

Research

Projected Losses of Arctic Sea Ice and Polar Bear Habitat May Be Reduced if Greenhouse-Gas Emissions are Stabilized

Sea-ice habitats essential to polar bears would likely respond positively should more curbs be placed on global greenhouse-gas emissions, according to a new modeling study published in December in the journal *Nature*.

The study, led by the U.S. Geological Survey (USGS), included university and other federal-agency scientists. The research broke new ground in the “tipping point” debate in the scientific community by providing evidence that during this century there does not seem to be a tipping point at which sea-ice loss would become irreversible.

The report does not affect the decision made by the U.S. Fish and Wildlife Service in 2008 to list the polar bear as a threatened species.

This new study builds and expands upon studies published by the USGS in 2007. The new study evaluates additional scenarios in which greenhouse-gas emissions are reduced in comparison with the business-as-usual scenario that was exclusively used in the previous research. Modeling outcomes for the additional scenarios provided evidence that the projected continuation of Arctic sea-ice decline could be altered if greenhouse-gas emissions were mitigated in a manner that stabilizes atmospheric CO₂ levels at or less than around 450 parts per million (ppm). Current CO₂ levels are around 390 ppm.

The USGS studies conducted in 2007 had projected that under the business-as-usual greenhouse-gas emission scenario, future reduction of Arctic sea ice could result in a loss of two-thirds of the world’s polar bear population by mid-century. They had also shown that under this scenario, loss of sea ice would have such a

drastic negative effect on polar bears that other efforts to reduce stress on their populations would have negligible benefits. Other stress factors considered in the modeling include disease and predation, overharvest, contaminants, tourism, bear-human interactions, oil and gas activity, and shipping. The earlier study did not examine other greenhouse-gas emission scenarios.

The new analyses published in the journal *Nature* indicate that with lower greenhouse-gas emissions, as well as reductions in other population stressors, polar bears could persist in all four Arctic ecoregions where they now occur, said **Steve Amstrup**, lead author of the study and a scientist emeritus with the USGS Alaska Science Center.

Amstrup noted that their new work emulated the rapid sea-ice loss that occurred in the Arctic between September 2006 and September 2007, when the loss of sea ice equaled the total amount of ice lost during the previous 27 years. This exponential loss of ice during such a short time was one of the reasons why so many scientists were concerned that there might be a tipping point beyond which sea ice would be irreversibly lost.



Polar bear leaps from one ice floe to another in the Beaufort Sea of the Arctic Ocean, August 9, 2010. Photograph by Mark Patsavas, University of South Florida.

“Instead, we found that the relationship between the loss of sea ice and the average global temperature is linear,” said **Amstrup**. “In fact, the models indicate that major losses of summer sea ice can occur without pushing ice into a tipping point with permanent ice-free summers. If such a tipping point had existed, it would have meant that efforts to reduce greenhouse gases would have had little value in stemming the loss of polar ice critical for polar bears.”

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Sound Waves

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Submission Guidelines

Deadline: The deadline for news items and publication lists for the April issue of *Sound Waves* is Tuesday, February 15.

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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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

Research, continued

(Polar Bear Habitat continued from page 1)



Sunset over sea ice on the Arctic Ocean, September 1, 2008. Photograph by **Jessica Robertson**, USGS.

Polar bears depend on sea ice as a platform to hunt seals, their primary food. Current declines in habitat have been associated with declines in body stature, survival rates, and population size in broad areas of the current polar bear range.

The new paper, "Greenhouse Gas Mitigation Can Reduce Sea-Ice Loss and Increase Polar Bear Persistence," was published by the journal *Nature* on December 16 (<http://dx.doi.org/10.1038/nature09653>). The study was authored by **Steven Amstrup** (USGS), **Eric DeWeaver** (National Science Foundation), **David Douglas** (USGS),

Bruce Marcot (USDA Forest Service), **George Durner** (USGS), **Cecilia Bitz** (University of Washington), and **David Bailey** (National Center for Atmospheric Research).

The full citation for the report is: Amstrup, S.C., DeWeaver, E.T., Douglas, D.C., Marcot, B.G., Durner, G.M., Bitz, C.M., and Bailey, D.A., 2010, Greenhouse gas mitigation can reduce sea-ice loss and increase polar bear persistence: *Nature*, v. 468, no. 7326, p. 955-958, doi:10.1038/nature09653.

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ARkStorm: California's Other "Big One"

By **John Bwarie**

Imagine California being bombarded for 45 days with one strong winter storm after another. That's what happened in 1861-62, causing severe flooding up and down the state. Geologic evidence suggests that earlier, prehistoric floods were even bigger. Although no living person remembers such a catastrophe, there's no reason it couldn't happen again.

For emergency-planning purposes, scientists unveiled in mid-January a hypo-

thetical California scenario that describes a storm that could produce as much as 10 ft of rain, cause extensive flooding (in many cases overwhelming the state's flood-protection system), and damage nearly one-quarter of all the houses in California.

The "ARkStorm scenario," prepared by the U.S. Geological Survey (USGS) and released at the ARkStorm Summit in

(ARkStorm continued on page 3)

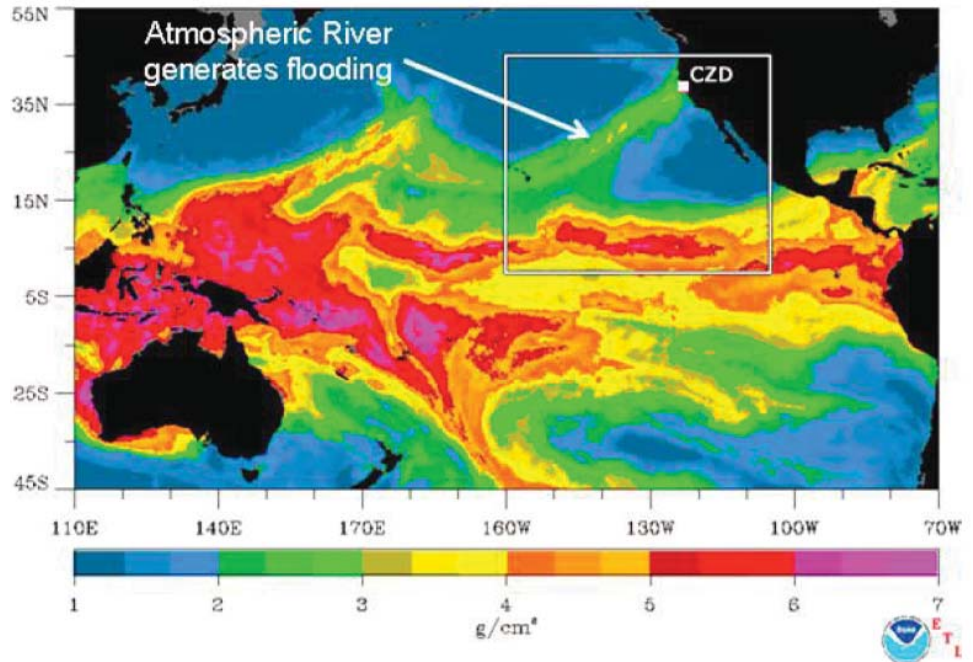
Research, continued

(ARkStorm continued from page 2)

Sacramento, California, on January 13-14, combines prehistoric geologic flood history in California with modern flood mapping and climate-change projections to produce a hypothetical, but plausible, scenario aimed at preparing the emergency-response community for this type of hazard.

The USGS, the Federal Emergency Management Agency (FEMA), and the California Emergency Management Agency (Cal EMA) convened the 2-day summit to engage stakeholders from across California to take action as a result of the scenario's findings, which were developed over the past 2 years by more than 100 scientists and experts.

"The ARkStorm scenario is a complete picture of what that storm would do to the social and economic systems of California," said **Lucy Jones**, chief scientist of the USGS Multi-Hazards Demonstration Project and architect of ARkStorm. "We think this event happens once every 100 or 200 years or so, which puts it in the same category as our big San Andreas earthquakes. The ARkStorm is essentially two historic storms (January 1969 and February 1986) put back to back in a scientific-



ally plausible way. The model is not an extremely extreme event."

Jones noted that the largest damages would come from flooding—the models estimate that almost one-fourth of the houses in California would experience some flood damage from this storm.

"The time to begin taking action is now, before a devastating natural-hazard event occurs," said USGS Director **Marcia McNutt**.

"This scenario demonstrates firsthand how science can be the foundation to help build safer communities. The ARkStorm scenario is a scientifically vetted tool that emergency responders, elected officials, and the general public can use to plan for a major catastrophic event to help prevent a hazard from becoming a disaster."

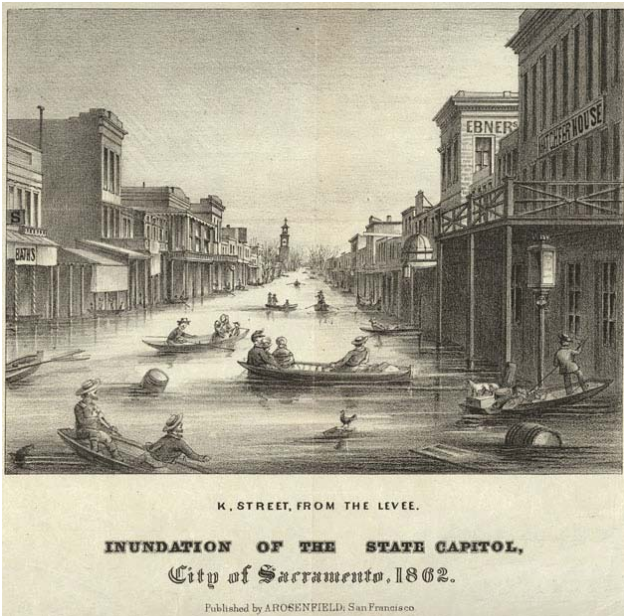
To define impacts of the ARkStorm, the USGS, in partnership with the California Geological Survey, produced the first statewide landslide-susceptibility maps for California—the most

▲ Example of an "atmospheric river" (popularly known as a "Pineapple Express") that draws moisture from the Pacific Ocean near the equator and transports it to the U.S. West Coast with firehose-like ferocity. This one originated over the central Pacific on February 16, 2004, indicated by high (green) vertically integrated water-vapor contents (in grams per square centimeter of water vapor) in the atmosphere extending from around Hawai'i to the California coast near the town of Cazadero (CZD). (From USGS Open-File Report 2010-1312, <http://pubs.usgs.gov/of/2010/1312/>.)

detailed landslide-susceptibility maps ever created. The project also resulted in the first physics-based modeling system for analyzing severe-storm impacts (beach erosion, coastal flooding, and cliff failures) under present-day scenarios and under various climate-change and sea-level-rise scenarios. This modeling system, designed by USGS coastal geologist **Patrick Barnard** and collaborators at the Netherlands-based research institute Deltares, is also capable of incorporating real-time atmospheric data inputs for potential use in real-time warning systems along the U.S. west coast.

Because ARkStorm research raised serious questions about existing national, state, and local disaster policy and emergency-management systems, the ARkStorm scenario, while still in preparation, became

(ARkStorm continued on page 4)



An extreme series of storms lasting 45 days struck California in late 1861-early 1862. They caused severe flooding that turned the Sacramento Valley into an inland sea, forced the State Capital to be moved from Sacramento to San Francisco for a time, and required **Governor Leland Stanford** to take a rowboat to his inauguration. (From <http://urbanearth.usgs.gov/winter-storm/>.)

(ARkStorm continued from page 3)

the theme of the 2010 California Extreme Precipitation Symposium, held June 23 at the University of California, Davis, and attended by more than 200 leaders in meteorology and flood management. ARkStorm is part of efforts to create a National Real-Time Flood Mapping initiative to improve flood management nationwide. ARkStorm also provided a platform for emergency managers, meteorologists, and hydrologists to work together to develop a scaling system for west coast storms.

“Cal EMA is proud to partner with the USGS in this important work to protect

California from disasters,” said Cal EMA Acting Secretary **Mike Dayton**. “In order to have the most efficient and effective plans and response capabilities, we have to have the proper science to base them on. Californians are better protected because of the scientific efforts of the United States Geological Survey.”

According to FEMA Region IX Director **Nancy Ward**, “The ARkStorm report will prove to be another invaluable tool in engaging the whole of our community in addressing flood emergencies in California. It is entirely possible that

flood-control infrastructure and mitigation efforts could be overwhelmed by the USGS ARkStorm scenario, and the report suggests ways forward to limit the damage that is sure to result.”

The 2-day January summit included professional flood managers, emergency managers, first responders, business continuity managers, forecasters, hydrologists, and decision makers. Many of the scientists responsible for coordinating the ARkStorm scenario presented the science behind the scenario, including meteorology, forecasting, flood modeling, landslides, and physical and economic impacts.

The ARkStorm scenario is the second scenario from the USGS Multi-Hazards Demonstration Project led by **Jones**, which earlier created the ShakeOut earthquake scenario. To listen to a podcast interview with **Jones** about the ARkStorm scenario, visit <http://www.usgs.gov/corecast/details.asp?ep=141>.

Abundant information about ARkStorm—including key findings, background information, descriptions of experts’ contributions, and links to videos and other graphics—is posted at <http://urbanearth.usgs.gov/winter-storm/>.

Also available online is USGS Open-File Report 2010-1312, *Overview of the ARkStorm Scenario*, at <http://pubs.usgs.gov/of/2010/1312/>. ❁



Estimated coastal inundation (blue shading) at Mission Bay in San Diego, California, using the Coastal Storm Modeling System (CoSMoS) developed for ARkStorm. (From USGS Open-File Report 2010-1312, <http://pubs.usgs.gov/of/2010/1312/>.)

Many Coastal Wetlands Likely to Disappear This Century

By Glenn Guntenspergen, Matthew Kirwan, and Jessica Robertson

Many coastal wetlands worldwide—including several on the U.S. Atlantic coast—may be more sensitive than previously thought to climate change and sea-level rise projected for the 21st century.

U.S. Geological Survey (USGS) scientists drew this conclusion from an international research-modeling effort published December 1, 2010, in the journal *Geophysical Research Letters*, a publication of the American Geophysical Union. Scientists identified conditions under which coastal wetlands could survive rising sea level.

Using a rapid sea-level-rise scenario, most coastal wetlands worldwide will

disappear near the end of the 21st century. In contrast, under the slow sea-level-rise scenario, wetlands with low sediment availability and low tidal ranges are vulnerable and may drown, while wetlands with higher sediment availability are more likely to survive.

Several coastal marshes along the east coast of the United States, for example, have limited sediment supplies and are likely to disappear this century. Vulnerable east coast marshes include the Plum Island Estuary (the largest estuary in New England) and coastal wetlands in North Carolina’s

(*Disappearing Wetlands continued on page 5*)



Coastal wetland on Maryland’s Eastern Shore—example of a disappearing marsh in the Mid-Atlantic U.S. Photograph taken in Blackwater National Wildlife Refuge, Maryland, by **James Lynch**, USGS.

Research, continued

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Albemarle-Pamlico Sound (the second-largest estuary in the United States).

“Accurate information about the adaptability of coastal wetlands to accelerations in sea-level rise, such as that reported in this study, helps narrow the uncertainties associated with their disappearance,” said USGS scientist **Glenn Guntenspergen**, an author of the December report. “This research is essential for allowing decision makers to best manage local tradeoffs between economic and conservation concerns.”

“Previous assessments of coastal-wetland responses to sea-level rise have been constrained because they did not consider the ability of wetlands to naturally modify their physical environment for adaptation,” said USGS scientist **Matthew Kirwan**, the report’s first author. “Failure to incorporate the interactions of inundation, vegetation, and sedimentation in wetlands limits the usefulness of past assessments.”

USGS scientists specifically identified the sediment levels and tidal ranges (differences between high and low tide) necessary for marshes to survive sea-level rise. As water floods a wetland and flows through its vegetation, sediment carried from upstream is deposited on the wetland’s surface, allowing it to gain elevation. High tidal ranges allow for better sediment delivery, and the higher sediment concentrations in the water allow wetlands to build more elevation.

Coastal wetlands provide critical services, such as absorbing energy from coastal storms, preserving shorelines, protecting human populations and infrastructure, supporting commercial seafood



*Tidal marshland in the Plum Island Estuary, Massachusetts. The marshes of Plum Island Estuary are among those predicted by scientists to submerge during the next century under conservative projections of sea-level rise. Photograph by **Matthew Kirwan**, USGS.*

harvests, absorbing pollutants, and serving as critical habitat for migratory bird populations. These resources and services will be threatened as sea-level rise inundates wetlands.

The rapid sea-level-rise scenario used as the basis for this study (*Science*, 2007, v. 315, no. 5810, p. 368-370, <http://dx.doi.org/10.1126/science.1135456>) was authored by **Stefan Rahmstorf** at Potsdam University, one of the contributing authors of the Intergovernmental Panel on Climate Change Fourth Assessment Report. The slow sea-level-rise projection (http://www.ipcc.ch/publications_and_data/ar4/

[wg2/en/ch6s6-3-2.html](http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch6s6-3-2.html)) is from the A1B scenario of the Intergovernmental Panel on Climate Change Fourth Assessment Report.

The recent paper, “Limits on the Adaptability of Coastal Marshes to Rising Sea Level,” is posted online at <http://dx.doi.org/10.1029/2010GL045489>.

The full reference is: Kirwan, M.L., Guntenspergen, G.R., D’Alpaos, Andrea, Morris, J.T., Mudd, S.M., and Temmerman, Stijn, 2010, Limits on the adaptability of coastal marshes to rising sea level: *Geophysical Research Letters*, v. 37, L23401, 5 p., doi:10.1029/2010GL045489. ☼

Outreach

USGS Promotes Ocean Research and Education at 12th Annual Open House in St. Petersburg, Florida

By **Ann B. Tihansky**

Focusing on the theme, “Liquid Earth: Our Fluid Planet,” the U.S. Geological Survey (USGS) St. Petersburg Coastal and Marine Science Center held its 12th annual Open House on Novem-

ber 5 and 6, 2010, in St. Petersburg, Florida. The theme promoted science and education to improve understanding of watersheds, coastal areas, and global ocean systems.

Letters from several community leaders lauded the event for providing a platform to educate the public about ocean research. **U.S. Senator Bill Nelson** sent

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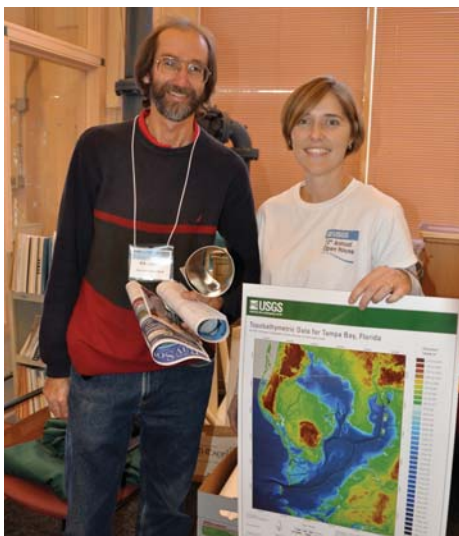
(12th Open House continued from page 5)

Center Director **Jack Kindinger** a letter expressing his appreciation for the annual USGS Open House, writing: “By focusing on the science behind the interconnectedness of our watersheds, coasts and oceans, you are promoting the responsible management of our natural resources for today’s and tomorrow’s generations. Events such as yours are critical to the understanding and preservation of our oceans, and I applaud your mission to promote ocean research and education.”

Nikki Capehart, Deputy District Director for **Congresswoman Kathy Castor**, toured the facility with **Kindinger**, as did Pinellas **County Commissioner Nancy Bostock**. **Bostock** remarked in a letter that “the event was a great way to showcase your important work and important role in our community.”

Other community leaders who attended the event included **R.B. Johnson**, Mayor of Indian Rocks Beach; **Peter Betzer**, President and CEO of the St. Petersburg Downtown Partnership; and **Stephen Andrasik**, Academic Chair of Physical Science at St. Petersburg College.

Together with many partner organizations, the USGS presented examples of how science and technology contribute to our understanding of watersheds, coasts, and oceans. The Open House highlighted



Theresa Burress (right) presents a USGS topobathymetric map of Tampa Bay to Open House visitor **R.B. Johnson**, mayor of Indian Rocks Beach, Florida.



Center Director **Jack Kindinger** introduces **Nikki Capehart** from **Congresswoman Kathy Castor's** office to the USGS St. Petersburg Coastal and Marine Science Center.

issues affecting coastal communities and demonstrated how scientific tools are developed and used to sustainably manage interconnected coastal and ocean resources.

Exhibits illuminated physical, geological, and biological aspects of ocean science, showing how waves work and how scientists drill into sediment or use acoustic technology to map remote undersea regions. From wave tanks to video footage of deep-marine coral ecosystems, exhibit offerings included visualizations, hands-on demonstrations, and scaled models to translate complex topics into entertaining and engaging presentations.

Awards were given to the most creative, visual, and hands-on interactive displays in three categories pertaining to ocean, coastal, or watershed resources. These were (1) Best Biological Exhibit, (2) Best Geological Exhibit, and (3) Best Data and Technology Exhibit. Displays were judged on how well they encouraged inquiry while illustrating how and why scientists investigate our oceans, coasts, and watersheds. Winners received a custom-made plaque and \$1,000 to be used toward travel expenses to a scientific meeting of their choice.

The Best Biological Exhibit was “Catch Climate Fever,” hosted by **Katie Mer-**

riweather, Jessica Spear, and Kathryn Richwine. The exhibitors designed interactive hands-on activities to illustrate how scientists collect and analyze a variety of information to reconstruct past climate history, as well as to forecast the future. These activities included a stratigraphy exercise, a pollen-grain matching game, and larger-than-life models of pollen and foraminifera (microscopic marine protozoans commonly referred to as “forams”) that you could hold in your hands. **Spear** and **Richwine** even dressed up as forams to show visitors what a foram is, where it lives, and what it eats. The “Catch Climate Fever” exhibit demonstrated that as we study biological clues and gain understanding of forams, we gain greater understanding of larger Earth climate systems.



Kathryn Richwine, dressed up as a foram, answers questions about what forams are and why they are important to understanding Earth's climate.

Paul Knorr, who literally breathed life into the concepts behind understanding ocean chemistry, presented the “Best Geological Exhibit.” In his display, titled “pH, CO₂, Our Oceans and You,” **Knorr** used a gas analyzer to demonstrate how humans generate carbon dioxide (CO₂) through breathing or respiring. **Knorr** asked visitors to breathe into the instrument so they could observe the concen-

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By blowing into a solution that changes color as the pH changes, a young visitor learns firsthand about how atmospheric carbon dioxide affects ocean chemistry.

tration of CO₂ in their breath. He showed how CO₂ can alter the pH of seawater and discussed how USGS scientists are monitoring changes in ocean chemistry associated with increasing atmospheric CO₂ levels. He went on to demonstrate how molluscs and other marine calcifiers—organisms that require a specific range of chemical conditions in seawater to successfully build their shells—may be susceptible to changes in ocean chemistry related to buildup of CO₂ in our atmosphere.

The “Best Data and Technology Exhibit” was a demonstration of 2-D and 3-D Earth-viewing applications called GeoMappApp and Virtual Ocean, developed by the National Science Foundation and the Lamont-Doherty Earth Observatory of Columbia University. These tools are publicly available online and work on both Windows and Apple computers. **Shawn Dadisman, Jennifer Miselis, and Arnell Forde** took visitors around the world to view such Earth-science phenomena as hurricane tracks dating back to 1851, earthquake activity along the Mid-Atlantic Ridge, a fly-through of the geology of the Grand Canyon, and satellite images of the globe in summer and winter.

The dark conference room was lit by colorful geologic maps and geomorphic features projected onto Earth’s round surface, allowing the viewer to turn the globe and zoom in to get a real “Planet Earth” perspective. Visitors could take away instructions on how to use these resources at home. To access these tools, go to <http://www.geomapp.org/> and <http://www.virtualocean.org/>.

Partner organizations hosted complementary and engaging booths promoting ocean science and education. **Chris Simoniello** and **Chad Lembke** with the Gulf of Mexico Coastal Ocean Observing System (<http://gcoos.tamu.edu/>) showed how science and technology played a major role in monitoring and understanding impacts from the Deepwater Horizon oil spill. They had a remotely operated submersible vehicle on display and used a hands-on activity to demonstrate how surfactants work to break up oil in seawater.

The U.S. Coast Guard Auxiliary display featured the “Marine Debris” game, in which participants match up types of marine debris (common household items) with the length of time these items take to decompose (as much as hundreds of years). Marine debris is a pressing and complex

problem affecting our oceans. Because marine debris is directly related to human activity, public education about the topic is a critical component of programs aimed at eliminating trash from our oceans.

The Clearwater Marine Aquarium shared information about how a prosthetic tail was designed and built for “Winter,” an Atlantic bottlenose dolphin who lost her tail after it was injured in a crab trap (<http://www.seewinter.com/>). The young students learned about how Winter was trained to use the prosthetic device and are looking forward to the upcoming movie that shares the story (<http://www.tampabay.com/features/movies/winter-the-dolphins-life-story-headed-for-the-silver-screen/1110108>). The movie is expected to be in theaters in the fall of 2011.

Visitors also had a chance to get up close and personal with a live alligator and crocodile provided by Gatorama and a pine snake and gopher tortoise provided jointly by the U.S. Fish and Wildlife Service and the Friends of the Tampa Bay Wildlife Refuges.

The two days of the Open House were “Earth Science Day for Fourth Graders” (November 5), attended by nearly 900 stu-

U.S. Coast Guard Auxiliary serviceman **John Curtis** shares information about marine debris and boating safety with Open House visitors.



Outreach, continued

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dents and their teachers, and a Public Day (November 6), attended by approximately 400 visitors, including formal and informal educators, youth activity groups such as Girl Scouts and Boy Scouts, academics, environmental professionals, science and resource enthusiasts, and the general public.

Students play an important role in the annual event, both by attending and by contributing. On “Earth Science Day for Fourth Graders,” nearly 50 high-school students served as tour guides or assisted scientists in presenting their information to the 4th graders. Students from Seminole High School’s National Honor Society and Lakewood High School’s Academy of Marine Science and Environmental Technology program volunteered at the event. This partnership introduces students to

Educational handouts, maps, and other Earth-science resources for teachers were nestled among blades of seagrass that were part of a bigger-than-life seagrass-ecosystem model.

new areas of study and career possibilities that they did not know about before attending the Open House. Another participating program is Oceanography Camp for Girls, a course unique to Pinellas County designed to give 8th-grade girls hands-on experience in the field of marine science.



Graduates of the Oceanography Camp for Girls participate in the Open House by sharing information about the program and what it has done for their educational careers.

Each year, alumni from this program return to participate in the Open House, sharing with visitors how their experiences in the program continue to influence their college educations and career choices; the program is run by the University of South Florida College of Marine Science and receives USGS support. Every student who visited “Earth Science Day for Fourth Graders” received a goody bag full of information about scientific resources, including hands-on activity pages, reference materials, and Web links to in-depth resources online.

The Open House provides unique opportunities for the USGS to discover engaging ways of sharing our science with our community partners and the public. You can learn more about this year’s Open House, as well as previous events, at <http://coastal.er.usgs.gov/openhouse/>. ❁

USGS Geographer Is Opening Speaker at GIS Day 2010

U.S. Geological Survey (USGS) geographer **Nadine Golden** was the opening speaker at GIS Day 2010 in Watsonville, California, on November 17, 2010. “GIS” refers to geographic information systems—combinations of software and hardware used to capture, store, analyze, and display data linked to geographic locations. GIS Day is an international event sponsored by local GIS communities around the world. The November 17 meeting, held in the Watsonville Civic Plaza Community

Room, was sponsored by the Central Coast Joint Data Committee (<http://www.ccjdc.org/>), which invited the USGS Pacific Coastal and Marine Science Center to participate. **Golden**, from the center’s National Seafloor Mapping and Benthic Habitat Studies project, spoke about the techniques and methods used by center scientists for seafloor mapping. In her talk, titled “Seafloor Mapping and Benthic Habitat Studies at the USGS Pacific Coastal and Marine Science Center (PCMSC),” she

outlined how project scientists collect and use traditional seafloor-mapping data—including rock and sediment samples, bottom video, sidescan-sonar data, and multibeam-sonar data—and how they develop new methods of combining these data to produce habitat and surficial-geology maps. She also described how methods of classification and displays of sonar, video, and lidar data are continually being enhanced, as well as how sampling data are compiled

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in usSEABED, a relational database of integrated quantitative and verbal data on seabed texture, composition, and geophysical properties (<http://walrus.wr.usgs.gov/usseabed/>). As an example of how all these data types can be used together, **Golden** discussed the California Seafloor Mapping Program (CSMP), an interdisciplinary study that USGS scientists are leading to create a series of comprehensive coastal and marine geologic and habitat base maps for all of California's state waters (<http://walrus.wr.usgs.gov/mapping/csmpl/>).✿



*USGS geographer **Nadine Golden** addresses participants at GIS Day 2010 in Watsonville, California, on November 17, 2011.*

Publications

Recently Published Articles

- Amstrup, S.C., DeWeaver, E.T., Douglas, D.C., Marcot, B.G., Durner, G.M., Bitz, C.M., and Bailey, D.A., 2010, Greenhouse gas mitigation can reduce sea-ice loss and increase polar bear persistence: *Nature*, v. 468, no. 7326, p. 955-958, doi:10.1038/nature09653 [<http://dx.doi.org/10.1038/nature09653>].
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