USGS

Sound Waves Coastal and Marine Research News from Across the USGS

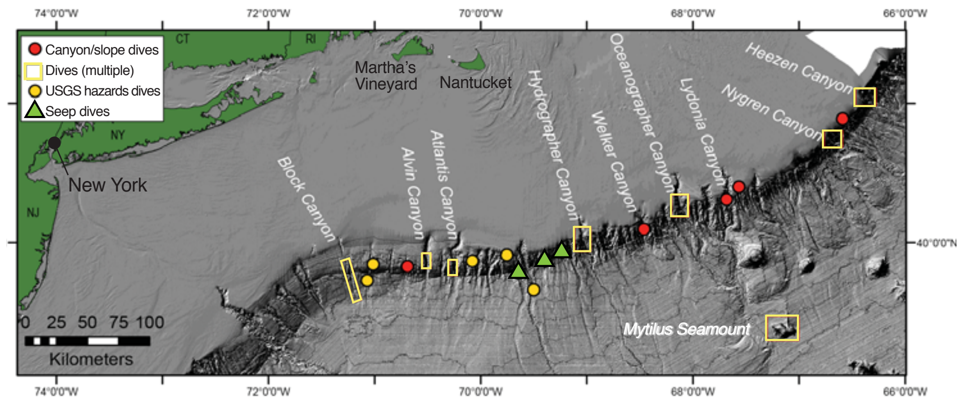
http://soundwaves.usgs.gov/

Fieldwork

Exploring Undersea Terrain Off the Northern U.S. Atlantic Coast Via Telepresence-Enabled Research Cruise

By Jason Chaytor, Amanda Demopoulos, and Carolyn Ruppel

In summer 2013, U.S. Geological Survey (USGS) scientists worked with colleagues from the National Oceanic and Atmospheric Administration (NOAA) and several academic institutions to explore submarine canyons, landslides, methane seeps, and seamounts off the northeast U.S. Atlantic coast. "Telepresence" video technology enabled many of them to participate in the expedition of the NOAA Ship *Okeanos Explorer* without actually being onboard. The goal of this two-leg, 36-day research cruise was to explore and characterize the diversity of benthic habitats and geologic features on the continental margin in this region (**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html**).



Sites visited by the National Oceanic and Atmospheric Administration (NOAA) remotely operated vehicle (ROV) Deep Discoverer *(D2) during the two legs of the Northeast U.S. Canyons Expedition 2013 (<***http://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html***>).*

The USGS participants were **Amanda Demopoulos** (science lead on leg 2; Southeast Ecological Science Center, Gainesville, Florida); **Jason Chaytor**, **Carolyn Ruppel**, **Uri ten Brink**, **Shannon Hoy**, and **Daniel Brothers** (Woods Hole Coastal and Marine Science Center, Woods Hole, Massachusetts); **Christina Kellogg** (St. Petersburg Coastal and Marine Science Center, St. Petersburg, Florida); and **Cheryl Morrison** (Leetown Science Center, Kearneysville, West Virginia).

The cruise ran from July 8 to August 16, 2013, using NOAA Ocean Exploration's two-body remotely operated vehicle (ROV) system, which consists of the *Seirios* camera sled tethered to the *Deep Discoverer* (D2) ROV, rated to 6,000 meters (20,000 feet) water depth. During 31 dives, the ROV visited ten major and minor canyons, several landslide scars, methane seeps, and Mytilus Seamount (see map). Multibeam bathymetric data (water depths) and subbottom profiles (images of sediment layers beneath the seafloor) were collected over areas of geologic interest, and full water-column CTD (conductivity [related to salinity], temperature, depth) casts were performed when the ROV was out of the water.

Amanda Demopoulos *(USGS Southeast Ecological Science Center, left) and* ***Martha Nizinski*** *(NOAA National Marine Fisheries) in the control room aboard the NOAA Ship* Okeanos Explorer *communicating with the remotely operated vehicle (ROV) team, shore-based expedition scientists, and the public. Image courtesy of NOAA* Okeanos Explorer *Program, Northeast U.S. Canyons Expedition 2013 (<***http://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html***>).*

The telepresence capability supplied by the University of Rhode Island (URI) Inner Space Center and NOAA's Ocean Exploration Research (OER) program (<**http://oceanexplorer.noaa.gov/explorations/07blacksea/background/telepresence/telepresence.html**>) enabled most USGS scientists to participate in the ROV's discoveries from their own offices and homes, or occasionally from the Exploration Command Center located at the URI Bay Campus. During each dive, imagery acquired by the ROV was supplied to ship- and shore-based participants and the public in near real-time by high-bandwidth satellite and Internet connections. OER also facilitated real-time audio and text communication among participating scientists and hosted daily teleconferences to plan dive strategies and summarize findings. USGS scientists were involved in planning specific ROV dives, advising on ROV maneuvers at the seafloor, and identifying geologic and biologic features as they were encountered by the ROV.

(Exploring via Telepresence continued on page 2)

Sound Waves

Editor
Helen Gibbons
Santa Cruz, California
Telephone: (831) 460-7418
E-mail: hgibbons@usgs.gov
Fax: (831) 427-4709

Print Layout Editors
Susan Mayfield, Sara Boore
Menlo Park, California
Telephone: (650) 329-5066
E-mail: smayfiel@usgs.gov; sboore@yahoo.com
Fax: (650) 329-5051

Web Layout Editor
Jolene Gittens
St. Petersburg, Florida
Telephone: (727) 502-8038
E-mail: jgittens@usgs.gov
Fax: (727) 502-8182

SOUND WAVES (WITH ADDITIONAL LINKS) IS AVAILABLE ONLINE AT URL
http://soundwaves.usgs.gov/

Contents

Submission Guidelines

Deadline: The deadline for news items and publication lists for the March/April issue of *Sound Waves* is Tuesday, February 4, 2014.
Publications: When new publications or products are released, please notify the editor with a full reference and a bulleted summary or description.
Images: Please submit all images at publication size (column, 2-column, or page width). Resolution of 200 to 300 dpi (dots per inch) is best. Adobe Illustrator© files or EPS files work well with vector files (such as graphs or diagrams). TIFF and JPEG files work well with raster files (photographs or rasterized vector files).

U.S. Geological Survey
Earth Science Information Sources:

Need to find natural-science data or information? Visit the USGS Frequently Asked Questions (FAQ's) at URL **http://www.usgs.gov/faq/**

Can't find the answer to your question on the Web? Call **1-888-ASK-USGS**

Want to e-mail your question to the USGS? Send it to this address: **ask@usgs.gov**

(Exploring via Telepresence continued from page 1)

The ROV dives marked the first time that many of the environments were ever examined visually. The new observations significantly enhance understanding of Atlantic continental margin areas that the USGS has studied for more than four decades. The data will also be critical to planning future USGS hazard, energy, and biology studies in the region.

Submarine Canyons

Found throughout the world, submarine canyons are complex seafloor features that cut across continental margins, linking the continental shelf to the abyssal plain and creating scenic seascapes reminiscent of their terrestrial counterparts. The steep walls and hard substrates exposed in submarine canyons serve as habitats for diverse communities of deep-sea corals, fish, anemones, sponges, crabs, and many other invertebrate species. The northeast U.S. Atlantic margin is incised by numerous major and minor submarine canyon systems cutting through sequences of sediment and rock units of Cretaceous to Pleistocene age (approximately 100 million to 2 million years old) that are mantled by a mix of fluvial and glacial sediments transported across the region since the Last Glacial Maximum (approximately 20,000 years ago). The sheer scale, complexity, and interaction of the geologic and biologic systems in these canyons and the adjacent parts of the slope require an interdisciplinary approach, involving geologists, physical oceanographers, biologists, ecologists, and modelers (for example, see *Sound Waves* articles at <**http://soundwaves.usgs.gov/2011/10/**> and <**http://soundwaves.usgs.gov/2013/06/fieldwork3.html**>).

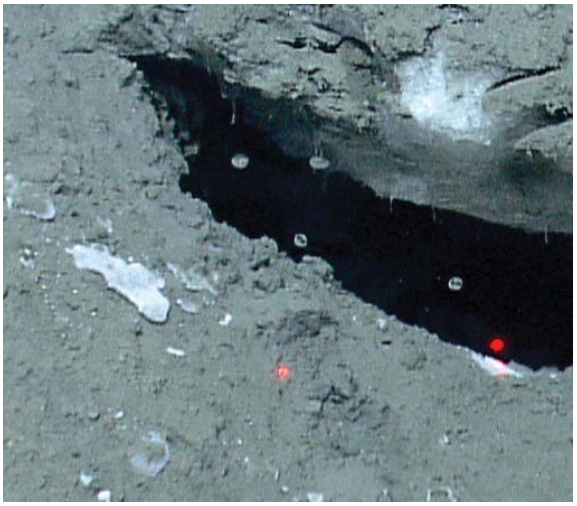
Although some canyons visited during the cruise have been previously explored via submersible dives (some conducted by USGS scientists), exploration using NOAA's D2 ROV system allowed for high-definition imaging of the margin stratigraphy exposed in the canyon walls, the long- and short-term erosion and morphological modification of the canyons, and the complex and multifaceted relationships of their geology and biology. Key observations included the distribution of different rock types; the style, timing, and size of wall collapse and sediment transport; the extensive evidence of biologic disturbance of rock and sediment and its role in erosion; and the documentation of large (tens of centimeters wide, up to meters long) burrows or fluid-transport features, many with open central apertures exposed along sections of the walls within several canyons.

(Exploring via Telepresence continued on page 3)

Layered chalk and porcellanite (?) exposed along the wall of Block Canyon. The thicker layers of chalk are heavily eroded, whereas the thin beds of porcellanite are relatively intact. Detached blocks of the wall material are visible at the bottom of the image. Image courtesy of NOAA Okeanos Explorer *Program, Northeast U.S. Canyons Expedition 2013 (<**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html**>).*

(Exploring via Telepresence continued from page 2)

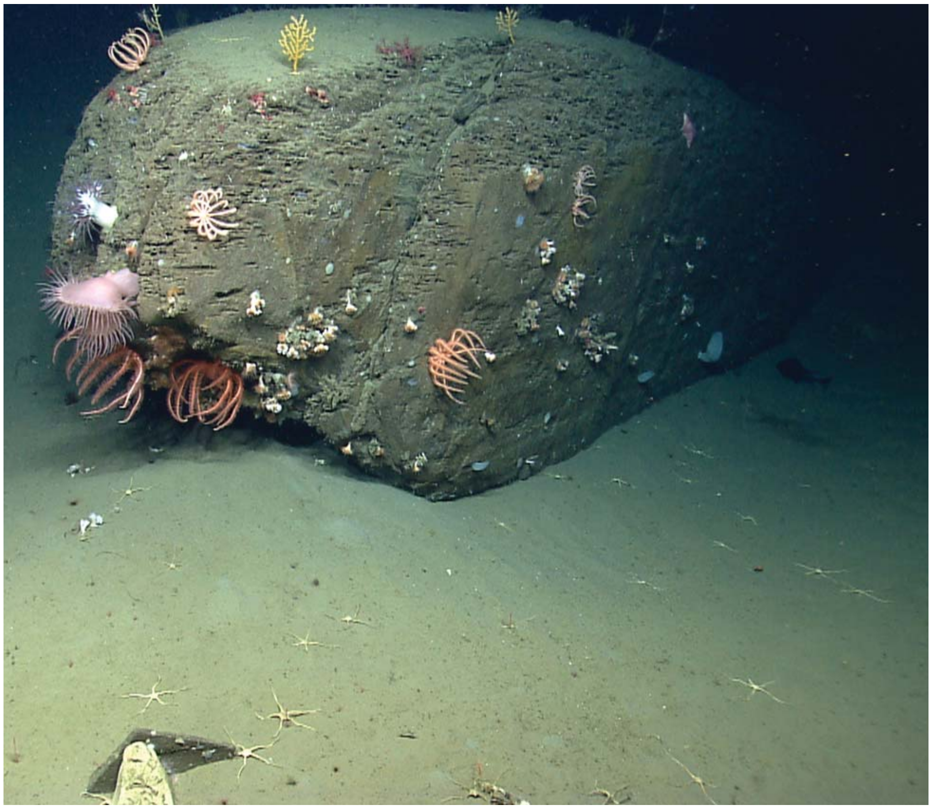
Exploring and imaging submarine canyons facilitated a better understanding of the distribution, species diversity, habitat affinities, and patchiness of enigmatic deep-sea animals. The canyons were found to contain diverse communities of habitat-forming foundation species (for example, corals and sponges) that host a wide variety of associated fauna, including, but not limited to, squat lobsters, brittle stars, shrimp, crabs, fishes, shark egg cases, and octopuses. Population size and species diversity of canyon fauna appeared to be a function of water depth, the presence and strength of bottom currents, and substrate type and morphology. Thus, the geology, biology, and ecology of submarine canyon environments are tightly intertwined.



Bubbles being emitted from a seafloor seep. A methane hydrate deposit (white icelike crystals) has formed beneath an overhanging rock above the seep. Red dots on the laser scale are separated by 10 centimeters (nearly 4 inches). Image courtesy of NOAA Okeanos Explorer *Program, Northeast U.S. Canyons Expedition 2013 (<**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html**>).*

Submarine Landslides

Five ROV dives were carried out over features related to submarine landslides being studied as part of a regional assessment of U.S. Atlantic margin landslide and tsunami hazards by USGS scientists at the Woods Hole Coastal and Marine Science Center (<**http://soundwaves.usgs.gov/2009/08/fieldwork.html**>). These dives provided the opportunity to investigate ongoing destabilization and modification of old landslide scarps and to evaluate the use of visual observations in constraining the relative ages of the most recent landslides. Between dives, the *Okeanos Explorer* conducted new high-resolution multibeam mapping and subbottom profiling in areas identified by the USGS as critical to the evaluation of landslide hazards in the region. The new bathymetric and subbottom data will aid in constraining the size and approximate age of submarine landslides along this part of the U.S. margin and assist planning for future investigations.



*Large detached block of mudstone sitting at the base of the west wall of Heezen Canyon. The block has been colonized by a host of sessile fauna, including at least two species of anemones, brisingid sea stars, sponges, cup corals, and octocorals (*Anthomastus *sp. and* Paramuricea *sp.). Scattered ophiuroids (brittle stars) were abundant on the sediment surface. Image courtesy of NOAA* Okeanos Explorer *Program, Northeast U.S. Canyons Expedition 2013 (<**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html**>).*

Methane Seeps

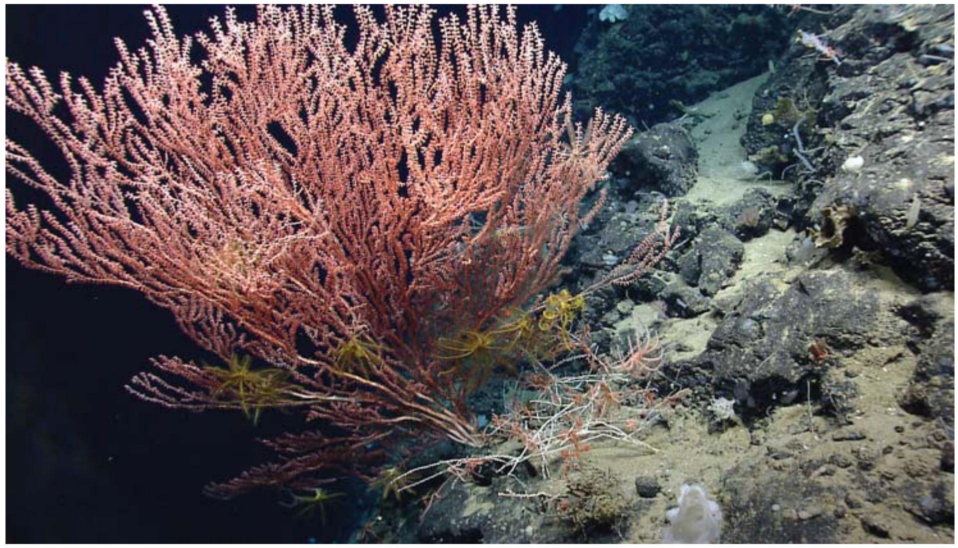
Three dives were conducted in areas hosting multiple methane seeps at more than 1,000-meter (3,000 foot) water depths on the Nantucket margin, about 165 kilometers (100 miles) south of the island of Nantucket, Massachusetts. Such deepwater seeps are always considered anomalous because they occur well within the gas hydrate stability zone, where the pressure-temperature conditions dictate that methane should combine with water to form an ice-like solid (for example, see <**http://soundwaves.usgs.gov/2012/06/**>). On the southeastern U.S. margin—off the Carolinas, Georgia, and Florida—deepwater seeps occur above salt formations that heat the sediments and break down the

(Exploring via Telepresence continued on page 4)

(Exploring via Telepresence continued from page 3)

gas hydrate, but no such salt deposits are known on the Nantucket margin.

The ROV dives confirmed that water-column anomalies discovered during a November 2012 cruise of the *Okeanos Explorer* (<**http://www.noaanews.noaa.gov/stories2012/20121219_gas_seeps.html**>) correlated with seafloor gas seeps. The ROV found gas hydrate forming at the seafloor at some seeps. The seeps were also characterized by special carbonate minerals formed as a result of anaerobic methane oxidation, mussel communities that rely on methane or hydrogen sulfide, and widespread bacterial mats. The ROV dives expanded the distribution of known gas hydrates on the northern Atlantic margin and constrained methane flux by collecting imagery that can be used to track gas-bubble sizes and emission rates. This set of dives also provided valuable information on the biodiversity of chemosynthetic communities at the newly discovered seeps and a basis for comparison with seeps that had been previously described on the southeastern U.S. margin.



Bamboo coral with numerous attached crinoids (yellow) on northern flank of Mytilus Seamount. Visible around this coral colony are a few other species of octocorals, brisingid seastars, brittlestars, and sponges. Image courtesy of NOAA Okeanos Explorer *Program, Northeast U.S. Canyons Expedition 2013 (<**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html**>).*

Mytilus Seamount

Mytilus Seamount, one of the least explored in the New England seamount chain, was visited during two dives, one on the north side and another on the south side. Seamounts represent oases of life, containing rich environments for deep-sea fauna. By systematically exploring the seafloor and surrounding area, the ROV collected critical baseline information that will be needed for better management and conservation of these environments. Stacked, manganese-coated basalt outcrops characterized the geology of the north side, whereas areas of sediment and talus accumulation were interspersed among basalt outcrops on the south side. No scleractinian (stony) corals were observed at the seamount, but several species of fishes, octocorals (which lack a stony outer skeleton), sponges, and other benthic invertebrates were documented.

More to Come

The breadth of scientific discoveries made during the recent series of ROV dives resulted from the outstanding operational support of NOAA OER and the URI Inner Space Center and the cooperation of many scientists at NOAA, the USGS, and U.S. and international academic institutions. The ROV imagery and associated data sets collected during these recent cruises, and continued collaborations as part of future exploration of the submerged margins of the United States, will provide data to support and inform aspects of the USGS science mission for years to come. ☸

The "Jetyak"—Autonomous Kayak Performs Shallow-Water Surveys

By Chris Sherwood

Boaters in the Connecticut River estuary, Connecticut, were puzzled by a seemingly driverless vessel last summer, when scientists from the U.S. Geological Survey (USGS) Woods Hole Coastal and Marine Science Center in Woods Hole, Massachusetts, and their partners from the Woods Hole Oceanographic Institution (WHOI) conducted pilot surveys with an autonomous kayak nicknamed the "jetyak." The jetyak is a relatively inexpensive vehicle that can execute various scientific missions in coastal waters. In August 2013, the scientists used it to map the floor of a shallow cove in the Connecticut River estuary with both downward-looking and sidescan sonar (see image on page 6) and to measure current profiles (current velocities at various heights above the seafloor) with an acoustic Doppler current profiler (ADCP).

The idea of developing an inexpensive autonomous surface vehicle began with ocean engineers **Hanumant Singh** and **Peter Traykovski** in the Applied Ocean Physics and Engineering Department at WHOI (<**http://www.whoi.edu/main/aope**>). They developed a prototype jetyak that was used to measure freshwater flow at the front of calving glaciers in Greenland in July 2013. The second-generation jetyak was built in summer 2013 with help from **Sara Goheen**, a USGS WHOI Summer Student Fellow (<**http://www.whoi.edu/main/summer-student-fellowship**>) coadvised by **Traykovski** and USGS oceanographer **Chris Sherwood**.

(Jetyak continued on page 5)

(Jetyak continued from page 4)

The core of the jetyak is a commercially sold gas-powered kayak built in upstate New York and marketed mostly to fishermen and hunters. It has a roto-molded polyethylene hull and an air-cooled 7-horsepower four-stroke engine. It is propelled and steered by means of a water-drive. The stock boat costs about $5,000, is 11 feet long, weighs 165 pounds, draws 3 inches, and has a payload of 360 pounds. Full speed is around 20 miles per hour, and the boat will run for 8 to 10 hours on 3 gallons of gas at survey speeds of 2 to 6 knots. Newer versions of the stock boat break into three pieces that nest together and can be transported inside an SUV or floatplane.

Modifications to make the jetyak autonomous draw on contributions from the hobbyist community. The two manual controls (throttle and steering) are replaced by servos—automatic devices that use error-sensing feedback to correct performance, such as those employed in remote-control airplanes and satellite-tracking antennas. The servos are run by an onboard computer developed for aerial drones. This computer, a modified Arduino, costs a few hundred dollars and includes Ardupilot software and a special circuit board that provides interfaces for the controls, radio, and Global Positioning System receiver (GPS). The only other modification is installation of a centrifugal clutch, which allows the engine to idle without moving the jetyak. With this setup, a "mission" (sequence of navigational waypoints) can be downloaded by radio from a laptop computer, and the jetyak will follow that mission autonomously. The boat can also be driven remotely by radio control.

The jetyak is rugged, has no propeller or other dangerous parts, and can run aground without damaging itself. The biggest operational problem is occasional clogging of the jet-drive intake with trash or weeds, which slow the boat down but can be easily removed. The simplicity that makes the vessel so sturdy and reliable, however, does have a drawback: the jetyak is not very smart and cannot, on its own, recognize or avoid hazards or obstacles. For this reason, it must be closely supervised while on a mission, particularly when other vessels (or swimmers) are in the area.

***Peter Traykovski** (Woods Hole Oceanographic Institution [WHOI]) operating the jetyak with a radio-control unit during tests in Woods Hole passage, Massachusetts. Photograph by **Ken Kostel**, WHOI; used with permission.*

*The jetyak at Pier 6 on the East River, New York. Water-jet drive (black) is visible on the stern, at bottom right. Red pole near bow supports a radio antenna; mounted silver brackets support instruments for measuring depth (Humminbird sidescan sonar, an inexpensive commercial unit marketed to recreational fishermen) and currents (Teledyne/RDI acoustic Doppler current profiler). Photograph by **Sara Goheen**, USGS WHOI Summer Student Fellow.*

The jetyak is ideal for work in areas that would be dangerous for humans, such as the calving glaciers in Greenland (see <**http://www.mokai.com/news**>); for repetitive and (or) protracted surveys that can be performed more precisely by autonomous systems than by human operators; and for data collection that increases the efficiency of field scientists conducting complementary tasks as they monitor the jetyak.

Sherwood, **Goheen**, **Traykovski**, and USGS technician **Jon Borden** used the jetyak to survey Hamburg Cove in the Connecticut River estuary from August 13 to 16, 2013. This cove is an important settling basin for sediment but was too shallow to be included in a survey conducted in fall 2012 from the research vessel (R/V) *Raphael*—a 26-foot survey vessel operated by the USGS Woods Hole

(Jetyak continued on page 6)

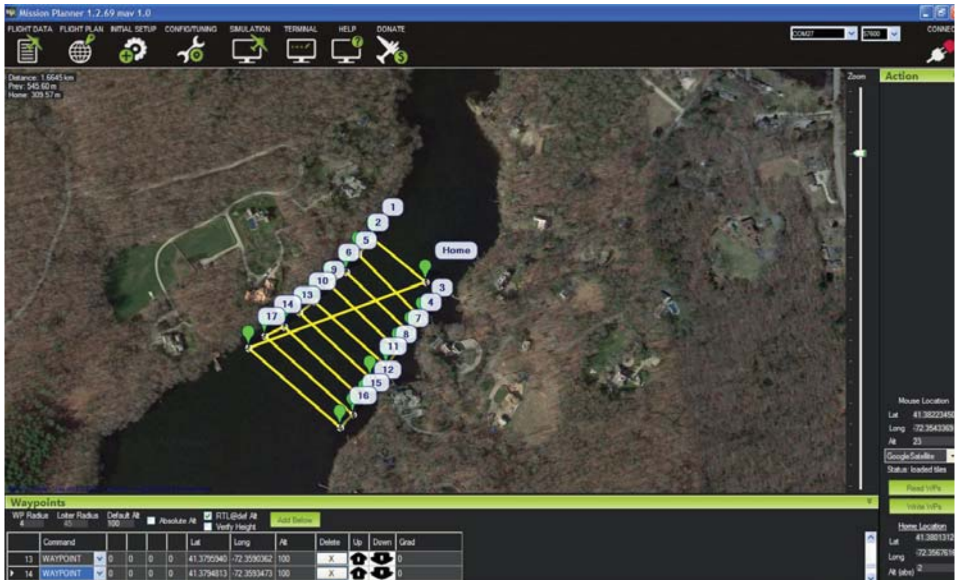
(Jetyak continued from page 5)

Coastal and Marine Science Center. (See Field Activity page at <**http://woodshole.er.usgs.gov/operations/ia/public_ds_info.php?fa=2012-024-FA**>.) During the August fieldwork, the team found that they could run the jetyak from their 16-foot skiff (the R/V *Knob*) with great efficiency. They programmed jetyak missions on the fly using Google Earth images in the Mission Planner software and easily modified the mission as conditions changed. Both vessels were equipped with relatively inexpensive sidescan sonars with integrated GPS, and thus the team had dual-vessel survey capability that could be conducted by two people. They sent the jetyak across the shallow regions while surveying the deeper parts from the skiff. In the crowded moorage basin, they drove the jetyak by radio control and enjoyed the shocked looks when the unmanned kayak motored past folks enjoying lunch on their yachts.

The jetyak has a generous capacity for batteries and scientific equipment. Over the course of summer 2013, it was deployed with various instruments, including a sidescan sonar, a 1200-KHz ADCP, a high-resolution pulse-coherent ADCP, and an RTK GPS. A scientific computer running Windows was mounted inside the jetyak and used to log data from some instruments, such as the ADCPs, using software from the manufacturers. This computer was accessed via wireless network. The prototype jetyak used by WHOI in Greenland was equipped with a davit, winch, and profiling CTD (conductivity, temperature, and depth recorder). For USGS studies, it would be easy to mount instruments to measure water-quality parameters (turbidity, pH, oxygen, chlorophyll, nitrates, and so on).

The jetyak's shallow draft makes it the ideal vessel for surveying in marshes and back-barrier lagoons. Its speed and stability allow it to operate easily in strong winds and currents. It was tested in summer 2013 in Woods Hole passage (between Woods Hole village and the Elizabeth Islands), where it surveyed supercritical flow (flow that is faster than waves can travel) with current speeds of more than 4 knots and a vertical drop in water-surface elevation of about 1 foot over a distance of about 300 feet, or about 17 feet per mile (fpm). (This is an impressive slope in the ocean; the average gradient of the Colorado River in Grand Canyon from Lees Ferry to Lake Mead is 9 fpm, and the maximum is 35 fpm.) The vessel is quite stable and runs comfortably across boat wakes and 2-foot wind waves. The autonomous navigation software is robust and surprisingly precise: the jetyak can repeat cross-channel transects with better precision than boat opera-

(Jetyak continued on page 7)



Screen grab of waypoints in Hamburg Cove, Connecticut, inserted into Mission Planner software. The jetyak can follow a sequence of waypoints, or "mission," autonomously, although operators guide the jetyak with radio control when other vessels are nearby.

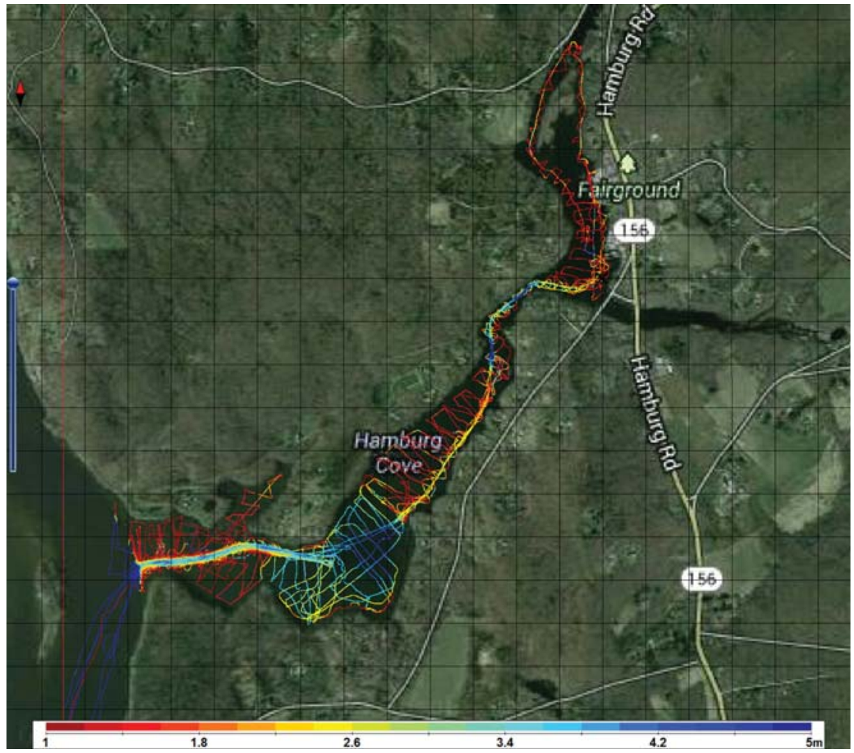
*Screen grab of image collected by jetyak's Humminbird sidescan sonar and displayed in SonarTRX software. Image shows boulders more than 2 meters (6 feet) across on the bottom of Hamburg Cove in the Connecticut River estuary, Connecticut, and a school of bait fish in the water column. (Tiny fish are easier to see in online image, <**http://soundwaves.usgs.gov/2013/12/fieldwork2.html**>.) The range displayed (vertical axis) is about 20 meters [65 feet], and the scales are the same in both vertical and horizontal directions, but the image has not been corrected for the "slant-range" distortions inherent in sidescan-sonar data (variations in scale from one side of the image to the other; see <**http://www.nrcan.gc.ca/earth-sciences/geography-boundary/remote-sensing/fundamentals/1595**>).*

(Jetyak continued from page 6)

tors, and can do it for hours on end without a lunch break. Additionally, it is remarkably inexpensive. Total cost for the jetyak, modifications for autonomous use, and survey equipment was less than $10,000.

As this article went to press, the third-generation prototype was being built for the USGS through our research cooperative agreement with WHOI and was scheduled for missions in February 2014.☸

USGS WHOI Summer Student Fellow ***Sara Goheen*** *aboard the research vessel* Knob *(a 16-foot skiff) during the survey of Hamburg Cove, Connecticut, with jetyak in background. USGS photograph by* ***Chris Sherwood****.*



Survey tracklines colored by water depth (meters) in Hamburg Cove, Connecticut, collected from the jetyak and the 16-foot skiff.

A Research Cruise to Investigate Natural Versus Human Impacts on Marine Ecosystems in Hood Canal, Washington

By Peter W. Swarzenski and Cordell Johnson

In September 2013, researchers from the U.S. Geological Survey (USGS) and the University of Washington (UW) collaborated on fieldwork in Hood Canal, a long, narrow fjord in Puget Sound, Washington. The bottom waters in parts of Hood Canal and its terminus, Lynch Cove, suffer periodic depletions in dissolved oxygen (hypoxia), which can negatively affect ecosystem health. Most fish, for example, cannot live in hypoxic water (water with less than 30 percent of the dissolved oxygen it could contain at the prevailing temperature and pressure). Oxygen depletion in the water column most commonly results from the introduction of nutrients—such as nitrogen and phosphorus—that spur the growth of algae, whose eventual decomposition by bacteria consumes oxygen. Natural nutrient sources that contribute to low bottom-water oxygen in Hood Canal—such as land-derived plant residues and animal waste—are likely enhanced by decades of widespread urbanization, agriculture, and forestry. The recent research is directed at distinguishing natural from anthropogenic controls on bottom-water oxygen depletion and other ecosystem stressors.

Loading the research vessel (R/V) Centennial *at its home port, Friday Harbor Laboratories, University of Washington, on San Juan Island, Washington.*

USGS personnel from the Pacific Coastal and Marine Science Center (PCMSC, Santa Cruz, California) and the St. Petersburg Coastal and Marine Science Center (SPCMSC; St. Petersburg, Florida) worked with colleagues from UW aboard the research vessel (R/V) *Centennial* (<**http://depts.washington.edu/fhl/fac_RVCentennialSpecifics.html**>) to collect sediment samples for their study.

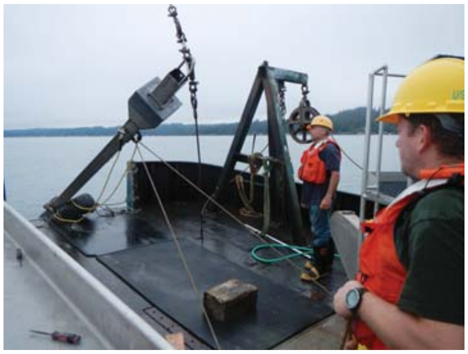
Under the direction of chief scientists **Peter Swarzenski** (USGS, PCMSC) and **Andrea Ogston** (School of Oceanography, UW; <**http://www.ocean.washington.**

(Hood Canal continued on page 8)

(Hood Canal continued from page 7)

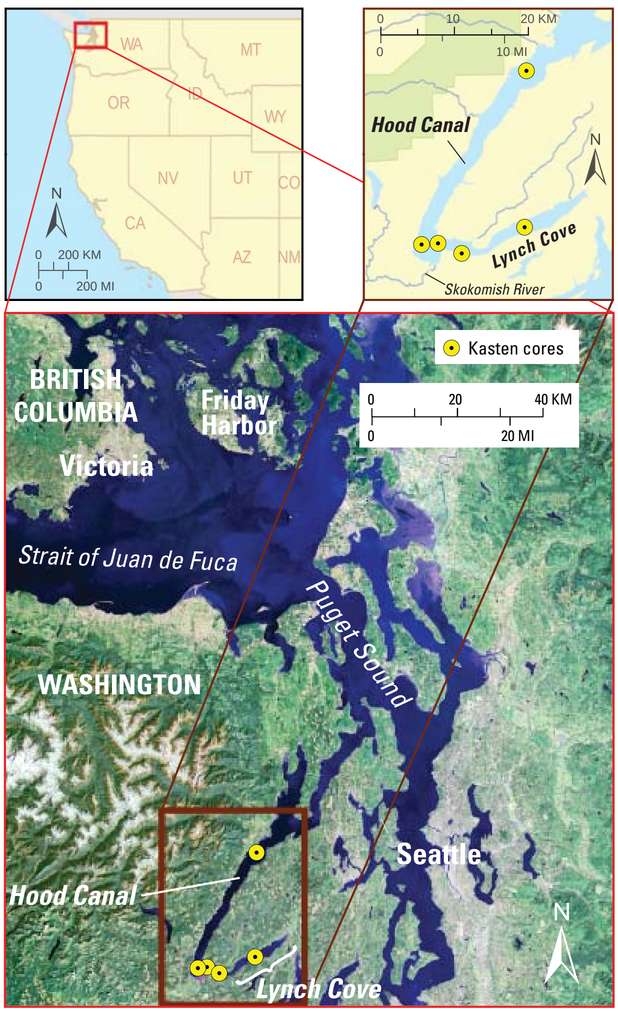
edu/home/Andrea+Ogston>), the R/V *Centennial* steamed to Hood Canal from Friday Harbor, Washington. After the vessel entered the study area, **Emily Eidam** (School of Oceanography, UW) and **Cordell Johnson** (USGS, PCMSC) assisted in collecting a series of Van Veen surface-sediment grab samples and a long kasten core.

The Van Veen grab sampler has a clamshell-type scoop that collects bottom sediment with minimal disturbance to the sediment surface (see examples of grab samplers at <**http://woodshole.er.usgs.gov/openfile/of2005-1001/htmldocs/grab.htm**>). The kasten corer has a rectangular-shaped barrel with a heavy weight at the top that helps push it into the sediment (see photographs at upper right).



Deploying a 3-meter (10 foot) kasten corer off the R/V Centennial.

A 2-plus meter (6-plus foot) kasten core of mud retrieved from Hood Canal.



Hood Canal, Washington, showing locations of kasten coring stations.

Sediment sampling continued at multiple sites seaward of the Skokomish River delta and into Lynch Cove. Coring sites were selected to aid in the interpretation of ecosystem stressors as well as the identification of sediment sources and the deciphering of delta evolution. **Elizabeth Nesbitt** and **Ruth Martin** (both from the Burke Museum of Natural History and the Earth and Space Sciences Department, UW; <**http://www.burkemuseum.org/paleontology/people_nesbitt**> and <**http://www.burkemuseum.org/paleontology/people_martin**>) took subsamples from the cores to investigate benthic infauna—animals living in the sediment—including foraminifera, single-celled organisms whose shells commonly record environmental conditions at the time of their growth. **Mary McGann** (USGS, PCMSC) and **Lisa Osterman** (USGS, SPCMSC) will examine subsets of foraminifera for evidence of invasive species (McGann) and low-oxygen events (Osterman).

Ably assisted by the captain (**David Duggins**) and crew (**Scott Lindgren**) of the R/V *Centennial*, the scientific party kept five long kasten cores and more than a dozen Van Veen grab samples. The sediment will be analyzed first for short-lived radioisotopes (for example, ^{210}Pb, ^{137}Cs, ^{7}Be) to establish a representative geochronology at each sampling site. Subsequently, a suite of analyses will include X-radiography; grain-size analysis; concentrations and isotopic compositions of carbon and nitrogen; concentrations of trace elements such as vanadium, rhenium, and uranium, which are sensitive to reduction-oxidation conditions in the sediment; and characterization of sterols and lignin phenols, which are biomarkers indicating the sources and fate of organic matter in the sediment. With the aforementioned work on foraminifera to complement these physical and geochemical analyses, the scientists hope to distinguish historical low-oxygen events from more modern processes and may also gain insight into how climate change might impact habitats and ecosystem health in Hood Canal. ☸

View toward the Olympic Mountains from the R/V Centennial *in Hood Canal, Washington.*

USGS Research to Support Hurricane Sandy Rebuilding Gets Boost from Supplemental Funds

By Christian Quintero and Clarice Nassif Ransom

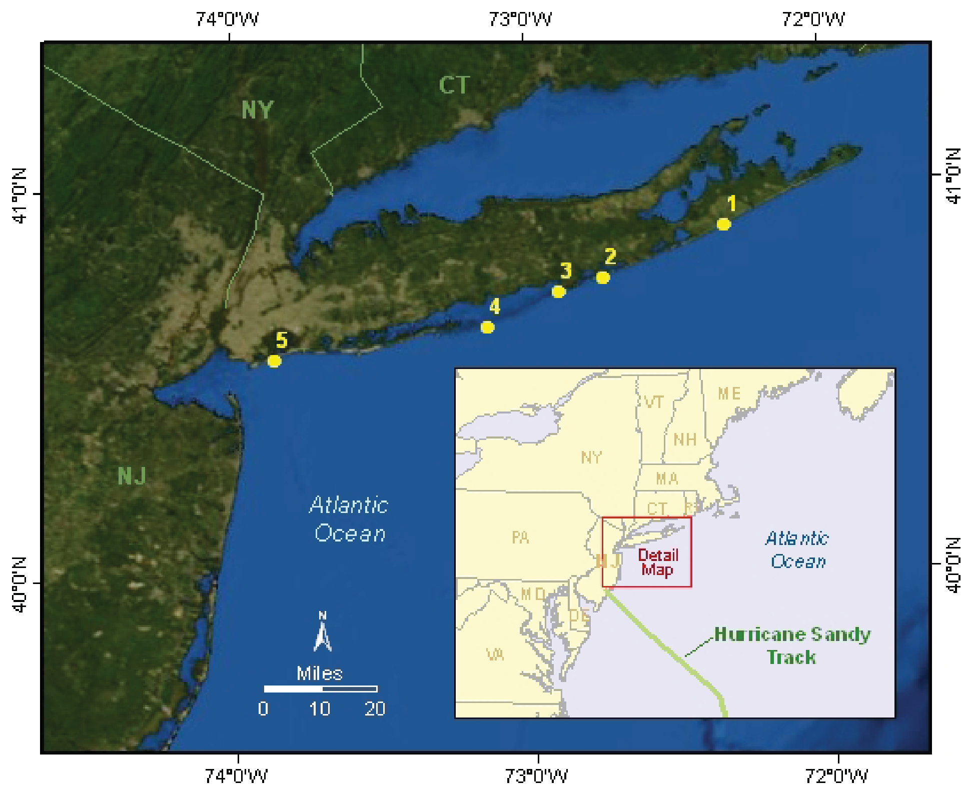
[Slightly modified from USGS Science Features: Top Story at <**http://www.usgs.gov/blogs/features/usgs_top_story/usgs-awarded-supplemental-funds-to-support-hurricane-sandy-rebuilding/**>.]

More than a year after Hurricane Sandy collided with the East coast on October 29, 2012, the U.S Geological Survey (USGS, <**http://www.usgs.gov/**>) continues to study the changes left behind in the storm's devastating path. Scientists are generating critical information to aid the recovery process of the coastal areas and to help communities become more resilient against future extreme storms.

The USGS' ability to conduct these studies got a big boost on October 24, 2013, when the Department of the Interior (DOI) announced the funding of supplemental appropriations, totaling $22.4 million, for nine USGS projects to mitigate the impacts of Hurricane Sandy and support the rebuilding process (<**http://www.doi.gov/news/pressreleases/secretary-jewell-announces-162-million-for-45-projects-to-protect-atlantic-coast-communities-from-future-storms.cfm**>). These new projects will deliver high-resolution topographical surveys; evaluations of ecosystem resiliency; enhanced storm-tide monitoring, vulnerability assessments, and data-display capabilities; documentation of coastal processes and vulnerabilities of the Fire Island (New York) and Assateague Island (off Maryland and Virginia) regions; assessments of estuarine responses to the storm and changes to barrier islands; and forecasts of biological vulnerabilities.

These funds add to the $18.8 million in DOI supplemental funds that the USGS received in May 2013 for science supporting response and recovery activities. The combined $41.2 million in supplemental funding is the largest ever received by USGS after a natural disaster.

"The understanding we gain from these studies will provide data and information to guide recovery activities and to set the stage for better models and assessments of future hazards," said USGS Acting Director **Suzette Kimball**. "It will help coastal communities be better prepared to withstand and respond to catastrophic storms."



*Long Island, New York. Fire Island is the thin barrier island just south of Long Island. The inset map shows the track of Hurricane Sandy, which made landfall on the U.S. Atlantic coast on October 29, 2012. Numbered dots are sites for which the USGS has posted pre- and post-storm photographs (sites 1 through 5) at <**http://coastal.er.usgs.gov/hurricanes/sandy/photo-comparisons/**>, and pre- and post-storm elevation maps (sites 3 and 4) at <**http://coastal.er.usgs.gov/hurricanes/sandy/lidar/**>.*

The USGS is collaborating with stakeholders in the affected areas and with other agencies to carry out a science plan (<**http://pubs.usgs.gov/circ/1390/**>) focusing on:

- Coastal topography and bathymetry (<**http://pubs.usgs.gov/fs/2013/3099/**>)
- Coastal-impact assessments (<**http://pubs.usgs.gov/fs/2013/3090/**>)
- Impacts of storm surge (<**http://pubs.usgs.gov/fs/2013/3092/**>)
- Impacts of environmental quality and persisting contaminant exposures (<**http://pubs.usgs.gov/fs/2013/3091/**>)
- Impacts to coastal ecosystems, habitats, and fish and wildlife (<**http://pubs.usgs.gov/fs/2013/3096/**>)
- New York and its heavily affected areas (<**http://pubs.usgs.gov/fs/2013/3089/**>)

Coastal Topography and Bathymetry

Hurricane vulnerability is, in large part, a consequence of coastal elevation. Accurate, up-to-date elevation data are vital to coastal communities that are preparing response strategies, anticipating impacts, or planning post-storm redevelopment.

The USGS is collecting high-resolution elevation data that will support scientific

(Sandy Research continued on page 10)

(Hood Canal continued on page 10)

Research, continued

(Sandy Research continued from page 9)

studies related to hurricane recovery and rebuilding activities, watershed planning, and resource management. It also aims to create a Coastal National Elevation Dataset, including data for Sandy-affected regions, which will compile topographic and bathymetric elevation data from multiple sources.

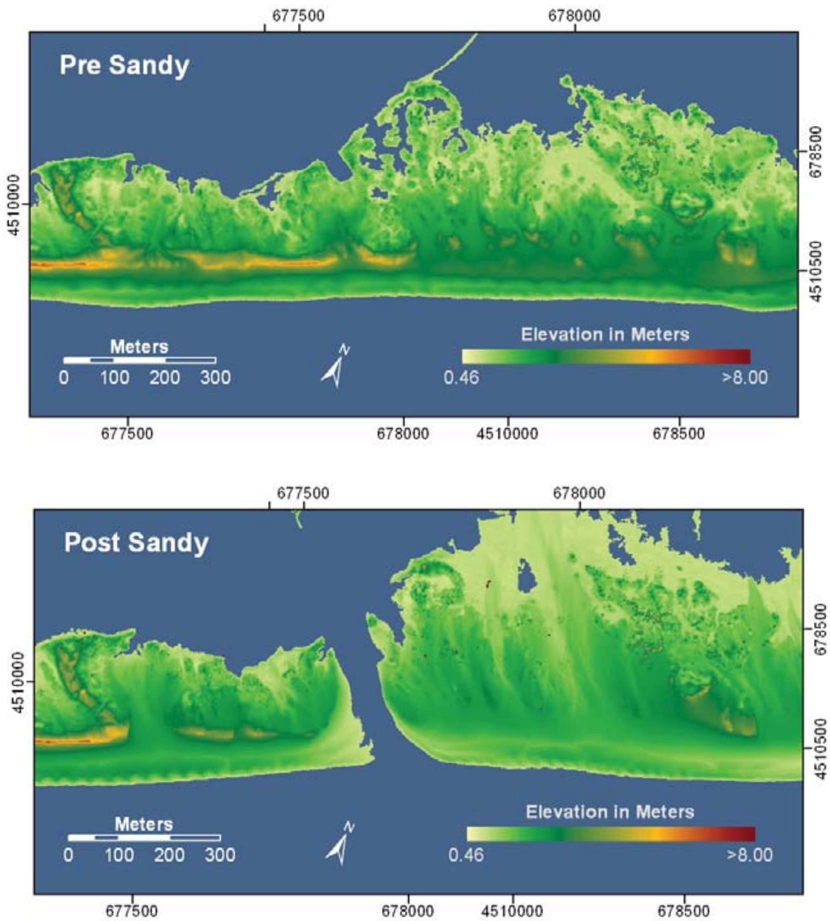
The post-Sandy data will be instrumental in guiding recovery activities, assessing impact, forecasting coastal vulnerability, and establishing new baselines for events and decisions. The funding announced in October will expand the geographic area being surveyed and provide more than 11,000 square miles of data, including coverage of many national parks, wildlife refuges, and tribal lands. The USGS will continue to coordinate with other DOI agencies and Federal, State, and local partners to ensure that additional data collections meet multiple agency needs.

Coastal Impact Assessments

The Nation's coast, which is fringed by beaches, dunes, barrier islands, wetlands, and bluffs, is its first line of defense against major storms. An accurate representation of these barriers is necessary to make informed decisions on recovery and rebuilding.

Sandy has transformed the shores and barrier islands from North Carolina through New York, New Jersey, and Massachusetts. Its waves and surges eroded and overtopped protective dunes and beaches.

The USGS will provide pre- and post-storm mapping of coastal impacts and vulnerability using photographic surveys and airborne lidar (light detection and ranging) flights, which use lasers to make closely spaced measurements of elevations of the Earth's surface. (Read about some of the earliest of these surveys in "USGS Scientists Predict, Measure Sandy's Impacts on the Coastal Landscape," *Sound Waves*, November/December 2012, <**http://soundwaves.usgs.gov/2012/12/**>.) USGS scientists will evaluate, improve, and deliver coastal-impact-forecast models that will provide information critical to identifying areas vulnerable to extreme erosion. The USGS will also provide online access to coastal-impact assessments and data.



*Pre- and post-storm elevations on Fire Island, New York, at site 3 on location map (previous page), derived from lidar (light detection and ranging) data. This site is within Fire Island National Seashore near Old Inlet—an extremely narrow part of the island that has undergone breaching in previous large storms. The island breached during Sandy, creating a new inlet, eroding the beach, and cutting through dunes 4 meters (13 feet) high. Images from <**http://coastal.er.usgs.gov/hurricanes/sandy/lidar/**>.*

The new funding enables key studies for Fire Island, New York, and its surrounding region, and the Assateague Island barrier system off Maryland and Virginia. The studies will include not only beach nourishment and inlet management, but also the development of predictive models used to identify coastal hazards. Emergency responders and coastal managers will benefit from this information because it will allow them to effectively direct response and recovery resources to the areas that will be most vulnerable during future storms.

Impacts of Storm Surge

The storm surge created by Hurricane Sandy's winds was the primary cause of destruction. The surge, which peaked at more than 19 feet, caused damage to the landscape and transported saltwater, sediment, and debris to areas rarely touched by the ocean.

Models predicting the level of the storm tide at the coast generally were accurate, but predictions of the extent, depth, and severity of the storm tide across the land surface were not uniformly accurate. In several instances, the impacts of the storm tide were higher than expected. The USGS will help improve how coastal communities respond and recover from the next coastal storm by focusing efforts on storm-tide data collection, data delivery, data networks, and data analysis.

The main goal of storm-surge response and data collection is to ensure that coastal regions are prepared for upcoming natural

(Sandy Research continued on page 11)

(Sandy Research continued from page 10)

hazards. The USGS upped its data collection in the Northeast and Mid-Atlantic States, and it will increase the amount of storm-tide data transmitted in real time.

New funding will increase the availability of monitoring instrumentation and real-time transmission. It will also help USGS personnel develop a more robust and functional database and webpage to display the real-time and recovered storm surge and wave data. These improvements in data transmission and display enhance the USGS capacity to monitor water levels, storm surge, and storm waves to meet requirements for improved hazard planning and response.

*Oblique aerial photographs of Ocean Bay Park, Fire Island, New York (site 4 on location map, page 9), before and after Hurricane Sandy. Photo pair from <**http://coastal.er.usgs.gov/hurricanes/sandy/photo-comparisons/**>.*

Impacts of Environmental Quality and Persisting Contaminant Exposures

Low-elevation coastal areas damaged by storm surge or river floodwater are susceptible to chemical and microbial contaminants. During Hurricane Sandy, multiple wastewater treatment facilities failed for prolonged periods, which allowed the release of raw sewage into the environment. Public health agencies were advised to disinfect the water, but the long-term effect of the releases is undetermined. Debris from the surrounding environment is also a concern. Changes to bays and other water bodies can affect salinity levels, fisheries and shellfish habitats, and contaminant exposures.

First responders focused their efforts on repairing immediate threats. Now, USGS scientists are studying the potential for long-term effects. Scientists are testing environmental samples from affected coastal areas in New York and New Jersey for toxic contaminants, which may still be harmful to the ecosystem.

The USGS is also focused on the potential long-term effects of contaminants on humans. Similar to the ecologically focused study, the human-focused study begins where first responders stopped. Together these strategies will support long-term cleanup efforts along the coasts.

Impacts to Coastal Ecosystems, Habitats, and Fish and Wildlife

Natural coastal ecosystems are valuable because they provide many benefits, such as reducing the force of storms, mitigating pollution from storms, and providing food and shelter to many species, especially coastal birds. USGS expertise will be used to assess Hurricane Sandy's impact on wetland integrity (ability to recover from disturbance); waterfowl and migratory birds; wetland conditions and food supply for birds; and coastal forests.

New work the USGS will do with the additional supplemental funds includes evaluating ecosystem resiliency and forecasting biological vulnerabilities. This work entails developing a more powerful web-based modeling tool that helps scientists better manage and store their complex data and display it in ways decision makers can use.

Moving Forward

It's hard to imagine that it has been little more than a year since Hurricane Sandy's brutal collision with some of the most heavily populated areas in the Nation. The powerful landscape-altering destruction of Hurricane Sandy is a stark reminder of why the Nation must become more resilient to coastal hazards. The storm's effects will be felt for many years to come. The USGS is committed to producing the science that will help the Nation respond to and mitigate future storm damage. ❆

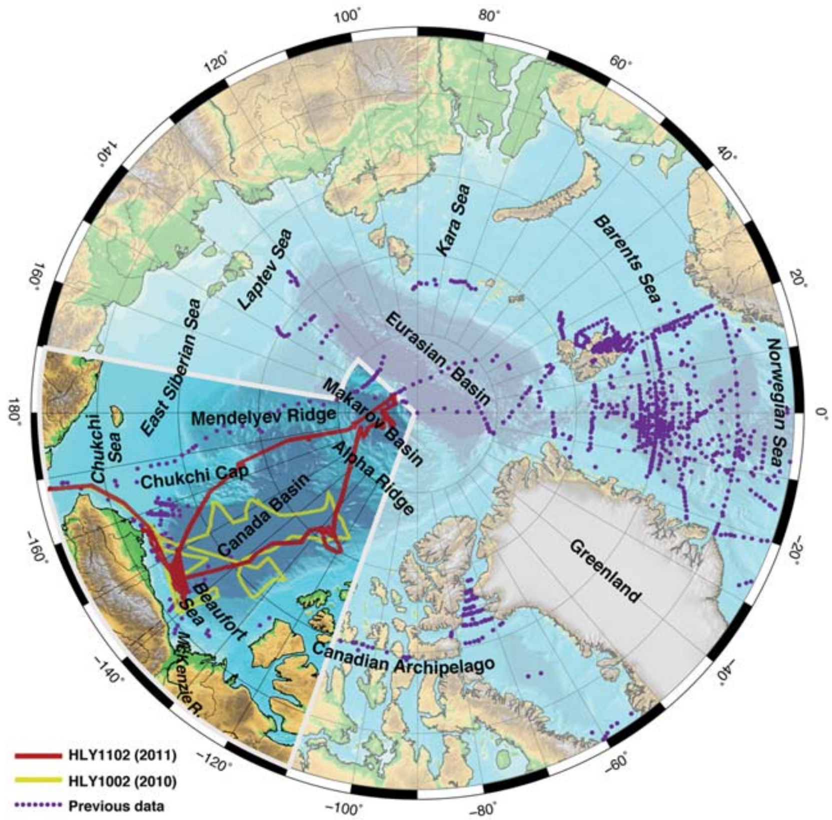
Watch for "Spotlight on Sandy," featuring updates on USGS Hurricane Sandy research, in future issues of *Sound Waves*.

USGS scientist recovers a storm-surge sensor after Hurricane Sandy in Annapolis, Maryland.

Unprecedented Rate and Scale of Ocean Acidification Found in the Arctic

By Lisa Robbins (USGS) and Jonathan Wynn (University of South Florida)

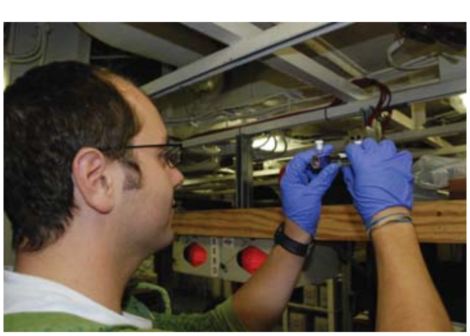
Acidification of the Arctic Ocean is occurring faster than projected, according to new findings published in September 2013 in the journal *PLOS ONE* (<**http://dx.doi.org/10.1371/journal.pone.0073796**>). The increase in rate is being blamed on rapidly melting sea ice, a process that may have important consequences for health of the Arctic ecosystem.



Arctic Ocean, showing locations of seawater chemical measurements from research cruises aboard the U.S. Coast Guard Cutter Healy *in 2011 (HLY1102) and 2010 (HLY1002), as well as previous work. Sources of previous data are listed in caption for figure 1 in the PLOS ONE paper at <**http://dx.doi.org/10.1371/journal.pone.0073796**>.*

Ocean acidification is the process by which pH levels of seawater decrease because of greater amounts of carbon dioxide (CO_2), an important greenhouse gas, being absorbed by the oceans from the atmosphere. Currently, oceans absorb about one-fourth of the CO_2 released into the atmosphere each year. Lower pH levels make water more acidic, and lab studies have shown that more acidic water decreases calcification rates in marine organisms that build shells or skeletons (for example, see "Coral Reef Builders Vulnerable to Ocean Acidification," *Sound Waves*, March 2008, <**http://soundwaves.usgs.gov/2008/03/research.html**>). These changes, in organisms ranging from corals to shrimp, have the potential to impact species throughout the food web.

A team of Federal and university researchers found that the decline of sea ice in the Arctic summer has important consequences for the surface layer of the Arctic Ocean. As sea-ice cover recedes to record lows, as it did late in the summer of 2012, the seawater beneath is exposed to atmospheric CO_2, which is the main driver of ocean acidification. In addition, the freshwater melted from sea ice dilutes the seawater, lowering pH levels still further and reducing the concentrations of calcium and carbonate ions, which are the constituents, or building blocks, of the mineral aragonite. All of these chemical changes lower the "saturation state" of seawater with respect to aragonite. This chemical index is defined in such a way that if the saturation state for a given mineral is greater than 1, the seawater is "supersaturated" and the mineral will not readily dissolve; but if the saturation state is less than 1, the seawater is "undersaturated" and the mineral will dissolve. Aragonite and other carbonate minerals make up the hard part of many marine microorganisms' skeletons and shells. The lowering of saturation states for these minerals may impact the growth of such organisms and the many species that rely on them for food.



Brian Buczkowski *of the USGS Woods Hole Coastal and Marine Science Center uses a benchtop spectrometer to measure carbonate ion (CO_3^{2-}) concentration in a seawater sample during the 7-week 2011 research cruise in the Arctic Ocean aboard the U.S. Coast Guard Cutter* Healy. *USGS photograph by* ***Lisa Robbins****.*

Globally, Earth's ocean surface is becoming acidified by the absorption of manmade CO_2. Ocean acidification models project that with increasing atmospheric CO_2, the Arctic Ocean will become undersaturated with respect to carbonate minerals in the next decade. In the recently published *PLOS ONE* paper, Robbins and the ocean acidification team members show that acidification in surface waters of the Arctic Ocean is happening faster than expected and is rapidly expanding into areas that were previously isolated from contact with the atmosphere by the former widespread ice cover. Already, approximately 20 percent of the Canada Basin, a deep basin in the Arctic Ocean,

(Arctic Ocean Acidification continued on page 13)

(Arctic Ocean Acidification continued from page 12)

has become undersaturated with respect to aragonite in a time frame faster than models predicted. In fact, the new data indicate that undersaturation with respect to aragonite is occurring 30 times faster in the Arctic than in the Pacific Ocean. Nowhere else on Earth has such large-scale, rapid ocean acidification been documented.

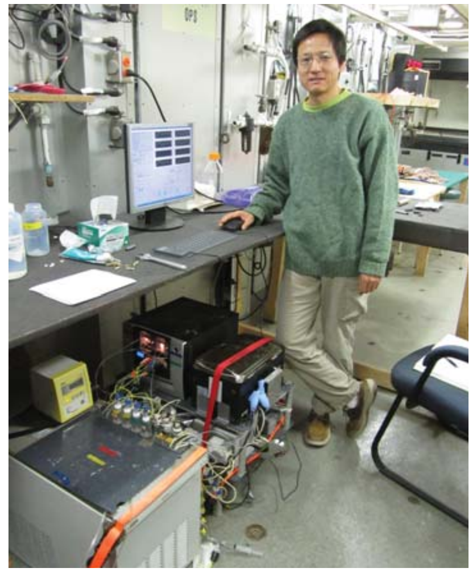
The rapidity of ocean acidification in the Arctic is a result of climate change accelerating the melting of multiyear sea ice (ice that has survived more than one melting season) and the subsequent dilution of seawater. Not only is the ice cover removed, leaving the surface water exposed to manmade CO_2, the surface layer of frigid waters is now fresher, and this means that lower concentrations of calcium and carbonate ions are available for organisms. Researchers measured oxygen isotopes in the water to distinguish seawater, meltwater, and river runoff. This critical piece of information was used to document the extent of the meltwater: more than 370,000 square kilometers (140,000 square miles), an area the size of the State of Montana. The oxygen isotope data show that the freshwater from sea-ice melt is most closely linked to zones of carbonate mineral undersaturation.

Compared with other oceans, the Arctic Ocean has been rather lightly sampled. The remoteness and extreme temperatures make it a challenging place to work and require instruments adapted to the harsh climate. The ocean acidification team was fortunate to work aboard the U.S. Coast Guard Cutter *Healy*, a polar icebreaker designed to support scientific research. The team investigated the chemistry of seawater continuously collected by the ship's flow-through system, which takes in water from a port in the hull about 8 meters (26 feet) below the waterline. They were able to use new automated instruments that provided high spatial resolution by automatically analyzing seawater continuously every 2–7 minutes while the *Healy* was underway. The team also analyzed samples collected from the flow-through system at discrete locations. More than 34,000 water-chemistry measurements were made during 3 years of research cruises on the *Healy* in the Arctic Ocean.

"This unusually large data set, in combination with earlier studies, not only documents remarkable changes in Arctic seawater chemistry but also provides a much-needed baseline against which future measurements can be compared," said **Robert Byrne**, a marine chemist at the University of South Florida (USF). He credits scientists and engineers at the USF College of Marine Science with developing much of the new underway technology, such as the Multiparameter Inorganic Carbon Analyzer (MICA). The MICA is capable of simultaneously analyzing three chemical parameters in seawater collected while a vessel is underway: pH, total dissolved inorganic carbon, and partial pressure of CO_2 (a measure of its content in the water, abbreviated pCO_2). (Read about early uses of the MICA in "Research Cruises Collect Measurements on the West Florida Shelf for Modeling Climate Change and Ocean Acidification," *Sound Waves*, April 2009, <**http://soundwaves.usgs.gov/2009/04/fieldwork2.html**>.)

On the *Healy*, the ocean acidification researchers worked alongside other researchers involved in joint U.S.-Canada efforts to map the seafloor as part of the U.S. Extended Continental Shelf (ECS) Project (<**http://continentalshelf.gov/**>). The ocean acidification research was funded by the USGS, the National Science Foundation, and the National Oceanic and Atmospheric Administration.

Sun over the Arctic Ocean as viewed from atop the bridge of the U.S. Coast Guard Cutter Healy. *Photograph taken August 2012 by* ***Jonathan Wynn****, University of South Florida.*



Xuewu (Sherwood) Liu *of the University of South Florida (USF) checks on the Multiparameter Inorganic Carbon Analyzer, or MICA (assembly of boxes, tubes, and wires on the floor), during the 2010 research cruise in the Arctic Ocean aboard the U.S. Coast Guard Cutter* Healy. *Developed at USF under the leadership of* ***Robert Byrne****, the MICA continuously measures partial pressure of* CO_2 *(*pCO_2*), pH, and total dissolved inorganic carbon of seawater sampled from an onboard flow-through system. USGS photograph by* ***Helen Gibbons****.*

Data sets for the 2010 and 2011 cruises are posted at: <**http://pubs.usgs.gov/ds/741/pubs741/**> (2010) and <**http://pubs.usgs.gov/ds/748/pubs748/**> (2011).

Information on the 2012 Arctic research cruise is available on the USGS Ocean Acidification website (<**http://coastal.er.usgs.gov/ocean-acidification/polar.html**>), and you can follow the research on Twitter @USGSArctic (<**https://twitter.com/USGSArctic**>).

The full citation for the recent report is:

Robbins L.L., Wynn, J.G., Lisle, J.T., Yates, K.K., Knorr, P.O., Byrne, R.H., Liu, X., Patsavas, M.C., Azetsu-Scott, K., and Takahashi, T., 2013, Baseline monitoring of the western Arctic Ocean estimates 20% of Canadian Basin surface waters are undersaturated with respect to aragonite: PLOS ONE, v. 8, no. 9, e73796, doi:10.1371/journal.pone.0073796 <**http://dx.doi.org/10.1371/journal.pone.0073796**>.

Travels with Sediment in the San Francisco Bay, Delta, and Coastal System

Special Issue of *Marine Geology* Focuses on Complex Urbanized Estuary and Coast

By Barbara Wilcox and Helen Gibbons

[Slightly modified from USGS Science Features: Top Story at <**http://www.usgs.gov/blogs/features/usgs_top_story/travels-with-sediment-in-the-san-francisco-bay-delta-and-coastal-system/**>.]

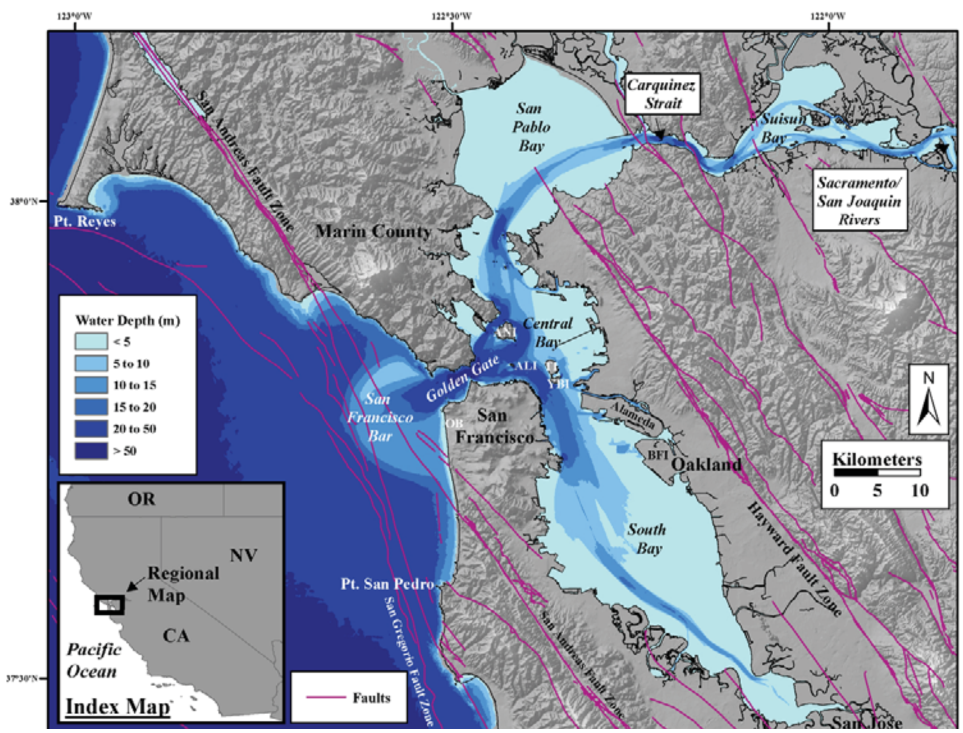
Wherever water flows, it almost always carries sediment—particles of sand, silt or clay that flow, scour, accumulate and disperse to help form and reform Earth's features over time. Sediment helps to create natural habitats and to alter geography, and an understanding of its complex processes is key to many planning and conservation decisions.

In the San Francisco Bay Area—an estuarine region defined by its bay, rivers, delta and coast—sediment plays a particularly major role. Sediment helps shape the Bay Area's quality of life, from its water quality to its coastal beaches to the ongoing restoration of its tidal wetlands. Dams, dredging and a legacy of hydraulic mining have left their marks on the Bay Area's system of "sediment transport"—the scientific term for the water-borne movement of sediment from place to place—making U.S. Geological Survey science crucial to charting the potential impacts of future human interventions. Yet the Bay Area's complex sediment-transport processes have never before been comprehensively studied on a regional scale.

The first ever compilation of research focused on sediment transport in the San Francisco Bay coastal system was published in November as a special issue of the journal *Marine Geology*, edited by USGS scientists. The volume's 21 papers from USGS and other research scientists investigate this complex and ever-changing system through the lenses of hydrology, chemistry, ecology and many other disciplines. The authors characterize how water-borne sand and mud affect not just local landforms and hydrology but also environments hundreds of miles away, through the Golden Gate to the Pacific Ocean and beyond. The research will help planners manage resources

(Sediment Transport continued on page 15)

USGS personnel surveying the bathymetry offshore of Crissy Field in San Francisco, California, in 2008. They are using the Coastal Profiling System—personal watercraft equipped with echo sounders and kinematic Global Positioning System (GPS) units. The Golden Gate Bridge is in the background. USGS photograph by ***Tom Reiss****.*



The San Francisco Bay coastal system, including major tributaries. Fault lines from Quaternary Fault and Fold Database of the United States *(<**http://earthquake.usgs.gov/hazards/qfaults/**>). ALI = Alcatraz Island, ANI = Angel Island, BFI = Bay Farm Island, OB = Ocean Beach, TI = Treasure Island, YBI = Yerba Buena Island. Figure 1 of "Sediment transport in the San Francisco Bay coastal system: An overview," by Patrick L. Barnard, David H. Schoellhamer, Bruce E. Jaffe, and Lester J. McKee, in* Marine Geology *special issue (volume 345) released November 2013.*

(Sediment Transport continued from page 14)

of benefit to more than 25 million Californians.

"The interaction of natural and anthropogenic drivers of sediment transport is highly complex in this heavily urbanized region, and understanding it is critical to the efficient management of sediment resources that affect beaches, tidal-wetland restoration, and sensitive ecosystems throughout the region," said **Patrick Barnard**, USGS coastal geologist and managing guest editor of the special issue. "We hope that this special issue will be instrumental in guiding management decisions for years to come."

A History of Sediment

In the late 19th century, the high-pressure jets of water used for hydraulic gold mining pulverized large swaths of the Sierra Nevada foothills and sent trillions of cubic feet of gravel, sand, and mud 150 miles downstream into San Francisco Bay and then into the Pacific Ocean. The sediment changed local landforms by building out Bay shorelines and tidal wetlands, accreting river channels, and adding to the huge, submerged sand bar outside the Golden Gate. This gigantic sediment pulse has taken more than a century to flow through the system. Now

*View of gold miners excavating an eroded bluff with jets of water at a placer mine in Dutch Flat, California, between 1857 and 1870. Public domain image (<**http://en.wikipedia.org/wiki/File:X-60072.jpg**>).*

that the Gold Rush sediment is on its way out and the water is clearer, scientists are evaluating how the Bay Area's natural processes and quality of life will change.

Biological Effects

Sediment influences how hospitable water is to certain organisms. Sediment-laden waters are preferred by some wildlife species, notably the endangered Delta Smelt. In the Bay Area, sediment suspended in bay and delta water has also performed the welcome function of making the water less prone to algal blooms. As the water's sediment content has declined in the last couple of decades, its algae count has risen. This phenomenon has been most pronounced in El Niño years of heavy rain. Discharges or diversions of water from various parts of California's complex water-resources infrastructure can also affect this sensitive balance. To understand the ever-shifting water and sediment dynamics of the San Francisco Bay and delta, and to help managers plan, the USGS deployed automated instruments that have continually measured suspended-sediment concentration, temperature, salinity, and water level at many sites throughout the bay and delta since the 1980s, producing the longest continuous estuarine water-quality data set in history and a model for water-quality monitoring programs throughout the world.

"The USGS data set is a cornerstone of our Federal, State, and local agency collaborative monitoring program," said **Thomas Mumley**, Assistant Executive Officer of California's San Francisco Bay Regional Water Quality Control Board (<**http://www.waterboards.ca.gov/rwqcb2/**>). "It continues to inform major management actions and decisions on water-quality control, dredging, and habitat restoration."

Physical Changes

Complementing sediment's biological effects are its physical effects. Sediment carried through the bay to the Pacific nearshore replenishes beaches eroded by coastal waves. In the far north and south

(Sediment Transport continued on page 16)

USGS research vessel Parke Snavely *mapping in Alviso Slough (south San Francisco Bay) in October 2011 to document how the bottom changed after levees were breached in December 2010. Breaching was part of the South Bay Salt Pond Restoration Project , the largest tidal-wetland restoration on the U.S. west coast (<**http://www.southbayrestoration.org/**>). USGS scientists conduct regular surveys to monitor change as restoration progresses (<**http://soundwaves.usgs.gov/2012/02/pubs.html**>). USGS photograph by **Helen Gibbons**.*

*USGS hydrologic technician **Kurt Weidich** services continuous monitoring instruments at the Dumbarton Bridge in south San Francisco Bay. USGS photograph by **Amber Powell**.*

(Sediment Transport continued from page 15)

reaches of San Francisco Bay, sediment helps to restore tidal marshes lost to former salt ponds by counteracting local sinking caused by historical groundwater pumping, in effect elevating the ground so that it remains in the tidal zone, where tide-adapted plants and animals thrive. With the giant sediment pulse from hydraulic mining largely past, these processes of replenishment and restoration must now rely on smaller and more localized sediment sources. USGS research aims to chart how sustainable California beaches will be, and how long it will take to restore bay wetlands, in light of the region's changing sediment budget.

Useful to Land Managers and Planners

"The information provided in the *Marine Geology* special issue has fundamentally changed the way managers are thinking about the sediment supply to San Francisco Bay and the outer coast, and how we manage projects," said **Brenda Goeden**, Sediment Program Manager of California's San Francisco Bay Conservation and Development Commission (<**http://www.bcdc.ca.gov/**>). "For example, the suspended-sediment research is helping managers understand how sediment supply will affect habitat restoration projects around the Bay that are funded by millions of public dollars, and it offers a rare opportunity to intervene where sediment supply may not support a given restoration site in the face of rising seas. Similarly, the coarse-grained-bedload findings inform policy analysis of projects proposing to extract large quantities of coarse-grained sediment from the Bay system."

The amount and character of sediment is affected by waves, which are shaped partly by underwater landforms that, in turn, owe their forms to past sediment deposition. The submerged sand bar outside the Golden Gate alters nearshore waves by refracting or bending their paths and causing the waves to break as the water gets shallow (shoals). The sand bar is expected to continue shrinking in future decades owing to the combined effects of reduced sediment and projected sea-level rise. This shrinkage, in turn, is likely to alter wave behavior and thus expose the coastline for many miles south to more aggressive and potentially erosive wave action.

Studying sediment transport trains a special lens on San Francisco's bay, delta and nearshore as part of a fluid and interconnected system. Human intervention has altered the sediment budget and thus the whole environment in ways unforeseen in the 19th century. USGS science aims to understand this changing and complex system and to give managers tools to address future change.

*USGS scientists positioning a current profiler on the sandy seabed at Ocean Beach in San Francisco, California, in 2006 (<**http://soundwaves.usgs.gov/2006/04/**>) as part of a study begun in 2004 to investigate sand transport and sedimentation patterns along the beach and the mouth of San Francisco Bay. Their findings will help coastal managers address Ocean Beach erosion that threatens public infrastructure and safe recreational use of the beach (<**http://pubs.usgs.gov/of/2007/1217/**>). USGS photograph by **Patrick Barnard**.*

"What had previously been a black box for managers is now becoming clearer," said Goeden. "Three cheers for the work that has been so well researched and clearly explained!"

The complete special issue of *Marine Geology*, with 21 articles, is available online at <**http://www.sciencedirect.com/science/journal/00253227/345**>.

A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system: San Francisco Bay, edited by P.L. Barnard, B.E. Jaffe and D.H. Schoellhamer, volume 345, pages 1–326 (1 November 2013).

Selected Papers from *Marine Geology* Special Issue (<http://www.sciencedirect.com/science/journal/00253227/345>):

Adjustment of the San Francisco estuary and watershed to decreasing sediment supply in the 20th century *(<http://dx.doi.org/10.1016/j.margeo.2013.04.007>)* Because of hydraulic mining and subsequent development, the San Francisco estuary and watershed experienced a period of increasing sediment supply beginning in 1852 and decreasing sediment supply by the late 1900s. The San Francisco Bay Area has followed the typical progression of human land use in coastal watersheds of initial disturbance (deforestation, mining, agricultural expansion, overgrazing, and urbanization) that creates a sediment pulse to an estuary followed by dams that reduce sediment supply. Conceptual models and syntheses of other studies show how the estuary and watershed have adjusted to decreasing sediment supply.

Comparison of sediment supply to San Francisco Bay from watersheds draining the Bay Area and the Central Valley of California *(<http://dx.doi.org/10.1016/j.margeo.2013.03.003>)* A comprehensive, quantitative analysis of sediment supply to San Francisco Bay shows that local, urbanized watersheds now contribute more suspended sediment to San Francisco Bay than the large Sacramento and San Joaquin rivers draining California's Central Valley. If San Francisco Bay is typical of other estuaries in active tectonic or climatically variable coastal regimes, managers responsible for water quality, dredging and reusing sediment accumulating in shipping channels, or restoring wetlands in the world's estuaries may need to more carefully account for nearby small urbanized watersheds that may dominate sediment supply.

(Sediment Transport continued on page 17)

(Sediment Transport continued from page 16)

Integration of bed characteristics, geochemical tracers, current measurements, and numerical modeling for assessing the provenance of beach sand in the San Francisco Bay coastal system *(<http://dx.doi.org/10.1016/j.margeo.2013.08.007>)* The authors established the sources of beach-sized sand in the San Francisco Bay coastal system, the places where it has been deposited, and the transport pathways it has followed. Their work highlights the regional impact of a sharp reduction in sediment from historic hydraulic mining in the Sierra Nevada and the need to more efficiently manage existing in-bay sediment resources. Informed management of sediment resources can promote the sustainability of fringing tidal wetlands and beaches, the first line of defense as sea level rises and potentially larger storms increase the vulnerability of coastal environments over the next century and beyond. ☸

Outreach

"Native Youth in Science–Preserving Our Homelands" Completes Year Two

By Ben Gutierrez

For the second consecutive year, sixth-through-eighth graders from the Mashpee Wampanoag Tribe enjoyed a summer science and Wampanoag cultural program to help them reconnect with the ecology and geology of their traditional homelands in southwestern Cape Cod, Massachusetts. "Native Youth in Science—Preserving Our Homelands" was organized by the Mashpee Wampanoag Departments of Education and Natural Resources, the Bureau of Indian Affairs, the Waquoit Bay National Estuarine Research Reserve, and the U.S. Geological Survey (USGS) Woods Hole Coastal and Marine Science Center (WHCMSC) in Woods Hole, Massachusetts. Fifteen students participated in the program, which met 2 days a week for 4 weeks during July 2013.

To demonstrate how science topics learned in school relate to Wampanoag culture and the environmental health of local lands, lessons focused on addressing tribally important sites and topics through the perspectives of both environmental science and tribal culture. This year, the program focused on the importance of environmental quality as related to traditional Wampanoag food sources, including shellfish—such as the quahog (*Mercenaria mercenaria*), oyster (*Crassostrea virginica*), and other species—as well as migratory fish species, such as herring (*Alosa pseudoharengus*).

Each 2-day session involved field trips in which scientists and Wampanoag tribe members collaborated to present specific topics from both Wampanoag and Western science perspectives. Topics included water quality, marsh ecology, fisheries ecology, forest restoration, and glacial geology. Field trips included visits to local wetlands, oyster farms, and waterways. One of the highlights was a hike through the Quashnet River valley, a local river system that is the focus of Federal and State restoration efforts. This hike, led by **Jim Rassman** of the Waquoit Bay National Estuarine Research Reserve and **Earl Mills**, **Jr.** of the Mashpee Wampanoag Tribe, followed the route of the annual herring migration to Johns Pond while taking participants through a range of environments, some restored to their natural state and some still under the influence of human activity.

*Mashpee Wampanoag Tribe students using seine nets in a Waquoit Bay marsh creek to capture samples of local fish and crabs under the direction of program instructors. USGS photograph by **Dann Blackwood**.*

The science program was organized by **Renee Lopez-Pocknett** (Mashpee Wampanoag Tribe), **Kristen Wyman** (Nipmuc, tribal education consultant), **Chuckie Green** (Mashpee Wampanoag Tribe), **Quan Tobey** (Mashpee Wampanoag Tribe), **Kitty Hendricks** (Mashpee Wampanoag Tribe), **Ben Gutierrez** (USGS-WHCMSC), and **Monique Fordham** (USGS National Tribal Liaison). Science instructors included **Ambrose Jearld** of the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service Northeast Fisheries Science Center, **Jim Rassman** of the Waquoit Bay National Estuarine Research Reserve, **Cara O'Donnell** of the Water Resources Department of the Houlton Band of the Maliseet Indians (Littleton, Maine), and **Ben Gutierrez** of the USGS-WHCMSC. Each scientist worked with Wampanoag culture keepers, who included **Chuckie Green**, **Earl Mills**, **Jr.**, and **Daryl Wixon**. **Dann Blackwood** (USGS-WHCMSC) was the program photographer and contributed to science instruction as well. The program concluded with an opportunity for the students to explore and celebrate on Washburn Island, which is part of the Waquoit Bay National Estuarine Research Reserve and a historically important site for the Mashpee Wampanoag Tribe.

Learn more about this program and the first year of its implementation at <**http://soundwaves.usgs.gov/2012/12/outreach.html**>. ☸

Michael E. Field Honored by U.S. Coral Reef Task Force

***Michael E. Field** (right), recipient of the U.S. Coral Reef Task Force (USCRTF) 2013 Outstanding Scientific Advancement of Knowledge award, holds the plaque with **Curt Storlazzi**, who is on the USCRTF science steering committee, has worked closely with Mike on USGS coral reef studies for the past decade and a half, and now leads the USGS Pacific Coral Reef Project (<**http://coralreefs.wr.usgs.gov/**>) initiated by Mike.*

U.S. Geological Survey (USGS) emeritus geologist **Michael E. Field** received the U.S. Coral Reef Task Force (USCRTF) 2013 Outstanding Scientific Advancement of Knowledge award for his "outstanding leadership in developing the USGS Coastal and Marine Geology Program's Pacific Coral Reef Project…to better understand the influences of natural processes and impacts of human activities on coral reef health."

Presented November 15, 2013, at a USCRTF meeting in the U.S. Virgin Islands, the award commends Field and his team for continuing "to provide the foundational science helping to preserve and protect the biodiversity, health, and social and economic value of coral reef ecosystems." The USCRTF, established in 1998 by former President Clinton, includes leaders of 12 Federal agencies, 7 U.S. States, Territories, Commonwealths, and 3 Freely Associated States (<**http://www.coralreef.gov/**>).

The award justification details some of Field's many accomplishments in coral reef studies:

"In 1999, following the International Year of the Reef, **Dr. Michael E. Field** started the U.S. Geological Survey (USGS) Coastal and Marine Geology Program's Pacific Coral Reef Project [<**http://coralreefs.wr.usgs.gov/**>] to better understand the geologic and oceanographic controls on the structure and processes of our Nation's coral reef ecosystems. Focusing its efforts to better understand the influences of natural processes and impacts of human activities on coral reef health, the Pacific Coral Reef Project has made large advances in understanding the impacts of land-based pollution—primarily terrestrial sediment run-off from high islands—on coral reef ecosystem health and sustainability.

"Since its inception, the USGS Pacific Coral Reef Project has published 65 scientific journal articles and 63 official government reports, and disseminated its scientific findings through 155 conference presentations and 63 invited talks to Federal, State, and local agencies on high-resolution mapping techniques; coastal circulation and sediment, nutrient, larval, and contaminant dynamics; records of climate and land-use change; and numerical models of present and future physical processes affecting coral reef health.

"Dr. Field brought together experts in remote sensing, geomorphology, vegetation and land-use, hydrology, coral reef ecology, and coastal circulation and sediment dynamics in the first comprehensive effort to understand how impaired watersheds impact coral reef ecosystems through the USGS 'Ridge-to-Reef' effort in 2003 [<**http://www.usgs.gov/ecosystems/pierc/research/rtr.html**>]. In recognition of these achievements, the USGS presented the 2006 Western Region Innovation in Integrated Science Award to the Ridge-to-Reef team for their multidisciplinary work in the Hawaiian Islands [<**http://soundwaves.usgs.gov/2007/01/awards2.html**>]. The USGS publication, *The Coral Reef of South Moloka'i, Hawai'i—Portrait of a Sediment-Threatened Fringing Reef* (USGS Scientific Investigations Report 2007-5101, <**http://pubs.usgs.gov/sir/2007/5101/**>), synthesizing USGS Pacific Coral Reef Project and USGS Ridge-to-Reef studies, was honored with numerous awards. The report won the Association of Earth Science Editors 2009 Outstanding Publication Award and a 2009 National Association of Government Communicators Blue Pencil Award of Excellence [<**http://soundwaves.usgs.gov/2010/02/awards.html**>].

"This research inspired a multimillion-dollar American Recovery and Reinvestment Act proposal and resulted in *The Encyclopedia of Modern Coral Reefs* (2011) stating, 'Recent research on the fringing reef of Moloka'i, Hawai'i, by the USGS has set the bar for sediment research in coral environments.' Results from these comprehensive studies also triggered the Hawai'i State Senate and Hawai'i House of Representatives to issue Concurrent Resolution #2009-0916 SCR SMA-1: 'Expressing support for the USGS Report, *The Coral Reef of South Moloka'i,*

(Coral Reef Task Force continued on page 19)

(Coral Reef Task Force continued from page 18)

Hawai‘i: Portrait of a Sediment-Threatened Fringing Reef, encouraging federal, state, and community cooperation to steward the South Moloka‘i reef. Be it further resolved that state agencies and federal agencies are encouraged to recognize and support the conclusions of the USGS report.’ [See related *Sound Waves* article at <**http://soundwaves.usgs.gov/2009/05/awards.html**>.]

“In addition to his scientific leadership in the USGS, Dr. Field provided scientific guidance and direction on land-based pollution impacts on coral reefs as a member of U.S. Coral Reef Task Force, National Oceanic and Atmospheric Administration (NOAA), U.S. Army Corps of Engineers, and U.S. Department of State review panels. His and his team’s efforts continue to provide the foundational science helping to preserve and protect the biodiversity, health, and social and economic value of the United States’ coral reef ecosystems.” ❁

Staff and Center News

Passing the Torch, Take 2—Barbara Lidz Steps Down as *Sound Waves* Contributing Editor at USGS Center in St. Petersburg, Florida

By the Sound Waves Team

U.S. Geological Survey (USGS) Research Geologist **Barbara Lidz**, the original editor of *Sound Waves* and for 12 years the contributing editor and *Sound Waves* liaison at the USGS Coastal and Marine Science Center in St. Petersburg, Florida, has passed the torch to **Theresa Burress**. Theresa, librarian and outreach coordinator at the St. Pete center, will now handle the center’s submissions to the newsletter.

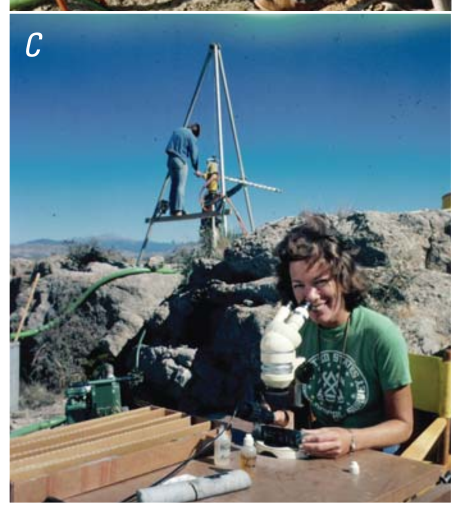
In a note to scientists and staff at St. Pete, Barbara wrote:

“It has been a genuine pleasure for me to call for and edit newsletter articles over the years. For those of you who don’t know, the newsletter was initiated in the St. Pete Field Office in 1999 at the request of Reston [Virginia] headquarters. I was asked to be its first editor, and a member of my family coined the name *Sound Waves*, intending to encompass the many types of waves experienced in the natural terrestrial, hydrologic, and atmospheric realms of the Earth, as well as those propagated by the many types of man-made scientific-research instruments. The newsletter has been and remains a successfully established outreach tool that highlights Bureau-wide research on coastal and marine-science efforts. It is widely read throughout the country by members of academia, scientists of all disciplines in State and Federal agencies, government officials and their staff, and students, teachers, and interested members of the general public. Thank you for the opportunity to help disseminate our St. Pete contributions to USGS scientific endeavors and those of the entire USGS to the public. I know I am passing the torch on to competent hands!”

Barbara joined the USGS in 1974 and has a long record of research on upper Cretaceous and Cenozoic stratigraphic sequences on St. Croix in the U.S. Virgin Islands, Cenozoic planktic biostratigraphy of the Great Bahama Bank, and the Quaternary sedimentary and seismic stratigraphy, coral reef history, and present benthic habitats of the Florida Keys and shallow shelf-wide reef tract. She passed the *Sound Waves* torch once before, when she stepped down from the position of original editor in late 2001 (<**http://soundwaves.usgs.gov/2001/11/pubs.html**>). Thank you, Barbara, for having launched *Sound Waves* and for being a mainstay of its success for so many years! ❁


A


B


C

*Among her many research activities, **Barbara Lidz** was part of a USGS team led by **Gene Shinn** (now retired) that used a custom-designed hydraulic drill to collect cores from modern and ancient carbonate reefs. A, The hydraulic drill was originally used underwater, as in this photograph of USGS scientists coring a coral reef at Grecian Rocks in the upper Florida Keys (see map at <**http://soundwaves.usgs.gov/2011/04/research.html**>). B, The drill worked well on land, too. Here (left to right), **Barbara Lidz**, **Harold Hudson**, and **Dan Robbin** are coring a Permian algal reef, well known among geologists and the oil-and-gas industry as Scorpion Mound, in New Mexico in 1981. C, While Scorpion Mound was being drilled (background), Barbara used a binocular microscope to examine core segments as they came out of the ground.*

Award-Winning Student Intern Experiences Life at the USGS

By Lisa Robbins and Jennifer Miselis

Research oceanographer **Lisa Robbins** and research geologist **Jennifer Miselis** welcomed recent high-school graduate **Katie Krueger** to the U.S. Geological Survey (USGS) St. Petersburg Coastal and Marine Science Center in St. Petersburg, Florida, as a spring/summer 2013 intern. **Krueger** graduated in June 2013 from Tampa Preparatory School in Tampa, Florida, where the Athena Society in Tampa Bay honored her in 2012 with a "Dr. Sylvia Richardson Young Women of Promise" award (<**http://www.tampabay.com/news/humaninterest/athena-society-honors-10-inspiring-high-school-juniors/1223818**>). Krueger won the award because of her exceptional academic record (4.2 grade point average), more than 150 hours of community service, and her commitment to athletics on the Tampa Prep Volleyball team. Tampa Prep has a senior internship program for its students, and Krueger was excited to discover that she could complete the internship at the USGS since she plans to pursue a degree in geology at Virginia Tech. Krueger split time with Robbins and Miselis during the three weeks that she was at the center.

Krueger started her time at USGS St. Pete with Robbins, helping to clean, sieve, and analyze sediment samples that Robbins had collected for ocean-acidification studies during an August 2012 research cruise in the Arctic Ocean. Krueger picked out foraminifera—one-celled marine animals whose shells provide information about their age and the physical and chemical environment in which they formed—from four different dredge samples and got to look at some of the forams using the scanning electron microscope. She also helped Robbins analyze data from the research cruise, and she took photographs of Robbins' Arctic coral and manganese samples.

According to Robbins, who is also a member of the Athena Society, "It is easy to see how Katie won the 'Young Women of Promise' award. She has a bright future ahead of her because she is so adaptable and wanted to learn everything possible about what a career in geology could offer."

*Summer intern **Katie Krueger** (center) and her USGS supervisors: research oceanographer **Lisa Robbins** (left) and research geologist **Jennifer Miselis**. Because of her stellar academics and volleyball skills, Krueger was notified of her acceptance to Virginia Tech early in her junior year. She is now in her first year at Virginia Tech, where she plays for the Hokies volleyball team. USGS photograph by **Betsy Boynton**.*

***Katie Krueger**, a summer intern at the USGS St. Petersburg Coastal and Marine Science Center in St. Petersburg, Florida, uses an optical microscope to pick out foraminifera from Arctic Ocean sediment samples. USGS photograph by **Lisa Robbins**.*

To learn more about **Lisa Robbins'** work on ocean acidification, visit the "Arctic Cruise 2012: Cruise Plan and Map" webpage at <**http://coastal.er.usgs.gov/ocean-acidification/arcticcruise2012/cruiseplan.php**>.

Miselis introduced Krueger to everyday skills essential for working in the field of coastal geology. Krueger learned how to use ArcMap software to make a map, as well as how to use OpendTect software to digitize seismic data that provide images of sediment layers beneath the seafloor. **Kyle Kelso**, a member of Miselis' team, then taught Krueger how to analyze core samples collected from the Chandeleur Islands off Louisiana. Later that week, Krueger got to go out on the water in Tampa Bay to help Miselis and her team test a new personal-watercraft system outfitted to measure water depth in shallow water.

Miselis was highly impressed with Krueger and her willingness to tackle new subjects. "Katie seemed equally as excited about reading about a new concept in a textbook as she was about putting that new skill into practice at a computer, in the lab, or out on the water," she said. "That eagerness to learn will serve her well in geology or any other science field."

(Student Intern continued on page 21)

(Student Intern continued from page 20)

To learn more about **Jen Miselis'** seafloor mapping and sediment studies in the Chandeleur Islands, visit the *Sound Waves* article at <**http://soundwaves.usgs.gov/2012/12/fieldwork3.html**>.

What did Krueger have to say about her time at USGS St. Pete? "This has been so much fun, I think I have the best senior internship at my school!" ☸

*USGS summer intern **Katie Krueger** helps to test a new personal-watercraft system for measuring water depths in areas too shallow for small boats. USGS photograph by **Kyle Kelso**.*

Coastal and Marine Geology Program Contributes to "Feds Feed Families" Campaign

By Andrea Toran

Throughout the United States, millions of families are living below the poverty line. Basic needs such as nutritious food, sanitary supplies, and medicine are difficult to obtain for many, and as of November 2012, nearly 20 percent of American children were reported to be living in poverty (<**http://washington.cbslocal.com/2012/11/15/census-u-s-poverty-rate-spikes-nearly-50-million-americans-affected/**>). In response to the alarming statistics relating to poverty and poor nutrition in the United Sates, a government-wide effort was launched in 2009 to help combat hunger. This initiative, called Feds Feed Families (<**http://www.fedsfeedfamilies.gov/**>), runs each summer and challenges Federal employees to collect nonperishable and nutritious food, which is then donated to community service centers for distribution to local families in need.

The 2013 Feds Feed Families campaign ran from June 1 to August 28. For the second year running, the three science centers in the U.S. Geological Survey (USGS) Coastal and Marine Geology Program competed to see which center could donate the most food (read about last year's effort at <**http://soundwaves.usgs.gov/2012/10/staff.html**>). By the end of the drive, the cumulative total was 1,000 pounds, collected by staff, contractors, and volunteers at the three centers working on their own time. Third place went to the Pacific Coastal and Marine Science Center in Santa Cruz, California; second place to the St. Petersburg Coastal and Marine Science Center in St. Petersburg, Florida; and first place to the Woods Hole Coastal and Marine Science Center in Woods Hole, Massachusetts.

This year's winner, the center in Woods Hole, has participated in the Feds Feed Families initiative since 2010, providing more than 1,000 pounds of food to the Falmouth Service Center, the local food pantry whose mission is to ease stress, reduce hunger, and improve quality of life for neighbors in need. Here's the approach the Woods Hole food-drive team used to encourage contributions in 2013:

To keep center staff motivated and interested during the three-month collection period, the Woods Hole team—**Andrea Toran**, **Kelleen List**, and **Linda McCarthy**—brainstormed ideas to make the food drive productive and fun. They set a goal of 500 pounds, or about 5 pounds per person, and developed ideas for marketing the campaign, including colorful flyers with tag lines of "Donate Heavy and Healthy" and "Give Away 5 Pounds to the Feds Feed Families." Donations trickled in, but trickles are not enough to have an effective impact. After some thought, the team created theme weeks, during which people were encouraged to shop for and donate specific food items. Canned-fruit-and-juice week was a hit, as was protein week, but canned-ham week was the most successful by far. Although the Woods Hole team didn't meet the goal of collecting 500 pounds of food, the center did donate 373 pounds of food to the Falmouth Service Center, including 10 canned hams!

Personnel at the three Coastal and Marine Geology Program science centers are committed to building strong and healthy relationships with community agencies that provide a helping hand in times of need.

For more information on the Feds Feed Families initiative, please visit the campaign's official website at <**http://www.fedsfeedfamilies.gov/**>. To learn how to help feed families in need in your area, please contact your local service center. ☸

USGS Woods Hole Coastal and Marine Science Center staff display food items donated to the Feds Feed Families campaign.

Recently Published Articles

Andrews, B.D., Chaytor, J.D., ten Brink, U.S., Brothers, D.S., and Gardner, J.V., 2013, Bathymetric terrain model of the Atlantic Margin for marine geological investigations: U.S. Geological Survey Open-File Report 2012–1266, 11 p., doi:10.3133/ofr20121266 [**http://dx.doi.org/10.3133/ofr20121266**].

Barnard, P.L., Erikson, L.H., Elias, E.P.L., and Dartnell, P., 2013, Sediment transport patterns in the San Francisco Bay coastal system from cross-validation of bedform asymmetry and modeled residual flux, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 72–95, doi:10.1016/j.margeo.2012.10.011 [**http://dx.doi.org/10.1016/j.margeo.2012.10.011**].

Barnard, P.L., Foxgrover, A.C., Elias, E.P.L., Erikson, L.H., Hein, J.R., McGann, M., Mizell, K., Rosenbauer, R.J., Swarzenski, P.W., Takesue, R.K., Wong, F.L., and Woodrow, D.L., 2013, Integration of bed characteristics, geochemical tracers, current measurements, and numerical modeling for assessing the provenance of beach sand in the San Francisco Bay coastal system, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 181–206, doi:10.1016/j.margeo.2013.08.007 [**http://dx.doi.org/10.1016/j.margeo.2013.08.007**].

Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., 2013, Preface for special issue of Marine Geology, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 1–2, doi:10.1016/j.margeo.2013.09.010 [**http://dx.doi.org/10.1016/j.margeo.2013.09.010**].

Barnard, P.L., Schoellhamer, D.H., Jaffe, B.E., and McKee, L.J., 2013, Sediment transport in the San Francisco Bay coastal system—An overview, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 3–17, doi:10.1016/j.margeo.2013.04.005 [**http://dx.doi.org/10.1016/j.margeo.2013.04.005**].

Browman, H.I., Dupont, S., Havenhand, J., Robbins, L.L., and others, 2013, Biological responses to ocean acidification, chap. 3 *in* AMAP assessment 2013—Arctic Ocean acidification: Oslo, Norway, Arctic Monitoring and Assessment Programme (AMAP), p. 37–54 [**http://www.amap.no/documents/doc/AMAP-Assessment-2013-Arctic-Ocean-Acidification/881**].

Buchinger, T.J., Wang, H., Li, W., and Johnson, N.S., 2013, Evidence for a receiver bias underlying female preference for a male mating pheromone in sea lamprey: Proceedings of the Royal Society B, v. 280, no. 1771, 8 p., doi:10.1098/rspb.2013.1966 [**http://dx.doi.org/10.1098/rspb.2013.1966**].

Chapman, D.C., Davis, J.J., Jenkins, J.A., Kocovsky, P.M., Miner, J.G., Farver, J., and Jackson, P.R., 2013, First evidence of grass carp recruitment in the Great Lakes Basin: Journal of Great Lakes Research, v. 39, no. 4, p. 547–554, doi:10.1016/j.jglr.2013.09.019 [**http://dx.doi.org/10.1016/j.jglr.2013.09.019**].

Danielson, J.J., Brock, J.C., Howard, D.M., Gesch, D.B., Bonisteel-Cormier, J.M., and Travers, L.J., 2013, Topobathymetric model of Mobile Bay, Alabama: U.S. Geological Survey Data Series 769 [**http://pubs.er.usgs.gov/publication/ds769**].

Davis, A.C.D., Kvitek, R.G., Mueller, C.B.A., Young, M.A., Storlazzi, C.D., and Phillips, E.L., 2013, Distribution and abundance of rippled scour depressions along the California coast: Continental Shelf Research, v. 69, p. 88–100 doi:10.1016/j.csr.2013.09.010 [**http://dx.doi.org/10.1016/j.csr.2013.09.010**].

De La Cruz, S.E.W., Takekawa, J.Y., Spragens, K.A., Yee, J., Golightly, R.T., Massey, G., Henkel, L.A., Larsen, R.S., and Ziccardi, M., 2013, Post-release survival of surf scoters following an oil spill—An experimental approach to evaluating rehabilitation success: Marine Pollution Bulletin, v. 67, no. 1–2, p. 100–106, doi:10.1016/j.marpolbul.2012.11.027 [**http:dx.doi.org/10.1016/j.marpolbul.2012.11.027**].

Downing-Kunz, M.A., and Schoellhamer, D.H., 2013, Seasonal variations in suspended-sediment dynamics in the tidal reach of an estuarine tributary, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 314–326, doi:10.1016/j.margeo.2013.03.005 [**http://dx.doi.org/10.1016/j.margeo.2013.03.005**].

Draut, A.E., and Ritchie, A.C., 2013, Sedimentology of new fluvial deposits on the Elwha River, Washington, USA, formed during large-scale dam removal: River Research and Applications, published online December 12, 2013, doi:10.1002/rra.2724 [**http:/dx.doi.org/10.1002/rra.2724**].

Draut, A.E., and Rubin, D.M., 2013, Assessing grain-size correspondence between flow and deposits of controlled floods in the Colorado River, USA: Journal of Sedimentary Research, v. 83, p. 962–973, doi:10.2110/jsr.2013.79 [**http://dx.doi.org/10.2110/jsr.2013.79**].

Eggleston, J., and Pope, J., 2013, Land subsidence and relative sea-level rise in the southern Chesapeake Bay region: U.S. Geological Survey Circular 1392, 30 p., doi:10.3133/cir1392 [**http://dx.doi.org/10.3133/cir1392**].

Egler, A.L., Risch, M.R., Alvarez, D.A., and Bradley, P.M., 2013, Organic wastewater compounds in water and sediment in and near restored wetlands, Great Marsh, Indiana Dunes National Lakeshore, 2009–11: U.S. Geological Survey Scientific Investigations Report 2013–5186, 52 p.,

(Recently Published continued on page 23)

(Recently Published continued from page 22)

doi: 10.3133/sir20135186 [**http://dx.doi.org/10.3133/sir20135186**].

Elias, E.P.L., and Hansen, J.E., 2013, Understanding processes controlling sediment transports at the mouth of a highly energetic inlet system (San Francisco Bay, CA), *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 207–220, doi:10.1016/j.margeo.2012.07.003 [**http://dx.doi.org/10.1016/j.margeo.2012.07.003**].

Erikson, L.H., Wright, S.A., Elias, E., Hanes, D.M., Schoellhamer, D.H., and Largier, J., 2013, The use of modeling and suspended sediment concentration measurements for quantifying net suspended sediment transport, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 96–112, doi:10.1016/j.margeo.2013.06.001 [**http://dx.doi.org/10.1016/j.margeo.2013.06.001**].

Field, E.H., Biasi, G.P., Bird, P., Dawson, T.E., Felzer, K.R., Jackson, D.D., Johnson, K.M., Jordan, T.H., Madden, C., Michael, A.J., Milner, K.R., Page, M.T., Parsons, T., Powers, P.M., Shaw, B.E., Thatcher, W.R., Weldon, R.J., II, and Zeng, Y., 2013, Uniform California earthquake rupture forecast, version 3 (UCERF3)—The time-independent model: U.S. Geological Survey Open-File Report 2013–1165, 97 p., California Geological Survey Special Report 228, and Southern California Earthquake Center Publication 1792 [**http://pubs.usgs.gov/of/2013/1165/**].

Francy, D.S., Brady, A.M.G., Carvin, R.B., Corsi, S.R., Fuller, L.M., Harrison, J.H., Hayhurst, B.A., Lant, J., Nevers, M.B., Terrio, P.J., and Zimmerman, T.M., 2013, Developing and implementing predictive models for estimating recreational water quality at Great Lakes beaches: U.S. Geological Survey Scientific Investigations Report 2013-5166, 68 p., doi:10.3133/sir20135166 [**http://dx.doi.org/10.3133/sir20135166**].

Gingerich, S.B., 2013, The effects of withdrawals and drought on groundwater availability in the Northern Guam Lens Aquifer, Guam: U.S. Geological Survey Scientific Investigations Report 2013–5216, 76 p., doi:10.3133/sir20135216 [**http://dx.doi.org/10.3133/sir20135216**].

Gorman, O.T., and Sitar, S.P., 2013, Ups and downs of Burbot and their predator Lake Trout in Lake Superior, 1953–2011: Transactions of the American Fisheries Society, v. 142, no. 6, p. 1757–1772, doi: 10.1080/00028487.2013.824918 [**http://dx.doi.org/10.1080/00028487.2013.824918**].

Greene, H.G., Endris, C., Vallier, T., Golden, N., Cross, J., Ryan, H., Dieter, B., and Niven, E., 2013, Sub-tidal benthic habitats of central San Francisco Bay and offshore Golden Gate area—A review, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 31–46, doi:10.1016/j.margeo.2013.05.001 [**http://dx.doi.org/10.1016/j.margeo.2013.05.001**].

Hansen, J.E., Elias, E., and Barnard, P.L., 2013, Changes in surfzone morphodynamics driven by multi-decadal contraction of a large ebb-tidal delta, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 221–234, doi:10.1016/j.margeo.2013.07.005 [**http://dx.doi.org/10.1016/j.margeo.2013.07.005**].

Hapke, C.J., Kratzmann, M.G., and Himmelstoss, E.A., 2013, Geomorphic and human influence on large-scale coastal change: Geomorphology, v. 199, p. 160–170, doi:10.1016/j.geomorph.2012.11.025 [**http://dx.doi.org/10.1016/j.geomorph.2012.11.025**].

Hartwell, S.R., Finlayson, D.P., Dartnell, P., and Johnson, S.Y., 2013, Bathymetry and acoustic backscatter—Estero Bay, California: U.S. Geological Survey Open-File Report 2013–1225, doi:10.3133/ofr20131225 [**http://dx.doi.org/10.3133/ofr20131225**].

Hartwell, S.R., Wingfield, D.K., Allwardt, A.O., Wong, F.L., and Lightsom, F.L., 2013, Shapefile for Coastal Zone Management Program counties of the United States and its territories, 2009 (CZMP_counties_2009.shp): U.S. Geological Survey Open-File Report 2013–1284, doi:10.3133/ofr20131284 [**http://dx.doi.org/10.3133/ofr20131284**].

Hein, J.R., and Koschinsky, A., 2014, Deep-ocean ferromanganese crusts and nodules, chap. 11 *of* Scott, S.D., ed., Treatise on geochemistry (second edition), v. 13, p. 273–291, doi:10.1016/B978-0-08-095975-7.01111-6: Elsevier [**http://dx.doi.org/10.1016/B978-0-08-095975-7.01111-6**].

Hein, J.R., Mizell, K., and Barnard, P.L., 2013, Sand sources and transport pathways for the San Francisco Bay coastal system, based on X-ray diffraction mineralogy, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 154–169, doi:10.1016/j.margeo.2013.04.003 [**http://dx.doi.org/10.1016/j.margeo.2013.04.003**].

Hestir, E.L., Schoellhamer, D.H., Morgan-King, T., and Ustin, S.L., 2013, A step decrease in sediment concentration in a highly modified tidal river delta following the 1983 El Niño floods, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 304–313, doi:10.1016/j.margeo.2013.05.008 [**http://dx.doi.org/10.1016/j.margeo.2013.05.008**].

Jackson, P.R., 2013, Circulation, mixing, and transport in nearshore Lake Erie in the vicinity of Villa Angela Beach and Euclid Creek, Cleveland, Ohio, September

(Recently Published continued on page 24)

(Recently Published continued from page 23)

11–12, 2012: U.S. Geological Survey Scientific Investigations Report 2013–5198, 34 p., doi:10.3133/sir20135198 [**http://dx.doi.org/10.3133/sir20135198**].

Jones, C.A., and Jaffe, B.E., 2013, Influence of history and environment on the sediment dynamics of intertidal flats, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 294–303, doi:10.1016/j.margeo.2013.05.011 [**http://dx.doi.org/10.1016/j.margeo.2013.05.011**].

Kellogg, C.A., Piceno, Y.M., Tom, L.M., DeSantis, T.Z., Gray, M.A., Zawada, D.G., and Andersen, G.L., 2013, Comparing bacterial community composition between healthy and white plague-like disease states in *Orbicella annularis* using PhyloChip™ G3 microarrays: PLOS ONE, v. 8, no. 11, e79801, doi:10.1371/journal.pone.0079801 [**http://dx.doi.org/10.1371/journal.pone.0079801**].

Khanna, S., Santos, M.J., Ustin, S.L., Koltunov, A., Kokaly, R.F., and Roberts, D.A., 2013, Detection of salt marsh vegetation stress and recovery after the Deepwater Horizon oil spill in Barataria Bay, Gulf of Mexico using AVIRIS data: PLOS ONE, published online November 5, 2013, doi:10.1371/journal.pone.0078989 [**http://dx.doi.org/10.1371/journal.pone.0078989**].

Kratzmann, M., Himmelstoss, E.A., Ruggiero, P., Thieler, E.R., and Reid, D., 2013, National Assessment of Shoreline Change—A GIS compilation of vector shorelines and associated shoreline change data for the Pacific Northwest coast: U.S. Geological Survey Open-File Report 2012–1008, doi:10.3133/ofr20121008 [**http://dx.doi.org/10.3133/ofr20121008**].

Kumar A., Abouchami, W., Galer, S.J.G., Garrison, V.H., Williams, E., and Andreae, M.O., 2014, A radiogenic isotope tracer study of transatlantic dust transport from Africa to the Caribbean: Atmospheric Environment, v. 82, p. 130–143, doi:10.1016/j.atmosenv.2013.10.021 [**http://dx.doi.org/10.1016/j.atmosenv.2013.10.021**].

Langevin, C.D., and Zygnerski, M.Z., 2013, Effect of sea-level rise on salt water intrusion near a coastal well field in southeastern Florida: Groundwater, v. 51, no. 5, p. 781–803, doi:10.1111/j.1745-6584.2012.01008.x [**http://dx.doi.org/10.1111/j.1745-6584.2012.01008.x**].

Layhee, M.J., Gross, J.A., Parsley, M.J., Romine, J.G., Glover, D.C., Suski, C.D., Wagner, T.L., Sepulveda, A.J., and Gresswell, R.E., 2013, Asian carp behavior in response to static water gun firing: U.S. Geological Survey Fact Sheet 2013–3098, 4 p. [**http://pubs.usgs.gov/fs/2013/3098/**].

Manning, A.J., and Schoellhamer, D.H., 2013, Factors controlling floc settling velocity along a longitudinal estuarine transect, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 266–280, doi:10.1016/j.margeo.2013.06.018 [**http://dx.doi.org/10.1016/j.margeo.2013.06.018**].

McGann, M., Erikson, L., Wan, E., Powell, C., II, and Maddocks, R.F., 2013, Distribution of biologic, anthopogenic, and volcanic constituents as a proxy for sediment transport in the San Francisco Bay coastal system, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 113–142, doi:10.1016/j.margeo.2013.05.006 [**http://dx.doi.org/10.1016/j.margeo.2013.05.006**].

McKee, L.J., Lewicki, M., Schoellhamer, D.H., and Ganju, N.K., 2013, comparison of sediment supply to San Francisco Bay from watersheds draining the Bay Area and the Central Valley of California, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p.47–62, doi:10.1016/j.margeo.2013.03.003 [**http://dx.doi.org/10.1016/j.margeo.2013.03.003**].

Morgan, K.L.M., Kron, M.D., Doran, K., and Guy, K., Baseline coastal oblique aerial photographs collected from Pensacola, Florida, to Breton Islands, Louisiana, February 07, 2012: U.S. Geological Survey Data Series 799 [**http://pubs.usgs.gov/ds/0799/**].

Mullaney, J.R., and Schwarz, G.E., 2013, Estimated nitrogen loads from selected tributaries in Connecticut draining to Long Island Sound, 1999–2009: U.S. Geological Survey Scientific Investigations Report 2013–5171, 65 p., doi:10.3133/sir20135171 [**http://dx.doi.org/10.3133/sir20135171**].

Petkewich, M.D., and Conrads, P.A., 2013, Estimation of missing water-level data for the Everglades Depth Estimation Network (EDEN), 2013 update: U.S. Geological Survey Open-File Report 2013–1251, 45 p. [**http://pubs.usgs.gov/of/2013/1251/**].

Poppe, L.J., McMullen, K.Y., Ackerman, S.D., and Glomb, K.A., 2013, Sea-floor geology and topography offshore in northeastern Long Island Sound: U.S. Geological Survey Open-File Report 2013–1060, DVD-ROM, doi:10.3133/ofr20131060 [**http://dx.doi.org/10.3133/ofr20131060**].

Reynolds, C.E., Richey, J.N., and Poore, R.Z., 2013, Seasonal flux and assemblage composition of planktic foraminifera from the northern Gulf of Mexico, 2008–2012: U.S. Geological Survey Open-File Report 2013–1243, 13 p. [**http://pubs.usgs.gov/of/2013/1243/**].

Robbins L.L., Wynn, J.G., Lisle, J.T., Yates, K.K., Knorr, P.O., Byrne, R.H., Liu, X., Patsavas, M.C., Azetsu-Scott, K., and Takahashi, T., 2013, Baseline monitoring of the western Arctic Ocean estimates 20% of Canadian Basin surface waters are undersaturated with respect to aragonite: PLOS ONE, v. 8, no. 9, e73796, doi:10.1371/journal.pone.0073796 [**http://dx.doi.org/10.1371/journal.pone.0073796**].

Rosenbauer, R.J., Foxgrover, A.C., Hein, J.R., and Swarzenski, P.W., 2013, A Sr–

(Recently Published continued on page 25)

(Recently Published continued from page 24)

Nd isotopic study of sand-sized sediment provenance and transport for the San Francisco Bay coastal system, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 143–153, doi:10.1016/j.margeo.2013.01.002 [**http://dx.doi.org/10.1016/j.margeo.2013.01.002**].

Ruggiero, P., Kratzmann, M.G., Himmelstoss, E.A., Reid, D., Allan, J., and Kaminsky, G., 2013, National Assessment of Shoreline Change—Historical shoreline change in the Pacific Northwest: U.S. Geological Survey Open-File Report 2012–1007, 62 p., doi:10.3133/of20121007 [**http://dx.doi.org/10.3133/ofr20121007**].

Schenk, C.J., Charpentier, R.R., Klett, T.R., Gaswirth, S.B., Pitman, J.K., Brownfield, M.E., Mercier, T.J., Wandrey, C.J., and Weaver, J.N., 2013, Assessment of undiscovered technically recoverable oil and gas resources of Puerto Rico and the Puerto Rico–U.S. Virgin Islands Exclusive Economic Zone, 2013: U.S. Geological Survey Fact Sheet 2013–3101, 2 p., doi:10.3133/fs20133101 [**http://dx.doi.org/10.3133/fs20133101**].

Schoellhamer, D.H., Wright, S.A., and Drexler, J.Z., 2013, Adjustment of the San Francisco estuary and watershed to decreasing sediment supply in the 20th century, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 63–71, doi:10.1016/j.margeo.2013.04.007 [**http://dx.doi.org/10.1016/j.margeo.2013.04.007**].

Schofield, P.J., Slone, D.H., Gregoire, D.R., and Loftus, W.F., 2014, Effects of a non-native cichlid fish (African jewelfish, *Hemichromis letourneuxi* Sauvage 1880) on a simulated Everglades aquatic community: Hydrobiologia, v. 722, no. 1, p. 171–182, doi:10.1007/s10750-013-1697-0 [**http://dx.doi.org/10.1007/s10750-013-1697-0**].

Shellenbarger, G.G., Wright, S.A., and Schoellhamer, D.H., 2013, A sediment budget for the southern reach in San Francisco Bay, CA—Implications for habitat restoration, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 281–293, doi:10.1016/j.margeo.2013.05.007 [**http://dx.doi.org/10.1016/j.margeo.2013.05.007**].

Shouse, M.K., and Cox, D.A., 2013, USGS science at work in the San Francisco Bay and Sacramento-San Joaquin Delta estuary: U.S. Geological Survey Fact Sheet 2013–3037, 6 p. [**http://pubs.usgs.gov/fs/2013/3037/**].

Smith, C.G., and Osterman, L.E., 2013, An evaluation of temporal changes in sediment accumulation and impacts on carbon burial in Mobile Bay, Alabama, USA: Estuaries and Coasts, published online December 4, 2013, doi:10.1007/s12237-013-9731-z [**http://dx.doi.org/10.1007/s12237-013-9731-z**].

Stapanian, M.A., Witzel, L.D., and Cook, A., 2013, Temporal changes and sexual differences in spatial distribution of Burbot in Lake Erie: Transactions of the American Fisheries Society, v. 142, no. 6, p. 1724–1732, doi:10.1080/00028487.2013.795191 [**http://dx.doi.org/10.1080/00028487.2013.795191**].

Storlazzi, C.D., Field, M.E., Cheriton, O.M., Presto, M.K., and Logan, J.B., 2013, Rapid fluctuations in flow and water-column properties in Asan Bay, Guam—Implications for selective resilience of coral reefs in warming seas: Coral Reefs, v. 32, p. 949–961, doi:10.1007/s00338-013-1061-x [**http://dx.doi.org/10.1007/s00338-013-1061-x**].

Thorne, K.M., Elliott-Fisk, D.L., Wylie, G.D., Perry, W.M., Takekawa, J.Y., 2013, Importance of biogeomorphic and spatial properties in assessing a tidal salt marsh vulnerability to sea-level rise: Estuaries and Coasts, published online November 23, 2013, doi:10.1007/s12237-013-9725-x [**http://dx.doi.org/10.1007/s12237-013-9725-x**].

U.S. Geological Survey, 2013, Coastal processes influencing water quality at Great Lakes beaches: U.S. Geological Survey Fact Sheet 2013–3070, 4 p. [**http://pubs.usgs.gov/fs/2013/3070/**].

U.S. Geological Survey, 2013, Real-time assessments of water quality—Expanding nowcasting throughout the Great Lakes: U.S. Geological Survey Fact Sheet 2013–3069, 4 p. [**http://pubs.usgs.gov/fs/2013/3069/**].

U.S. Geological Survey, 2013, Research on pathogens at Great Lakes beaches—Sampling, influential factors, and potential sources: U.S. Geological Survey Fact Sheet 2013–3071, 4 p. [**http://pubs.usgs.gov/fs/2013/3071/**].

U.S. Geological Survey, 2013, Tools for beach health data management, data processing, and predictive model implementation: U.S. Geological Survey Fact Sheet 2013–3068, 6 p. [**http://pubs.usgs.gov/fs/2013/3068/**].

Van der Wegen, M., and Jaffe, B.E., 2013, Does centennial morphodynamic evolution lead to higher channel efficiency in San Pablo Bay, California?, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 254–265, doi:10.1016/j.margeo.2013.06.020 [**http://dx.doi.org/10.1016/j.margeo.2013.06.020**].

Wong, F.L., Woodrow, D.L., and McGann, M., 2013, Heavy mineral analysis for assessing the provenance of sandy sediment in the San Francisco Bay coastal system, *in* Barnard, P.L., Jaffe, B.E., and Schoellhamer, D.H., eds., A multi-discipline approach for understanding sediment transport and geomorphic evolution in an estuarine-coastal system—San Francisco Bay: Marine Geology, v. 345, p. 170–180, doi:10.1016/j.margeo.2013.05.012 [**http://dx.doi.org/10.1016/j.margeo.2013.05.012**].

Publications That Have Received Bureau Approval

Brothers, D.S., Ruppel, C., Kluesner, J.W., Chaytor, J.D., tenBrink, U.S., Hill, J.C., Andrews, B.D., and Flores, C., Seabed fluid expulsion along upper slope and outer shelf of the U.S. Atlantic continental margin: Geophysical Research Letters.

Dalyander, P.S., Long, J.W., Plant, N.G., and Thompson, D.M., Assessing mobility and redistribution patterns of sand and oil agglomerates in the surf zone: Marine Pollution Bulletin.

Dalyander, P.S., Long, J.W., Plant, N.G., and Thompson, D.M., Use of USGS wave scenarios to assess potential submerged oil mat (SOM) formation along the coast of Florida and Alabama, appendix to Operational Science Advisory Team (OSAT)-3 report: RestoreTheGulf.gov (official Federal portal for the Deepwater BP oil spill response and recovery).

Draut, A.E., Logan, J.B., Mastin, M.C., Ritchie, A.C., and Bountry, J., 2013, Sedimentary processes and channel change on the Elwha River, Washington, during the first two years of large-scale dam removal [abs.]: American Water Resources Association Annual Water Resources Conference, Portland, Oreg., November 4–7, 2013.

Foxgrover, A.C.,Barnard, P.L., Danielson, J.J., Tyler, D., and O'Neill, A., Mapping the impact of climate change on the San Francisco Bay area—Challenges and lessons learned [abs.]: Association of American Geographers Annual Meeting, Tampa, Fla., April 8–12, 2014.

Golden, N.E., California Seafloor Mapping Program GIS database of high-resolution base-map data [abs.]: Esri International User Conference, San Diego, Calif., July 14–18, 2014.

Guy, K.K., Stockdon, H.F., Plant, N.G., Doran, K.S., and Morgan, K.L.M., Hurricane Isaac—Observations and analysis of coastal change: U.S. Geological Survey Open-File Report.

Higman, B., Richmond, B., and Gibbs, A., Comparison of ShoreZone and National Assessment of Shoreline Change data at six sites along Alaska's Arctic coast [abs.]: Alaska Marine Science Symposium, Anchorage, Alaska, January 20–24, 2014.

Jokiel, P.L., Jury, C.P., and Kuffner, I.B., Coral calcification and ocean acidification, *in* Hubbard, D., ed., Coral reefs at the crossroads: Springer.

Kellogg, C.A., and Gray, M.A., 2014, Bacterial diversity and biogeography of the cold-water gorgonian *Primnoa resedaeformis* in Norfolk and Baltimore canyons [abs.]: Ocean Sciences Meeting, Honolulu, Hawaii, February 23–28, 2014.

Lacy, J.R. Gladding, S., Brand, A., Collignon, A., and Stacey, M.T., Lateral baroclinic forcing enhances transport of sediment from shallows to channel in an estuary: Estuaries and Coasts.

Parsons, T.E., and Segou, M., Does the success or failure of a stress-based aftershock forecast depend on M?—The 2013 M=6.6 Lushan earthquake and other examples: Seismological Review Letters.

Plant, N.G., Flocks, J., Stockdon, H.F., Long, J.W., Cormier, J., Guy, K., and Thompson, D.M., Predictions of barrier-island berm evolution in a time-varying storm climatology: Journal of Geophysical Research–Earth Surface.

Richmond, B.M., Gibbs, A., Erikson, L.H., Jones, B., and Higman, B., Understanding regional coastal change along the north coast of Alaska [abs.]: Alaska Marine Science Symposium, Anchorage, Alaska, January 20–24, 2014.

Robbins, L.L., Wanninkhof, R., Barbero, L., Hu, X., Mitra, S., Yvon-Lewis, S., Cai, W.-J., Huang, W.-J., and Ryerson, T., Air-sea exchange, *in* Benway, H.M., and Coble, P.G., eds., Report of the U.S. Gulf of Mexico Carbon Cycle Synthesis Workshop, March 27–28, 2013: Ocean Carbon and Biogeochemistry Program and North American Carbon Program.

Smith, K., Stockdon, H., and Doran, K., National Assessment of Hurricane-Induced Coastal Erosion Hazards—Using GIS to improve data dissemination [abs.]: Esri International User Conference, San Diego, Calif., July 14–18, 2014.

Smith, T.J., Balentine, K., and Ellis, L., Patterns of sediment surface elevation change in relation to surface and groundwater level fluctuation in the coastal Everglades: Wetlands.

Thieler, E.R., Foster, D.S., and Himmelstoss, E.A., Geologic framework of the northern North Carolina, USA, inner continental shelf and its influence on coastal evolution: Marine Geology.

Xu, J.P., Rosenberger, K., and Noble, M., Turbidity in California submarine canyons [abs.]: Ocean Sciences Meeting, Honolulu, Hawaii, February 23–28, 2014.

Zawada, D.G., and Mazel, C.H., Unsupervised classification of Caribbean coral reef organisms and substrates based on fluorescence spectra [abs.]: Ocean Sciences Meeting, Honolulu, Hawaii, February 23–28, 2014.

Zawada, D.G., and Mazel, C.H., Fluorescence-based classification of Caribbean coral reef organisms and substrates: PLOS ONE.