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Fieldwork

Beyond the Abyss—Scientists Investigate the Virtually Unexplored Mariana Trench

By Kaitlin Kovacs, Jill Bourque, and Amanda Demopoulos

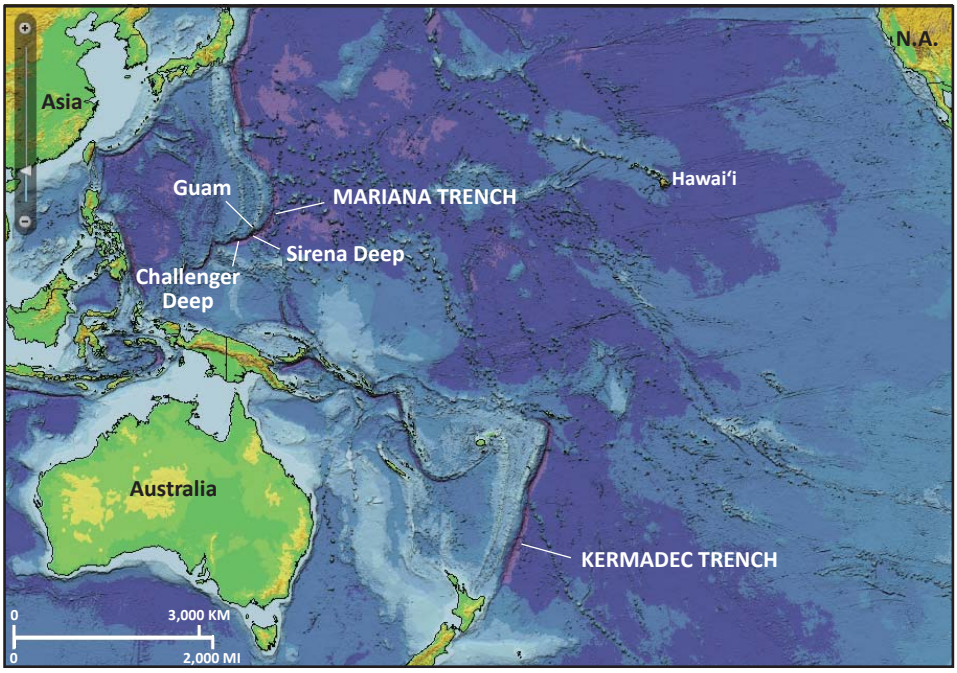
In November and December of 2014, **Jill Bourque** of the U.S. Geological Survey (USGS) Southeast Ecological Science Center's Benthic Ecology Group (Gainesville, Florida; <**http://fl.biology.usgs.gov/benthic_ecology**/>) joined an international team of scientists exploring the biology and geology of the Mariana Trench, the deepest known part of the ocean. The Mariana Trench, approximately 7 miles deep, lies in the western Pacific Ocean off the coast of Guam. Its deepest point, the Challenger Deep, has received increased attention from deep-sea explorers as technology advances, yet there is still much to learn about the biology, ecology, and geology of trench ecosystems. The deepest parts of the oceans, trenches remain a largely unstudied ocean frontier.

Led by co-chief scientists from the University of Hawai'i, **Jeff Drazen** and **Patty Fryer**, the Hadal Ecosystem Studies (HADES, <**http://www.whoi.edu/hades**/>) Mariana expedition set out to understand the basic environmental conditions within the trench, how animals in the trench have adapted to withstand pressure at such depths, how they are distributed across depth ranges, and the processes that control earthquake and tsunami generation.

Trenches typically form where two tectonic plates collide and one plate slides beneath the other (known as subduction). These subduction zones are geologically active areas that produce complex topography and some of the world's largest earthquakes. The Mariana Trench was created where the Pacific plate subducts beneath the Mariana plate. The expedition targeted multiple locations within the trench, on both tectonic plates and at multiple depths ranging from approximately 5,000 to almost 11,000 meters. Investigations included sampling from the second-deepest spot in the trench, the Sirena Deep (10,731 meters). The broad spectrum of sampled environments enabled scientists to directly address hypotheses concerning the relationships between biological and geological processes across the abyssal (less than 6,000 meters deep) and hadal (greater than 6,000 meters deep) zones.

Aboard Schmidt Ocean Institute's research vessel (R/V) *Falkor*, the researchers relied on five deep-sea landers for insight into life on the seafloor

(Mariana Trench continued on page 2)



*Western Pacific Ocean, showing location of Mariana Trench and Kermadec Trench. Challenger Deep is the Mariana Trench's deepest point. The 2014 Mariana Expedition included exploration of the Sirena Deep, the second-deepest part of the Mariana Trench. (View a map of the ship's tracks at <**http://www.schmidtocean.org/map/expedition/2394**>.) N.A., North America; KM, kilometers; MI, miles. Basemap from* This Dynamic Planet *interactive map at <**http://nhb-arcims.si.edu/ThisDynamicPlanet/index.html**>.*

*Amphipods, ranging in size from a few millimeters to 30 centimeters, were one of the species collected from the Mariana Trench. Photo courtesy of SOI/**Stuart Piertney**.*

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Deadline: The deadline for news items and publication lists for the September/October issue of *Sound Waves* is Wednesday, August 12, 2015.
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).

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Fieldwork, continued

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(<**http://www.schmidtocean.org/story/show/3414**>). Landers are free-falling vehicles that are deployed by the ship and sink to the seafloor. Outfitted with various types of instruments, they are deep-sea observatories, collecting data and sampling the seafloor. Once sampling is complete, an acoustic signal is sent from the ship to the lander to release weights, and the lander rises to the surface. Landers fitted with coring respirometers measured the change in sediment oxygen content over time to help scientists understand the activity or pace of life of organisms residing in the seafloor sediment. In addition, the same sediment was returned to the surface for further analysis of organic content (proxy for food), sediment characteristics, and species diversity. The landers also collected water samples, sediments, and rocks for chemical, microbial, and geological analyses. Camera landers were baited with fish, providing the researchers an opportunity to observe and record scavenger species, including larger-than-life amphipods and hadal fish. Researchers used specimens collected by baited fish and amphipod traps to conduct morphological studies and tests of physiological adaptations to pressure, to assess population dynamics via genetic analysis, and to study feeding ecology through stable isotope analysis.

*One of five deep-sea landers that provided insight into life on the trench seafloor. Outfitted with various types of instruments, the landers collected data and samples from the seafloor. Photo courtesy of SOI/**David Wotherspoon**.*

*Plastic syringes are used to collect precise volumes of sediment brought back from the seafloor. These samples will help answer questions about faunal communities and organic composition. Photo courtesy of SOI/**Jill Bourque**.*

USGS benthic ecologist Bourque collected sediment samples to help determine population abundance and diversity of macrofauna (organisms larger than 0.3 millimeter) and meiofauna (less than 0.3 millimeter). These organisms are important to ecosystem functioning because they provide a mechanism for energy transfer between the water column and the sediment. Meiofauna and macrofauna play a major role in the breakdown and burial of organic carbon raining down from surface waters, and they serve as food for larger invertebrates and fish.

Samples from the Mariana Trench will help researchers build upon previous work done with HADES in the Kermadec Trench, which lies off of New Zealand. In contrast to the Mariana Trench, the Kermadec Trench occurs in an area where there is higher productivity in the water column, potentially providing more food for animals at the bottom of the trench. Led by **Tim Shank** of the Woods Hole Oceanographic Institution, the May 2014 Kermadec expedition (<**http://web.whoi.edu/hades/kermadec-2014/**>) used landers and the hybrid remotely operated vehicle (HROV) *Nereus* (<**https://www.**

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whoi.edu/main/nereus>) to understand trench environments, enabling scientists to directly compare these two different trench systems. The collaborating researchers aim to assess how food supply, depth, and sediment characteristics structure communities in the two trenches.

New species were discovered on both HADES expeditions, including an unknown variety of snailfish (Family: Liparidae) in the Mariana Trench that broke the record for the deepest living fish caught or seen on video (<**https://www.youtube.com/watch?v=cBxsm5T2yN8**>). Found as deep as 8,143 meters, the fish was first spotted on a lander camera while sediment samples were being collected. These rare sightings provide unique insight into how organisms adapt to extreme pressure. Rocks collected from the inner slope of the trench broke depth records for previous rock collections, and their analysis will provide a unique opportunity to improve scientists' understanding of the mechanisms involved in tectonic plate subduction.

*Found as deep as 8,143 meters, a new species of snailfish represents the deepest living fish caught or seen on video (<**https://www.youtube.com/watch?v=cBxsm5T2yN8**>). Courtesy of SOI.*

The scientific discoveries following the Kermadec and Mariana Trench Expeditions have been extensive, and the researchers have only begun to analyze their data. As data are analyzed and samples processed, scientists will gain insight into the ecological functioning of each trench, as well as assess what patterns are consistent among trench systems as a whole.

For more information on the Mariana Trench expedition:

- <**http://www.schmidtocean.org/story/show/2394**>
- <**http://www.schmidtocean.org/files/soi-marianatrenchexplorationpressreleasefinal.pdf**> (455 KB)
- <**http://www.whoi.edu/hades/**> ❁

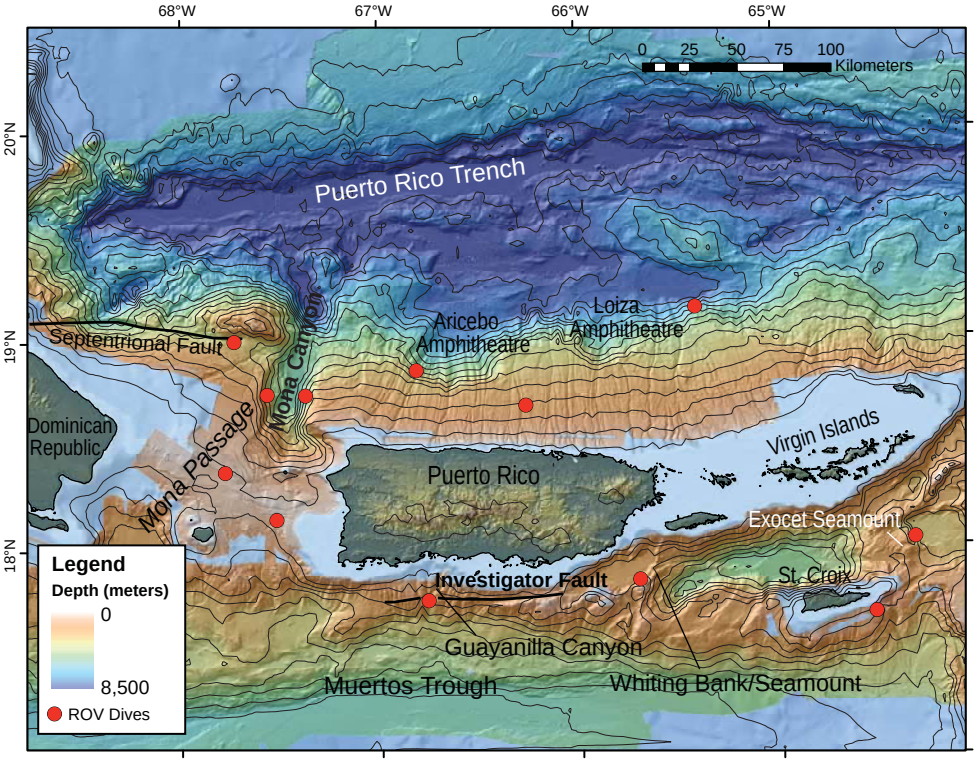
Telepresence Expedition Explores Unknown Deep-Sea Areas off of Puerto Rico and U.S. Virgin Islands

By Andrea Quattrini, Amanda Demopoulos, Jason Chaytor, and Uri ten Brink

In April 2015, U.S. Geological Survey (USGS) scientists participated in a National Oceanic and Atmospheric Administration (NOAA) Ocean Exploration research cruise investigating unknown and poorly understood deep-sea areas off Puerto Rico and the U.S. Virgin Islands. An interdisciplinary team of scientists working at sea and on shore examined the geology and biodiversity along various seafloor features at depths ranging from 300 to 4,500 meters. Twelve dives were completed with a dual-bodied remotely operated vehicle (ROV) system consisting of the ROV *Deep Discoverer* (*D2*) and the *Seirios* camera platform, both of which were launched and controlled from the NOAA Ship *Okeanos Explorer*.

Okeanos Explorer missions are different from most other oceanographic research expeditions, as video captured from the seafloor by *D2* and *Seirios* is streamed back to shore in real time (<**http://oceanexplorer.noaa.gov/okeanos/media/exstream/exstream.html**>). This live-

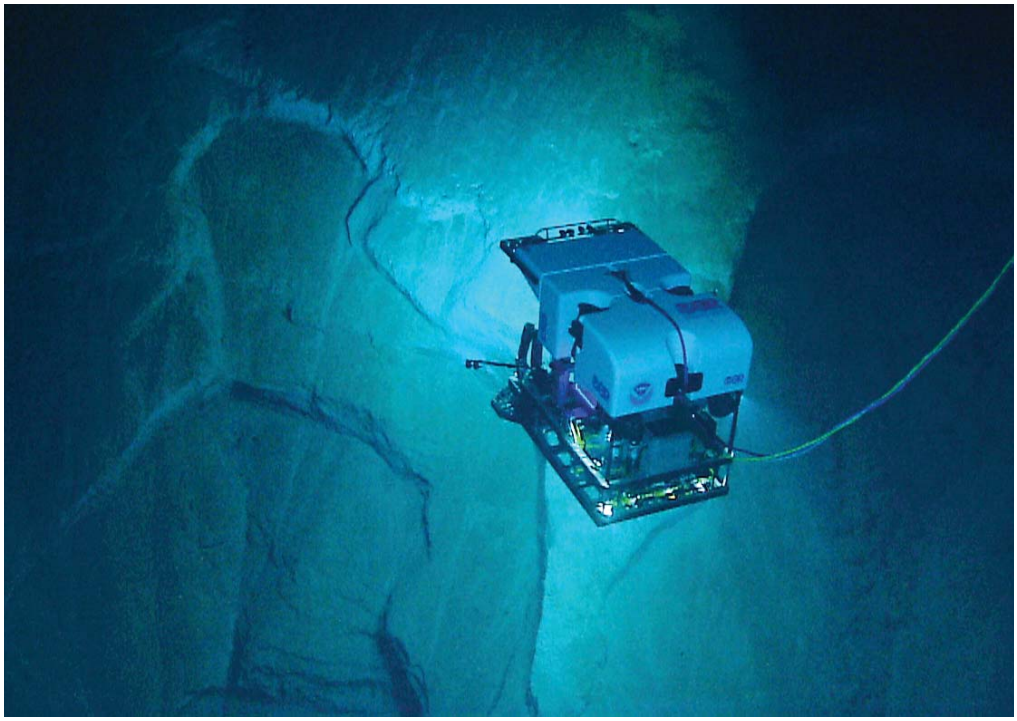
(Telepresence Expedition continued on page 4)



Locations (red dots) of dives conducted by remotely operated vehicle (ROV) D2 *in deep waters (300–6,000 meters) around Puerto Rico and the U.S. Virgin Islands.*

(Telepresence Expedition continued from page 3)

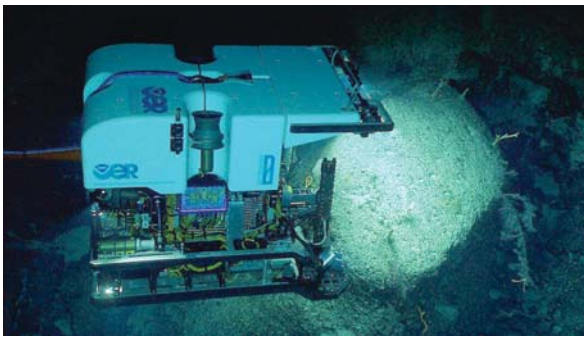
streaming makes it possible for the public to watch the cruise unfold and for researchers all over the world to collaborate with scientists aboard the ship. During the mission, as many as 40 scientists participated per day, either by calling in on a teleconference line or by logging their observations in an Internet chat room. This is participation by "telepresence" (<**http://oceanexplorer.noaa.gov/explorations/07blacksea/background/telepresence/telepresence.html**>). It allowed scientists with expertise in various fields—such as taxonomy, ecology, geology, and oceanography—to work closely together to advance our knowledge about the deep sea.



View of the ROV D2 *surveying evidence of slope failure on the wall of Guayanilla Canyon south of Puerto Rico at 1,800 meters depth. Note the semicircular scars where slabs of rock have broken away from the canyon wall. USGS scientists describe highlights of this canyon in a video at <**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1502/logs/dive7/dive7.html**>. Courtesy of NOAA* Okeanos Explorer *Program.*

Serving as the biological science lead on the *Okeanos Explorer* was **Andrea Quattrini**, a postdoctoral researcher with the USGS Benthic Ecology Group at the Southeast Ecological Science Center (SESC) in Gainesville, Florida (<**http://fl.biology.usgs.gov/benthic_ecology/**>). Helping to guide at-sea operations from shore via telepresence were USGS scientists **Amanda Demopoulos** of the SESC and **Jason Chaytor** and **Uri ten Brink** of the Woods Hole Coastal and Marine Science Center in Woods Hole, Massachusetts.

The research cruise, conducted April 9–30, 2015, was Leg 3 of the NOAA expedition "Océano Profundo 2015: Exploring Puerto Rico's Seamounts, Trenches, and Troughs." Leg 1 (<**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1502/background/leg1/welcome.html**>) and Leg 2 (<**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1502/background/leg2/welcome.html**>) focused on mapping the seafloor at high resolution. Leg 3 (<**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1502/background/plan/welcome.html**>) used the ROV system to make some of the deepest dives ever accomplished in the region. Because of mechanical issues with the ship, only 12 of 20 planned dives were completed. However, those 12 dives collected valuable deep-sea data that will improve ecosystem understanding and inform federal and local resource managers. For example, the mission included two dives in the Mona Passage (300–700 meters) to survey areas near fishing grounds for deepwater snappers (<**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1502/background/snapper-grouper/welcome.html**>). The Caribbean Fishery Management Council (<**http://caribbeanfmc.com/**>) worked with local fisherman in Puerto Rico to recommend locations for these dives.



View from the camera platform Seirios *shows the ROV* D2 *surveying a rock outcrop to which numerous deep-water corals are attached (800 meters). Courtesy of NOAA* Okeanos Explorer *Program.*

Geological Setting

Surveyed areas included the Puerto Rico Trench, Mona Canyon, Mona Passage, and local seamounts and submarine canyons (see map on page 3). These rugged seafloor features are the result of the long-term and complex interactions between the North American and Caribbean tectonic plates. Active oblique subduction (where the North American plate slides below and along the Caribbean plate) and extension (opening) perpendicular to the plate boundary and throughout the Greater Antilles island arc have generated numerous damaging earthquakes and tsunamis. (Learn more about the Caribbean's tectonic setting and its earthquake and tsunami hazards at

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<**http://woodshole.er.usgs.gov/project-pages/caribbean/background.html**>.) The region's complex underwater terrain influences ocean currents and provides a wide variety of seafloor habitats that harbor diverse deep-sea communities.

Biological Highlights

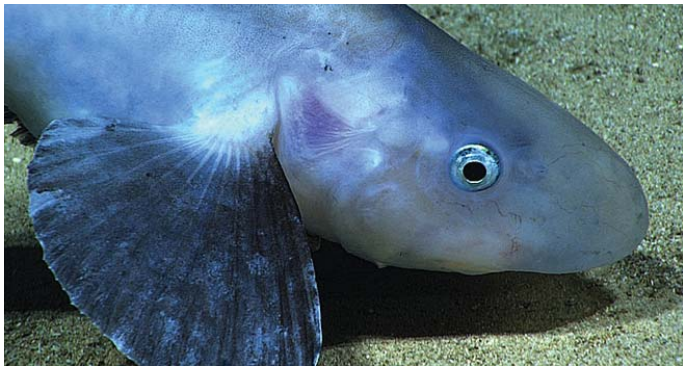
The exceptional high-definition video on the ROV *D2* captured stunning images of at least 100 species of fishes, 50 species of deep-sea corals, and 100s of other invertebrates during the April expedition. It was the first time that many of these species had been imaged in their natural habitat, providing valuable information on their behavior and their live-coloration (specimens commonly change color when brought up from the deep sea). The researchers discovered at least two new species—a fish and a ctenophore (ctenophores resemble jellyfish, although they are from a different phylum)—and they observed many species not previously recorded from waters off Puerto Rico. One exciting discovery was a starfish, *Laetmaster spectabilis*, previously known only from the original specimen used for the species description, collected more than 130 years ago. This starfish was seen at 3,915 meters in Mona Canyon; view it on a video at <**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1502/logs/dive5/dive5.html**>.

During the dive when this starfish was observed, **Christopher Mah**, a starfish expert at the Smithsonian Institution Natural History Museum, called the ship to explain its significance. This discovery is a great example of how little we have explored topographically complex and deep habitats, and how telepresence technology allows shipboard scientists to benefit from working with shore-based scientists in real time. The Benthic Ecology Group and their collaborators at the Woods Hole Coastal and Marine Science Center will use the data gathered on the seamount dives to better understand the distribution of benthic organisms and habitat associations within the region.

Learn more about the expedition on the NOAA *Okeanos Explorer* website at <**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1502/welcome.html**>.

◀ *The high-definition video footage allowed for amazing close-ups. In this image, calcium carbonate structures known as sclerites (small, opaque white lines approximately 1 mm long) can be seen embedded in the tissue of this octocoral. Courtesy of NOAA* Okeanos Explorer *Program.*

▶ *Starfish* Laetmaster spectabilis*, not seen since the original specimen was collected more than 130 years ago. This starfish was observed at 3,915 meters in Mona Canyon; view it on a video at* <**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1502/logs/dive5/dive5.html**>*. Courtesy of NOAA* Okeanos Explorer *Program.*



Rarely observed deep-sea fish, a jellynose. Courtesy of NOAA Okeanos Explorer *Program.*

This shrimp was observed at 850 meters depth, grooming itself with its specialized grooming appendage. View a video at <**http://soundwaves.usgs.gov/2015/06/fieldwork2.html**>*. Courtesy of NOAA* Okeanos Explorer *Program.*

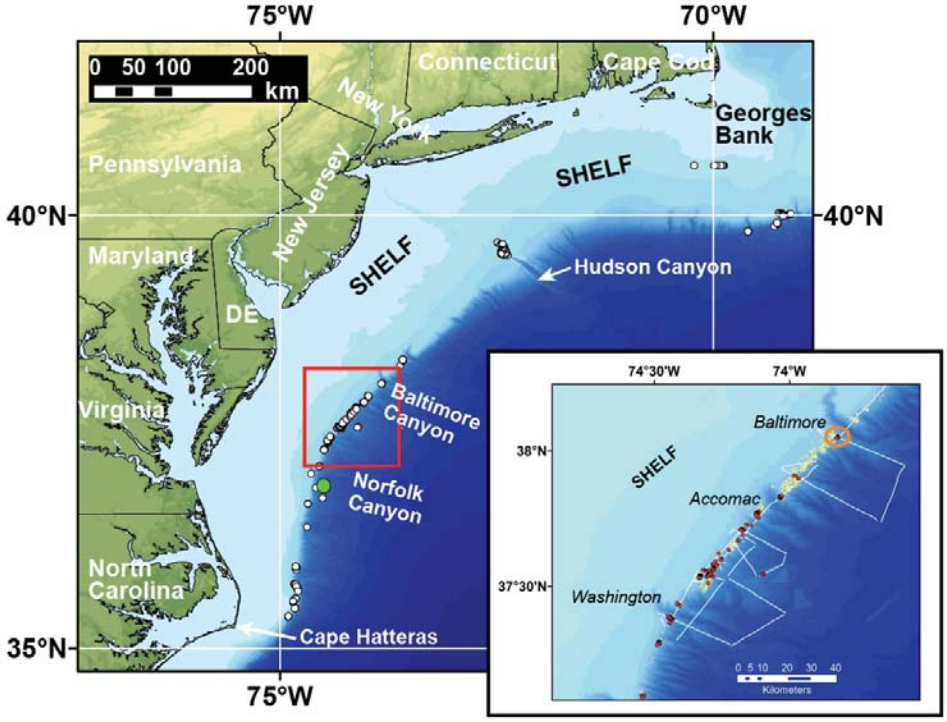
Imaging Methane Seeps and Plumes on the U.S. Atlantic Margin

By Carolyn Ruppel, Jared Kluesner, and William Danforth

Scientists from the U.S. Geological Survey (USGS) Gas Hydrates Project surveyed methane seeps and plumes on the northern part of the U.S. Atlantic margin aboard the research vessel (R/V) *Endeavor* in April 2015. The researchers collected high-resolution seismic data (cross-sectional views of sediment layers and other features beneath the seafloor) along ship tracks totaling nearly 580 kilometers (360 miles), in addition to continuous imagery of methane plumes in the water column above seafloor cold seeps. They also measured the flux of methane and carbon dioxide (CO_2) from the ocean to the atmosphere.

In 2014, a *Nature Geoscience* paper coauthored by USGS scientists **Carolyn Ruppel** and **Daniel Brothers** described hundreds of newly identified methane seeps (<**http://soundwaves.usgs.gov/2014/10/**>) in the area later visited by the 2015 R/V *Endeavor* cruise. The goal of the 2015 cruise was to study the connection of these seeps to methane gas and methane hydrate in the underlying sediments. Methane hydrate (<**http://woodshole.er.usgs.gov/project-pages/hydrates/primer.html**>) is a frozen form of gas and water ("methane ice") stable at the pressure and temperature conditions that prevail on the U.S. Atlantic margin in sediments below at least 505 to 550 meters (1,650–1,800 feet) of water. The Bureau of Ocean Energy Management (BOEM; see <**http://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Resource_Evaluation/Gas_Hydrates/BOEM-FactSheetRED_2012-01.pdf**>, 754 KB) estimates that as much methane is trapped in gas hydrates in sediments on the U.S. Atlantic margin as in the northern Gulf of Mexico **(<http://soundwaves.usgs.gov/2013/08/>)**, which is known as a world-class petroleum basin.

Many of the seeps first described in 2014 are at upper continental slope depths (200–550 meters, or 650–1,800 feet). The prevailing hypothesis is that these seeps may be leaking methane that is released when gas hydrate breaks down due to warming ocean temperatures (see <**http://www.nature.com/scitable/knowledge/library/methane-hydrates-and-contemporary-climate-change-24314790**>). A 2014 study (<**http://dx.doi.org/10.1002/2013GL058048**>) led by **Daniel Brothers** mapped more than 5,000 pockmarks—shallow seafloor depressions thought to be mostly related to past methane expulsion events—on the upper slope and outer continental shelf (depths as much as 180 meters, or 590 feet) on the northern U.S. Atlantic margin. That study also showed that seismic data from the New York segment of the margin might be consistent with ongoing breakdown of gas hydrate in response to decades-long ocean warming.



Large map shows newly discovered methane seeps on the northern U.S. Atlantic margin (white circles) described in a 2014 Nature Geoscience *paper (<**http://dx.doi.org/10.1038/ngeo2232**>). Red box indicates area of inset map. Green dot shows locations of Norfolk Canyon deepwater seeps depicted in close-up perspective view on next page. Inset: The upper continental slope between Baltimore Canyon on the north and Washington Canyon on the south hosts more than 200 methane seeps and was a particular focus of the R/V* Endeavor *cruise. Red dots are seeps found with geophysical methods; small yellow dots are upper slope pockmarks mapped by **Daniel Brothers**. White lines show locations of some of the newly acquired multichannel seismic (MCS) data. Orange circle highlights the seeps overlooking Baltimore Canyon. **Amanda Demopoulos** and **Nancy Prouty** have analyzed data obtained during remotely operated vehicle exploration of nearby seeps.*

On the April 2015 R/V *Endeavor* cruise, researchers collected high-resolution 72-channel multichannel seismic (MCS) data of unprecedented quality for this USGS instrumentation. A sparker towed behind the ship provided the source of the seismic (sound) energy. A sparker creates electrical pulses that emit sound that penetrates the seafloor and is reflected from boundaries between layers that have contrasting physical properties. The reflected sound is recorded by a 450-meter (about 1,500 foot)-long streamer of 72 hydrophones (or receivers). A sparker is less powerful than an airgun source, but allows scientists to image features as much as several hundred meters (approximately 1,000 feet or more) below the seafloor at a resolution of less than a meter.

The seismic data acquisition was supported by **Thomas O'Brien**, **Emile Bergeron**, **Charles Worley**, and **Alex Nichols** from the USGS Woods Hole Coastal and Marine Science Center in

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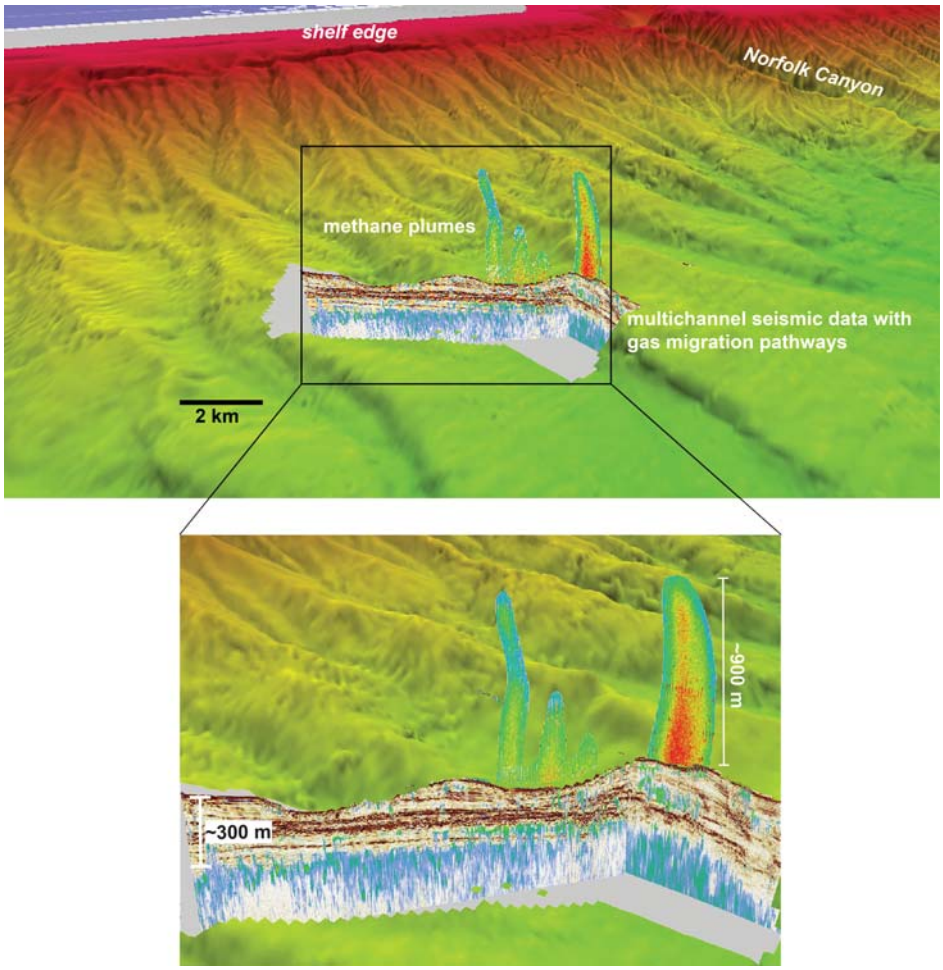
(Methane Seeps continued from page 6)

Woods Hole, Massachusetts. Processing of the seismic data was completed shipboard under the direction of USGS scientists **Jared Kluesner** and **William Danforth**, with assistance from University of California-Santa Cruz graduate student **Joel Edwards**. Also participating in the cruise was Massachusetts Institute of Technology (MIT) graduate student **Xiaojing (Ruby) Fu**, who does numerical modeling with MIT Associate Professor **Ruben Juanes** in support of an MIT-USGS-University of New Hampshire (UNH) study funded by the U.S. Department of Energy (DOE) to examine the fate of methane plumes in the water column (<**http://204.154.137.14/technologies/oil-gas/FutureSupply/MethaneHydrates/projects/DOEProjects/fe0013999-MIT.html**>). **Carolyn Ruppel** was the Chief Scientist on the cruise, which was supported by a USGS-DOE Interagency Agreement.

Michael Casso and **Thomas (Wally) Brooks** (USGS) led shipboard geochemical measurements, acquiring data to constrain the flux of methane from the ocean to the atmosphere. Over the past 5 years, USGS scientists **John Pohlman**, **Emile Bergeron**, and Casso have combined two cavity ring-down spectrometers with other USGS-designed peripherals to permit continuous measurement of methane and CO_2 concentrations in near-surface waters and in the air right above the sea surface (<**http://soundwaves.usgs.gov/2012/06/research2.html**>). When these data are combined with other information, the sea-air flux of methane, a potent greenhouse gas, can be determined. The instrumentation has been deployed by the USGS Gas Hydrates Project in the U.S. Arctic (see page 7 of <**http://www.netl.doe.gov/File%20Library/Research/Oil-Gas/methane%20hydrates/MHNews_2012_June.pdf**>, 2.7 MB) and on the Svalbard margin (<**http://meetingorganizer.copernicus.org/EGU2015/EGU2015-10015.pdf**>, 49 KB). The R/V *Endeavor* cruise added new data over the northern Atlantic margin methane seep province at water depths of approximately100 to 1,400 meters (330–4,600 feet). The data provide an important test of the hypothesis that methane seeps at greater water depths contribute little or no methane directly to the atmosphere (<**http://soundwaves.usgs.gov/2012/06/**>), regardless of the amount of methane they emit.



*Three-dimensional perspective view of deepwater seeps south of Norfolk Canyon on the northern U.S. Atlantic margin. Image looks westward toward the shelf edge at approximately 150 meters (490 feet) water depth. The bathymetric data were published in USGS Open File Report 2012–1266 (<**http://dx.doi.org/10.3133/ofr20121266**>) led by **Brian Andrews**. The seafloor seeps that produce methane plumes up to 900 meters (2,950 feet) high in the water column lie at a water depth of 1,500 meters (4,900 feet) and are called the "Norfolk seeps" by researchers. They lie on two lines forming an oblique angle and may originate with methane leaking from fractured Eocene rock. The methane plumes were recorded with a fisheries-type water-column imaging system operated at 38 kHz. The multichannel seismic (MCS) data in the cutaway show coherent reflections to at least 300 meters (985 feet) below the seafloor. Blue features on the seismic image show gas-migration pathways beneath the seafloor determined through specialized analyses. Seismic processing and analysis by **Jared Kluesner** (USGS); figure prepared by **William Danforth** (USGS). Inset: Close-up of area enclosed by black box in top image, from a perspective slightly to the southwest of the top view.*

The cruise also marked the first deployment of a water-column imaging system recently acquired by the USGS Gas Hydrates Project. The discovery of U.S. Atlantic margin methane seeps described in the 2014 paper relied on imaging methane plumes in the water column using a multibeam sonar system that is more typically applied to map seafloor bathymetry. The instruments best suited to mapping water-column methane plumes are those that are normally used to locate fish. The Gas Hydrates Project has previously adapted a simple recreational fishfinder for imaging methane plumes in freshwater lakes (<**http://soundwaves.usgs.gov/2009/10/**>). For the R/V *Endeavor* cruise, the USGS used a special 38-kHz transducer (transmitter) and

(Methane Seeps continued on page 8)

(Methane Seeps continued from page 7)

fisheries transceiver (receiver) to continuously map deepwater methane plumes, as previously done by collaborator **Thomas Weber** (UNH). **Michael Jech**, **Joseph Godlewski**, and their coworkers at the National Oceanic and Atmospheric Administration (NOAA) Northeast Fisheries Science Center in Woods Hole assisted the USGS with system calibration prior to the ship's departure. The data collected during the cruise showed that some previously mapped seeps were not emitting methane when the ship crossed over and also revealed new methane seeps, particularly at the edge of the continental shelf.

The data from the R/V *Endeavor* cruise were used for planning deep submergence vehicle (DSV) *Alvin* dives at some of the seeps on a cruise led by **Cindy Van Dover** (Duke University) in July 2015. The new data may also inform studies of seeps near Baltimore Canyon and Norfolk Canyon by USGS ecologist **Amanda Demopoulos** (<**http://www.sgmeet.com/osm2014/viewabstract.asp?AbstractID=18101**>) and USGS oceanographer **Nancy Prouty** (<**https://agu.confex.com/agu/fm14/meetingapp.cgi#Paper/18637**>). The new results are also being used to choose sites for piston coring, heat flow, and biogeochemical studies to be conducted in September 2015 as part of a DOE-funded cruise led by the USGS Gas Hydrates Project, with collaboration from **Frederick Colwell** (Oregon State University), **Tina Treude** (University of California, Los Angeles), and **Matt Hornbach** (Southern Methodist University). Since the newly acquired data constrain gas hydrate distributions in an area not previously surveyed with modern imaging techniques, the data are also expected to prove useful if future studies of gas hydrate as a potential energy resource (<**http://woodshole.er.usgs.gov/project-pages/hydrates/energy.html**>) shift to the U.S. Atlantic margin.

Alex Nichols *(USGS) moves a "bird" that contains electronics used to position the seismic streamer (blue cable on reel on the right) at the correct depth and angle in the water column when the streamer is being towed behind the ship and receiving sound from the sparker source.*

Learn more about research by the USGS Gas Hydrates Project at <**http://woodshole.er.usgs.gov/project-pages/hydrates/**>.

Research

Some Coastal Communities May Not Have Time for Tsunami Evacuation

By Nathan Wood, Jeanne Jones, and Leslie Gordon

Tens of thousands of people along the U.S. Pacific Northwest coastline may not have enough time to evacuate low-lying areas before tsunami waves arrive, according to a new publication by researchers at the U.S. Geological Survey (USGS), University of Colorado Boulder, and California State University, Sacramento.

"All coastal communities in the U.S. Pacific Northwest are vulnerable to varying degrees to tsunami hazards from a Cascadia subduction-zone earthquake," said **Nathan Wood**, lead author of the study and scientist with the USGS. "Having a better sense of how a community is specifically vulnerable provides officials with the ability to develop outreach, preparedness, and evacuation plans that are tailored to local conditions and needs."

The authors detailed their findings in the April 28, 2015, issue of the journal *Proceedings of the National Academy of Sciences* (<**http://dx.doi.org/10.1073/pnas.1420309112**>). They examined the 49 cities, seven tribal reservations, and 17 counties from northern California through northern Washington that are directly threatened by tsunami waves that could be generated by a future Cascadia subduction-zone earthquake. The scientists evaluated the number of people or businesses exposed to tsunami hazards, as well as demographics and evacuation time by foot for each of these communities. (Read

◀*Internationally adopted tsunami-evacuation sign in the city of Nehalem, Oregon.*

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about a USGS mapping tool for estimating pedestrian evacuation time in "Getting Out of Harm's Way—Evacuation from Tsunamis" in *Sound Waves*, January/February 2015, <**http://soundwaves.usgs.gov/2015/02/outreach2.html**>.)

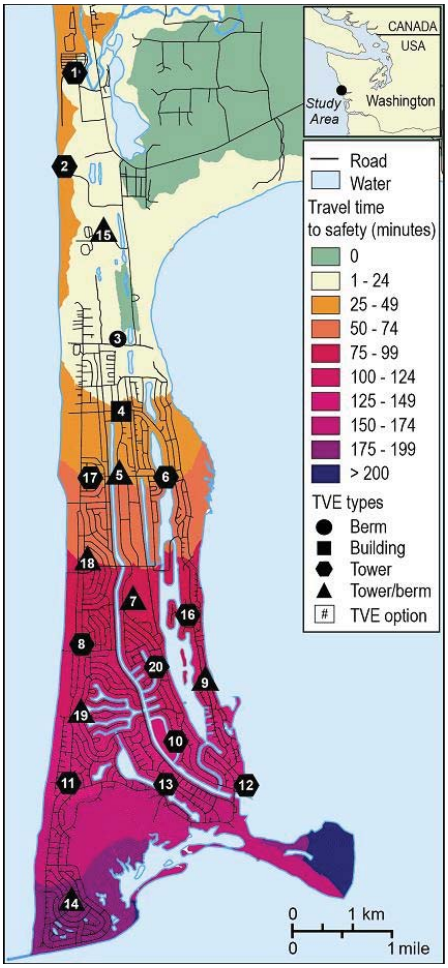
In their analysis, the scientists found that coastal communities fall into one of three groups differentiated by the size of their population and the time it would take to safely evacuate people. Communities in the first group have relatively small populations in tsunami-hazard zones and likely have sufficient time to evacuate, suggesting the need for tsunami education. A second group of communities has large populations in tsunami-hazard zones and likely will have sufficient time to evacuate if people are able to move quickly, suggesting a need for evacuation training. The third group of communities has moderate-sized populations in tsunami-hazard zones and insufficient time for everyone to evacuate before wave arrival, suggesting the need for solutions such as vertical-evacuation refuges.

"This new research confirms the underlying need for continuing the important public-education efforts to ensure coastal residents know how to reach safety in the event of a tsunami," said **John Schelling**, Earthquake & Tsunami Program Manager for the Washington Military Department's Emergency Management Division. "Perhaps more importantly, this research confirms the need for continued implementation of the multiagency collaboration known as 'Project Safe Haven' and ensuring communities on the Washington Coast have tsunami vertical-evacuation refuges, from which to escape a tsunami."

"Identifying communities with similar tsunami-hazard vulnerabilities will build a regional network among officials to share success stories of risk reduction and create opportunities for collaboration," said Wood. "Our goal was to provide officials with actionable information for saving lives with community-specific interventions."

The full study, "Community clusters of tsunami vulnerability in the US Pacific Northwest," is available online at <**http://dx.doi.org/10.1073/pnas.1420309112**>.

The USGS is leading studies of community vulnerability to various natural hazards through its Land Change Science Program (<**http://www.usgs.gov/climate_landuse/lcs/**>). For further information on this study and other current projects across the United States, visit the USGS Risk and Vulnerability to Natural Hazards project, <**http://geography.wr.usgs.gov/science/vulnerability/**>.



*Map showing the time it would take to walk to a safe area in low-lying Ocean Shores, Washington, to avoid a tsunami. If a Cascadia subduction-zone earthquake occurred, the corresponding tsunami could arrive in less than 25 minutes. Black symbols represent proposed vertical evacuation sites, which would offer more people access to closer safe areas. From USGS Top Story at <**http://www.usgs.gov/blogs/features/usgs_top_story/preparing-communities-for-the-next-great-tsunami/**>.*

Spotlight on Sandy

Mendenhall Postdoctoral Research Fellow Joins Hurricane Sandy Estuarine Physical Response Project

By Neil K. Ganju

In March 2015, **Dan Nowacki** joined the U.S. Geological Survey (USGS) Woods Hole Coastal and Marine Science Center in Woods Hole, Massachusetts. Dan is a Mendenhall Research Fellow (<**http://geology.usgs.gov/postdoc/**>) working primarily with USGS research oceanographer **Neil Ganju** as part of the Estuarine Physical Response to Storms project (<**http://woodshole.er.usgs.gov/project-pages/estuarine-physical-response/**>). He is developing techniques to quantify the role of vegetation in the response and resilience of coastal areas to large storm events. Using a combination of numerical modeling techniques and field measurements, he will work to better understand how a variety of vegetation types modify waves and associated sediment-transport processes. Although coastal vegetation is generally thought to mitigate wave action and storm surge, the specific dynamics of the interaction remain poorly known; this work could ultimately help coastal planners understand the role of natural ecosystems in storm protection.

(Mendenhall Fellow continued on page 10)

(Mendenhall Fellow continued from page 9)

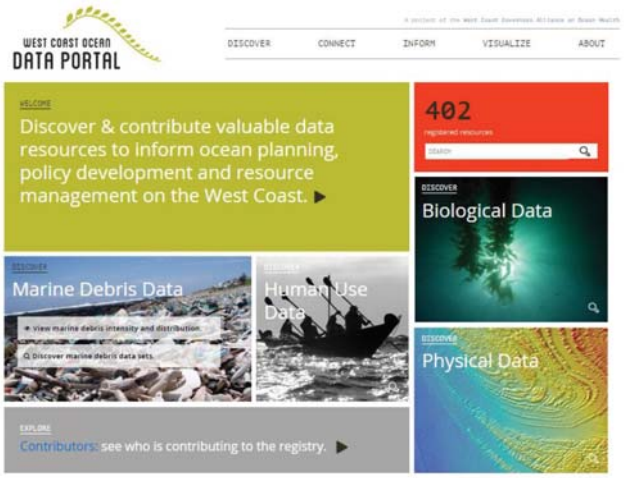
Originally hailing from Maine, Dan comes most recently from the University of Washington, where he earned a Ph.D. in oceanography and an M.S.E. (Master of Science in Engineering) in civil and environmental engineering. His doctoral thesis research focused on sediment-transport processes in a number of diverse environments and brought him to the muddy tidal flats of the Pacific Northwest; the vegetated tidal floodplains of the tidal Amazon River, Brazil; and the tidal distributaries of the Mekong River, Vietnam. Prior to his graduate career, after earning his undergraduate degree at Syracuse University, Dan was a hydrologist with the USGS National Research Program in Reston, Virginia, studying surface-water flows in the Florida Everglades. ☸

***Daniel Nowacki** deploying instruments in extremely soupy mud south of the Amazon River mouth near Bragança, Brazil. Photograph by **Aaron Fricke**, University of Washington.*

Spring 2015 Monterey Bay Marine GIS User Group Meeting

By Nadine Golden

The fifth meeting of the Monterey Bay Marine GIS User Group was held on April 16, 2015, at the U.S. Geological Survey (USGS) Pacific Coastal and Marine Science Center in Santa Cruz, California. A GIS (geographic information system) is a computer-based system for storing, manipulating, analyzing, and managing all types of geographically referenced information. The goals of this user group are to foster collaboration among academic institutions, the private sector, government agencies, and non-governmental organizations (NGOs) in the Monterey Bay marine GIS science community; to facilitate hands-on GIS training; and to increase awareness of marine spatial data sets within the broader GIS science community in the Monterey Bay area.



*Slide from **Todd Hallenbeck** (West Coast Governor's Alliance on Ocean Health), showing the home page of the West Coast Ocean Data Portal website (<**http://portal.westcoastoceans.org/**>).*

Approximately 65 members of the Monterey Bay coastal and marine community, including GIS users, marine scientists, and policy makers, gathered for a morning of networking and presentations with a focus on marine GIS participatory mapping. Participatory mapping is a general term for enhancing maps by adding the knowledge of local experts, such as fishermen, harbormasters, or longtime residents. **Mimi D'Iorio** (National Oceanic and Atmospheric Administration [NOAA], <**http://marineprotectedareas.noaa.gov/welcome.html**>) and **Will McClintock** (University of California, Santa Barbara [UCSB], <**http://mcclintock.msi.ucsb.edu/**>) led an afternoon workshop about the advantages, limitations, and costs associated with various participatory mapping approaches. This interactive panel discussion provided an opportunity to explore a suite of participatory mapping tools and to discuss best practices, lessons learned, and strategies for integrating community knowledge into research and planning.

The first speaker, **Todd Hallenbeck** (West Coast Governors Alliance on Ocean Health, <**http://www.westcoastoceans.org/**>), began the day with a demonstration of discovering data and informing regional ocean health priorities with the West Coast Ocean Data Portal (<**http://portal.westcoastoceans.org/**>). He showed examples of data types, data sources, and new features, such as data search catalog and data filtering.

Caitlyn Raines, a member of the Oceans team at Esri (<**http://www.esri.com/**>), led the group through the new features of the Esri Ocean Basemap

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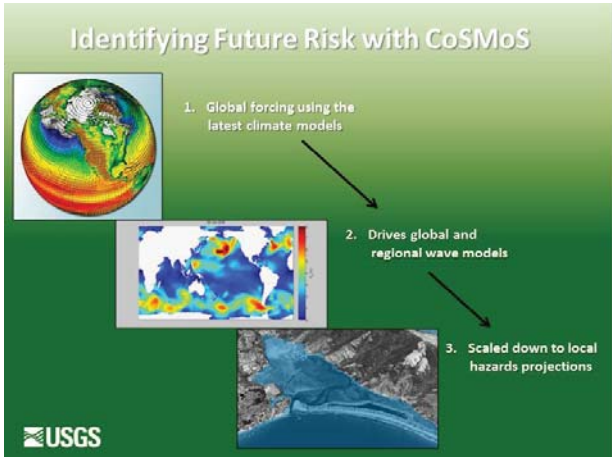
(<**http://www.esri.com/esri-news/arcwatch/0614/a-new-and-improved-world-ocean-basemap**>), described Esri's new maritime products and tools, and discussed the future of Esri's ArcGIS Ocean efforts.

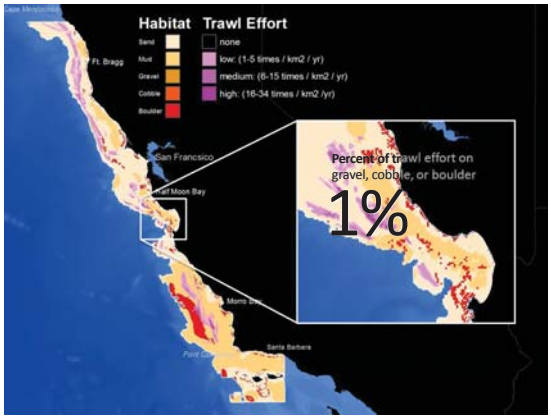
Next, **Patrick Barnard** (USGS) demonstrated the Coastal Storm Modeling System (CoSMoS, <**http://walrus.wr.usgs.gov/coastal_processes/cosmos/**>) and led the group through its products, tools, and options. He discussed how the modeling system was developed to meet overwhelming needs of USGS partners by using the most sophisticated tools available. Barnard described how CoSMoS makes detailed projections of storm-induced coastal flooding, erosion, and cliff failures over large geographic scales. He emphasized that CoSMoS was developed for hindcast studies, operational applications, and future climate scenarios to provide emergency responders and coastal planners with critical storm-hazards information that can be used to increase public safety, mitigate physical damage, and more effectively manage and allocate resources in complex coastal settings.



*Slide from **Patrick Barnard** (USGS), demonstrating uses of the Coastal Storm Modeling System (CoSMoS, <**http://walrus.wr.usgs.gov/coastal_processes/cosmos/**>).*

Melissa Stevens of the Nature Conservancy (TNC) presented TNC's eCatch tool (<**https://www.ecatch.org/**>) and lessons learned in the development process. eCatch provides a simple way for fishermen to collect, map, and share their fishing information, thus helping stakeholders in commercial fisheries to better align ocean health with profitability.

Mimi D'Iorio and **Hugo Selbie** (NOAA) described their recent work empowering communities through participatory mapping. Their process is designed to capture spatial data where coastal communities use the ocean across a full range of typical human activities. D'Iorio described how participatory mapping techniques offer a proven, flexible, and scalable approach that empowers coastal communities to paint an accurate picture of human use on a scale appropriate for ocean planning at the local, state, or regional level. D'Iorio also described the outline and goals for the afternoon workshop.



*Slide from **Melissa Stevens** (TNC), showing an eCatch (<**https://www.ecatch.org/**>) map of fish habitats and trawl effort (a measure of trawling intensity, in this case, number of trawls per square kilometer per year) along the California coast.*

The final speaker of the morning, **Will McClintock** (UCSB), gave a brief overview of SeaSketch (<**http://www.seasketch.org/**>), a web and mobile application for ocean planning, monitoring, and enforcement. Many organizations use SeaSketch during the participatory mapping process. McClintock also provided additional information about the afternoon workshop.

After a break for lunch, workshop participants gathered again at the meeting site. They saw demonstrations by workshop instructors **Mimi D'Iorio** and **Will McClintock**, explored the details of a well-developed participatory mapping process, and learned how to configure SeaSketch for gathering information. D'Iorio and McClintock closed the workshop by discussing participants' unique projects and answering questions about customizing the process.

The Monterey Bay Marine GIS User Group will meet again in spring 2016; details will be announced on the Monterey Bay Marine GIS User Group website (<**http://walrus.wr.usgs.gov/MontereyBayMarineGIS/**>). For any questions about the Monterey Bay Marine GIS User Group or its meetings, please contact **Nadine Golden** at **ngolden@usgs.gov**, **Lisa Wedding** at **lwedding@stanford.edu**, or **Mimi D'Iorio** at **Mimi.Diorio@noaa.gov**. ❁

***Mimi D'Irio** addresses participants at the afternoon workshop on participatory mapping. USGS photograph by **Nadine Golden**.*

Amanda Demopoulos Receives 2014 USGS Early Career Excellence in Leadership Award

The U.S. Geological Survey (USGS) has awarded its 2014 Early Career Excellence in Leadership Award to research ecologist **Amanda Demopoulos** of the Southeast Ecological Research Center in Gainesville, Florida. The award was presented on May 5, 2015, at the USGS Honor Awards Ceremony in Reston, Virginia, where Demopoulos was recognized for her "outstanding acts, services, and achievements that exemplify and support the USGS leadership goals throughout the Bureau."

Here is the award citation, written by **Nancy Prouty**, research oceanographer with the USGS Pacific Coastal and Marine Science Center in Santa Cruz, California, and frequent collaborator with Demopoulos.

"In recognition of **Dr. Amanda Demopoulos'** tremendous leadership, as well as her scientific contributions to both the U.S. Geological Survey and the scientific community, it is my pleasure to nominate Dr. Demopoulos for the Early Career Excellence in Leadership Award. As Project Chief for the Outer Continental Shelf, Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats with Emphasis on Canyon and Coral Communities in the USGS Terrestrial, Freshwater, and Marine Ecosystems Program [<**http://www.usgs.gov/ecosystems/environments/**>], Dr. Demopoulos developed and strengthened relationships with the Bureau of Ocean Energy Management (BOEM) and the National Oceanic and Atmospheric Administration (NOAA). As a result of Dr. Demopoulos' leadership, this project received the Department of the Interior Partners in Conservation Award for "Deepwater Canyons" [see <**http://soundwaves.usgs.gov/2014/02/awards.html**>].

"Dr. Demopoulos' effective communication skills and ability to sustain cooperative working relationships with both Federal and academic partners were pivotal to the success of this project as well as its predecessor 'Lophelia II,'

Amanda Demopoulos

which was also awarded the National Oceanographic Partnership Program Excellence in Partnering Award [see <**http://soundwaves.usgs.gov/2012/12/awards.html**>]. Dr. Demopoulos' recent nomination to the Ocean Exploration Advisory Board [<**http://oeab.oarhq.noaa.gov/**>] as Special Government Employee as well as to the Deep Submergence Science Committee [<**https://www.unols.org/committee/deep-submergence-science-committee-dessc**>] is testament to her leadership skills and scientific credentials. As a result of her ability to communicate effectively both orally and in writing, Dr. Demopoulos was sought out to represent the USGS at both national and international meetings, presenting and contributing to over 17 presentations over the last two years, highlighting her technical competence and scientific creativity.

"Dr. Demopoulos is incredibly focused and well organized, having participated and led over eight research cruises within the last two years in partnership with NOAA, BOEM, and NSF [National Science Foundation]. Her success at sea as both a research scientist and chief scientist is in large part due to Dr. Demopoulos' problem-solving skills to make logistical decisions that support science excellence. At sea, Dr. Demopoulos has demonstrated creative solutions to manage conflicts effectively, confronting issues and disagreements in a positive and constructive manner. As Project Chief for the USGS DISCOVRE project [<**http://fl.biology.usgs.gov/DISCOVRE/**>], Dr. Demopoulos effectively handles pressure, maintaining focus and intensity, and successfully juggles administrative responsibilities with a prolific science career.

"As a result of her thoughtful leadership manner and ability to translate vision into action, Dr. Demopoulos was appointed by the USGS Steering Committee to spearhead the RESTORE Act proposal to support restoration and conservation of deep-sea coral habitats and adjacent ecosystems in partnership with BOEM. She currently serves as a USGS Marine Science Advisor for the DOI [Department of the Interior] Ocean Partnerships Team, providing guidance for ocean research priorities for the DOI, expanding on her role as a USGS Expert Reviewer of the Secretary's Report on a Comprehensive Offshore Energy Program.

"At the USGS Southeast Ecological Science Center, Dr. Demopoulos is the director of the Benthic Ecology Laboratory [<**http://fl.biology.usgs.gov/benthic_ecology/**>], overseeing the work of six employees (one Federal and five contractors). She is responsible for supervising the finances, human resources, and technical resources effectively. Additionally, Dr. Demopoulos advises two Ph.D. students and a post-doc, as well as mentors two student contractors and five volunteers. As a mentor, Dr. Demopoulos is both respectful and values differences and opinions within her lab group, meeting with individuals at least once a week to review targeted tasks and progress. In managing her lab, she offers personnel a chance to pursue academic and career growth, recognizing the importance of future scientists.

"Dr. Demopoulos' outstanding leadership achievements are demonstrated by

(Early Career Leadership continued on page 13)

(Early Career Leadership continued from page 12)

these activities as well as her accomplishments over her eight-year tenure with the USGS. It is truly a pleasure to work with Dr. Demopoulos. Whether in the field, the lab, or the office, Dr. Demopoulos demonstrates and integrates the USGS Guiding Principles [<**http://www.usgs.gov/humancapital/ecd/ecd_guidingprinciples.html**>] to support science excellence. As both a colleague and collaborator, I have experienced and benefited greatly from Dr. Demopoulos' outstanding leadership skills. She encourages and inspires her colleagues, collaborators, and students to excel and to continually learn, whether it be mastering new techniques or developing new science directions. Dr. Demopoulos is a tremendous asset to the USGS and to the next generation of aspiring scientists. For her unparalleled scientific contributions and leadership, Dr. Demopoulos is most deserving of the Early Career Excellence in Leadership Award."

Learn more about Demopoulos at <**https://profile.usgs.gov/ademopoulos**>.

Amanda Demopoulos *about to board the deep submergence vehicle* Alvin *on the research vessel* Atlantis *during a shakedown cruise in the Gulf of Mexico in March 2014. Demopoulos was one of the deep-sea scientists chosen to test the capabilities of the newly upgraded submersible. (See <**http://alvinverification.whoi.edu/riding-in-style/#more-787**>.) USGS photograph by **Jill Bourque**, contractor to USGS through Cherokee Nation Technology Solutions*

Oceanographer Fran Lightsom Receives Leadership and Innovation Award from the USGS Community for Data Integration

By Lisa Zolly and Viv Hutchison

The U.S. Geological Survey (USGS) Community for Data Integration (CDI, <**http://www.usgs.gov/cdi/about.html**>) presents its Leadership and Innovation Award to a community member for outstanding contributions in guiding USGS data integration activities through the CDI working groups. The award is meant to recognize someone who brings new ideas to life and provides unwavering leadership in producing tangible results that will improve data integration, access, and discovery. The awardee actively seeks collaborative approaches, embraces new perspectives, and provides a stimulating forum to address on-the-ground data integration needs of the community. Through this leadership, the awardee's contributions move the CDI, and on a broader scale, the USGS and its partners, forward to a more integrated data landscape that ultimately advances USGS science.

▶ ***Fran Lightsom*** *(USGS) receives the USGS Community for Data Integration (CDI) Leadership and Innovation Award from **Kevin Gallagher**, Associate Director for USGS Core Science Systems, at the CDI Annual Workshop, May 11–14, 2015. USGS photograph by **Daniel Wieferich**.*

At the CDI Annual Workshop, May 11–14, 2015, **Kevin Gallagher**, Associate Director for USGS Core Science Systems (<**http://www.usgs.gov/core_science_systems/**>), honored **Fran Lightsom** with the 2015 CDI Leadership and Innovation Award. Lightsom is a Supervisory Oceanographer at the USGS Woods Hole Coastal and Marine Science Center (<**http://woodshole.er.usgs.gov/**>), a leader in the Data Management Council of the USGS

(Leadership and Innovation continued on page 14)

(Leadership and Innovation continued from page 13)

Coastal and Marine Geology Program (<**http://marine.usgs.gov**/>), the USGS Ocean Data Ambassador (see <**http://soundwaves.usgs.gov/2014/12/research2.html**>), and the USGS representative to the Data and Information Working Group of the National Ocean Council (<**https://www.whitehouse.gov/administration/eop/oceans**>). In all of these roles Lightsom has been a persistent advocate for excellence in data management and open data. She has brought this same dedication and enthusiasm to the wider CDI, and has been a dynamic and enthusiastic participant since the community's inception.

Lightsom has made significant leadership and innovative contributions to the CDI for more than four years. She has worked tirelessly to bring together subject-matter experts from the USGS, other agencies, and academia in a variety of working groups and open sessions to consider issues related to data lifecycle policies and best practices, as well as data reuse. Lightsom fully engages in every working group and project team in which she participates, and she is both renowned and appreciated for the sense of humor and the insights that she brings to these activities. Additionally, she has the gift for seeing both the forest and the trees, engaging every challenge with a clear and focused approach that motivates teams, inspires dialogue, and ensures progress.

In 2012, Lightsom launched the CDI Data Release Use Case Team to streamline workflows for releasing USGS data on the web. Additionally, she led the Data Policy team to complete the newly released data-management instructional memos for USGS personnel. She has played a major role in the CDI Semantic Web Working Group, leading or co-leading two successfully funded CDI projects to explore innovative linked-data approaches that allow scientific data from disparate sources to "speak the same language," thereby facilitating multidisciplinary collaboration and synthesis on issues of importance to decision-makers. She is also on a collaborative CDI project to bring geographic search capabilities to the USGS Publications Warehouse (<**http://pubs.er.usgs.gov**/>) and help develop new workflows for enhancing USGS publication records with geographic "footprints"—typically, the study area relevant to the publication. All of this work has important lasting impacts that will ultimately advance the management and publication of scientific data throughout the USGS. Please join the USGS Community for Data Integration in congratulating **Fran Lightsom** on this important award.

Jim Hein Receives Distinguished Service Award—U.S. Department of the Interior's Highest Honor

When U.S. Geological Survey (USGS) senior scientist **James R. Hein** joined the USGS in the early 1970s, he began a long career of marine research, with a particular emphasis on deep-ocean mineral deposits. On May 7, 2015, "in recognition of his outstanding contributions to the U.S. Geological Survey in the fields of coastal and marine geology and geochemistry," Hein received the U.S. Department of the Interior (DOI) Distinguished Service Award—the highest award that can be granted to a career employee within the DOI. Here is the award citation, signed by Secretary of the Interior **Sally Jewell**.

"**Dr. James R. Hein** is the United States' international authority on marine mineral deposits. He was an innovator in first recognizing and then implementing the seismic bottom-simulating reflector to identify oil and gas deposits. His expertise and creative work was recognized immediately and favorably by the international community. Dr. Hein conceived and led multiple International Geoscience Programme projects that studied manganese nodules in the Clarion-Clipperton Manganese Nodule Zone located in the Pacific plate southeast of Hawai'i. He has become the worldwide expert in all types of deep-ocean mineral deposits, including manganese nodules, ferromanganese crusts, seafloor massive sulfides, phosphorites, and barites. Dr.

Five of twelve USGS employees who received the Department of the Interior's highest honor—the Distinguished Service Award: (left to right) ***Rama Kotra, Peter Lyttle, James Hein, David Oppenheimer,*** *and* ***David Lockner****. Behind them is a portrait of the first director of the USGS,* ***John Wesley Powell****.*

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(Jim Hein continued from page 14)

Hein recognized the importance of studying land-based mineral deposits to gain insight into these deep-sea deposits. The body of his work has focused on the need for critical minerals for high-tech, green-tech, energy, and military applications. He discovered that ferromanganese crusts are not only an ore, but also a geologic record of changes in oceanographic and atmospheric conditions dating back hundreds of thousands of years. The scientific and societal impacts of Dr. Hein's research extend into many other arenas of marine science. Dr. Hein is responsible for pioneering fundamental studies in the use of clay mineralogy to understand sediment transport and sediment deposit evolution. His work led him to spearhead a Cook Islands atoll-drilling program that produced crucial new knowledge on how reef growth varies with changes in sea level. His many highly influential and groundbreaking scientific contributions resulted in his leadership of several international programs involving hundreds of scientists from around the world. For his sustained leadership and unparalleled scientific contribution to the USGS and the Nation, **Dr. James R. Hein** is awarded the highest honor of the Department of the Interior, the Distinguished Service Award."

Congratulations, Jim!

Jim Jacobi Receives Distinguished Service Award—U.S. Department of the Interior's Highest Honor

James D. Jacobi, U.S. Geological Survey (USGS) botanist and a lead scientist in the USGS Ridge-to-Reef project, received a Department of the Interior Distinguished Service Award—the highest honor that can be granted to a career employee within the DOI. Jacobi received the award "in recognition of his outstanding contributions to the U.S. Geological Survey in the field of ecology" at an all-hands meeting of the USGS Pacific Island Ecosystems Research Center in Hawai'i. Here is the award citation, signed by Secretary of the Interior **Sally Jewell**.

"**Dr. James D. Jacobi** is an internationally recognized scientist who has worked on the ecology of Hawaiian forests for over 40 years. Through his research, devoted to processes that shape island ecosystems and threaten biodiversity, he pioneered the use of remote sensing and geospatial tools and their application to landscape change in Hawai'i. Dr. Jacobi is recognized as an expert on Hawaiian flora, and has published numerous publications on the distribution of plant communities. This work has transformed the understanding of ecosystems change, and highlights the role of invasive species in ecosystem degradation. As a renowned scientist and communicator, Dr. Jacobi is recognized for addressing actions needed to protect Hawai'i's biodiversity and ecosystems. His work led to the inclusion of several areas into the State's Natural Area Reserve System and inspired the formation of various partnerships to manage watersheds and protect biodiversity. The research he conducted on landscape change provided the foundation for the Hawai'i Forest Bird Surveys, a large-scale effort to document the occurrence and distribution of Hawai'i's unique and impaired forest bird fauna. Dr. Jacobi also led the U.S. Geological Survey's (USGS) Ridge to Reef project [<**http://pubs.usgs.gov/fs/2011/3049/**>], which linked impacts of invasive species in the watershed to erosion, coastal water quality, and coral reef health. His surveys showing the extent of re-vegetation after feral ungulate control were the genesis of a multi-million dollar project by the State of Hawai'i for watershed protection. Currently, Dr. Jacobi leads an effort to assess the effectiveness of conservation actions in Hawai'i and identifies areas for additional attention. His knowledge, commitment, and communication skills have been instrumental in developing coordinated plans between Federal, State, private, non-governmental organizations, landowners, regulators, and scientists. The result of Dr. Jacobi's work has greatly improved coordination and effective use of conservation resources throughout the State. For his outstanding contributions to the USGS, **Dr. James D. Jacobi** is granted the highest honor of the Department of the Interior, the Distinguished Service Award."

Congratulations, Jim!

***Jim Jacobi** in the native forest on Tutuila Island, American Samoa, while helping the National Park Service develop vegetation-monitoring protocols as part of their Pacific Island Network Inventory and Monitoring Program (<**http://science.nature.nps.gov/im/units/pacn/**>). This Samoan fieldwork was unusual for Jim, who has conducted virtually all of his research and fieldwork in the main Hawaiian Islands.*

Cheryl Hapke Named New Director of St. Petersburg Coastal and Marine Science Center in Florida

By Jess D. Weaver and Helen Gibbons

U.S. Geological Survey (USGS) research geologist **Cheryl J. Hapke** is the new director of the USGS St. Petersburg Coastal and Marine Science Center in St. Petersburg, Florida, one of three science centers of the USGS Coastal and Marine Geology Program (<**http://marine.usgs.gov/**>). USGS Southeast Regional Director **Jess D. Weaver** announced Hapke's selection in April 2015; she assumed the duties of center director on a full-time basis on June 28.

"Cheryl is an outstanding choice," said USGS Associate Director of Natural Hazards **David Applegate**. "She brings a unique set of experiences across multiple USGS science centers and programs, building extensive partnerships to tackle important coastal issues confronting our Nation. Her demonstrated ability to build cooperative projects will continue to be invaluable in her new role as center director."

Hapke is a research geologist with expertise in coastal-erosion hazards within a variety of geomorphic environments, including rocky coasts, barrier islands, and carbonate systems. Her USGS career began 18 years ago at the Pacific Coastal and Marine Science Center in Santa Cruz, California (<**http://walrus.wr.usgs.gov/**>), where she studied coastal cliff erosion hazards (<**http://soundwaves.usgs.gov/2002/08/staff.html**>) and coastal landslide processes (<**http://soundwaves.usgs.gov/2004/09/fieldwork3.html**>).

In 2005, Hapke moved to the East Coast, where she collaborated with the National Park Service, first through the USGS Patuxent Wildlife Research Center (<**https://www.pwrc.usgs.gov/**>) from an office at the University of Rhode Island, and then through the USGS Woods Hole Coastal and Marine Science Center in Woods Hole, Massachusetts (<**http://soundwaves.usgs.gov/2008/09/staff2.html**>). Her research focused on beach and bluff erosion hazards on various U.S. shores, including Fire Island, New York.

*New St. Petersburg Coastal and Marine Science Center Director **Cheryl Hapke** on a recent trip to the Grand Canyon, June 2015.*

In 2011, Hapke transferred to the St. Petersburg Coastal and Marine Science Center (<**http://coastal.er.usgs.gov/**>), and in October 2012, Hurricane Sandy hit the U.S. east coast. Hapke's research on Sandy's impacts on Fire Island has contributed significantly to the broad understanding of how barrier islands respond to and recover from major storms (<**http://soundwaves.usgs.gov/2014/10/spotlight.html**>). In the months after Sandy, Hapke served a 3-month detail to the Federal Emergency Management Agency (FEMA), where she provided expertise in coastal science to numerous federal and New York State agencies as part of the National Disaster Recovery Framework (<**https://www.fema.gov/national-disaster-recovery-framework**>).

"Cheryl's career path, of working at all three USGS Coastal and Marine Geology Program science centers, as well as with the USGS Patuxent Wildlife Research Center, gives her a unique and broad perspective of both USGS and the Coastal and Marine Geology Program goals, objectives, and roles within their respective regions," said Southeast Regional Director Weaver. "Cheryl's vision is one of unity and integration—from the community level in St. Petersburg to enhanced collaboration and resource-sharing across the multidiscipline science centers in the Southeast Region. Cheryl will be a tremendous addition to the Southeast Region Management Team as she welcomes the opportunity to build and strengthen integrated capabili-

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(New Director continued from page 16)

ties and coordinated research investment across both the Southeast Region and the three Coastal and Marine Geology Program science centers."

Hapke succeeds **Richard (Dick) Poore**, who recently retired after serving as Center Director in St. Petersburg for nearly 4 years (<**http://soundwaves.usgs.gov/2011/11/staff.html**>).☸

▶ ***Cheryl Hapke*** *in the field at Fire Island, New York, during a beach survey on October 28, 2012, the day before Hurricane Sandy made landfall in New Jersey.*

New Maps Reveal Seafloor off San Francisco Area

By Sam Johnson and Leslie Gordon

Three new sets of maps detail the offshore bathymetry, habitats, geology, and submarine environment of the seafloor off the coast of San Francisco (<**http://dx.doi.org/10.3133/ofr20151068**>), Drakes Bay (<**http://dx.doi.org/10.3133/ofr20151041**>), and Tomales Point (<**http://dx.doi.org/10.3133/ofr20151088**>). Critical for resource managers, the maps are part of the California Seafloor and Coastal Mapping Program (<**http://walrus.wr.usgs.gov/mapping/csmp/**>) series of maps published by the U.S. Geological Survey (USGS) with support from the California Ocean Protection Council (OPC, <**http://www.opc.ca.gov/**>), the National Oceanic and Atmospheric Administration (NOAA,

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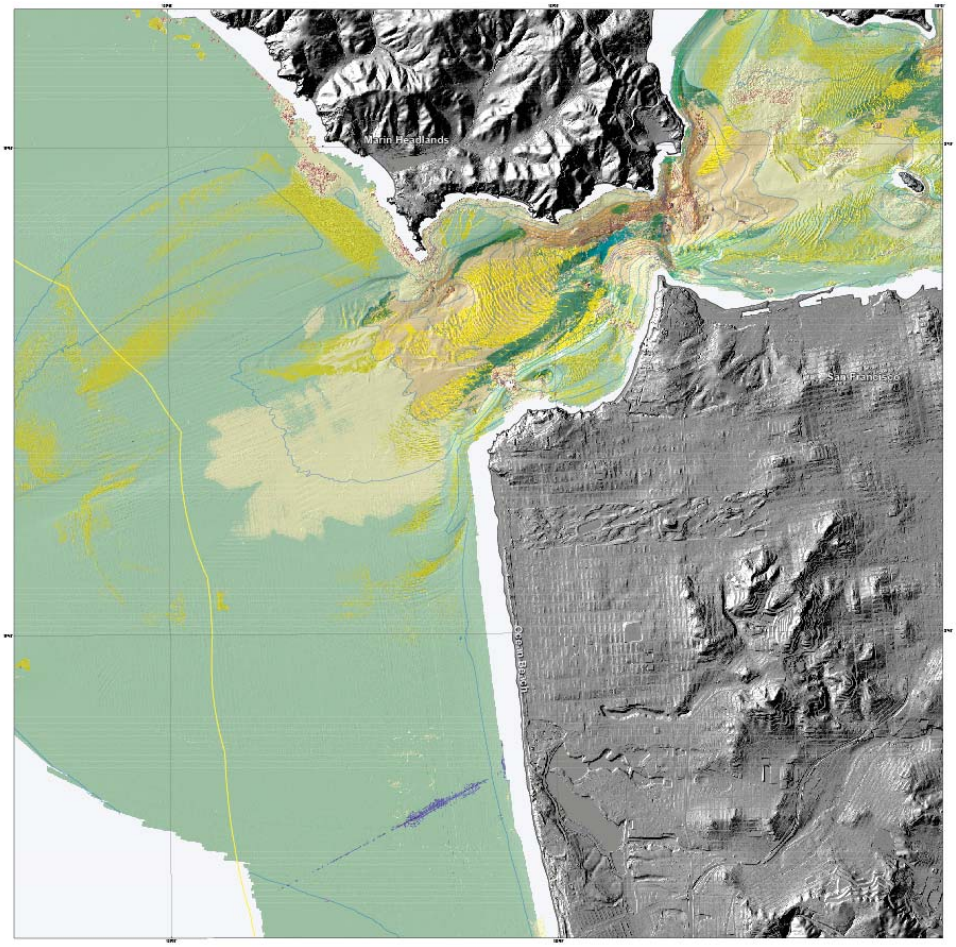


▶ *"Seafloor character" map of the San Francisco region. This is a type of habitat map that classifies the seafloor on the basis of surface hardness and roughness. Such maps are used in various types of ecosystem assessments and seafloor zoning, such as delineation or monitoring of marine protected areas. From "California State Waters Map Series—Offshore of San Francisco, California," <**http://dx.doi.org/10.3133/ofr20151068**>.*

(New Maps continued from page 17)

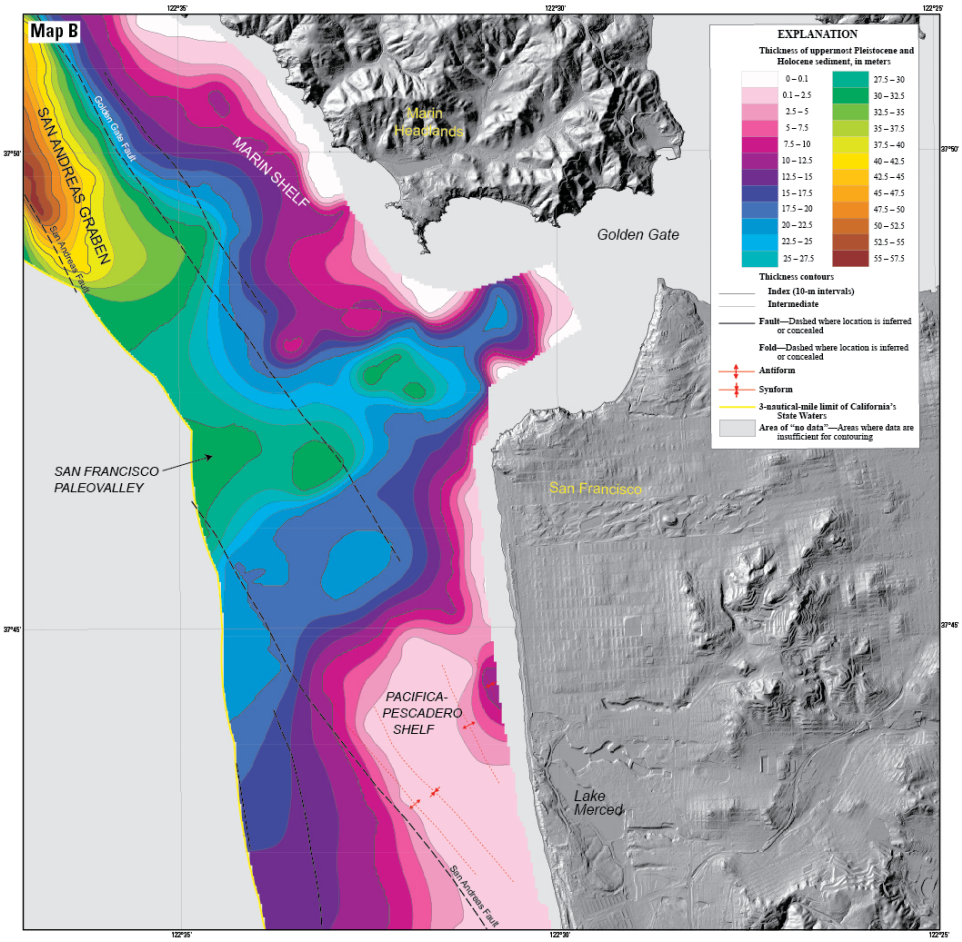
<**http://www.noaa.gov/**>), and 15 other state and federal partners. The maps are designed to be used by a large stakeholder community and the public to manage and understand California's vast and valuable marine resources.

"OPC is proud to be a partner in this interagency effort," said California's Secretary for Natural Resources and OPC Chair **John Laird**. "These maps are critical to the state's innovative approach to coastal resource management. USGS's products form the foundation for assessing the performance of our Marine Protected Area network and preparing for climate change impacts such as sea-level rise."

"NOAA is pleased to be partnering in this integrated ocean and coastal mapping project. By working with partners from across federal, state, academic, and private sectors, we are able to combine data resources and maximize our efficiency in applying a 'map once, use many times' approach that benefits all," said Rear Admiral **Gerd F. Glang**, director of NOAA's Office of Coast Survey (<**http://www.nauticalcharts.noaa.gov/**>).

The program was initiated 7 years ago with the goal of comprehensively surveying and mapping all of California's state waters (from the shore out 3 nautical miles)—a tremendously ambitious vision. Each of the three publications includes 10 map sheets, a pamphlet, and a digital data catalog. The maps and mapping data have a large range of applications. They provide:

- A foundation for assessing marine protected areas and habitats.
- Baselines for monitoring coastal change and sea-level-rise impacts.
- Critical input data for modeling and mitigation of coastal flooding.
- A framework for understanding coastal erosion and developing regional sediment management plans.
- Contributions to earthquake- and tsunami-hazard assessments.
- More accurate maps for safer navigation.
- Essential information for planning, siting, or removing offshore infrastructure.



*Map of sediment thickness in state waters (from shoreline out 3 nautical miles) offshore of San Francisco. About 21,000 years ago, sea level in this area was about 125 meters (410 feet) lower, and the shelf offshore San Francisco was an emergent land surface. At that time, the Sacramento River drained through the Golden Gate and eroded a valley ("the San Francisco paleovalley") that was filled with sediment during subsequent sea-level rise. The thickest young sediment in the region occurs in the "San Andreas graben," a basin that formed by crustal down-dropping along the offshore section of the San Andreas fault. There is very little sediment on the shelf offshore of southern Ocean Beach (a pattern that extends more than 50 kilometers [30 miles] to the south), a factor important for understanding and forecasting coastal erosion in this area. From "California State Waters Map Series—Offshore of San Francisco, California," <**http://dx.doi.org/10.3133/ofr20151068**>.*

The new "Offshore of San Francisco" maps (<**http://dx.doi.org/10.3133/ofr20151068**>) document the complex submarine environments along the inlet to San Francisco Bay formed by strong tidal currents, including spectacular sand waves, a deep scour pool beneath the Golden Gate, and the dynamic offshore San Francisco mouth bar and "Potato Patch" shoal. Sediment distribution maps reveal only a thin sediment cover offshore of the Ocean Beach (San Francisco) erosional hotspot (a pattern extending more than 50 kilometers [30 miles] south to San Gregorio), indicating that today's present coastal erosion will be a continuing problem, likely to be exacerbated by continuing sea-level rise. Geologic maps incorporating subsurface data document the location and geometry of the San Andreas, San Gregorio, and Point Reyes fault systems, and show how their interactions led to uplift of Point Reyes and development of a deep sediment-filled basin. The

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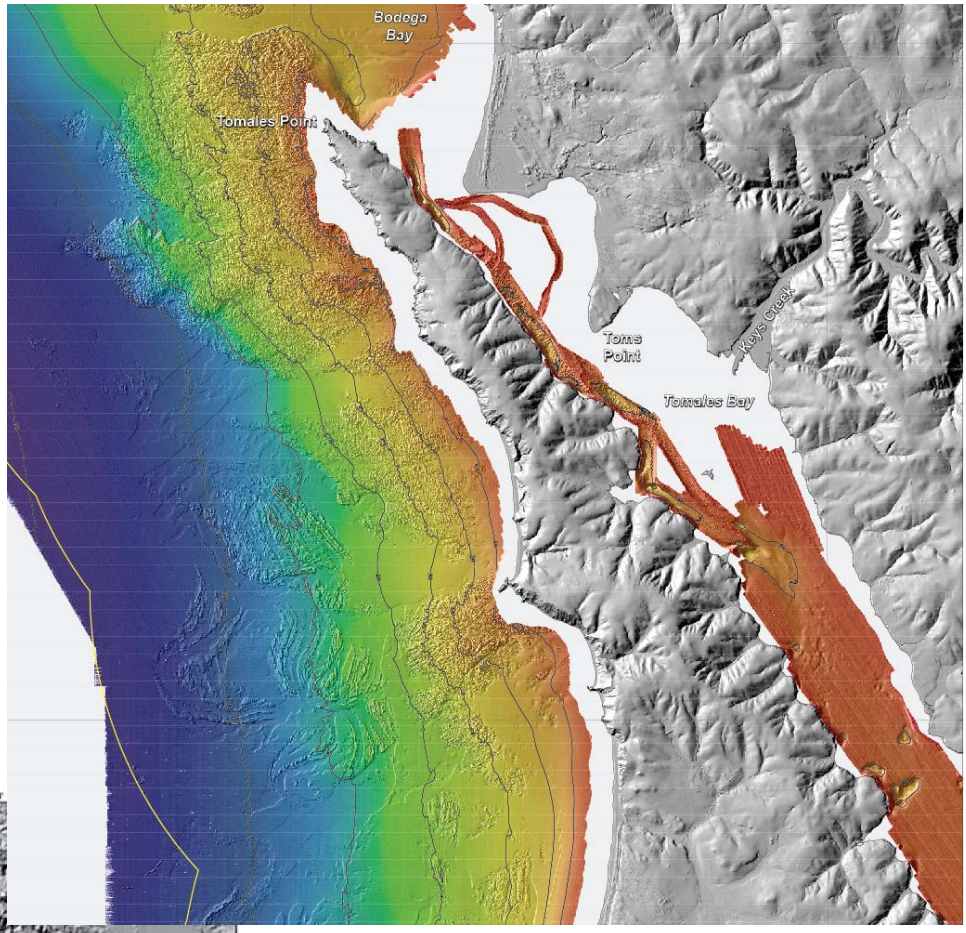
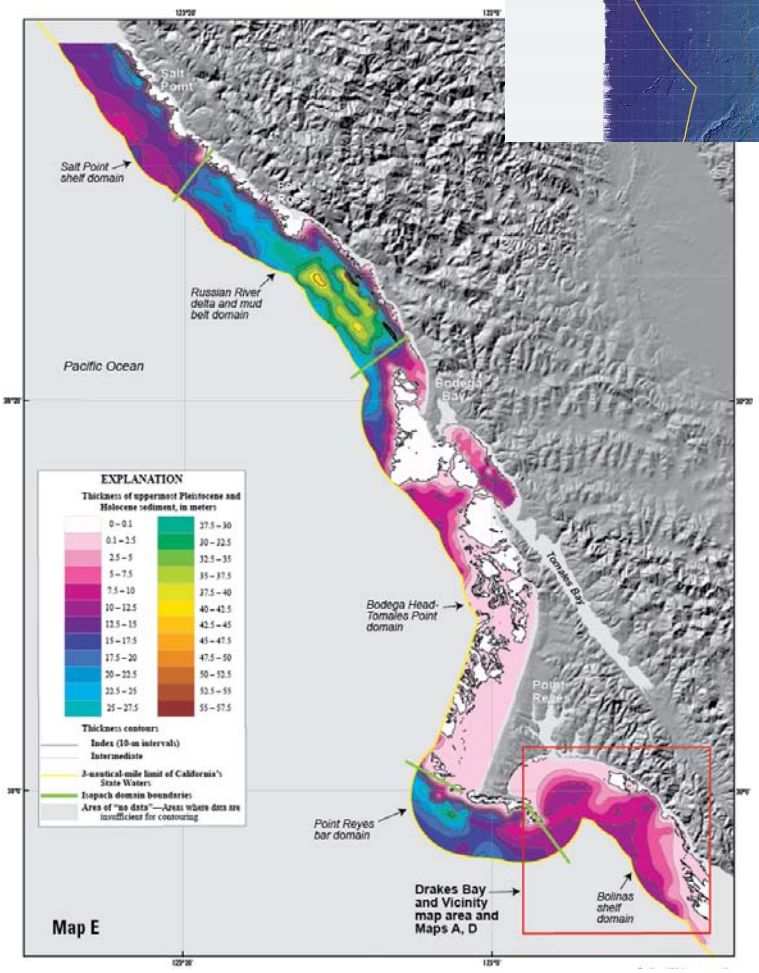
"Drakes Bay and Vicinity" (<**http://dx.doi.org/10.3133/ofr20151041**>) and "Offshore of Tomales Point" (<**http://dx.doi.org/10.3133/ofr20151088**>) maps reveal the diverse and complex range of seafloor habitats typical of the California coast, ranging from the rugged granitic bedrock along the high-energy west coast of Point Reyes, to smooth sand and mud in the more protected Drakes Bay environment that includes the Point Reyes State Marine Reserve.

Sam Johnson, the USGS project lead, notes, "There is a 'WOW!' factor to the new high-resolution datasets and maps. They're allowing scientists to pose new questions and are having a significant role in stimulating research. We're also seeing a positive impact on public education and awareness."

(New Maps continued on page 20)



▲*Bathymetry bounding Tomales Point. Rugged and massive granitic outcrops extend offshore from Tomales Point to water depths of as much as 60 meters (200 feet). Offshore sedimentary rock outcrops (lower left part of image) form distinctive "ribs" on the seafloor and have a notably different appearance. There is minimal sediment on this part of the California shelf because the watersheds draining the west flank of Tomales Point are very small and because Tomales Point and Tomales Bay block sediment transport from the north. Rocky-shelf outcrops and rubble are excellent habitats for rockfish and lingcod, recreationally and commercially important species. Tomales Bay, approximately 20 kilometers (10 miles) long and 1 to 2 kilometers (two-thirds to one-and-a-quarter mile) wide, formed along a submerged stretch of the San Andreas fault (very shallow water depths preclude collection of high-resolution bathymetric data at the mouth of Tomales Bay). From "California State Waters Map Series—Offshore of Tomales Point, California," <**http://dx.doi.org/10.3133/ofr20151088**>.*



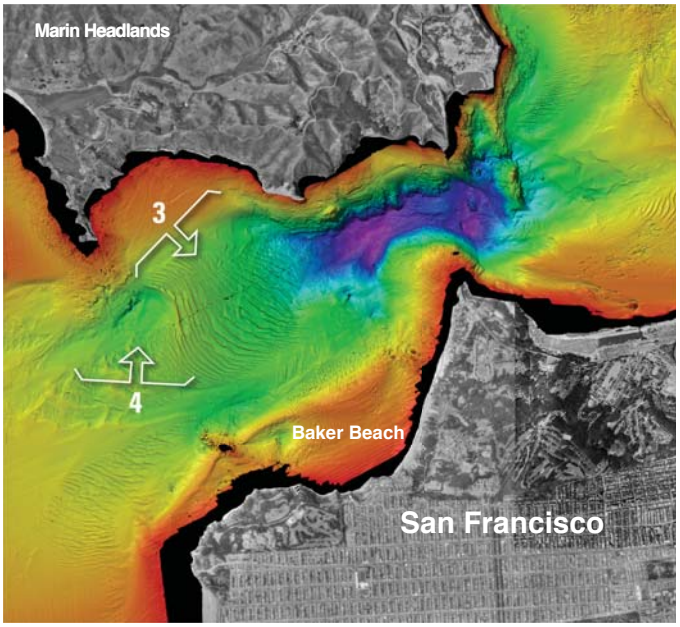
◀*Map of offshore sediment thickness in state waters between Drakes Bay and Salt Point, north of the Russian River. The thickest sediment in the region occurs offshore of the Russian River and in a large bar along the south flank of Point Reyes Head. There is a relative lack of offshore sediment between Bodega Head and Point Reyes, where the shelf is characterized by abundant rocky habitat and much of the coastal sediment is trapped in large onshore dune fields. From "California State Waters Map Series—Drakes Bay and Vicinity, California," (<**http://dx.doi.org/10.3133/ofr20151041**>.*

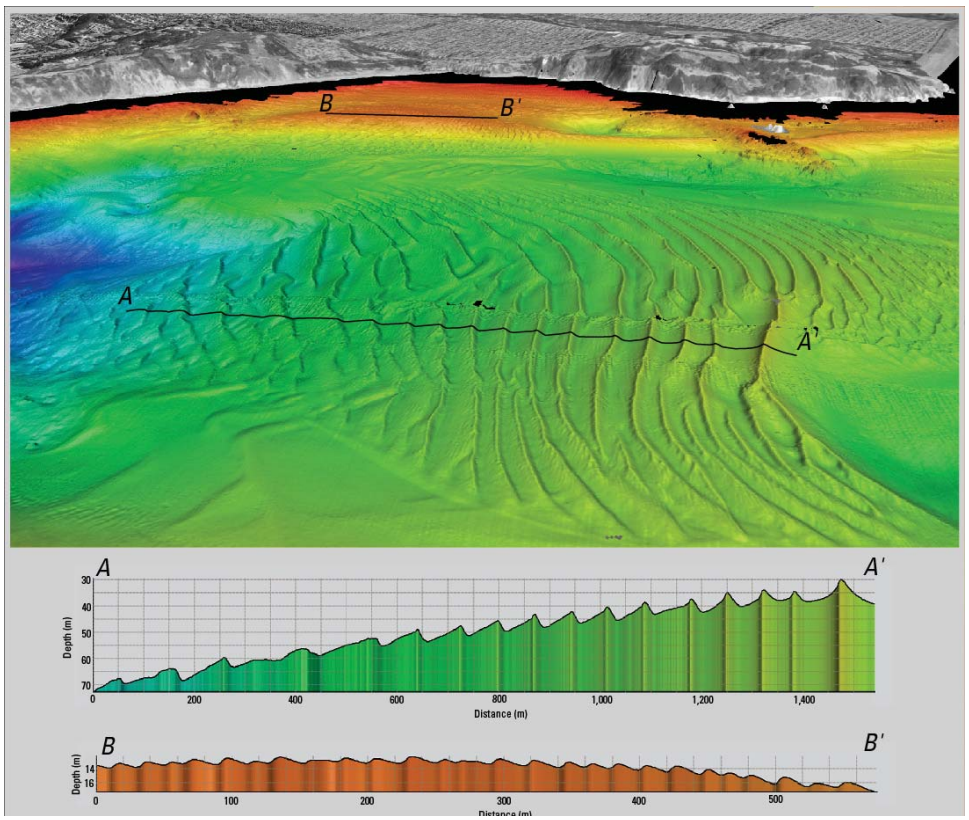
(New Maps continued from page 19)

It takes a large team to gather, process, and present the abundant mapping data, and Johnson praised the vital contributions of other USGS leaders of the California Seafloor and Coastal Mapping Program, including research geophysicist **Guy Cochrane**, geographer **Nadine Golden**, and physical scientist **Pete Dartnell**.

To date, thirteen map sets and catalogs have been published. Nine additional map sets are now being formatted for publication, which will complete coverage in the Santa Barbara Channel (Oxnard to Gaviota) and from Marina northward to beyond the Russian River. The maps are created through the collection, integration, interpretation, and visualization of swath sonar data, acoustic backscatter, seafloor video, seafloor photography, high-resolution seismic-reflection profiles, and bottom-sediment sampling data.

The California Seafloor and Coastal Mapping Program (<**http://walrus.wr.usgs.gov/mapping/csmp/**>) is a unique collaborative effort supported by the USGS, the California Ocean Protection Council (<**http://www.opc.ca.gov/2010/03/mapping-californias-seafloor-2/**>), NOAA (<**http://www.noaa.gov/**>), California State University Monterey Bay (<**https://csumb.edu/**>), Moss Landing Marine Laboratories (<**https://www.mlml.calstate.edu/**>), and many other academic, government, and industry partners. ☸





▶ *Perspective view looking southeast over entrance to San Francisco Bay, from sheet 4 of "California State Waters Map Series—Offshore of San Francisco, California," <**http://dx.doi.org/10.3133/ofr20151068**>. The Golden Gate Bridge is to the left (east) of this view. (Orientation of view is indicated on upper map by arrow labeled "3." Arrow 4 refers to another perspective view on the same sheet.) The large sand-wave field lies within Golden Gate channel and was formed from sediment transported out of the bay by strong tidal currents. Profile A–A' shows that the larger bedforms can reach heights of more than 7 meters (23 feet) and are asymmetrical with steeper sides toward the open ocean. A smaller field of sand waves to the south near Baker Beach shows the opposite symmetry (steep sides toward the bay), indicating that the strongest tidal currents in that local area are directed eastward.*

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