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Gulf's Complexity and Resilience Seen in Studies of Oil Spill

By LESLIE KAUFMAN

In the year since the wellhead beneath the Deepwater Horizon rig began spewing rust-colored crude into the northern Gulf of Mexico, scientists have been working frantically to figure out what environmental harm really came of the largest oil spill in American history.

What has emerged in studies so far is not a final tally of damage, but a new window on the complexities of the gulf, and the vulnerabilities and capacities of biological systems in the face of environmental insults.

There is no doubt that gulf water, wildlife and wetlands sustained injury when, beginning on April 20 last year, some 4.9 million barrels of oil and 1.84 million gallons of dispersants poured into the waters off Louisiana. But the ecosystem was not passive in the face of this assault. The gulf, which experiences a natural seepage of millions of gallons of oil a year, had the innate capacity to digest some of crude and the methane gas mixed with it. Almost as soon as the well was capped, the deep became cleaner to the eye. By the same token, dozens of miles of marsh still remain blackened by heavy oil, government crews are still grooming away tar balls that wash up ceaselessly on beaches and traces of the dispersants are still found floating in the currents.

Biologists are nervously monitoring as yet unexplained dolphin strandings this year, trying to come up with a realistic count of birds and mammals killed during the spill and working to understand what happens when the gulf floor is covered with the remains of oil-eating bacteria. "It is really kind of hard to get a grasp of the big picture, and it is not for a lack of trying," said Christopher Reddy, a senior scientist at the Woods Hole Oceanographic Institution who studies long-term consequences of oil spills. "Hundreds of scientists are working day and night trying to carve out a piece of that giant puzzle, but it is an entire region and it is complicated."

How the regional ecosystem has responded, its strengths and weaknesses, will keep scientists busy analyzing data for years and help them in understanding the effects of environmental disasters.

An Army in Hot Pursuit

After an oil spill, the government is responsible for toting up the ecological damages in something called a Natural Resource Damage Assessment. The document, which requires battalions of researchers, makes the case for damages that the companies responsible for the spill should pay to restore the ecosystem to its pre-spill health. The companies hire their own teams of assessors, who might paint a very different picture. The two sides settle or go to court.

At of the end of January, the government said its scientists alone had taken 35,000 images, walked more than 4,000 miles of shoreline and culled more than 40,000 samples of water, sediment and tissue.

The scientists are also testing how to estimate what they can't count precisely, like animal deaths. One group of evaluators is scattering bird carcasses offshore and measuring how many sink and how many wash ashore. Those numbers will be used to calculate how many birds may have died in addition to the ones that were found and counted.

For all this effort, it will take time for some of the consequences to manifest themselves. It was three years after the Exxon Valdez spill in Prince William Sound in Alaska, for example, that the herring fishery suddenly collapsed.

During the Deepwater Horizon disaster, as the slick was spreading, the federal Fish and Wildlife Service moved about 28,000 eggs from turtles' nests on at-risk beaches in Alabama to the coast of Florida. While 51 percent of the eggs hatched — roughly consistent with normal survival rates — it will be another two decades or so before the hatchlings that survive come back to Florida as adults to lay eggs. Only then will anyone know how successful the rescue effort really was.

Many of the results that have been gained so far, by government or private industry, are not yet public; they are awaiting rigorous review before eventual release. Moreover, in some key cases, scientists must keep their findings confidential because of continuing legal actions.

"We have a real responsibility to make sure that we come out of this process with as much compensation as is appropriate for the damages," said Bob Haddad, chief of the assessment and restoration division of the National Oceanic and Atmospheric Administration, which is taking the lead in coordinating the damage assessment. "I don't want to get tripped on issues like inadmissibility of evidence."

Oil and Water Do Mix

Still, there has been some independent scientific work done in the gulf, and it has produced some good news. Because the spill occurred at very high pressure a mile beneath the ocean's

surface, some of the oil was reduced to tiny droplets that remained suspended thousands of feet deep in a fine mist.

Terry C. Hazen, who leads the ecology department at Lawrence Berkeley National Laboratory, took 170 samples from around the Deepwater Horizon between July 27 and Aug. 26 last year, just weeks after the wellhead was capped.

Dr. Hazen was looking to track the fate of the underwater oil as it spread and instead found it to be entirely gone. "We can detect down to 2 parts per billion," he said, "but nothing was there."

His work was financed by a grant his lab won from BP, the owner of the well, long before the spill, and it was not in any way reviewed or influenced by the company, he said.

The results showed that the oil had not just been diluted with water but that it had largely been eaten by naturally occurring bacteria. Researchers worried early on that such bacteria might not exist thousands of feet down or that the process of digestion might be particularly slow because of colder temperatures at these depths. But Dr. Hazen's group found bacteria that specialized in oil eating in frigid temperatures.

Another byproduct of the spill was roughly 200,000 metric tons of methane gas. In June 2010 there was as much as 100,000 times as much methane dissolved gas in the gulf as normal. Scientists worried that it could remain dissolved in the water column, depleting oxygen levels, for years.

But by fall, researchers from the University of California, Santa Barbara, and Texas A&M took water samples from 207 sites near the spill and found that methane proportions were back to normal.

John Kessler, an oceanographer at Texas A&M, said: "It appeared that the methane would be present in the gulf for years to come. Instead, methane respiration rates increased to levels higher than have ever been recorded."

In other words, bacteria ate it. Other scientists, however, are not convinced. Samantha B. Joye, a professor of marine science at the University of Georgia, said her team found elevated methane levels at exactly the time Dr. Kessler's team did not.

Further, at a recent meeting of the American Association for the Advancement of Science, Dr. Joye said that the digestion of the oil and methane had not been entirely benign. Her team took sediment samples in a roughly 35-square-mile area at several different times, most recently in December, and found the muddy gulf floor covered with a blanket of dead bacteria, much of it oily and sticky. At every one of the sites she sampled, she said, bottom-dwelling invertebrates

— worms, starfish, even coral — were dead.

"These are keystone species to the ecosystem," she said, "and we don't know what will happen without them."

Her findings have been substantiated in part by Charles Fisher, a biologist at Pennsylvania State University, who has documented dead fan corals seven miles from the wellhead, probably killed by oil plumes in the deep sea, Dr. Fisher said. "Fan corals live for hundreds, perhaps hundreds of thousands of years," he said. "The odds that something beside the oil from the spill killed them are vanishingly small."

Dispersants in Diaspora

The fate of some 1.84 million gallons of dispersant poured into the gulf to get the oil to break into smaller pieces and thus degrade more quickly is less definitive than what happened to the oil and methane. Some 770,000 gallons were applied to the wellhead itself.

Dispersants have toxic elements, and at the time critics of the application saw it as a gigantic unregulated experiment.

The Environmental Protection Agency has now done extensive testing on the most commonly used dispersant, Corexit 9500, mixed with Louisiana crude and found it to be no more or less toxic to marine life than eight other alternative dispersants or than the oil alone. The E.P.A. administrator, Lisa P. Jackson, said that not only was the toxicity of the dispersants evaluated, so was their effectiveness. "The chemicals helped break up the oil," Ms. Jackson said in a recent interview. "It was the right decision to use them."

That doesn't mean the dispersants were harmless, however. Elizabeth Kujawinski, an associate scientist in chemistry at Woods Hole, was able to track dispersants using highly sensitive tests. Dr. Kujawinski found that while they have become diluted, they are "not entirely biodegraded or decomposed."

In other words, she said, they remain in the gulf, but in amounts that the government does not consider dangerous.

"Toxicity looks at acute exposure — huge concentration, and then you are done," she said. "But in case of the Deepwater Horizon it was low concentrations, but over a long period of time. We don't know about how this affects living creatures in the deep water that can't move, like corals."

Sudden Death

During the spill, the daily tallies of birds, turtles and sea mammals found dead or alive and covered in oil were heartbreaking. They were also just a beginning.

For every pelican or whale found beached or floating at sea, some much larger number died. After the Exxon Valdez accident, 30,000 birds were found, but 250,000 — eight times the number found — were eventually estimated to have been killed by the oil. Each situation is different, and scientists are trying to pin down the so-called death multipliers for this spill.

Looking at annual carcass recovery rates for 14 groups of cetaceans — the mammal group that includes whales and dolphins — a group of biologists from the University of British Columbia recently said that the multiplier for that group should be around 50. So although 115 cetaceans were found dead or stranded during the spill and in the months immediately after, they might represent 5,000 actual deaths.

Melanie Driscoll, director of bird conservation in the gulf for the National Audubon Society, said similar multipliers may need to be applied to 8,000 birds so far discovered by the government, especially in a category known as secretive marsh birds. “They already hide in dark grasses naturally, so they were certainly missed,” Ms. Driscoll said.

Some species may, however, have done better than it seemed at first. Jim Franks, a fisheries professor from the University of Southern Mississippi Gulf Coast, has been monitoring larvae of bluefin tuna. While he says oil did affect some of their spawning grounds, it spared some as well. Dr. Franks refuses to say what percentage of larvae might have been killed, but it certainly was not a total wipeout, as had been feared.

Plant life also suffered from the spill. Marshes in Bay Jimmy, south of New Orleans, were hit particularly hard and remain coated in heavy oil. Unknown amounts of pollution lay buried in the nearby sediments as well. Federal monitors are watching these areas now to see if new grasses come through the oiled ones this spring, or if it may be necessary to burn off some of the old, oiled growth.

And there are the deaths yet to come. In February 59 dolphins were founded stranded or dead on northern gulf beaches; 36 were premature or stillborn babies. That was nine times the average number that were found in the years 2002 through 2009. Dolphins began dying before the oil spill; 56 were stranded in March 2010. But the spike in neonatal dolphin deaths is new this year.

“Yes, their mothers were very likely in gestation during the spill,” said Blair Mase, a marine mammal stranding coordinator with the National Oceanic and Atmospheric Administration, “and exposure to petroleum in mammals can cause decreased success in keeping young.”

But, Ms. Mase said, there could be other causes. For example, the dolphins may be fighting a virus that appeared before the spill, but is more dangerous because the exposure to oil has weakened the dolphins' immune systems.

As with so many of the effects of the spill, said Ms. Mase "right now we cannot say for sure."