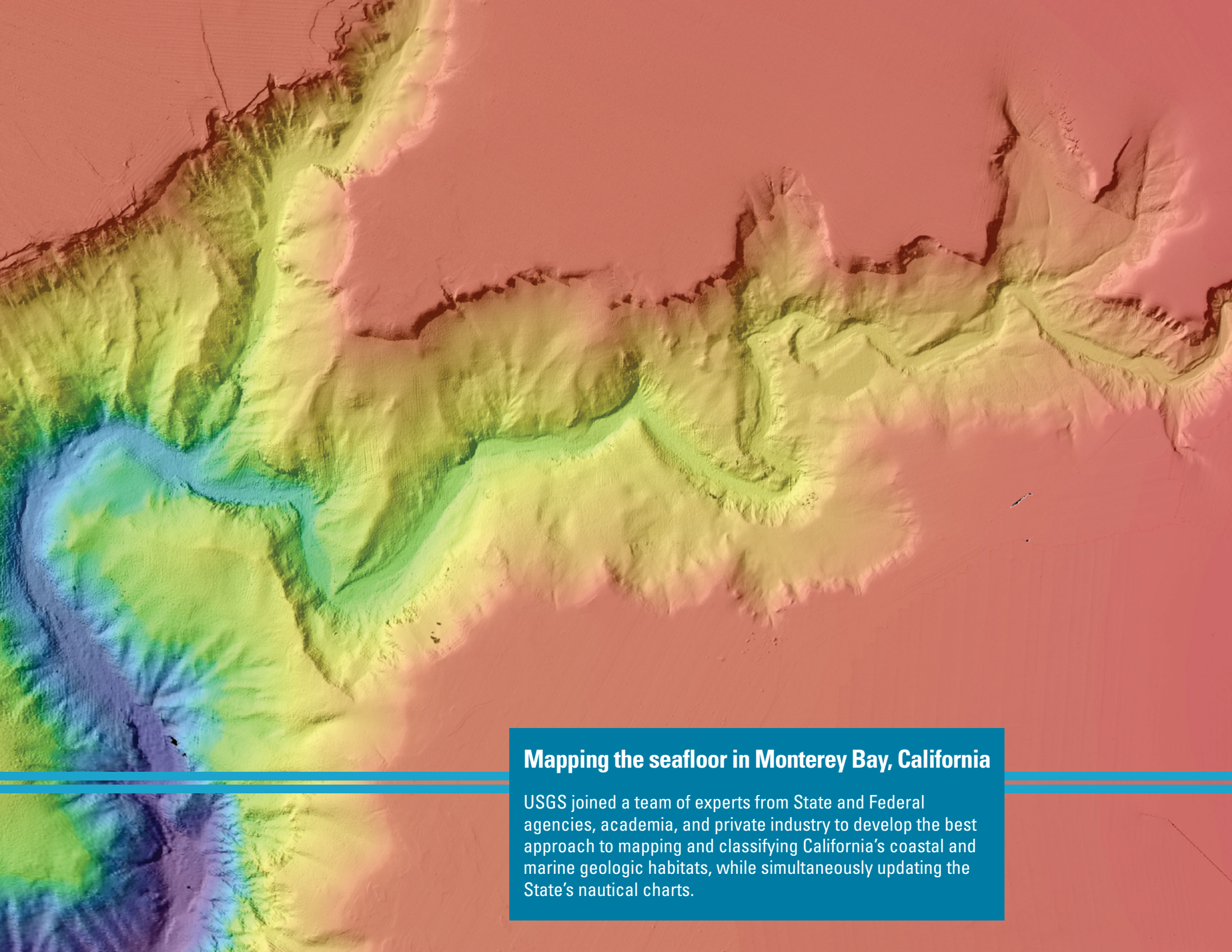
As part of the USGS Coastal and Marine Hazards and Resources Program, PCMSC scientists provide expertise to the Nation in understanding coastal hazards related to offshore earthquakes, landslides, and tsunamis that affect the United States and its territories.

PCMSC researchers work to ensure that hazard mitigation, forecasting, and planning efforts are based on scientifically sound assessments of the likelihood of loss of life, infrastructure, and property. The primary scientific goals are (1) to lead the field-going research needed to constrain geological limits of offshore earthquake, landslide, and tsunami hazards and (2) to ensure that this information is usable by major hazard assessment efforts at Federal, State, and local levels.

Project: Coastal and Marine Geohazards of the U.S. West Coast and Alaska

A fundamental tool for building robust future hazard assessments is subaqueous paleoseismology—the study of past seismic events, such as earthquakes, tsunamis, and landslides, as recorded in lake and marine sediments. To build resilience among coastal populations from future seismic events, PCSMC researchers use advanced mapping and seismic technology to gain a better understanding of how seafloor processes behaved in the past, allowing scientists to improve seismic hazard assessments for the U.S. West Coast and Alaska.

https://www.usgs.gov/centers/pcmsc/science/coastal-and-marine-geohazards-us-west-coast-and-alaska



Mapping the seafloor in Monterey Bay, California

USGS joined a team of experts from State and Federal agencies, academia, and private industry to develop the best approach to mapping and classifying California's coastal and marine geologic habitats, while simultaneously updating the State's nautical charts.

Facilities and Capabilities

The PCMSC maintains state-of-the-art laboratory facilities for rock, sediment, and geochemical analyses. The Marine Facility provides vessel operation, scientific instrument expertise, and field support for sampling and mapping. PCMSC engineers, designers, mechanics, and technicians have designed and developed specialized field equipment for use in field operations in the nearshore, in the deep sea, and on land.

Researchers at PCMSC conduct integrated mapping of the coastal and oceanic environment to define hazards and sediment processes, to support habitat and resource management, and to monitor change. PCMSC is an innovator in mapping, laboratory analyses, and field techniques, and that expertise is sought by other governmental agencies, educational institutions, and private companies.

Sediment Core Laboratory

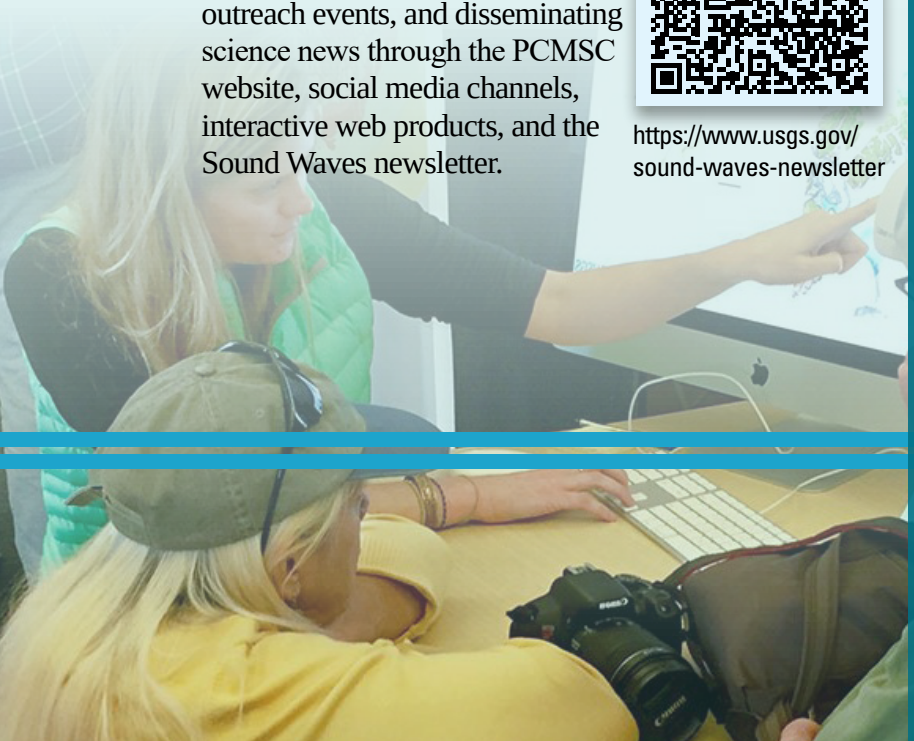
Staff at PCMSC process and analyze sediment cores collected from coastal, fluvial, estuarine, lacustrine, and marine environments. A core splitter, shrink wrap system, and wide assortment of sampling tools and balances are used for core sample preparation and analysis. Cores are cataloged and stored, along with other sediment samples, in a large walk-in refrigerated room that features library-style rolling shelving for efficient storage and easy access to all cores.

Information Sharing

The USGS provides natural science expertise and vast data holdings to its thousands of partners and stakeholders across the country. Scientists at PCMSC conduct basic and applied research so that policymakers and the public have the understanding they need to enhance preparedness, response, and resilience in a changing world.

PCMSC staff share information by maintaining local 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 the PCMSC website, social media channels, interactive web products, and the Sound Waves newsletter.

https://www.usgs.gov/sound-waves-newsletter



Project: CoSMoS

The Coastal Storm Modeling System (CoSMoS) makes detailed predictions of storm-induced coastal flooding, erosion, and cliff failures over large geographic scales. CoSMoS was developed for hindcast studies, operational applications, and future climate scenarios to provide emergency responders and coastal planners with critical storm-hazards information that can be used to increase public safety, mitigate physical damages, and more effectively manage and allocate resources within complex coastal settings.

https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos

Briefing Department leaders on coastal change hazards

USGS Research Geologist Patrick Barnard (second from left, wearing a maroon jacket) meets with former Department of the Interior Secretary Sally Jewell in San Francisco, California, to discuss coastal change hazards to communities and infrastructure.

Aerial view of the community of Unalakleet, Alaska

USGS Pacific Coastal and Marine Science Center scientists installed video cameras atop a windmill tower in Unalakleet, Alaska, pointing westward over Norton Sound, to observe and quantify coastal processes such as wave run-up, development of rip channels, bluff erosion, and movement of sandbars and ice floes. Alaska Native communities like Unalakleet are particularly susceptible to coastal change impacts.

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Photograph showing a coastal bluff at Pescadero State Beach, California. The north-central region of California's coastline is lined with coastal bluffs that have been shaped not only by runoff from rain, but also by wave- and wind-driven erosion.

Cover. Collage of images featuring USGS scientists in the field. PCMSC projects span the entire U.S. Pacific coast. In addition to studying the geophysical dynamics of rocky shorelines, sandy beaches, and estuaries along the western edge of California, Oregon, and Washington, PCMSC researchers focus on the rapidly changing permafrost bluffs in Arctic Alaska; the low-lying, reef-lined coasts of the Pacific Islands; and the depths of the sea along continental margins, where earthquakes and tsunamis originate and where marine mineral resources may occur.

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