

Fieldwork

USGS Scientists Investigate New Orleans Levees Broken by Hurricane Katrina

By Robert Kayen, Brian Collins, and Helen Gibbons

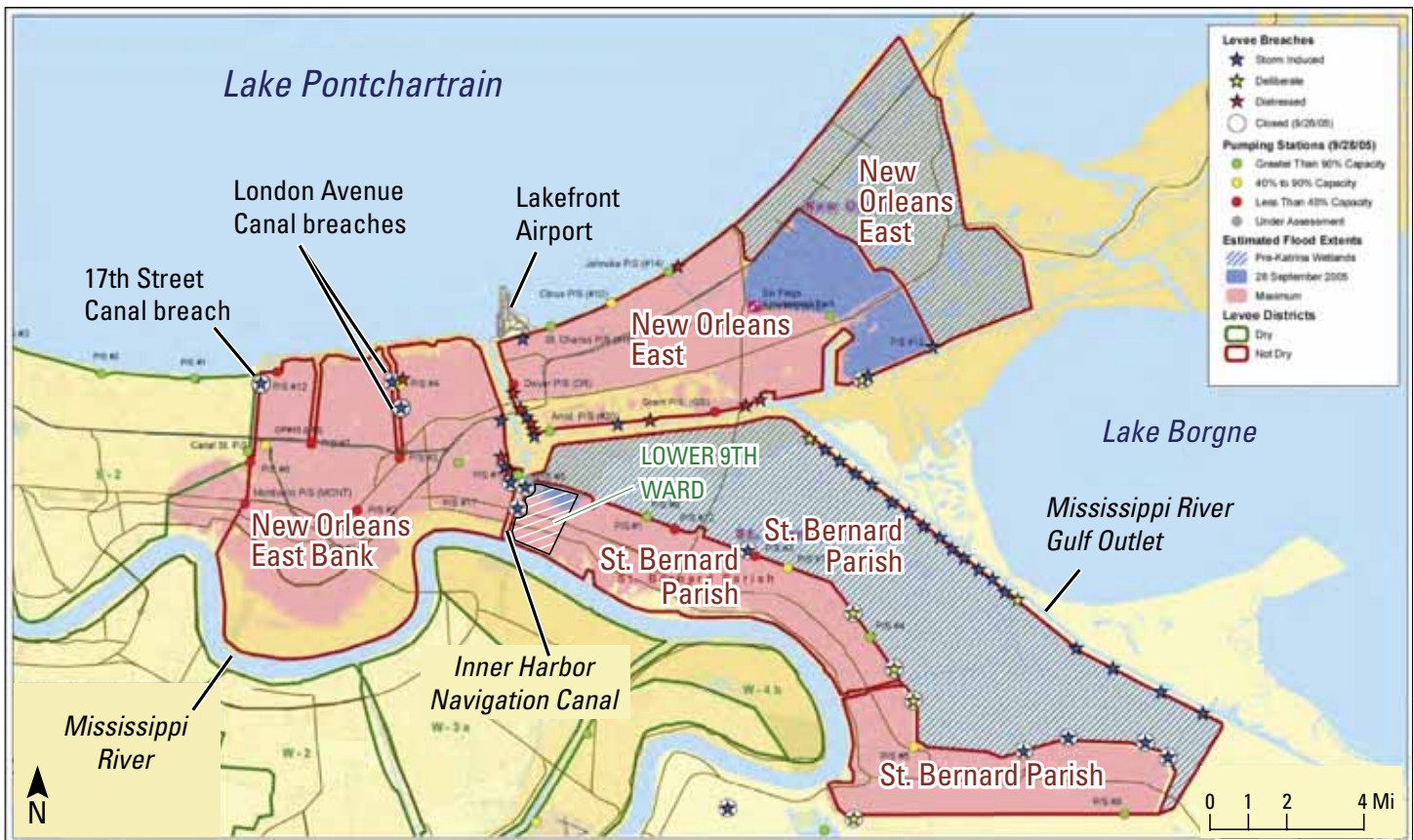
The storm surges produced by Hurricane Katrina on August 29, 2005, breached the levees protecting New Orleans in numerous places, flooding approximately 75 percent of the metropolitan area. Most of the levee failures were caused by overtopping, as the storm surge rose over the top of a levee and scoured out the base of the landward embank-

ment or floodwall. Three major and costly breaches appear to have been caused by failure of the soils underlying the levees or failure of the earthen levee embankments themselves; in several places, levee foundations failed when water levels were below the tops of the levees. Transitions between levees of differing heights or materials proved to be weak points in

the flood-protection system; a significant number of levee washouts occurred, for example, where the weaker of two adjacent materials was at a lower elevation.

In the aftermath of the flooding of New Orleans, the U.S. Army Corps of Engineers requested an external review of the levees' performance by teams of engineers

(New Orleans Levees continued on page 2)



Locations of places and levee breaches discussed in article. Three of the four main protected units that make up the New Orleans flood-protection system are labeled: the New Orleans East Bank section, the New Orleans East section, and the Ninth Ward and St. Ber-

nard Parish section. A fourth protected unit, southeast of this map, is a thin, protected strip along the Mississippi River heading southward from St. Bernard Parish to the river mouth. Blue hatching indicates pre-Katrina wetlands. Pink shading shows estimated maximum extent of

urban flooding; blue shading shows areas still flooded on September 28, 2005. Modified from figure 1.4 in the joint NSF-ASCE report available at URL http://hsgac.senate.gov/_files/Katrina/Preliminary_Report.pdf.

Sound Waves

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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

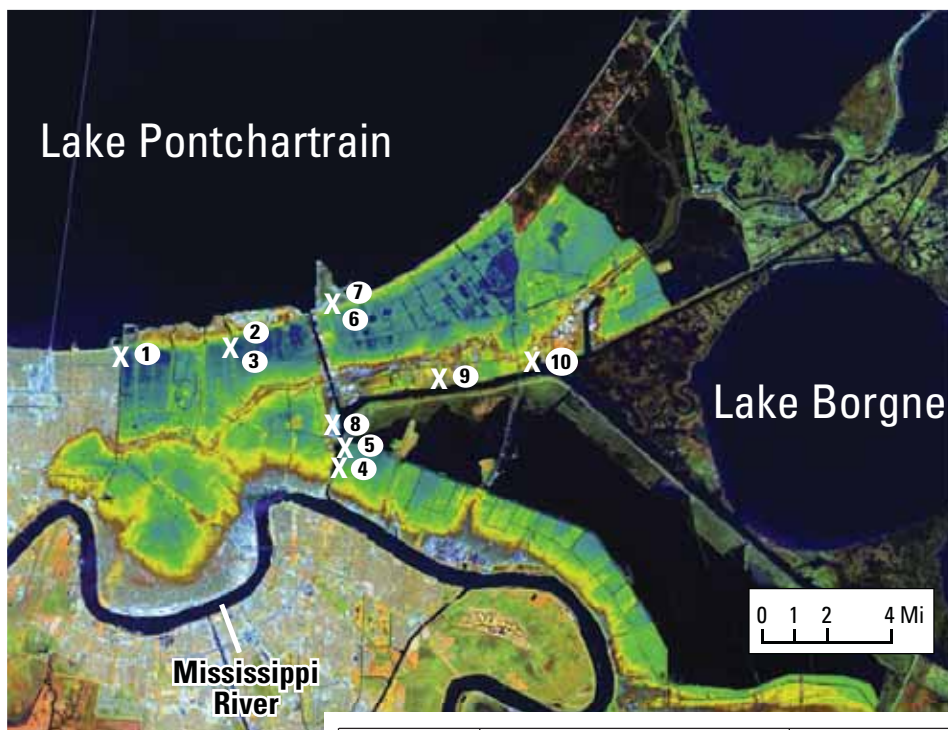
(New Orleans Levees continued from page 1)

and scientists sponsored by the National Science Foundation (NSF) and the American Society of Civil Engineers (ASCE). Various teams worked in New Orleans from September 28 through October 15, 2005—a time chosen by balancing the need to gather ephemeral data against the need to avoid interfering with emergency

operations. On numerous occasions, team units arrived and investigated sites only hours before vital information was buried by ongoing emergency repairs.

Two U.S. Geological Survey (USGS) scientists, research civil engineer **Robert Kayen** and Mendenhall Postdoctoral Fel-

(New Orleans Levees continued on page 3)



▲ Sites where **Kayen** and **Collins** conducted lidar (light detection and ranging) surveys. The background image shows estimated floodwater depths on September 2, 2005, superimposed on a Landsat satellite image. Darkest blue indicates deepest water (greater than 11.5 ft). For more information, visit URL <http://eros.usgs.gov/katrina/science.html> and click on "Topography-Based Analysis of Hurricane Katrina Inundation of New Orleans."

Sites where **Kayen** and **Collins** surveyed levees. ("I-wall" refers to concrete floodwall with a cross section roughly similar to an "I," as opposed to "T-wall," which has the cross section of an inverted "T.") ▶

Lidar-survey site number	Location	Number of lidar scans
1	17th Street Canal	20
2	London Ave. Canal, North on east side	29 with Site 3
3	London Ave. Canal, North on west side	29 with Site 2
4	IHNC East Side, South Breach 9th Ward	13
5	IHNC East Side, North Breach 9th Ward	14
6	Lakeside Airport Levee Transition Breach	14 with Site 7
7	Lakeside Airport Levee I-Wall	14 with Site 6
8	Structural Distressed I-Wall at Container Wharf	20
9	Incipient Earth Levee Failure	14
10	Entergy Plant I-Wall Scour	20

Fieldwork, continued

(New Orleans Levees continued from page 2)

low **Brian Collins**, both of the USGS Western Coastal and Marine Geology Team (WCMG), were asked to join as investigators on the NSF-sponsored team. They were in New Orleans from October 9 to 14, using a ground-based terrestrial laser-mapping system to conduct detailed surveys of the levee breaches. Gathering information about the magnitude and geometry of structural and soil deformation is paramount for analyzing how and why the levees failed.

Kayen and **Collins** arrived on the only United Airlines flight into New Orleans on October 9 and stayed in what appeared to be the only available hotel near the Mississippi River. The roof of their rental vehicle, a Nissan Pathfinder, served as a platform for the terrestrial laser-mapping instrument. They used a global-positioning-system (GPS) unit to navigate around the city, which was overwhelmed with flooded sections, downed trees and powerlines, and windblown and waterborne debris. Each day they drove on whatever surface allowed them get to a levee break—both sides of the road, sidewalks, lawns. In some areas, especially in the Lower Ninth Ward, the debris was so thick that they were unable to drive to their destination and had to carry in gear on foot.

“Both **Brian** and I are familiar with post-event [earthquake] damage, but the devastation of Hurricane Katrina was so unusually severe and affected so much of urban New Orleans that we were taken aback by the magnitude of this natural and manmade catastrophe, and the absence of all services and people,” said **Kayen**. “By analogy, imagine the impact of 50 to 80 percent of the San Francisco Bay area rendered uninhabitable by some event. That was the state of New Orleans as we worked.”

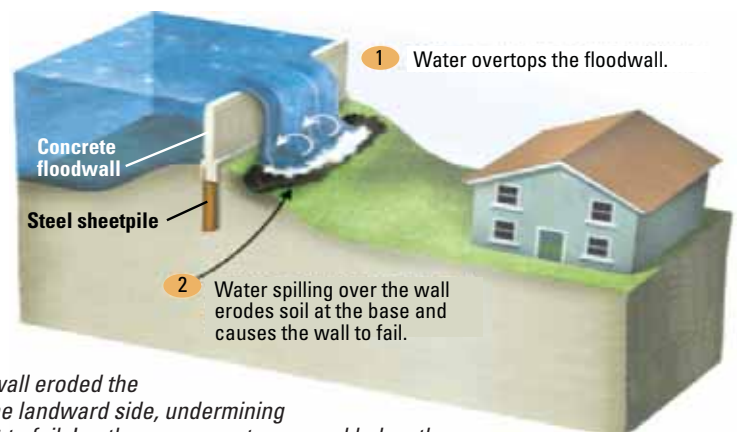
The two researchers used laser-mapping techniques they developed in their WCMG studies of coastal-seacliff erosion and earthquake ground deformation to capture the surface evidence of levee deformation and distress at 10 sites in the greater New Orleans area. To do this, they brought to the field area a new terrestrial tripod-mounted laser-mapping tool to perform lidar (light detection and ranging) data col-



*Tripod-mounted lidar (light detection and ranging) unit at the 17th Street Canal breach (survey site 1). **Brian Collins** mans a pushcart containing a laptop computer and other electronics connected to the lidar unit. Photograph by **Robert Kayen**.*

lection. The terrestrial lidar method consists of sending and collecting laser pulses from the surface of objects to build a data set of three-dimensional coordinates. The USGS laser-scanning system can measure the location of as many as 8,000 surface points in 1 second. Thus, within a few minutes, an entire surface can be imaged efficiently, producing a data set that contains several million position points. The data sets from collected scans are typically transformed into virtual three-dimensional

Diagram showing how overtopping caused levee breaches. The levee in the diagram is composed of concrete surrounding a corrugated steel “sheetpile,” so called because it serves as a piling when driven into the underlying earthen embankment. Water overtopping the floodwall eroded the soil embankment on the landward side, undermining the wall and causing it to fail. In other areas, water seeped below the sheetpile and weakened the embankment, causing failure even at water levels below the height of the floodwall. Modified from a Wall Street Journal graphic based on the NSF-ASCE report available at URL http://hsgac.senate.gov/files/Katrina/Preliminary_Report.pdf.



surfaces so that cross sections can be generated and volumetric calculations can be performed.

The objective of the laser-scanning effort in New Orleans was to obtain precise measurements of the ground surface in order to map

- soil displacements at each levee site,
- the nonuniformity of levee heights,
- the depth of erosion where scour occurred, and
- distress in structures that were on the verge of failure when floodwaters receded.

Overtopping was most severe on the east side of the flood-protection system, as the waters of Lake Borgne were driven west toward New Orleans, and also farther to the south, along the lower reaches of the Mississippi River. Significant overtopping and erosion caused numerous breaches in these areas. The magnitude of overtopping was less severe along the Inner Harbor Navigation Canal (IHNC, also called the “Industrial Canal”) and along the western part of the Mississippi River Gulf Outlet (MRGO) channel, but overtopping in these areas nevertheless caused erosion and levee failures. Although field observations suggest that little or no overtopping occurred along most of the levees fronting Lake Pontchartrain, evidence of minor overtopping or wave splashover was observed in several places. A breach in the levee system occurred at the northwest corner of the New Orleans East protected

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Fieldwork, continued

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area, near Lakefront Airport, at a complex transition between levee segments of varying heights and materials. It appears that many of the levees breached by overtopping might have performed better if conceptually simple details, such as scour protection on the land side, had been added during or after original design and construction.

Farther west, in the New Orleans East Bank Canal District, three levee failures

occurred along the banks of the 17th Street and London Avenue Canals. **Kayen** and **Collins** observed evidence indicating that the failures occurred when water levels were below the tops of the concrete floodwalls lining the canals. These three levee failures were likely caused by failure of the foundation soils underlying the levees. Signs of an incipient failure were observed at a fourth distressed levee/floodwall segment on the London Avenue Canal, where

lateral displacements, sinkholes, and sand boils all indicate that water was flowing through a weakening embankment.

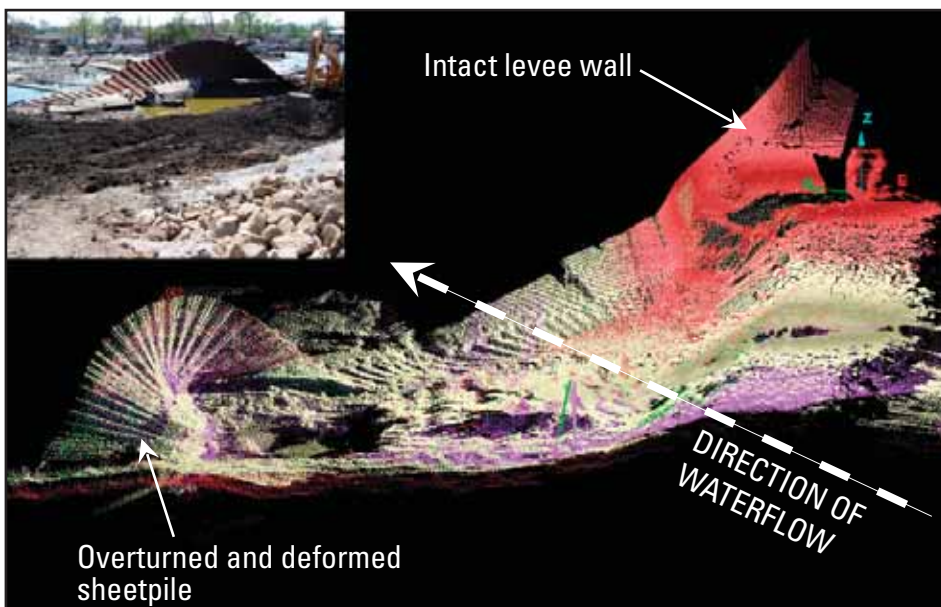
The levee-investigation teams pooled their findings to produce a joint NSF-ASCE report that was presented to Congress in early November, along with Congressional testimony from the NSF and ASCE team leaders. The report can be downloaded from URL http://hsgac.senate.gov/_files/Katrina/Preliminary_Report.pdf.

Kayen and **Collins** were among the experts featured in a 10-minute television news feature about the NSF-ASCE investigation of the New Orleans levee failures after Hurricane Katrina (see article in *Sound Waves*, November 2005, at URL <http://soundwaves.usgs.gov/2005/11/outreach3.html>). The segment aired on October 20, 2005, on the “News Hour with Jim Lehrer,” a national Public Broadcasting Service (PBS) news program. A transcript, photographs,

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◀ **Rob Kayen** and lidar unit near the southern levee breach on the Inner Harbor Navigation Canal (survey site 4). Floodwall behind **Kayen** is intact, but wall shows increasing damage from right to left. Breach is outside area of photograph to left. Photograph by **Brian Collins**.



Composite lidar image of northern levee breach on the Inner Harbor Navigation Canal (site 5). Inset photograph by **Robert Kayen**.



Tripod-mounted lidar unit at the northern levee breach on the Inner Harbor Navigation Canal (survey site 5). The floodwall—typically, concrete sandwiched around corrugated steel (called a “sheetpile”) that is driven into an earthen embankment—was flipped over when the levee was breached. Photograph by **Robert Kayen**.

(New Orleans Levees continued from page 4)

and links to video and audio files of the television feature, called “Investigating Broken Levees,” are available online at http://www.pbs.org/newshour/bb/science/july-dec05/levees_10-20.html. ❄



Brian Collins scans the area around the 17th Street Canal breach (survey site 1). The lidar unit is on the roof of the survey vehicle behind Collins. Photograph by Robert Kayen.



Lidar unit and tripod mounted to the roof of Kayen and Collins’ field vehicle. The fixed roof base allowed for leveling of the tripod and lidar instrument on sloping ground. Here the instrument is scanning scour at the base of intact floodwall at an Entergy New Orleans plant in east New Orleans (survey site 10). Photograph by Robert Kayen.

Special Feature:

Post-Katrina Cleanup in Biloxi, Mississippi— a Volunteer’s Reflections

By Doug George

His name was Tuli and he’d been sleeping on a soggy mattress for two months. After he had dragged the remnants of his bed from his house, he’d wrapped it in plastic and put it under a blue tarp suspended by bent chainlink-fence posts. Leaning against broken cinder blocks around him were framed wedding photographs of his son and daughter-in-law. Welcome to post-Katrina Biloxi, Mississippi.

I arrived in Biloxi on November 7, 2005, for five days of volunteer work but quickly realized that even 500 days would not be enough. From fallen 150-ft trees to flattened neighborhoods, this city of 50,000 people endured some of the worst damage inflicted by Hurricane Katrina when it slammed into the Gulf Coast on August 29 as a category 4 storm. With the sixth-lowest atmospheric pressure on record, Katrina brought sustained winds exceeding 145 mph and a storm surge of 20 to 30 ft.



Typical scene of hurricane destruction in the east half of Biloxi, Miss.

How did the storm’s statistics translate into impacts on the city? Roof shingles peeled off, exposing attics packed with diplomas and books, while sediment-laden seawater poured through shattered windows. Shoes floated through hallways, saturated teddy bears tangled with sewing machines, and Cheerios boxes wrapped around bedposts. Closet rods snapped from the weight of soggy clothes. The violence was absolute and unrelenting. The tale of the Three Little Pigs took a perverse turn in Biloxi. Many



houses were wooden boxes elevated on 2-ft-tall brick footings. When the winds roared in, the structures slid off their anchors and collapsed. Brick homes with solid foundations resisted the air attack but could not contend with the surging water.

At the base camp, we volunteers armed ourselves with sledge hammers, pickaxes, crowbars, and shovels to drag out a family’s wrecked belongings and then strip the house. Walls, insulation, ceilings, flooring—anything that was not a 2-by-4 had to go. The work dislodged showers of dust and muck that mingled with our sweat. Face masks blocked the airborne ruffraff but did little to filter the stomach-churning stench that emanated from kitchens. What had been food was now blackened

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masses of quivering rot, fermented in the subtropical heat of a late Mississippi summer. Once our task was complete, the frame of the house could be sprayed by professionals, killing the toxic mold that had blossomed as the floodwaters receded.

The human capacity to bear suffering was far greater than I had imagined. A 78-yr-old diabetic woman, Delphi, had slept in a wet La-Z-Boy recliner for two months outside her home before FEMA delivered a trailer. A wheelchair-bound man, Ralph, put his face in his hands as I pushed his dishwasher to the street but remained stoic as we dumped his personal items—ruined clothes, bedding, religious pictures—along the curb. And then there was Tuli, who donned blazing white rubber boots to wade into the wreckage of his home and help us purge his house with countless wheelbarrow trips.

My own lessons were strings of dichotomies. Though raised in drought-prone California, I learned to take showers with only two sun-warmed bottles of water. Despite years of backpacking, I discovered the difference between camping and living in a tent. As an oceanographer at the U.S. Geological Survey, I am paid to



Trees and boats mingling together more than two months after Katrina hit.

research a childhood fascination—mud—but it became my enemy when I slipped in 4 inches of it and my arms were nearly crushed by a toilet that two of us were carrying. My travels in developing nations with open sewers only marginally helped me face Biloxi's unsanitary conditions.

Relief efforts in disaster zones shove people to the edges of their physical ability, mental strength, and emotional endurance. Yet the moment a victim smiles in genuine appreciation as you stand with legs bloodied, shoulders aching, body caked in mud and soaked in sweat, nose raw from the rubbing of a face mask—that smile turns

you around to swing the sledge for one more hour. I hope to see Tuli's house a home again and return his smile. ❁



Doug George pulling down a wall with a pickaxe in Biloxi, Miss.

USGS Scientists Examine Offshore Impacts of Hurricane Katrina

By Peter Swarzenski

U.S. Geological Survey (USGS) scientists led a quick-response cruise aboard the research vessel *Cape Hatteras* in mid-October 2005 to study the impacts



of Hurricane Katrina on the Louisiana shelf. Sponsored jointly by the National Science Foundation (NSF) and the USGS Coastal and Marine Geology Program and Earth Surface Dynamics Program, the cruise collected data in the lower Mississippi River and on the northern continental shelf off Louisiana to investigate potential downriver en-

The research vessel Cape Hatteras off the Mississippi River mouth, October 2005. The Cape Hatteras is owned by the National Science Foundation.

vironmental impacts and to assess storm-related sediment transport on the shelf.

Hurricane Katrina caused major damage to natural-gas and petroleum facilities in the Gulf of Mexico, leading to oil spills whose exact extent has not yet been determined (see preliminary interpretations of satellite imagery by **Russell Rykhus** in *Eos*, v. 86, no. 41, p. 381-382). The storm's energy also disrupted oxygen-depleted waters in the previously stratified water column of the northern Louisiana shelf and thus abruptly ended the occurrence of widespread hypoxic conditions observed in this region during summertime. (Visit URL <http://www.lumcon.edu/Information/news/>, select year 2005, then click "Map-

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Fieldwork, continued

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ping of Dead Zone Completed” to learn more about this oxygen depletion.) A highly productive fisheries industry may be at risk from storm-related pollution and catastrophic sediment transport.

Among those studying these potential environmental threats are USGS scientists **Peter Swarzenski, Lisa Osterman, Chris Reich, John Ricardo, and Dick Poore** (St. Petersburg, Fla.) and their academic collaborators **David Senn, Michael Bank, and Laurel Schaidler** of the Harvard School of Public Health; **Rob Mason and Terill Hollweg** of the University of Connecticut; **Alan Shiller, Lyndsie Gross, and Jinggong Dong** of the University of Southern Mississippi; **David Hollander, Jen Flannery, Marianne Dietz, Zhiqiang Chen, Chuanmin Hu, and Frank Muller-Karger** of the University of South Florida; and **Nancy Rabalais** of the Louisiana Universities Marine Consortium (LUMCON).

The October cruise had the following broad objectives:

- To assess posthurricane offshore

sediment-transport processes, with the help of data from a prehurricane (May 2005) cruise on the research vessel *Pelican* that established the recent geochronologic framework at selected sites on the Louisiana shelf by using the radioactive isotopes ^7Be , ^{210}Pb , and ^{137}Cs to date sediment

- To examine the biogeochemical signatures of a suite of trace elements in Mississippi River water across a salinity gradient—from low-salinity (~1) water at a site about 40 km upriver from the mouth of the Mississippi to higher-salinity (36) water in the Gulf of Mexico about 150 km southwest of the river mouth.
- To analyze organic and inorganic contaminants in sediment immediately adjacent to the river mouth to determine whether their sources can be identified—are they normally present in Mississippi River water, or were they introduced by pumping of floodwaters into the river?

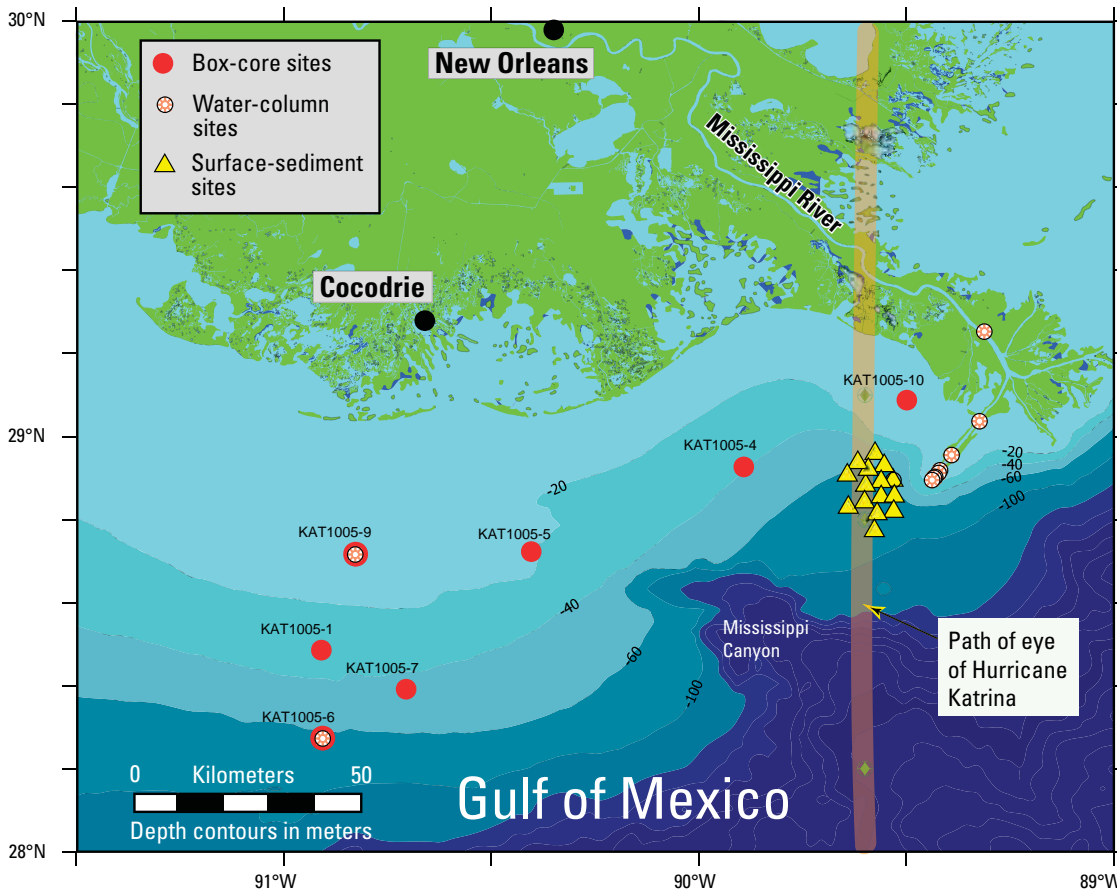
- To continue research on historical oxygen-depletion (hypoxia) events and storm-induced benthic-ecosystem changes, using benthic-foraminiferal assemblages
- To further study the cycling of mercury and methylmercury in the pore waters and water column in areas of recurring hypoxia

To achieve these objectives, the scientific staff sampled the water column and bottom sediment at previously established and new sites across the Louisiana shelf, using various sampling and coring devices. Planned onshore studies of cores collected on this cruise will include analyses of a suite of organic compounds and inorganic trace elements, mercury and methylmercury, ^7Be , ^{210}Pb , ^{137}Cs , foraminiferal assemblages, and grain size.

The research vessel *Cape Hatteras* departed from Cocodrie, La., on October 14, 2005, carrying 12 cruise participants. We owe special thanks to **Don Rice** of NSF, who funded this quick-response cruise; **John Haines** (USGS Coastal and Marine

Geology Program Coordinator) and **Tom Armstrong** (USGS Eastern Region Science Coordinator), who have jointly supported USGS efforts; and the captain and crew of the *Cape Hatteras*, who provided superb and invaluable help with all things shipboard. **Joseph Ustach** (Duke University) kindly coordinated the ship’s schedule around a multitude of hurricanes. The generosity of **Steve Rabalais** (LUMCON) in loaning us a large box corer from the research vessel *Pelican* ensured successful sediment collection. ☼

Box-core, surface-sediment, and water-column stations on the Louisiana shelf.



USGS Diving Operations Assist Sediment-Toxicity Studies in Western Long Island Sound

By Richard R. Rendigs

U.S. Geological Survey (USGS) dive-team personnel **Dann Blackwood** and **Rick Rendigs** recently helped collect sediment push cores at three sites in western Long Island Sound in support of sediment-toxicity studies. The work was conducted on October 14, 2005, in collaboration with researchers **Pengfei Zhang** of the City College of New York (CCNY) and **Michael Melcer** of the U.S. Merchant Marine Academy (USMMA) at Kings Point, N.Y.

The USMMA motor vessel *Dottie J* was used to transport the divers and scientific crew to three sites in the sound—at Little Neck Harbor, Manhasset Harbor, and Hempstead Harbor—that ranged in water depth from 3 to 12 m, respectively. The divers gently pushed two 4.5-in.-diameter core tubes into the silty sediment at each site. After carefully extracting the cores from the bottom sediment, the divers placed them in a sampling basket and hauled them back to the surface. Sediment quality and recovery were regarded as excellent because the sediment surfaces were virtually undisturbed and the average length of recovered cores was approximately 50 cm.

The cores will be dated by ^{210}Pb -isotopic analysis and will be further analyzed for the chlorinated pesticides chlordane and DDT. Additional spectral analyses will be used to examine the chiral signature of chlordane residues to determine whether or not microbial degradation has occurred. This study is part of a CCNY project sponsored by the U.S. Environ-



Sometimes maintaining your balance at sea is challenging! Left to right, researchers Pengfei Zhang, Youxian Wu (both CCNY), and Mike Melcer (USMMA). Photograph by Dann Blackwood.



Scientists siphon overlying water from the top of a recovered core. Left to right, researchers Pengfei Zhang and Youxian Wu (both CCNY). Photograph by Dann Blackwood.



The USMMA motor vessel Dottie J was used to transport the divers and scientific crew to three sampling sites in western Long Island Sound. Photograph by Dann Blackwood.

mental Protection Agency (EPA) for determining the “Concentrations and Enantiomeric Fractions of Chlordane in Sediments from Long Island Sound.” (For additional information, visit URL <http://mail.sci.cuny.cuny.edu/~pzhang/research.html>.)

The results will be compared with those of a sediment-toxicity survey originally carried out by the National Oceanic and

Atmospheric Administration (NOAA)’s National Status and Trends (NS&T) Program in Long Island Sound from 1986 to 1991. The NS&T survey was designed to determine the spatial distribution and severity of toxicity of heavy metals and chlorinated hydrocarbons at sites within 20 coastal bays in Long Island Sound. ❁

USGS, State of Massachusetts, and NOAA Cooperate to Map Sea-Floor Geology Off Massachusetts Coast

By Walter Barnhardt

Researchers at the U.S. Geological Survey (USGS) Woods Hole Science Center are producing high-resolution maps of the sea-floor geology off the Massachusetts coast, with a focus on the nearshore region in water depths of less than 40 m. The

mapping program is a cooperative effort involving the USGS, the Massachusetts Office of Coastal Zone Management (CZM), and the National Oceanic and Atmospheric Administration (NOAA). The need for high-resolution geologic and

bathymetric maps is driven by ongoing management concerns about declining fisheries and the impacts of offshore construction projects (for example, pipelines, wind farms, and liquified natural-gas

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terminals). The maps are an important first step toward protecting essential fish habitat, delineating marine reserves, and assessing changes in habitat due to natural or human impacts. Scientific questions focus on (1) clarifying the postglacial history of sea-level change in the region, (2) reconstructing coastal environments and

quantifying rates of change over the past few thousand years, and (3) calculating a sediment budget for the coastal system, which is undergoing chronic erosion.

This mapping project was initiated by USGS scientist **Brad Butman** in 2002 as a way to prepare companion maps to those already produced for the Stellwagen Bank

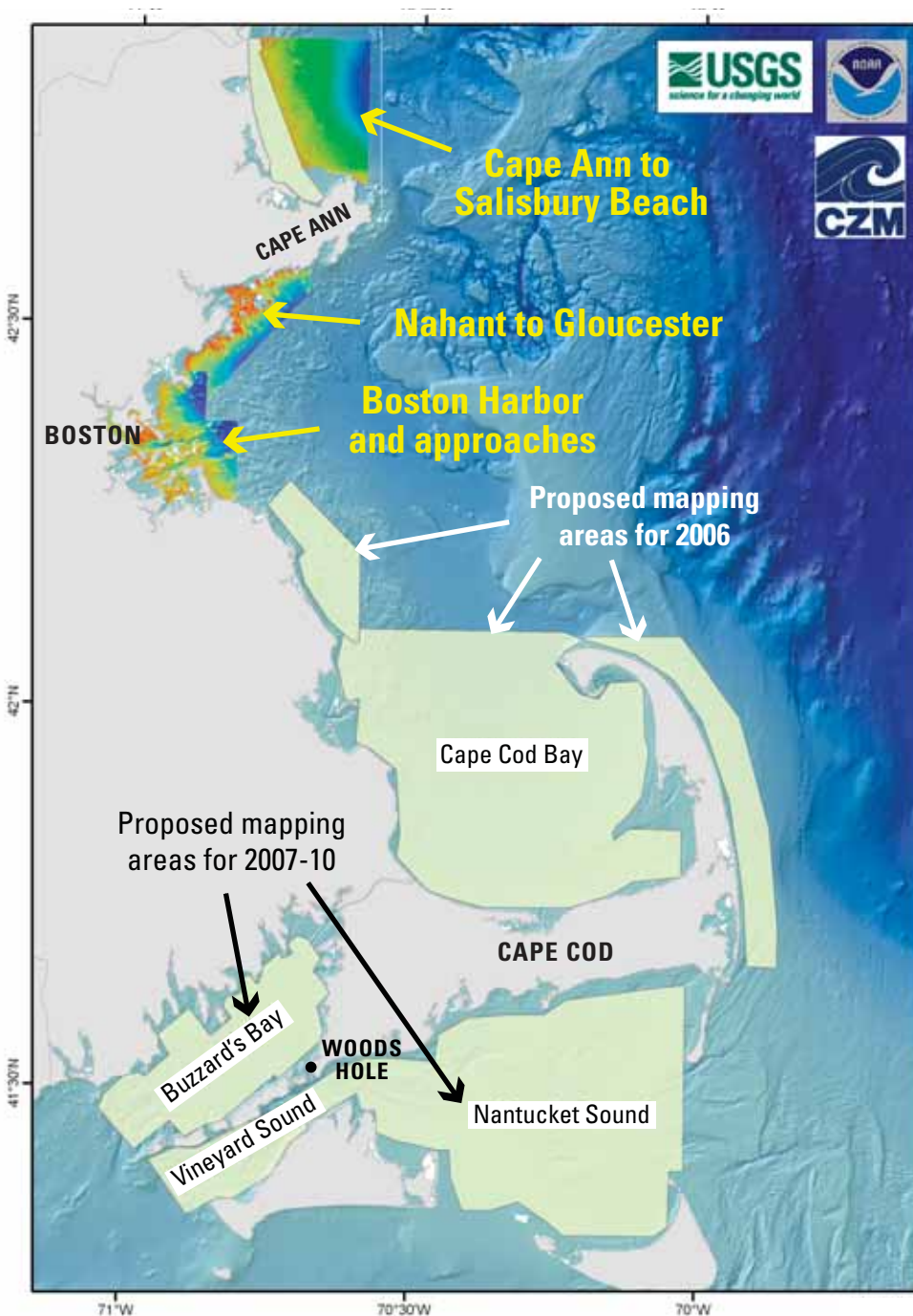
National Marine Sanctuary and western Massachusetts Bay (see URL http://woodhole.er.usgs.gov/project-pages/coastal_mass/). As part of the project, surveys of the inner continental shelf have been carried out in three areas that were identified as high-priority areas by local, State, and Federal agencies:

- Cape Ann to Salisbury Beach
- Nahant to Gloucester (see article in *Sound Waves*, Dec. 2003–Jan. 2004, at URL <http://soundwaves.usgs.gov/2004/01/fieldwork3.html>)
- Boston Harbor and approaches

These areas extend northeastward from Boston Harbor to the New Hampshire-Massachusetts State line, and offshore from the coast to the 3-mi limit of State waters. Water depths are mostly in the 5- to 40-m range but locally include areas as much as 90 m deep. Overall, approximately 450 km² of the inner shelf has been mapped at 1:25,000 scale, using interferometric and multibeam sonars (to map bathymetry), sidescan sonar (to map substrate type), and chirp seismic-reflection profiling (to map sediment thickness and structure). Sediment sampling and bottom photography and video were used to validate or “ground truth” the remotely sensed geophysical data. The State of Massachusetts recently committed an additional \$1 million toward mapping that will focus on Cape Cod Bay starting in 2006 and possibly expand to other areas of State waters in subsequent years.

Walter Barnhardt and **Brian Andrews** (USGS), along with **Seth Ackerman** (CZM), have run three research cruises since 2003, most recently on the research vessel *Connecticut* in September 2005. This latest survey mapped shallow-water areas between Cape Ann and Salisbury Beach. We collected more than 1,000 km of geophysical tracklines and occupied 93 stations for sampling and photography. Though constantly challenged with balky equipment, USGS operations wizards **Emile Bergeron**, **Bill Danforth**, and **Chuck Worley** kept the systems running through some long nights. Special commendation goes to **Chuck**, master and commander of the

(Massachusetts Mapping continued on page 10)



Eastern Massachusetts, showing locations of three areas being mapped off the northern part of the coast (yellow labels). Five additional areas along the central and southern parts of the coast are proposed for mapping in 2006 and beyond.

Fieldwork, continued

(Massachusetts Mapping continued from page 9)

Woods Hole Science Center's newly acquired remotely operated vehicle (ROV). The one-armed little robot passed its first test, retrieving a sound-velocity profiler that had spent several nights alone on the sea floor after the line normally used to retrieve it broke. Collaborators **Chris Hein** and **Duncan Fitzgerald** of Boston University also assisted in the survey. The infamously rough weather of the Gulf of Maine was kind to us—only 2 days out of 16 were lost when the remnants of Hurricane Ophelia roared through the region.

Seth Ackerman (left) and **Bill Danforth** prepare the remotely operated vehicle (ROV) for deployment from the research vessel Connecticut. The lightweight ROV, tethered to the ship by a yellow cable (shown coiled on deck), is fitted with forward- and downward-looking video cameras and a manipulator arm, which enabled the successful search and recovery of an errant piece of oceanographic gear. Photograph by **Walter Barnhardt**.

Results of the first phase of this mapping project (Nahant to Gloucester) are currently in review as USGS Open-File Report 2005-1293. (This first phase was described in *Sound Waves*, Dec. 2003–Jan. 2004; see URL <http://soundwaves.usgs.gov/2004/01/fieldwork3.html>.)



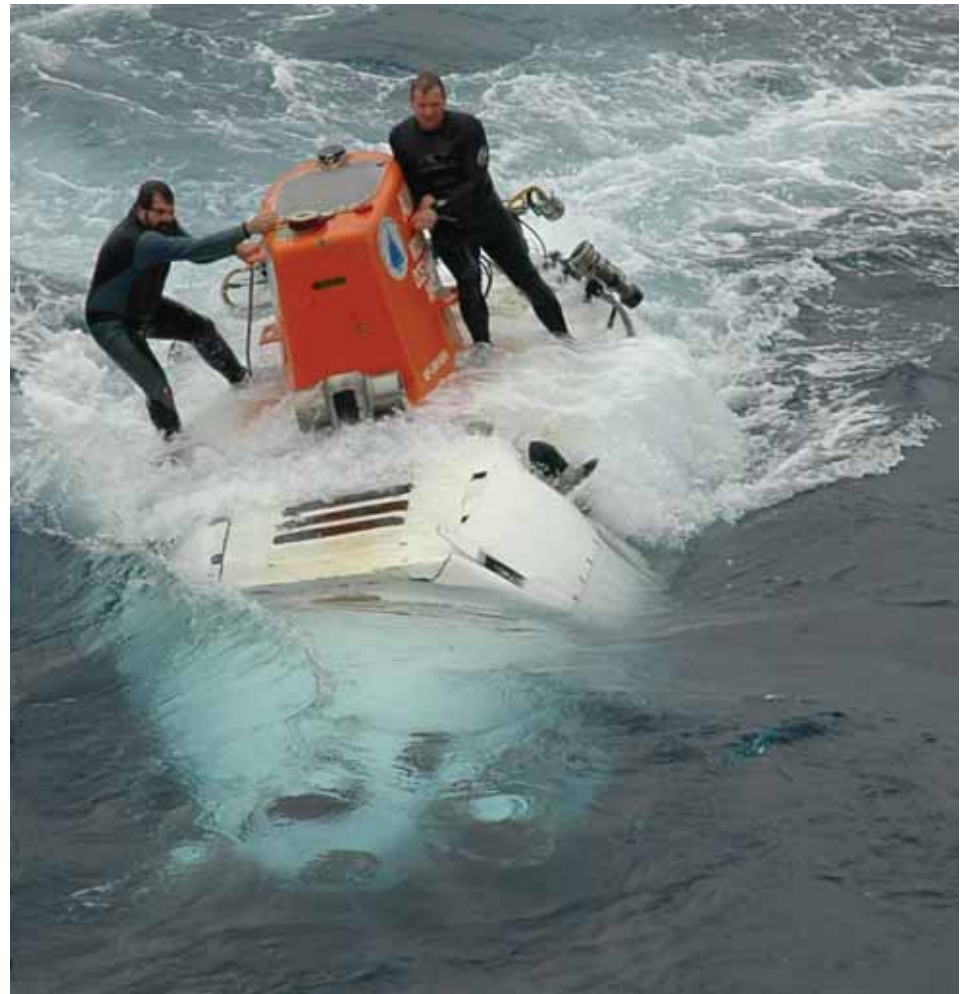
Preliminary maps and other data are posted on the Woods Hole Science Center Web site at URL http://woodshole.er.usgs.gov/project-pages/coastal_mass/. ❄

Alvin Dives to Deep-Water Coral Habitats off New England

By **Kathy Scanlon**

In October 2005, U.S. Geological Survey (USGS) scientist **Kathy Scanlon** participated in an expedition to collect data from deep-water coral habitats in submarine canyons off Georges Bank and on the New England Seamounts. The expedition was conducted by using the U.S. Navy's manned submersible *Alvin* from the research vessel *Atlantis*, both operated by the Woods Hole Oceanographic Institution (WHOI). **Scanlon** provided geologic expertise to biologist **Les Watling** (University of Maine), who is constructing a predictive model of deep-sea coral occurrences in the submarine canyons off New England. **Watling's** project is funded by the National Oceanic and Atmospheric Administration (NOAA)'s Undersea Research Program (NURP; see URL <http://www.nurp.noaa.gov/>).

Hurricane Wilma, Hurricane Alpha, and an unnamed nor'easter conspired to produce seas as high as 30 ft, causing the cancellation of 7 of the 10 scheduled *Alvin* dives. Two dives were carried out in the canyons, where habitat characteristics were observed and recorded. The third successful dive was on Pickett Seamount, where large amounts of fossil deep-sea coral (*Desmophyllum dianthus*) were collected for a paleoclimate study by **Jess Adkins** of the California Institute of Technology (Caltech). ❄



Swimmers assist the recovery of *Alvin* after the second dive of the cruise, to the floor of Oceanographer Canyon at 2,200-m water depth. **Les Watling** and **Kathy Scanlon** had the science seats; **Gavin Eppard** was the pilot. The submersible had been called back to the surface early because of deteriorating weather conditions. In spite of the sloppy seas, the recovery was mercifully quick and uneventful. Photograph by **Mark Hatay** (San Diego State University).

Study Shows That Urbanization Leads to Amphibian Declines in Southern California Coastal Watersheds

By Seth P.D. Riley, Lee B. Kats, and Robert N. Fisher

Scientists have long realized that urbanization is likely a major contributor to the disappearance of amphibians, but a new study by Los Angeles-area biologists indicates that even minimal alterations in watersheds create problems for native stream amphibians. The study found that increasing numbers of coastal watersheds in southern California, even in such protected areas as national and State parks, are being altered in ways that make them unsuitable for frogs and salamanders native to this region.

Thirty-five Los Angeles-area streams were intensively surveyed in a 3-year study conducted by biologists from the National Park Service, Pepperdine University, the U.S. Geological Survey (USGS), and the Resource Conservation District of the Santa Monica Mountains. The results of their study have been published online and in the December issue of the scientific journal *Conservation Biology* (see URL <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1523-1739.2005.00295.x>). The watersheds surveyed ranged from those in national or State parks with no development to those where as much as 37 percent of the watershed area is urbanized, including roads and commercial, industrial, and residential areas.

Previous studies in other parts of the country have indicated that when 15 to 20 percent of a watershed is developed or urbanized, stream organisms begin to suffer. This study, however, reveals that as little as 8-percent urbanization results in habitat changes that make streams unsuitable for native amphibians. Urban streams were commonly observed to have long uniform stretches of deeper water and to lack the variety of deep pools and shallow riffles needed to support native biodiversity. “The more urbanized streams had been transformed from babbling brooks to sand- and mud-filled trenches that were missing native species but full of nonnative invaders,” said Seth



Urban-influenced stretch of Medea Creek, which has year-round water, exotic predators (crayfish, bass, bluegill), and an absence of native amphibians, such as the California newt (*Taricha tarosa*) and the California treefrog (*Hyla cadaverina*). Photograph by Gary Busted, NPS.



Natural stretch of Conejo Creek, which is similar hydrologically to Medea Creek but has seasonal water availability, is free of exotic predators, and has abundant native amphibians, such as the California newt (*Taricha tarosa*). Photograph by Gary Busted, NPS.



Native amphibians, such as the California newt (above) and the California treefrog (right), are common in natural streams in southern California but rare in urbanized streams. Photographs by Chris Brown, USGS.



Riley, a National Park Service wildlife ecologist and lead author of the study.

According to the study, the urban streams were missing such native amphibians as California newts and California treefrogs but were rife with introduced invasive species, including crayfish, bass, bluegill, and bullfrogs. Although southern California streams commonly dry up in the late summer and in dry years, the ur-

ban streams examined in the recent study continued flowing year-round, likely as a result of increased runoff and water inputs. The urban-related changes facilitate invasion by nonnative animals that compete with or prey upon native amphibians.

“We hope that these new results will provide valuable guidance for land managers and policymakers throughout southern Cali-

(*Amphibian Declines continued on page 12*)

Research, continued

(Amphibian Declines continued from page 11)

fornia,” said **Lee Kats**, a professor of biology at Pepperdine University and one of the study coauthors. “Amphibians represent a fragile group of animals in southern California and elsewhere, and this study suggests that even minimal urbanization can contribute to their disappearance.” **Ray Sauvajot**,

Chief of Planning, Science and Resource Management with the National Park Service’s Santa Monica Mountains National Recreation Area, agreed: “Identifying factors that impact sensitive amphibians will help park managers maintain pristine stream conditions where they exist and restore or improve habitat conditions in areas affected by urbanization.”

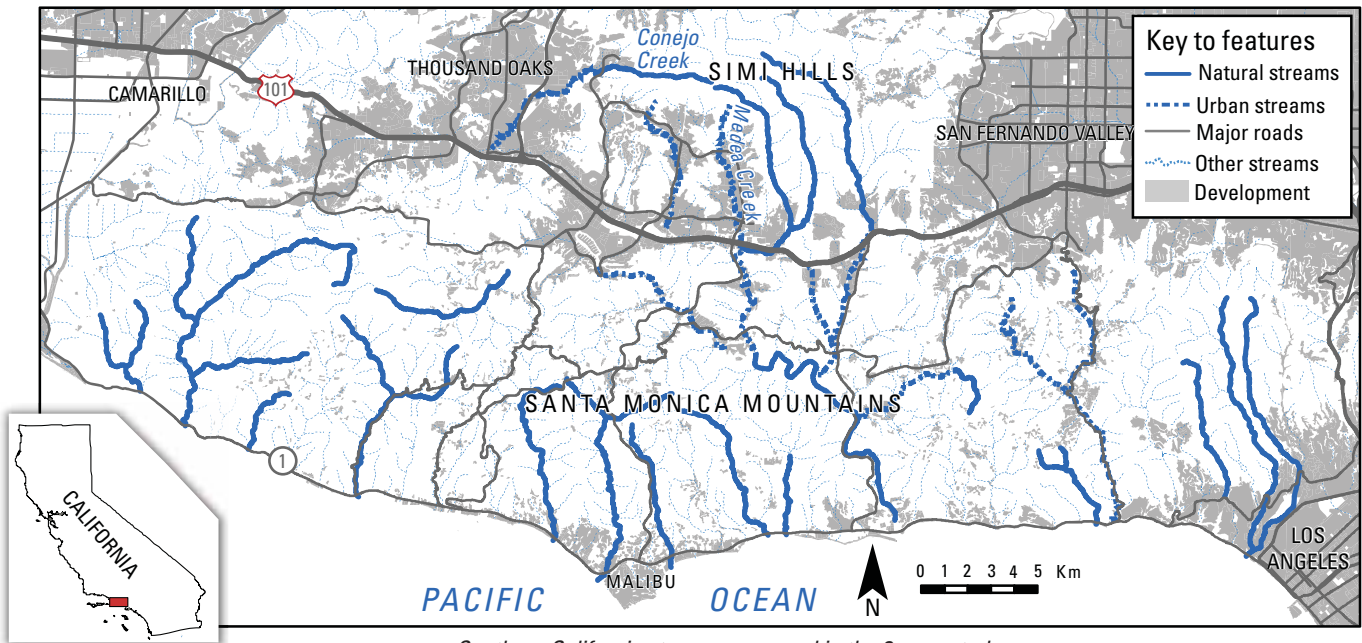
This study will help researchers and land managers further understand the

causes of amphibian declines nationally, said **Robert Fisher**, a research biologist with the USGS and study coauthor. “We continue to discover that these declines are not driven by single ‘smoking gun’ causes but instead are the result of synergistic effects of multiple stressors in the environments inhabited by amphibians.”

This work was funded in part by the USGS Amphibian Research and Monitoring Initiative (ARMI), initiated in 2000 to investigate the status and trends in the Nation’s amphibians and study the causes of their declines (for more information, visit URL <http://edc2.usgs.gov/armi/>).



Exotic predators, such as crayfish and bullfrogs, invade urbanized streams and compete with or prey upon native amphibians. Crayfish photograph by **Gary Busted**, NPS; bullfrog photograph by **Chris Brown**, USGS.



Southern California streams surveyed in the 3-year study.

Outreach

San Francisco Bay Floor Explored in Public Lecture

By **Helen Gibbons**

A public lecture on “Shifting Shoals and Shattered Rocks—How Man Has Changed the Floor of San Francisco Bay” drew more than 100 people to the U.S. Geological Survey (USGS) campus in Menlo Park, Calif., on the evening of November 17, 2005. The audience sat spellbound as

geologists **John Chin** and **Florence Wong** of the USGS Western Coastal and Marine Geology Team (WCMG) related historical events that have affected the bay and described mapping techniques that let us view its floor in unprecedented ways.

John began the lecture with a short his-

tory of human influences on the bay. He showed striking photographs of hydraulic mining washing away whole hillsides in the foothills of the Sierra Nevada during the 19th-century California Gold Rush; before this practice was banned in 1884, it

(Public Lecture continued on page 13)

(Public Lecture continued from page 12)

sent enormous volumes of sediment down the rivers and into San Francisco Bay, reducing the water depth over large areas. He identified bedrock knobs on the west-central bay floor that have been repeatedly blasted to accommodate increasingly larger vessels, and showed photographs of blasting in the early 1900s. He explained how San Francisco's Marina District, once sand dunes, was transformed into the site of the 1915 Panama-Pacific Exposition (only the Palace of Fine Arts remains from this era), and how Treasure Island was created from dredged sand for the 1939 Golden Gate Exposition.

John also described multibeam swath-sonar mapping, a fairly recent technology that has enabled scientists to study the San Francisco Bay floor in more detail than ever before. In contrast to single-point soundings that were the norm through the early 1900s, and lines of soundings that were collected from World War II into the 1990s, multibeam mapping allows scientists to map virtually 100 percent of the sea-floor surface, producing photograph-like views of the sea floor. In her section of the lecture, **Florence Wong** explained how geographic-information-system (GIS) techniques allow scientists to reconfigure multibeam and other mapping data for numerous purposes—from detecting and quantifying past changes, such as alteration of land by urbanization, to making models and predictions about the future, such as the likely intensities of earthquake shaking in different areas. She showed how multibeam data collected by the USGS in San Francisco Bay had been used to calculate how much rock must be removed from a bedrock knob to eliminate its threat to deep-draft vessels, and to reconstruct how disposal of dredged material transformed a deep depression off Alcatraz Island into a large mound (contradicting expectations that tidal currents would sweep away the disposed material).

Florence closed the lecture with a computer-generated “flythrough” of the central bay floor, created from multibeam-mapping data by **Peter Dartnell**, also of WCMG. This virtual tour, in which the viewer skims past Alcatraz Island, around

(Public Lecture continued on page 14)



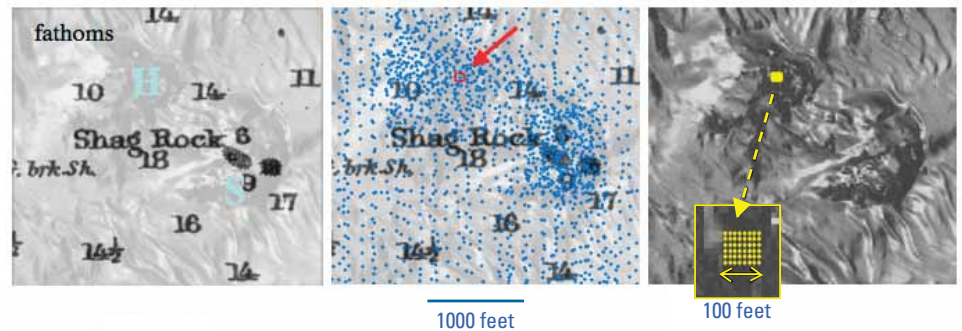
Cover photo from USGS Circular 1259, “Shifting Shoals and Shattered Rocks....” This panoramic view from the Marin Headlands shows a large container vessel passing beneath the Golden Gate Bridge and entering west-central San Francisco Bay. Photograph by **Mike Diggles**, USGS.



Blasting of Arch Rock in 1901. View from San Francisco. Alcatraz Island is in the right middle ground. Photograph courtesy of U.S. Army Corps of Engineers.



Hydraulic mining at the Malakoff Diggings in the foothills of the Sierra Nevada. Photograph by **Carleton E. Watkins**, courtesy of the Bancroft Library, University of California, Berkeley.

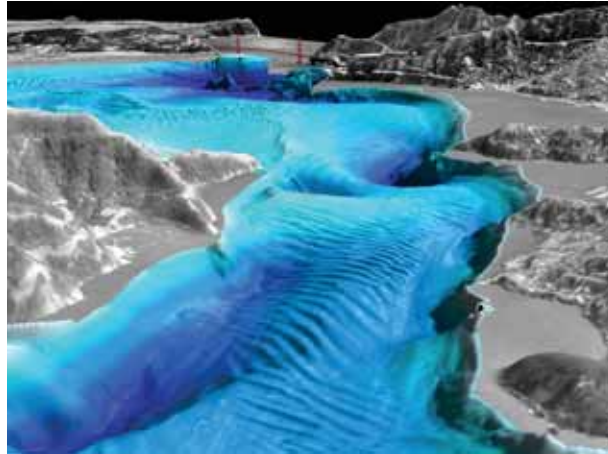


Increasing data density has led to increasingly detailed bay-floor maps. Lefthand image is part of a navigational chart published in 1883; each number represents one sounding (depth reported in fathoms). Center image is the same chart overlaid with soundings (blue dots) collected by the National Oceanic and Atmospheric Administration (NOAA) in the 1990s. Right-hand image is the same area mapped by multibeam swath sonar in 1997. Red rectangle in the center image contains 1 sounding; the same area (yellow rectangle) in the right-hand image contains 48 soundings.

Outreach, continued

(Public Lecture continued from page 13)

Angel Island, over large sandwaves, deep depressions, and bedrock knobs, and out to the brink of the Golden Gate, drew so many oohs and ahhs from the crowd that it was played twice (posted online at URL <http://soundwaves.usgs.gov/2006/01/outreach.html>). The lecture was based on a USGS Circular that **John** and **Florence** coauthored with **Paul Carlson**, now a WCMG emeritus scientist. Circular 1259 is posted online at URL <http://pubs.usgs.gov/circ/2004/c1259/>. ❁



High-density multibeam swath-sonar data produce photograph-like views of underwater terrain, as shown in this frame from a computer-generated "fly-through" created by **Peter Dartnell** from USGS data collected in 1997 (view the flythrough at URL <http://soundwaves.usgs.gov/2006/01/outreach.html>). In the foreground are sand waves on the bay floor between Angel Island (gray tones on left) and the Tiburon Peninsula (on right). View southwestward, toward the Golden Gate.

Department of the Interior Briefing on Coastal Research in Hawai'i

On November 11, 2005, U.S. Geological Survey (USGS) geologists **Michael Field**, **Eric Grossman**, and **Curt Storlazzi** briefed Department of the Interior (DOI) Assistant Secretary **Mark Limbaugh** on USGS Coastal and Marine Geology Program research in Kaloko-Honokohau National Historical Park on the west coast of the Big Island of Hawai'i. The multifaceted research includes high-resolution mapping of the park's coral-reef resources and investigation of dynamic processes, including coastal circulation and submarine ground-

water discharge, that influence the transport and flux of associated nutrients and contaminants to the benthic habitat.

Limbaugh was in the islands for the National Water Resources Association's 74th Annual Conference in Honolulu, where he was the keynote speaker. After attending the water conference, **Limbaugh** toured some facilities operated by DOI agencies, including several on the Big Island: the USGS Hawaiian Volcano Observatory, the USGS Pacific Island Ecosystems Research Center's Kilauea Field Station, and the National Park Service's

Kaloko-Honokohau National Historical Park (NHP).

Limbaugh spent November 11 at Kaloko-Honokohau NHP, where he and his party were hosted by NPS biologist **Sallie Beavers**. An introduction to the park was followed by a visit to anchialine pools (nearshore pools with no surface connection to the sea but with saltwater and tidal cycles; see URL <http://www.nps.gov/kaho/pphtml/subnaturalfeatures27.html>) led by USGS research ecologist **David Foote**, who also described some endangered terrestrial and aquatic species. Next came the briefing by **Field**, **Grossman**, and **Storlazzi** on ground-water issues and coral-reef studies. To wrap up the visit, **Field** led **Limbaugh** and others on a short snorkeling field trip in the coral gardens of Kaloko-Honokohau NHP, where the USGS scientists pointed out salient aspects of the coral community and the processes that control it. ❁



NPS biologist **Sallie Beavers**, in right foreground, introduces visitors to Kaloko-Honokohau National Historical Park. Left to right: **Alan Mikuni** (USGS), **Cindy Limbaugh**, Department of the Interior (DOI) Assistant Secretary **Mark Limbaugh**, **Pat** and **Sharon O'Toole**, **Sallie Beavers** (NPS), **Curt Storlazzi** (USGS), and **Eric Grossman** (USGS).

Telling the Public About USGS Research on the Kona Coast, Hawai'i

U.S. Geological Survey (USGS) scientists took time out from a week of fieldwork on the Big Island of Hawai'i to explain some aspects of their research to the public last November. **Eric Grossman**, **Curt Storlazzi**, and **Josh Logan** were on the Big Island to investigate submarine ground-water discharge and the flux of associated nutrients and contaminants into coastal waters in Kaloko-Honokohau National Historical Park on the island's west coast.

On November 10, **Grossman** delivered a "ReefTalk" to approximately 75 people from the community of Kailua-Kona, Hawai'i. Sponsored by the National Oceanic and Atmospheric Administration's Sea Grant Program, the talk described a new study of submarine ground-water discharge being conducted by scientists from the USGS, Stanford University, the University of Hawai'i, and Florida State University to generate baseline data on the delivery of freshwater, nutrients, and contaminants to West Hawai'i's coral reefs. West Hawai'i's growing human population and the ecosystems in its unique anchialine ponds (nearshore ponds with no surface connection to the ocean but with saltwater and tidal cycles) and near-pristine coral reefs are closely tied to ground water—the principal form of freshwater along the arid West Hawai'i coast. **Grossman** also described recent findings about Holocene coral-reef development by USGS and University of Hawai'i collaborators. The talk was recorded for airing on Public Access Television in Kailua-Kona.

On November 11, **Grossman** and **Storlazzi** joined other scientists, including USGS geologist **Mike Field**, to brief Department of the Interior (DOI) Assistant Secretary **Mark Limbaugh** on coastal research being conducted in the Hawaiian Islands by various DOI agencies (see related article, this issue).

On November 16, **Grossman** delivered an invited talk on USGS mapping in coastal and marine environments to approximately 100 high-school students and teachers as part of Kealakehe High School's GIS (Geographic Information Systems) Day. This event included pre-



Eric Grossman (right) talks to students and teachers at Kealakehe High School's GIS Day, November 16, 2005, in Kailua-Kona, Hawai'i.

sentations and displays by local and State professionals, such as ESRI (Environmental Systems Research Institute), Hawai'i County, Hawai'i Volcanoes National Park, the U.S. Department of Agriculture's Natural Resources Conservation Service, Forest Solutions (a privately owned forest-management group), Hawai'i Community College, and the University of Hawai'i, Hilo. **Logan** presented posters and maps to the group.

Later in the day, **Grossman** led several high-school teachers, students, and parents on a 1-hour field trip to a USGS field location in Kaloko-Honokohau National

Historical Park, where research projects for four students were initiated. These projects will contribute to USGS studies of the effects of submarine ground-water discharge and the coastal processes that influence shoreline morphology. Three projects in particular will provide monthly to bimonthly data on:

1. temperature and salinity variations and algae cover at several intertidal sites where algae growth is increasing, probably owing to excess nutrients percolating through the beach in submarine ground-water discharge.
2. temperature and salinity measurements in the water column, using remotely operated vehicles (ROVs) in an area of Kaloko-Honokohau Harbor bordering the National Park where the USGS is using moored instruments and periodic mapping to monitor the persistence and temporal/spatial variations in submarine ground-water-discharge plumes.
3. coastal morphologic change resulting from seasonal wave exposure.

The students are implementing these projects under the supervision of **Larry Rice**, who heads the Kealakehe High School GIS and ROV development program. ❁



Setting up student research projects, November 16, 2005, in Kaloko-Honokohau National Historical Park, Hawai'i.

USGS Cosponsors Third International Symposium on Deep-Sea Corals

By **Kathy Scanlon**

The Third International Symposium on Deep-Sea Corals was held November 28–December 3, 2005, in Miami, Fla., attracting more than 250 participants from 27 countries. About 40 percent of the attendees were from outside the United States. The symposium was sponsored by several U.S. agencies and institutions, including the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), and the Minerals Management Service (MMS). **Kathy Scanlon** (USGS) and **Anthony Grehan** (National University of Ireland) were co-conveners for a double session on Habitat Mapping, Sampling, and Characterization. **Ken Sulak** (USGS) and **Tony Koslow** (Commonwealth Scientific and Industrial Research Organisation [CSIRO], Australia) convened a session on Fish Ecology.

Deep-sea corals include both “hard” (for example, scleractinian) and “soft” (for example, gorgonian) corals that live with-

out the benefit of the symbiotic algae (zooxanthellae) that the more familiar tropical corals depend on. Because they don't rely on zooxanthellae, deep-sea corals can live in cold and dark waters. During the last decade, scientists have advanced our understanding of these animals tremendously. They are now known to occur as individual colonies and as large reef communities in a wide variety of environments in all the oceans of the world.

Presentations at the symposium addressed a wide range of topics, including the use of fossil coral skeletons as recorders of paleoclimate, the potential of deep-sea corals as pharmaceuticals, their value as habitat for other organisms, threats to their survival, and efforts to protect them. Protection of deep-sea corals is particularly difficult because many live in areas outside the jurisdiction of any nation, in international waters. ❁



The white coral (right) is *Lophelia pertusa*, a scleractinian coral; the orange-pink coral (left) is an octocoral. This photograph—taken in the northeastern Gulf of Mexico in 2005 (see article in *Sound Waves*, May 2005, at URL <http://soundwaves.usgs.gov/2005/05/>)—is now linked to an entry in a geographic-information-system (GIS) database of deep-sea corals off the eastern and southern United States being compiled by **Kathy Scanlon**, **Julia Knisel** (USGS), and **Rhian Waller** (Woods Hole Oceanographic Institution). The database was presented at the recent symposium. Photograph by **Lance Horn** of NOAA's Undersea Research Program (NURP).

Award for USGS Map *Hawaii's Volcanoes Revealed*

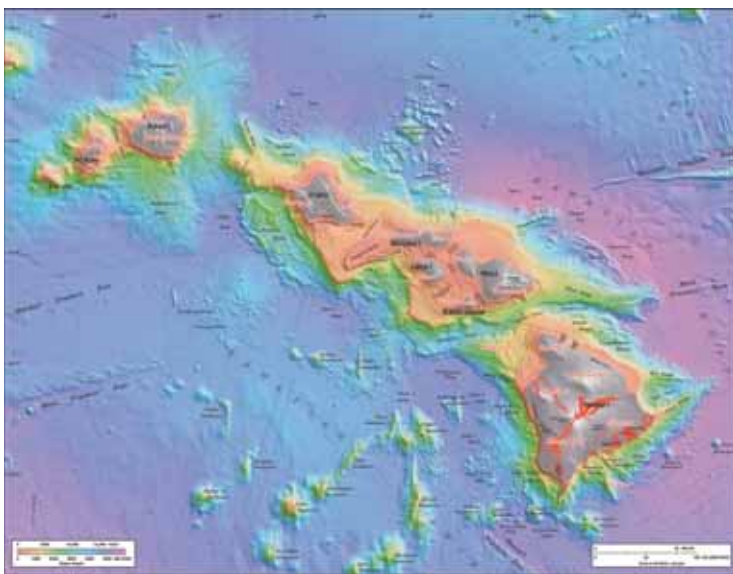


Image of Hawai'i sea floor from award-winning map.

An innovative and colorful U.S. Geological Survey (USGS) map portraying Hawaiian volcanoes, prepared in cooperation with the Japan Marine Science and Technology Center, the University of Hawai'i's School of Ocean and Earth Science and Technology, and the Monterey Bay Aquarium Research Institute, recently received the 2005 Outstanding Publication Award from the Association of Earth Science Editors (URL <http://www.aese.org/>). The map, *Hawaii's Volcanoes Revealed*, depicts the submarine volcanic history of Hawai'i in vivid colors representing various stages of historical geologic development.

To learn more about the map, read “Scientists Unveil New Map of Hawai'i Sea Floor” in *Sound Waves*, December 2003–January 2004 (URL <http://soundwaves.usgs.gov/2004/01/pubs.html>). To view the map online, visit URL <http://geopubs.wr.usgs.gov/i-map/i2809/>. The full reference is Eakins, B.W., Robinson, J.E., Kanamatsu, Toshiya, Naka, Jiro, Smith, J.R., Takahashi, Eiichi, and Clague, D.A., 2003, *Hawaii's volcanoes revealed*: U.S. Geological Survey Geologic Investigations Series I-2809, scale approx. 1:85,342. ❁

USGS Citizen Soldier on the Move!

By Paul F. Boetcher

Since joining the U.S. Geological Survey (USGS) in January 2000 as a Hydrologic Aid GS-3 at the USGS Florida Integrated Science Center office in Tampa, Fla., **Patrick Marasco** has accomplished much. He graduated from the University of South Florida, married his college sweetheart, and is the proud father of a 2-year-old son. In June 2001, **Patrick** received an appointment as a Hydrologic Technician GS-4, and he is now a GS-7 in the Tampa Data Section.

But **Patrick** has an additional role—that of Sergeant First Class in the Florida Army National Guard. **Patrick** joined his unit in Arcadia, Fla., more than 9 years ago and has risen through the ranks because of his competent leadership and organizational skills. Since 1636, the National Guard has brought glory and honor upon itself and its soldiers through quiet and selfless service, traits that **Patrick** certainly exemplifies in his everyday living.

Today, **Patrick** finds himself serving our country in Iraq. He is in his first few weeks of a more-than-1-year deployment as a military policeman. He has had only a few hours off since beginning his tour of duty, which entails transporting detainees all around Iraq and providing convoy escort security.

Adding to his already-busy schedule, **Patrick** and his family are building a new



USGS employees from **Patrick Marasco's** office in Tampa, Fla., help **Patrick's** wife and 2-year-old son move into an apartment while the family builds a new home during **Patrick's** tour of duty in Iraq with the Florida Army National Guard.

house. Recently, an energetic group of USGS employees from **Patrick's** office helped his wife and son move from their old home into an apartment, where they will live until the new home is finished. The Tampa office has not only assisted in this move but also frequently provides other assistance to help **Patrick's** family adjust to his absence.

Although **Patrick's** presence in the Tampa office is truly missed, he can rest assured that his USGS friends are here for his family during his deployment in Iraq.✿

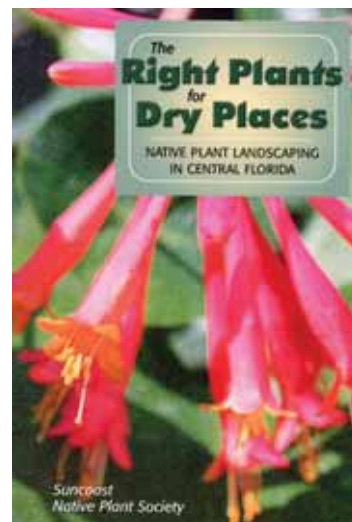
About the author: Paul F. Boetcher is a USGS Hydrologic Technician and a Master Sergeant (Retired) of the Florida Air National Guard.

USGS Hydrologist Coauthors Book on Native-Plant Landscaping in Florida

George Kish, a hydrologist in the Tampa, Fla., office of the U.S. Geological Survey, is coauthor of a newly revised edition of *The Right Plants for Dry Places—Native Plant Landscaping in Central Florida*. Originally published in 1997, the book was revised by **George Kish** and **Dick Wunderlin**, University of South Florida botany researcher. This revised and expanded second edition (2005) has more plant species and more photographs, as well as all the information needed to

incorporate native species into your central Florida garden. It tells how to identify, where to use, and how to care for 46 native trees, shrubs, groundcovers, and vines. It also gives blooming and fruiting times, mature size, wildlife value, and ethnobotanical uses.✿

*Cover of the newly revised book coauthored by USGS hydrologist **George Kish**.*



New Book on *Benthic Habitats and the Effects of Fishing*

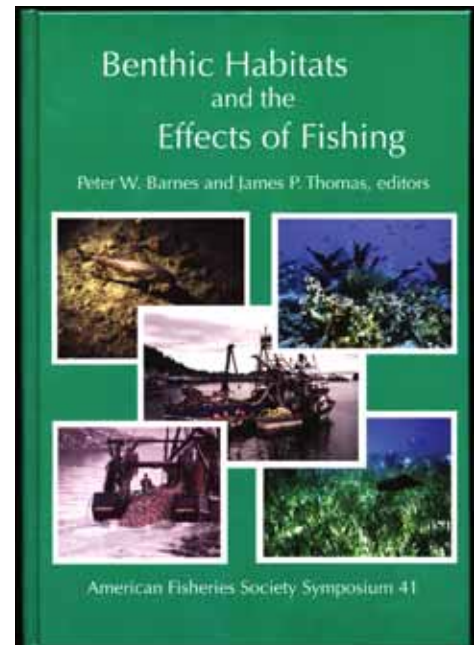
By Peter Barnes

The U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) cooperate in many ways. Recently, USGS work with NOAA's National Marine Fisheries Service has focused on mapping benthic ecosystems, determining the geology and sedimentology of ecosystem substrates, and understanding substrate stability. Some of the results of this work are now available in a new book published by the American Fisheries Society in September 2005, entitled *Benthic Habitats and the Effects of Fishing*. The book's 60 papers and 100 abstracts cover a broad range of geologic, biologic, sociologic, and management research. The volume is an outgrowth of an Ecological Society of America Symposium, "Effects of Fishing Activities on Benthic Habitats: Linking Geology, Biology, Socioeconomics, and Management," organized and underwritten by NOAA and the USGS. The symposium was held November 12-14, 2002, in Tampa, Fla. (see article in *Sound Waves*, December 2002/January 2003, at URL <http://soundwaves.usgs.gov/2003/01/meetings.html>).

The new book identifies several information and research needs, including:

- Systematic physical and biological characterization (maps) of the U.S. Exclusive Economic Zone (EEZ)
- A national seabed-classification scheme
- Linking of fisheries and ecosystems to benthic-habitat characteristics and dynamics
- Comparisons of natural and human-induced changes
- Extrapolation of site-specific studies to regional fishery-management areas
- New technology for assessing seabed habitat

The full reference for the volume is Barnes, Peter W., and Thomas, James P., eds., 2005, *Benthic habitats and the effects of fishing*: American Fisheries Society, Symposium 41, Bethesda, Md. Copies have been sent to USGS science centers and libraries and are available from the American Fisheries Society's online bookstore at URL <http://www.fisheries.org/html/publications/catbooks/x54041>.



Cover of new book edited by **Peter Barnes** (USGS) and **James Thomas** (NOAA).

shtml. The 890-page hardcover book with index costs \$53.00 for American Fisheries Society members, \$75.00 for nonmembers. ❁

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