or just a drop in the bucket?

Texas scientists on the real effects of the Deepwater Horizon oil spill

What if gasoline pumped into cars, seafood eaten at restaurants, and waste thrown away or flushed all eventually called the same place home?

Welcome to the Gulf of Mexico.

Dr. Larry McKinney, executive director of the Harte Research Institute (HRI) for Gulf of Mexico Studies at Texas A&M University–Corpus Christi, likes to say that the Gulf of Mexico is "America's gas station, sushi bar, and waste disposal."

McKinney and his colleagues sometimes call the Gulf "the Forgotten Coast," but on Earth Day 2010—April 22—it was anything but forgotten as the wreckage of the *Deepwater Horizon MC252* drilling platform sank into its waters.

A crude awakening

Like any large oil spill, this one took its toll in many ways. Eleven BP employees on the rig died in the explosion that caused the leak. Thousands of barrels of oil leaked from the well each day until it was capped on July 15, 2010. The National Oceanic and Atmospheric Administration's (NOAA) final total estimate, contested by BP for being too high, was 4.9 million barrels or 205.8 million gallons.

Wildlife were harmed by both the smothering capacity of the oil and its toxicity. As of early November, NOAA Natural Resource Damage Assessment response teams had documented 2,263 visibly oiled dead birds, 2,079 visibly oiled live birds, 18 visibly oiled dead sea turtles, and 456 visibly oiled live sea turtles.

A major concern after the spill was the possibility of the oil seeping into Louisiana's wetlands. About half of the wetlands in the United States are in Louisiana, according to McKinney, who added that the heart of wetland areas was not impacted by the oil, but some impacts to wetlands are yet to be seen.

"People were really worried about keeping the oil out of the marshes in Louisiana and Mississippi," said Dr. Piers Chapman, professor and head of the Department of Oceanography at Texas A&M University. "The edges of the marshes served as a barrier, and luckily no hurricanes pushed the oil deep into those wetlands."

At a public lecture at Texas A&M, McKinney predicted that Gulf beaches, shrimp, and crabs would be fully recovered within one to two years, but oysters would take longer to recover. McKinney was particularly concerned about bluefin tuna populations, as the spill occurred during their spawning season.

Cleaning up the spill presented more complexities. The type of oil spilled and the particulars of the Gulf's ecosystem are important to consider, Chapman said during an October community conversation event at Texas A&M. "This was very light crude, and the spill occurred during summer in the Gulf, so much of it evaporated," he said.

This type of oil also contained large amounts of methane, creating huge plumes, McKinney said.

Skimming the oil, using dispersants, and using bioremediation are all artificial processes for breaking down oil. Natural processes, such as photo-oxidation, physical breakdown from waves, and biodegradation by bacteria, also exist to break down oil. Approved by the U.S. Environmental Protection Agency (EPA), 1.84 million gallons of chemical dispersants were used to break up the oil, and more than 40,000 personnel were involved in the extensive cleanup, Chapman said.

"More dispersants were used in this spill than any other in history," said McKinney, who in a previous position oversaw the State of Texas' oil spill response for 20 years.

"EPA has an elaborate system for evaluating dispersants and consciously used huge amounts of dispersants for this spill," McKinney said. "I think that open ocean systems have taken a hit because of the use of these dispersants."

The Gulf is tough, but sensitive

"Humans have been extracting oil from the Gulf for 50 years or so, but bacteria have been chewing up oil for millions of years," Chapman said, referring to the 2 million barrels of oil that naturally seep from the Gulf's floor every year. The ecosystem there has adapted to it.

Naturally occurring microbes thrive on those small amounts of crude, and acres of deep coral forests live off of the seeps, McKinney said. However, massive amounts of oil released in a short amount of time, such as the *Deepwater Horizon* spill, are very dissimilar from the smaller natural seeps, as are organisms' reactions to them. When dispersants break up oil, the particles do not disappear but sink instead —becoming deceptively out of sight and out of mind, McKinney said.

And these oil particles can harm certain organisms, Chapman said.

"These tiny particles are bite-sized for the zooplankton (small floating organisms), which is a concern," said Chapman, who has tested oil spill dispersants for toxicity and effectiveness in the past.

One major effect of the spill was the huge economic loss in the Gulf fishing industry, McKinney said.

"The realization that you must have a healthy environment to have a healthy economy was made in spades by this spill," McKinney said.

"Public perception was that seafood from the Gulf was contaminated, though tests have not shown that," Chapman said. "Louisiana's economy loves fishing and oil, and you could argue that those are conflicting."

This spill could only cause irrevocable harm if it somehow acted as a sort of tipping point on natural habitat loss or on climate change in the Gulf, which is the most vulnerable region to climate change in the United States because it is basically a shallow, subtropical sea, McKinney said.

Researchers flock to the Gulf

"One good thing that resulted from the spill is that the Gulf of Mexico is finally getting some of the research attention it deserves," McKinney said at an October 2010 event honoring Texas A&M scientists involved with the spill research. "We have neglected much research for decades, but now it is finally happening, and with BP promising that it will spend $50 million a year for the next 10 years on Gulf research, we can do some very valuable work for years to come."

Much of this needed research is happening in Texas and within The Texas A&M University System.

Dr. John Kessler, assistant professor of oceanography at Texas A&M, was awarded a National Science Foundation (NSF) grant to examine methane gas in the spill, and also received additional funding from the U.S. Department of Energy and NOAA. His crew first visited the oil spill site June 11-21, 2010, aboard the research vessel *Cape Hatteras*, operated by Duke University and the University of North Carolina.

Kessler and his crew—including fellow scientists, students, and technicians from Texas A&M, the University of California at Santa Barbara, and NOAA—found plumes of highly concentrated methane from the disaster dissolved in the Gulf's deep waters. UC Santa Barbara's Dr. David Valentine and Kessler led the expedition. They found that three gases—ethane, propane, and butane—were responsible for most of the oxygen loss in the deep plumes.

In September, the team returned to the site to collect additional information about the impact of hydrocarbon gases in the water column, focusing specifically on the longer-term fate of methane.

"Dissolving these gases in the ocean is a bit of a double-edged sword," Kessler said to Texas A&M News & Information Services in September. "On the one hand, these gases influenced both the air quality and the radiative budget of the atmosphere, so trapping them within the ocean is a good thing. But their eventual marine biodegradation leads to the consumption of dissolved oxygen, which is an annual problem in the northern Gulf of Mexico."

Kessler's team also found that although methane gas was initially consumed by bacteria very slowly, the rate increased as other gases were depleted. They estimated that ultimately two-thirds of the bacterial productivity and respiration in the deep-water plumes will be linked to these gases.

Calling the results "extremeley surprising," in January 2011 the team announced that methane concentrations had returned to near normal levels because of consumption by bacteria.

Dr. Thomas Bianchi, another Texas A&M oceanography professor who has spent time studying the oil spill, had conducted research on Louisiana marshes for years. His oil spill work, funded by a NSF Division of Chemistry (Environmental Chemical Sciences) grant, also included scientists from Louisiana State University, Georgia Tech, and the Louisiana Universities Marine Consortium.

After returning to the marshes in September 2010, he said that areas he examined around Barataria Bay—east of the city of Houma—showed that river diversions helped keep oil out of marshes. However, Bianchi said, he did observe a change in the overall ecosystem as measured by a significant increase in dissolved organic carbon (DOC). He observed that oil was still present in some wetland areas, and it often gets caught by particles and settles in marshes' bases, where it can't be seen by the human eye, unlike oil floating in the ocean.

"One thing to point out is that some of these marshes have not rebounded, and they have, in part, been also impacted by the 'cleaning' approach used by some oil companies," Bianchi commented to Texas A&M News & Information Services in November. "They use high pressure water systems, which on rocks is fine, but not on plant material. So this has likely cut them [the plant material] back so short that changing water levels with tides and storms will make them more vulnerable in the upcoming months. The high DOC we are observing also was likely impacted by this 'washing' technique."

Another major player in research following the oil spill, Texas Tech's Institute of Environmental and Human Health (TIEHH) faculty members made multiple trips to the coast, collecting samples ⇨

to analyze impacts of the oil and dispersants on the area's wildlife and environment. In August 2010, Dr. Ron Kendall, director of TIEHH, testified before the U.S. Senate Committee on Environment and Public Works at the "Oversight Hearing on the Use of Oil Dispersants in the *Deepwater Horizon* Oil Spill."

"We have very limited information on the environmental fate and transport of the mixture of dispersant and oil, particularly in the deep ocean," Kendall said during the hearing. "We have very little information on the ecological effects of this particular oil and dispersant mixture in terms of acute, chronic, and indirect effects on marine and coastal organisms. And given the volume of oil and dispersant that have been released into the Gulf of Mexico, we have a very poor understanding of the ultimate ecosystem level effects which may occur in the weeks, to months, to years ahead."

Will anything change?

When considering the future of oil-spill technology, McKinney reflects on the past.

"I was there for the Ixtoc spill," McKinney said of the 1979 Ixtoc spill in the southern Gulf. "BP called a well-cap a 'top hat,' while at Ixtoc it was called a 'sombrero'—30 years later, most of the approaches we had for BP were the same ones we had for Ixtoc. There was very little learned from Ixtoc that was ready to apply to *Deepwater Horizon*."

The area mostly recovered from the Ixtoc spill in two to four years, but 30 years later, researchers are still finding inert Ixtoc oil in Mexican coral reefs, McKinney said.

"The Gulf is resilient and has tremendous natural variability, to which its organisms adapt," McKinney said. "Forty percent of the U.S. drains into it, providing a huge nutrient supply, which is a good thing in moderation. It is a high-energy ecosystem, with incredibly complex interconnectivity."

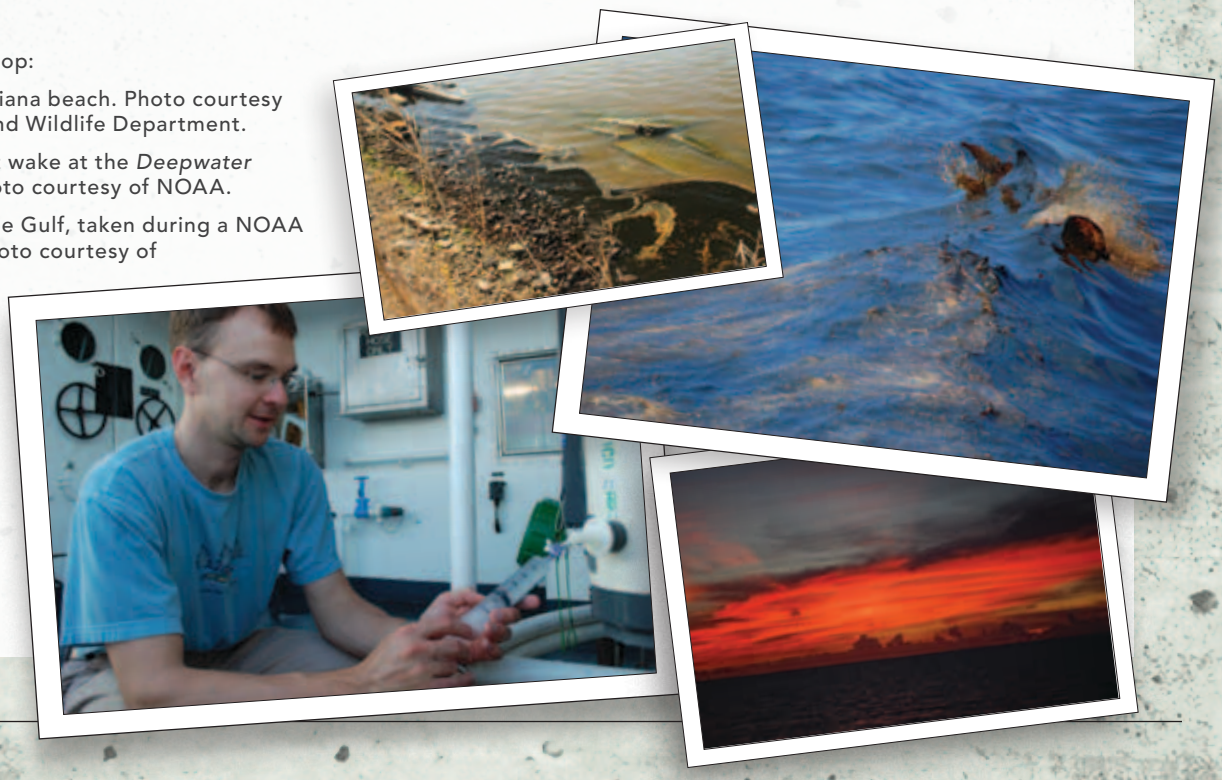
Though Texas largely did not feel the physical effects of the spill, Texas researchers' work related to the spill drew media attention nationally and internationally. Texas A&M researchers were featured in the *New York Times*, Discovery Channel, BBC, Fox News, and many others. Texas A&M's Department of Oceanography and Department of Petroleum Engineering, HRI, TAMU-Galveston, the Geochemical and Environmental Research Group, and the Texas Sea Grant College Program were all recognized in October 2010 with the university's Newsmaker Award for their faculties' and staffs' assistance in responding to media inquiries about the oil spill.

"The media tends to like answers right now about the long-term effects of the spill," McKinney said at the award event. He had helped HRI field more than 250 media inquiries. "But there are a lot of questions that will take months, if not years, to answer.

"We all have a stake in the Gulf of Mexico—if you use plastic, need gasoline, eat seafood, or enjoy fishing, you have a stake in it," McKinney said. "The Gulf is magnificent, hugely diverse, and hugely worth saving."

Please visit *twri.tamu.edu/txH2O* for a full listing of links and resources.

Note: Information from Texas A&M news releases was used in this story.



Clockwise from top:

1. An oiled Louisiana beach. Photo courtesy of Texas Parks and Wildlife Department.

2. Oil in the boat wake at the *Deepwater Horizon* site. Photo courtesy of NOAA.

3. Sunset over the Gulf, taken during a NOAA research trip. Photo courtesy of NOAA.

4. Kessler extracts a Gulf water sample from a CTD (conductivity, temperature, depth) device while aboard a NOAA research vessel. Photo courtesy of NOAA.