number of hubs and their funding levels are less than he had aimed for.

Some lawmakers have been critical of another DOE effort to speed new energy technologies into the marketplace by having the government guarantee the repayment of private loans to companies. When several firms heavily backed by DOE went bankrupt—most notably a solar panel maker named Solyndra—Republicans in Congress accused Chu of having wasted public money by trying to pick "winners and losers." His defense of the program was seen as weak, even by some allies.

Some members of Congress have also complained about the administration's decision to kill the long-planned Yucca Mountain repository in Nevada for nuclear waste from commercial reactors. Critics of the 2010 decision—including governors who fear their states will now be asked to take the waste—have sued to overturn the decision. But Chu has steadfastly said there is no going back, and last month DOE released a plan that calls for creating two temporary storage sites by 2025 and a permanent facility by 2048.

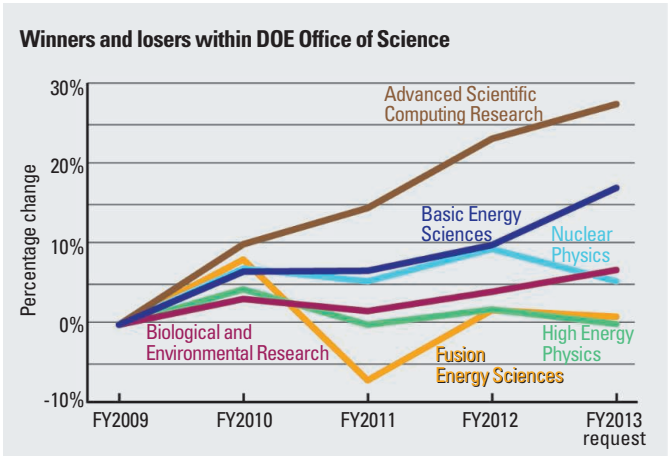
In his letter, Chu claims to have made "historic progress" on another waste issue—cleaning up the contamination created by decades of nuclear weapons manufacture. He also notes that he's taken a hands-on role with a DOE-created expert panel in trying to resolve problems surrounding a controversial, $12 billion plan to immobilize weapons waste at DOE's Hanford nuclear site in Washington state, "typically devoting 5-10 hours a week that include nights and weekends."

But Chu acted only after whistleblowers attracted the attention of reporters and members of Congress, says Tom Carpenter, director of the Hanford Challenge, a local citizen's group. "And he did so by forming a secret panel of scientists that operated behind closed doors." At the same time, Carpenter and other environmentalists give Chu kudos for his efforts to defend climate change science and his hands-on approach to finding a fix for the 2010 *Deepwater Horizon* oil spill in the Gulf of Mexico.

In his letter of resignation, Chu wrote that "I would like to return to an academic life of teaching and research." It is unlikely it will be as tumultuous as his tenure in Washington.

–ADRIAN CHO AND DAVID MALAKOFF

With reporting by Robert F. Service.



Growth curves. Energy-related research and computing flourished during Chu's tenure, while fusion, nuclear, and high-energy physics stagnated.

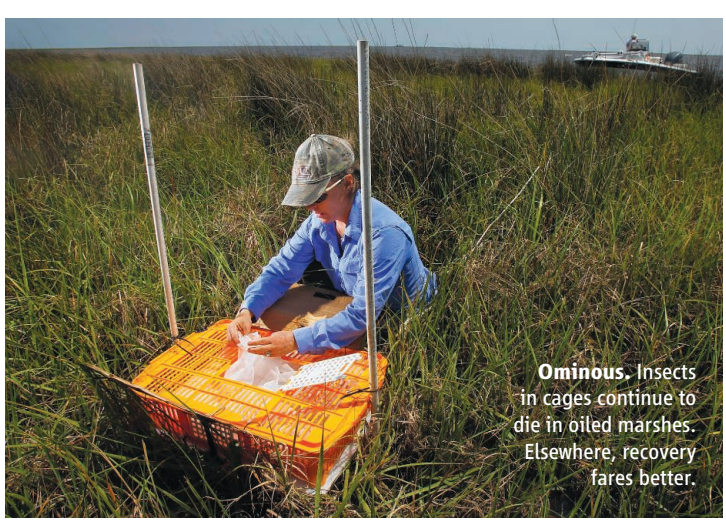
GULF OIL SPILL

BP Research Dollars Yield Signs of Cautious Hope

NEW ORLEANS, LOUISIANA—Here's an unfamiliar group of victims hard hit by the 2010 *Deepwater Horizon* oil spill tragedy: insects and spiders. When the scope of the Gulf of Mexico blowout became clear, ecologist Linda Hooper-Bui of Louisiana State University (LSU) in Baton Rouge and her graduate student Xuan Chen raced to add sites to their study of coastal wetlands. Kick-started by a rapid grant from the National Science Foundation, they discovered that insects and spiders were few and far between in the oiled marshes. "I would call it devastation," Hooper-Bui says. The experiments have also shown—to her surprise—that insects continued to die in unusually high numbers even a year later, perhaps due to vapors from the oil.

That unexpected toll was just one of the new results described at an unusual interdisciplinary conference held here late last month. The event was the first public meeting of Gulf of Mexico Research Initiative (GOMRI), a nonprofit organization that is disbursing $500 million donated by oil giant BP to scientists over 10 years. The peer-reviewed grants cover a broad range of areas, such as the modeling of ocean currents, the chemistry of oil dispersants, and the biological impact of petroleum. "GOMRI money is stimulating a huge pool of scientists to study oil spills in the Gulf," says geochemist Christopher Reddy of the Woods Hole Oceanographic Institution (WHOI) in Massachusetts.

Many of the researchers got their grants from GOMRI just a year ago, so results were often preliminary. But, in general, the findings sketched a picture of ecosystems beginning to recover from one of the world's largest marine releases of hydrocarbons. "The scars are diminishing," says Charles "Chuck" Wilson, GOMRI's chief scientific officer. In large part, he explains, that is thanks to microbes that evolved in the Gulf to break down the oil and gas that emerge from natural seeps in the gulf; they feasted when the broken wellhead spewed almost 5 million barrels of crude and untold amounts of methane into the sea. But scientists emphasized that much remains to be learned. It's still unclear, for instance, "what the long term impacts of the oil in the deep-water Gulf will be,"



Ominous. Insects in cages continue to die in oiled marshes. Elsewhere, recovery fares better.

GRAPH SOURCE: DOE; PHOTO CREDIT: TED JACKSON/*THE TIMES-PICAYUNE*/LANDOV

Published by AAAS

notes Scott Eustis of the nonprofit Gulf Restoration Network in New Orleans.

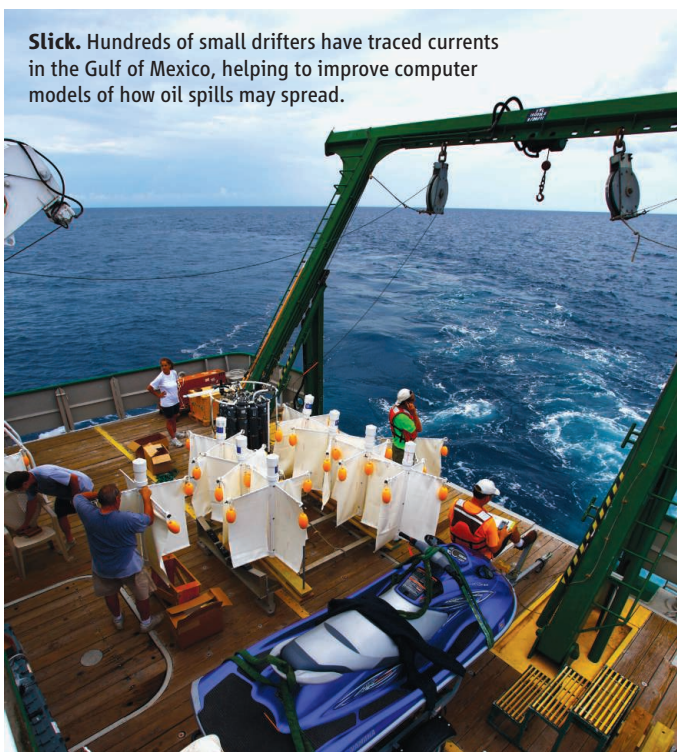
A major emphasis is figuring out the details of where the oil went—a full one-quarter of the estimated release is still unaccounted for—where it remains, and the toxicity of these residues. LSU ecologist Eugene Turner reported that sediments in coastal marshes still contain 1000 times the background level of aromatic hydrocarbons, although levels are decreasing very slowly. "There is a lot still out there," he says.

One hope is that new instruments will reveal previously undetected components of weathered oil. Several presentations discussed the use of a relatively new technique called Fourier transform ion cyclotron resonance mass spectrometry. Christoph Aeppli, a postdoc at WHOI, used it to identify so-called recalcitrant oxygenated hydrocarbons in tarballs collected from beaches. Traditional methods would have missed more than one-half of the compounds, says Reddy, who predicts that, "with time, you are going to see the field of oil spill science be completely changed" by such methods.

More oil is probably contained in a chocolate-brown layer on the seafloor. This fluffy gunk can be several centimeters thick and might have been deposited in what some researchers call a "dirty blizzard" of marine snow (dead microorganisms or plankton that accrete into large globs and sink). In recent lab experiments, a team led by biological oceanographer Uta Passow of the University of California, Santa Barbara, showed that, in the presence of oil, bacteria can create this snow solely with their own secretions and without larger particles from other organisms. "This is a totally new mechanism," she said at the meeting.

Although some corals were coated with the oily snow, the broader impact on seafloor organisms isn't clear. But if the blizzard was composed of bacteria that were feeding on hydrocarbons from the blowout, the sticky microbes could have helped clean the water column of oil droplets and fine sediment as they sank. Passow's experiments also showed that low concentrations of the oil dispersant Corexit—which was used to break up the spill—inhibited bacterial formation of marine snow. "That's huge," says biogeochemist Samantha Joye of the University of Georgia in Athens, because it means the dispersant may have made things worse by impeding the Gulf microbes' natural ability to break down oil. Passow, who hadn't studied oil spills before 2010, says: "I was really shocked about how little we know about oil in the system."

To help create more effective dispersants, GOMRI is funding other projects to better understand how they work at a molecular level. Courtney Ober, a Ph.D. student in chemical engineering at Auburn University in Alabama described research on developing "smart" particles of dispersant coated with water-insoluble polystyrene that dissolves in oil. Such a formulation might reduce the amounts of dispersants needed to break up a spill and reduce the chemicals' impacts on organisms.



Slick. Hundreds of small drifters have traced currents in the Gulf of Mexico, helping to improve computer models of how oil spills may spread.

CREDIT: TAMAY ÖZGÖKMEN/UNIVERSITY OF MIAMI

Other GOMRI researchers want to be able to do a better job of predicting where currents will push oil slicks. During the Gulf spill, responders lacked good data on currents and so had trouble figuring out where best to locate booms to prevent oil from reaching marshes and beaches. To improve computer models, a project called the Consortium for Advanced Research on Transport of Hydrocarbon in the Environment, directed by the University of Miami's Tamay Özgökmen, designed inexpensive GPS-enabled drifters to track so-called submesocale currents, on the scale of 100 meters to 10 kilometers. Last August, researchers released a dense array of 317 drifters, the most ever released in a single deployment, and gathered months of data.

Another big concern is the spill's long-term impact on wildlife and the ecosystems. Much of this research is being done to inform the federal government's effort to put a price tag on the damage caused by the spill, and it will remain confidential until a settlement or judgment is reached with BP and the other companies responsible for the spill. "Until the data are released, we're only seeing a bit of the elephant," says Edward Overton of LSU. "The amount of knowledge is going to explode."

Meanwhile, researchers are getting pieces of the picture from studies such as Hooper-Bui's look at wetland insects and surveys of various marine communities. Geochemicst Isabel Romero of the University of South Florida (USF), St. Petersburg reported that total levels of polycyclic aromatic hydrocarbons in deeper-water fishes, such hatchetfish, increased 10-fold from 2007 to 2011. The levels continued to rise in 2011 and haven't declined yet. "There is still oil in the system and it is still affecting the fish," she says.

A brighter note came from Steven Murawski of USF St. Petersburg who reported that skin ulcers and lesions declined significantly in shallower-water fish in the northern Gulf of Mexico in 2012. But it has been difficult to sort out how the spill may have affected overall fish populations. One major confounding factor is that officials closed many commercial fisheries during the spill—perhaps helping stressed populations to rebound. A study of blue crab numbers, for example, found no decline in 2010 and a big increase in 2011. That "really surprised" study leader Joseph Neigel, a population geneticist at the University of Louisiana, Lafayette. Survey data showed similar increases for six species of fish and a decrease for just one. "It's hard to draw a lot of firm conclusions, because marine populations are notoriously stochastic," he says.

Researchers have 8 more years of GOMRI funding to help answer questions, along with other, longer-term payouts related the spill that BP and other firms are making to the U.S. National Academies and other groups (*Science*, 30 November 2012, p. 1137). "It was a terrible accident," says Margaret Leinen of Florida Atlantic University. But it has provided "a once in a lifetime opportunity to look at the Gulf." **–ERIK STOKSTAD**

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