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Sound Waves

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Fieldwork

Imaging Remnants of Ancient Landscapes Beneath South Carolina Beaches

By Ilya Buynevich

In July, U.S. Geological Survey (USGS) scientists **Wayne Baldwin** (St. Petersburg, FL) and **Ilya Buynevich** (Woods Hole, MA) collected more than 10 km of ground-penetrating-radar (GPR) profiles as part of the South Carolina Coastal Erosion Study. The continuous, high-resolution subsurface records collected with GPR help scientists to visualize the geometry, thickness, and continuity of various sedimentary layers. The recent GPR records—collected in Myrtle Beach and North Myrtle Beach along the north coast of South Carolina—reveal remnants of ancient landforms created when barrier islands migrated landward with rising sea level and became welded to the mainland.

This survey complements mapping of the inner continental shelf offshore northern South Carolina by scientists from the USGS' Woods Hole Field Center, led by **William Schwab**, in collaboration with scientists from the USGS' Center for Coastal and Watershed Studies (St. Petersburg), Coastal Carolina University, and the Scripps Institution of Oceanography. Accurate mapping of the inner continental shelf and adjacent areas of the coast is critical to understanding how geologic framework—the distribution of rock and sediment—affects large-scale coastal behavior.

The GPR data collected in July will be used to link the shallow onshore geology of the area with nearshore seismic records collected last May. The attenuation of the GPR system's electromagnetic radar signal by saltwater, though one of the major limitations of the technique, was not an issue in the recent surveys, which were conducted on the upper part of the beach

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*View of North Myrtle Beach, looking east-northeast. Insets: **Ilya Buynevich** (left) and **Wayne Baldwin** (right) after running a survey on Myrtle Beach. North Myrtle Beach and Myrtle Beach are part of South Carolina's Grand Strand, a continuous stretch of sandy beach that runs about 60 mi, from north of the North Carolina border to near Georgetown, South Carolina. Photographs by **Wayne Baldwin** and **Ilya Buynevich**.*

*Where access was available, the GPR antenna was towed behind a truck. It has an attached survey wheel, which triggers the recording and measures distance. Photograph by **Wayne Baldwin**.*

*A control unit of the GSSI SIR-2000 system on the back of the truck records and stores digital images of the shallow subsurface structure of coastal sediment. The irregular orange reflector (arrow) is the contact between Holocene beach and dune sand and underlying Pleistocene beachrock. Photograph by **Wayne Baldwin**.*

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Submission Guidelines

Deadline: The deadline for news items and publication lists for the November 2003 issue of *Sound Waves* is Thursday, October 16.
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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and adjacent areas. The penetration was commonly 2 to 4 m, in some places more than 6 m.

Subsurface records from Myrtle Beach show a prominent shallow reflector—most likely the top of the Pleistocene beachrock, or sand that has been cemented by calcium carbonate, possibly during exposure to air and ground water during times of lower sea level. Above the shallow reflector are Holocene beach and dune sedimentary deposits and recent artificial fill. Along North Myrtle Beach, numerous buried inlets and ephemeral runoff channels, or "swashes," were identified, some filled with more than 5 m of sand. Beneath the roads and parking lots, shore-normal transects revealed several buried remnants of beach ridges and intervening wetland deposits.

The records are being postprocessed and incorporated into the existing geographic-information-system (GIS) data base. In the future, limited coring efforts will be required to ground-truth the key reflections and improve depth calculations on the geophysical images. The results of this study will be presented at the special theme session on paleo-inlets at the Northeastern-Southeastern Sections Joint Meeting of the Geological Society of America, which will take place near Washington, D.C., in March 2004.❁

New USGS Drifters Track Hawai'i Coral Larvae

By Gerry Hatcher

From June 30 to July 3, 2003, coral-reef-project scientists from the U.S. Geological Survey (USGS) conducted an experiment to investigate one possible cause of large variations in the amount of new reef production in adjacent areas around West Maui, Hawai'i. (See article in the

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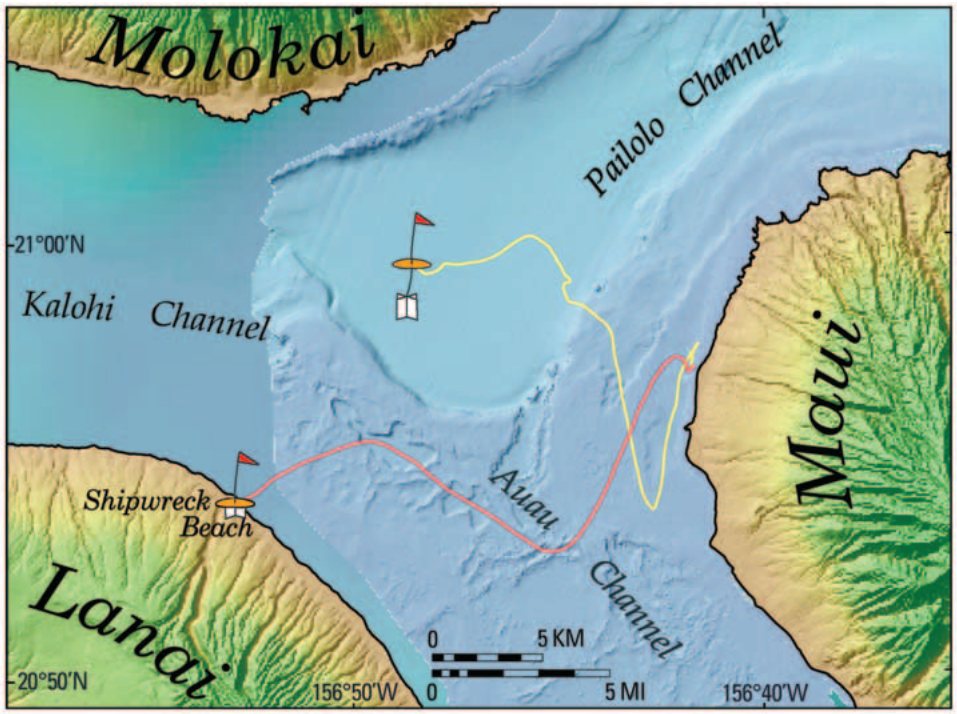

A representative track plot of two drifters released near West Maui, Hawai'i. The track in red on the left is from a drifter with the drogue attached directly to the surface float. That drifter was released at 10:14 p.m. local (Hawai'i standard) time June 30 and landed on Shipwreck Beach about 21 hours later, at 7:23 p.m. July 1. The track in yellow on the right is from a drifter with the drogue at 1-m depth; it was released at 10:11 p.m. July 2 and retrieved about 39 hours later, at 1:20 p.m. July 4. To view an animation of the drifter deployments on all 4 days of the experiment, go to URL ***http://walrus.wr.usgs.gov/infobank/a/a403hw/html/drifter.mpg.***

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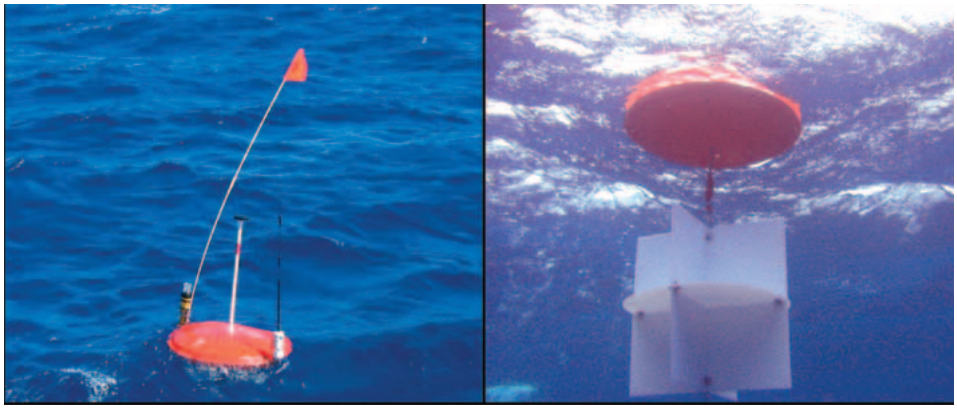
August 2003 issue of *Sound Waves*.) The goal was to determine whether the areas of poor growth are simply not getting enough new coral-larvae recruits because of local coastal-circulation effects. The experiment studied the spawning of the reef-building coral *Montipora capitata*, locally known as "rice coral," because its unique reproduction cycle makes it particularly suitable for study and it is one of the primary reef-building corals in the region.

Montipora capitata in Hawai'i reproduce each summer by synchronizing their production of eggs and sperm shortly after the new moon during spring tides. Bundles of eggs and sperm are simultaneously released into the water by millions of individual coral organisms just after sunset for approximately half an hour. The bundles rise to the surface, break apart, and then rely on chance encounters with the eggs and sperm from other bundles for fertilization. Once fertilized, most of the eggs settle to the bottom, generally within 2 to 4 days, and attach to hard substrate to begin the creation of a new coral colony.

To track the water containing the *Montipora capitata* sperm and eggs as it moved during several days from its origin above a healthy reef, a system of current drifters with an integrated real-time tracking system was developed by the USGS. The system is capable of continuously tracking multiple drifters, each following individual water masses at particular depths over a wide area.

The drifter's outer shell was designed to minimize its height above the water (or "sail area") and was attached either directly or by cable to a subsurface fin arrangement, called a drogue, that towed the drifter along with the water in which it floated, with little effect from surface winds. The entire drifter assembly weighed approximately 30 lb (13.5 kg) and was manageable by hand from a small boat.

To continuously monitor the track of the drifters with sufficient resolution anywhere within the Pailolo and Auau Channels, each drifter was outfitted with a global positioning system (GPS), a 900-MHz spread-spectrum data radio, and a microcontroller circuit created specifically for the project. The GPS was WAAS capable (WAAS, or Wide Area Augmentation System, is a system of satellites and ground stations that provide GPS signal corrections and improve position accuracy), and it reported positions with an accuracy of 4 m or better. Using the data radios, the drifters could communicate directly with the base station or, when farther offshore, by radio repeaters deployed on both Lanai and Molokai. The microcontroller removed redundant information supplied by the GPS, added an ID unique to each drifter, and controlled system timing to eliminate the possibility that two or more drifters would transmit simultaneously.



View of a drifter from above (left) and from below (right). Photograph on right shows the underwater fin assembly or "drogue." Photographs courtesy of ***Brian McLaughlin*** *(University of California, Santa Cruz) and* ***Mike Field*** *(USGS).*

At the base station, a laptop computer was configured to receive the drifter data over the radio network and graphically display the drifters' progress. The real-time display was necessary to dispatch a recovery team in the event that a drifter landed on shore or appeared to be heading out of the study area or out of radio range. For the display, a commercial geographic-information-system (GIS) package was modified to enable it to automatically update icons representing the drifters on the interactive map. A "trail of bread crumbs" was displayed for each drifter to facilitate tracking and forecasting the progress of the drifters.

The drifters were successfully deployed on all four nights of the experiment and indicated that the water containing coral larvae did, indeed, reach the areas of reef off West Maui showing decline. Thus, the cause of their poor condition must be looked for elsewhere. Additionally, the feasibility of interisland "larval seeding" was demonstrated when three of the drifters made the channel crossing from Maui to the north Lanai reef flat within the timeframe that the larvae are still viable and in the water column. The three drifters landed within 2 mi of one another on what is called "Shipwreck Beach." This evidence that viable larvae can drift from island to island confirms the concept that Hawaiian reef systems are an interconnected ecosystem—what happens to the reef on one island may have unanticipated effects on the reefs of neighboring islands.

The drifters and tracking system provided us with an extremely valuable new capability that enabled us to gain insight into the transport of coral larvae spawned off West Maui, Hawai'i. Building on the experience gained through this experiment, we will be able to further improve the system and provide the USGS with an even better system to track the dispersal and fate not only of larvae but also of other substances transported in the water column, such as sediment, nutrients, or contaminants.

The drifter design team consisted of **Tom Reiss** (Menlo Park, CA), responsible for the mechanical engineering, and **Gerry Hatcher** (Santa Cruz, CA), responsible for the electrical and software engineering. The USGS drifter-experiment chief scientist was **Mike Field** (Santa Cruz, CA). **Curt Storlazzi** (Santa Cruz, CA) was lead oceanographer. **Joshua Logan** (Santa Cruz, CA) was drifter technician. ❁

Quantifying Suspended Sediment in Hawaiian Waters With Digital Aerial Imaging

By Susan Cochran-Marquez

Every day, the calm clear waters along the south coast of the Hawaiian Island of Moloka'i undergo a dramatic change. As waves caused by the daily trade winds build and the tide rises, muddy sediment on the reef flat becomes resuspended, creating a belt of red-brown water and reducing visibility to a few inches. The muddiest water is nearest the shoreline and gradually dissipates farther offshore toward the reef crest. During calmer overnight conditions, the suspended sediment settles back onto the reef flat until the cycle is repeated the following day. In an effort to quantify the amount of sediment involved in this daily resuspension, scientists from the U.S. Geological Survey (USGS) conducted an experiment in July, using a new digital airborne imaging system and concurrent water sampling. This experiment was part of a large-scale USGS effort to better understand the effect of geologic processes on coral-reef systems in the United States and its trust territories, an effort that includes ongoing coral-reef studies in Moloka'i (for example, see articles in May 1999, March 2000, and April 2002 *Sound Waves*) and a recent coastal-circulation experiment off West Maui (see articles in August 2003 *Sound Waves* and this issue).

The digital airborne imaging system used in July's experiment includes a Duncan Tech MS3100 camera system mounted on the bottom of a helicopter. The imaging system was designed and assembled by **Pat Chavez**, **Dave Tucker**, and **Rian Bogle** (USGS, Flagstaff, AZ). The system has three spectral bands (10 bits per band), with one band selected to optimize clear-water penetration. It also has individual band gain control, which is quite useful when imaging low-radiance features, such as water. Images were collected three times throughout the day along the south coast of Moloka'i: early morning (calm), late morning (medium resuspension), and afternoon (highest resuspension). Between these flights, images were also collected over vegetated sites on land for use in soil-erosion studies.

***Greg Piniak** (left) and **Bryan Bailey** use a kayak to reach the clearer waters offshore during their sampling run.*

***Connie Hoong** uses a Niskin bottle to collect a water sample in muddy nearshore waters.*

During the coastal-water overflights, ground-based teams collected water samples with Niskin bottles from both clear and muddy water. The ground-based teams led by **Susan Cochran-Marquez** included **Greg Piniak** and **Eric Thompson** (USGS, Santa Cruz, CA), **Becky Stamski** (University of California, Santa Cruz), **Henry Wolter** and **Connie Hoong** (USGS Water Resources Discipline [WRD], Honolulu, HI), **Eric Wong** (USGS WRD, Maui, HI), and **Bryan Bailey** (USGS Earth Resources Observation Systems [EROS] Data Center, Sioux Falls, SD). Extra assistance was provided by our friends **Tina Lau**, **Scott Atkinson**, **Kathy Tachibana**, and **Niles "Kawehi" Soares** from the Nature Conservancy of Moloka'i. The water samples were analyzed for suspended-sediment concentration, which will be used to calibrate the digital images. This information will be used to calculate the total amount of resuspended sediment on the reef flat during the three overflights.

The Duncan Tech MS3100 camera system is mounted beneath a helicopter, using an industry-standard Tyler mount.

The new digital airborne imaging system has also been used to quantify sediment in the Colorado River through the Grand Canyon, to help map the benthic habitat of the Colorado River, and to image burned areas from wildfires in the Southwestern United States. It will also be used in September on east Maui to image streams to help with fish-habitat mapping, and next spring to image and monitor dust storms in the Mojave Desert.

Testing High-Resolution Profiling Instruments for Studying Sediment Movement Near the Sea Floor

By Marinna Martini

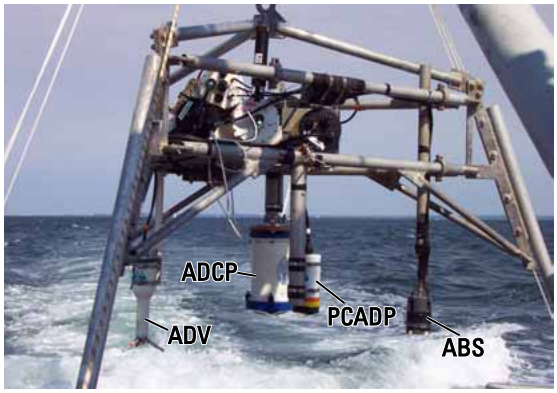
U.S. Geological Survey (USGS) scientists **Chris Sherwood**, **Jon Borden**, **Joanne Ferreira**, **Jessie Lacy**, **Steve Ruane**, **Marinna Martini**, and **Amit Bohara** have had fun in the sun with acoustic instrumentation this summer. First at the dock in Woods Hole, MA, then at the Woods Hole Oceanographic Institution (WHOI)'s Coastal Observatory off Martha Vineyard, the gang tested several acoustic-profiling systems that marine geologists use to study sediment transport at and near the sea floor. Deployed were the following:

- a Sontek Acoustic Doppler Velocimeter (ADV), which uses sound waves and the Doppler effect to make very accurate, high-frequency measurements of water velocity at a single point above the sea floor;
- a Sontek Pulse Coherent Acoustic Doppler Profiler (PCADP), which uses sound waves and the Doppler effect to measure water velocity at numerous points above the sea floor, to obtain a vertical profile showing how water velocities vary with height above the bottom;
- an RD Instruments' Acoustic Doppler Current Profiler (ADCP) in a pulse-coherent mode, which also uses sound waves and the Doppler effect to measure water velocity at numerous points above the sea floor; and
- an Aquatec Aquascat Acoustic Backscatter Sensor (ABS), which uses sound waves to measure vertical profiles of suspended-sediment concentration.

We deployed the instruments at WHOI's Coastal Observatory, mounted on a bottom-tripod frame borrowed from **Peter Traykovski** at WHOI. The test is part of an ongoing, joint effort between WHOI and the USGS to characterize errors in these instruments and develop calibration techniques.

Amit is a Summer Student Fellow in Oceanography at WHOI working with **Chris Sherwood** this summer on the calibration of the ABS. **Amit** is a student at Gustavus Adolphus College in Minnesota and is originally from Nepal. The USGS' Woods Hole Field Center is designing a new low-flow-disturbance tripod frame, similar to the one shown, for near-bed high-resolution profiling.

Testing the PCADP and ADCP off the dock to determine the best setup. ***Steve Ruane*** *is in the background.*



Transporting the tripod on the research vessel Asterias. *Sensor heads of the four tested instruments (labeled) extend below the tripod's superstructure.*

USGS Scientist Addresses the Gulf of Mexico Fishery Management Council

By Gene Shinn

On July 17, U.S. Geological Survey (USGS) scientist **Bob Halley** (St. Petersburg, FL) made an invited presentation before the Gulf of Mexico Fishery Management Council in Naples, FL. The presentation was based on ongoing research at Pulley Ridge, a deep (60-80 m) reef in the Gulf of Mexico off the west coast of Florida. The ridge is named after the late **Dr. T.E. Pulley**, malacologist and founder and long-time director of the Houston Museum of Natural Science. A recent expedition to Pulley Ridge was described in the July 2003 issue of *Sound Waves*.

The Gulf of Mexico Fishery Management Council is composed of representatives from various fishery associations and State and Federal agencies. It is one of three fishery councils in the Eastern United States whose missions include evaluation of marine-fishery issues, determination of sustainability and optimum yields for various fisheries, and balancing environmental and economic interests—not an easy task because many of the issues, such as shrimp-fishery bycatch, are highly contentious and involve millions of dollars in revenues.

As part of its charter, the council takes testimony from individuals and organizations and makes recommendations for closed seasons, size of fish harvests, and legal limits, and it recommends areas for protective status. Such activities usu-

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ally require several months to years of deliberation to reach a consensus. What happened on the day of **Bob Halley's** talk was unprecedented: the council came to a decision within 2 hours of his presentation, voting unanimously to designate Pulley Ridge a Habitat of Particular Concern (HAPC). This designation is the first step toward sanctuary or no-take status. That the council took action so quickly can be attributed to **Bob's** clear style of presentation, the quality of his information, and his lack of an agenda other than good science.

The ongoing Pulley Ridge study is based on multibeam mapping, high-resolution seismic profiling, dredging, ROV and submersible surveys, and a combined grab sampler and underwater camera system called SeaBOSS. The study has revealed an abundance of platy corals growing on a drowned barrier island, and an abundance of reef fishes. Pulley Ridge is one of the deepest coral reefs with hermatypic corals (corals with symbiotic algae called zooxanthellae) yet to be described. The study began jointly with University of South Florida (USF) faculty members **Al Hine**, **Stan Locker**, **Bret Jarrett**, and **Brian Donahue** and includes USGS scientists **Dave Twichell** and **Dann Blackwood** from the Woods Hole, MA, office and USF graduate students **Kate Ciembronowicz**, **Beau Suthard**, **Steve Obrochta**, and **Monica Wolfson**. There have been four cruises to Pulley Ridge, two with the NOAA-sponsored Sustainable Seas Program, one sponsored by USF, and the most recent one cosponsored by the USGS Coastal and Marine Geology Program and the University of South Florida.❁

Helping Local Organizations Enhance Spadefoot Toad Terrain in Orange County, California

By T'Shaka Touré

Local organizations have joined forces to restore and enhance wildlife communities in open-space park reserves on and near the coast in Orange County, CA. Among the beneficiaries of their efforts is the Western spadefoot toad (*Spea hammondii)*, a locally rare species in Orange County, where its natural habitat, which includes coastal plains, grasslands, and coastal sage scrub, has become threatened.

Life in a rut—a rain-filled rut, that is—can be highly productive for breeding Western spadefoot toads, and the efforts of members of several organizations, plus local volunteers, docents, naturalists, park rangers, and school children, are helping ensure that at least some Western spadefoot toads have plenty of suitable locations in which to breed. Restoring habitat for these toads can be as simple as using a global-positioning-system (GPS) unit and putting a spade to the earth.

As an ecologist for the U.S. Geological Survey (USGS), I have worked since 2001 in a pilot program at Laguna Coast Wilderness Park at Laguna Beach designed to educate, provide guidance, and demonstrate inexpensive ways to prevent continued loss of breeding populations and habitats of the Western spadefoot toad. The groups involved in this effort are the Laguna Canyon Foundation; Laguna Greenbelt, Inc.; the Nature Conservancy of Orange County; and Harbors, Beaches, and Parks, a division of Orange County's Public Facilities and Resources Department.

Now, just 2 years after the start of the pilot program, participants are creating small breeding pools for the toads throughout Laguna Coast Wilderness Park. Meeting volunteers 1 day each month at the park during the toad's breeding season, I help the group identify spadefoot-toad breeding sites and record their locations on a GPS unit. Then I demonstrate how to use a spade to modify the sites to restore natural habitat features conducive to the toad's reproductive success. Digging occurs in areas where road depressions already exist. The depth and length of the pools vary, depending on the roadside location. In most instances, the dugout depression is approximately 25 to 30 cm deep. Because of its roadside location, the depression has a narrow shape, approximately 0.5 to 1.0 m wide and 1.5 to 4.5 m long. Regular participants at these meetings include **Barbara Norton**, park ranger at Laguna Coast Wilderness Park; **Scott Thomas**, landscape architect for Orange County; and **Harry Huggins**, of Laguna Greenbelt, Inc.

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Photos at right: Road ruts filled with rain runoff are breeding pools for Western spadefoot toads at Laguna Coast Wilderness Park. Shallow depressions that are located near the road edge can be deepened for toad habitat in a way that still allows vehicle passage. All the vernal pools shown here have been enhanced.

(Spadefoot Toad Terrain continued from page 6)

Spadefoot toads are known for the wedge-shaped spade on their hind feet used to dig small burrows to escape heat and arid conditions. Western spadefoot toads breed early, during winter and spring (January through May). Brief episodes of rainfall set in motion their rapid reproductive cycle in shallow depressions that are temporarily filled with rainwater, which are referred to as vernal pools. A choice breeding pool may even be a rain-filled road rut.

Before working in the Pacific Southwest, I conducted inventory and monitoring surveys of amphibian communities on U.S. Department of Defense installations in Fort Belvoir, VA. During those surveys, I saw that some of the best temporary pools for breeding amphibians occurred in road ruts formed by military vehicles traveling over the terrain. When I began conducting monitoring surveys on amphibians and reptiles in southern California as part of the multiagency Natural Communities Conservation Plan/Habitat Conservation Plan (NCCP/HCP), I took GPS coordinates of road-rut locations. Later, during rainy periods, I returned to the road ruts to survey for amphibian activity. The rain-filled road ruts contained Western spadefoot toad tadpoles, which were in most of the road ruts in Laguna Coast Wilderness Park, as well as in road ruts at the adjacent Crystal Cove State Park.

To my surprise, upon my second return to these locations to monitor the tadpoles, I discovered that these vernal pools had been drained. The inadvertent drainage of these temporary breeding sites alerted me to the need to educate reserve managers on the life cycle of this and other amphibians and led to the pilot education program at Laguna Coast Wilderness Park.

Education efforts at Laguna Coast Wilderness Park gave rise to the Spadefoot Toad Enhancement Project sponsored by the Irvine Ranch Land Reserve. The enhancement project now includes the Laguna Coast Wilderness Park, Crystal Cove State Park, Irvine Regional Park, Fremont Canyon Wilderness Area, Limestone Canyon Wilderness Area, Peters Canyon Regional Park, Weir Canyon Wilderness Area, and additional lands managed by the Irvine Ranch Land Reserve.

This tadpole has nearly completed the transformation (metamorphosis) to its terrestrial life stage. The development from egg to metamorphosis can take place over a 28- to 32-day period!

These ongoing efforts have begun to aid in increasing the breeding populations of the Western spadefoot toad in the region.

Additional information about the Western spadefoot toad, and other amphibians and reptiles that occur in coastal southern California, is available at URL **http://www.werc.usgs.gov/fieldguide/**.

On Nov. 12, 2003, from 7:00 to 8:30 p.m., **T'Shaka Touré** will give a public lecture at the Natural History Museum of Orange County, on "Amphibians and Vernal Pools in the County of Orange."

ESRI International User Conference 2003

The ESRI (Environmental Systems Research Institute) International User Conference was held in San Diego, CA, from July 7-11, 2003. This excellent conference offered lectures, technical workshops, and demonstrations of the latest techniques in geographic information systems (GIS), including several sessions emphasizing marine science. Attendees at the conference were left with a vivid impression of the U.S. Geological Survey (USGS) as a leader in science and a generous host of large geospatial data sets. In fact, the USGS presence was positively felt at the ESRI conference, where USGS participants won awards in several categories. In addition, the USGS information booths and "Earth as Art" exhibit were well received and gained attention from USGS peers and other attendees. At the closing plenary session's question-and-answer period, it became evident that the role of the USGS is unquestionably relevant to providing sound viable solutions to problems that affect land and people. For more information about the conference, please go to URL **http://www.esri.com/events/uc/**.

Among the attendees at ESRI's International User Conference 2003 were (left to right) ***Dawn J. Wright*** *(Oregon State University),* ***Glynn F. Williams*** *(USGS, Woods Hole, MA), and* ***Florence L. Wong*** *(USGS, Menlo Park, CA).*

(Recently Published continued from page 8)

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