Overrun. Dunes in Cape May, New Jersey, are no match for Sandy's record storm surge, which reached 4.3 meters in some places.

U.S. HURRICANE

Scientists Assess Damage From Sandy's Deadly Punch

As superstorm Sandy surged ashore in New Jersey on the night of 29 October, coastal scientists watched their computer screens with wonder as a string of 28 specialized radars collected exquisitely detailed data on the churning waves and currents far offshore. It was an opportunity to study "a storm that might come just once in a career," says physical oceanographer Josh Kohut of the Institute of Marine and Coastal Sciences at Rutgers University, New Brunswick, in New Jersey.

But that opportunity didn't last long. Sandy's pummeling winds and record floodwaters began to snuff out the signals, and in just a few hours, 17 of the 5- to 7-meter-tall radar towers were silent. "Sandy ripped right through the heart of the network," says Rutgers oceanographer Scott Glenn, adding that only sand remains where some towers once stood. "We may have lost equipment worth millions of dollars."

Glenn isn't the only scientist picking up the pieces after a storm that swept across the U.S. Atlantic Coast, submerging communities, killing more than 100 people, and leaving tens of thousands without housing and millions without power. Sandy pounded other marine science installations and flooded biomedical research facilities, killing thousands of research rodents at one New York City laboratory. The storm also disrupted countless experiments and meetings, leaving scientists wondering when they will be able to get back to work.

At the same time, Sandy presented some researchers with unprecedented opportunities. U.S. government geologists scrambled in the days before the storm to measure beaches and shorelines along its expected path for data that would improve computer models that predict coastal flooding and erosion. Other researchers rushed to launch a robotic submarine off the New Jersey coast, providing a rare look at how Sandy reshuffled conditions beneath the ocean's surface.

The storm also created some scientific heroes. Researchers at Johns Hopkins University in Baltimore, Maryland, battled dire conditions to rescue hundreds of animals from a flooded basement. And a few laboratories not only weathered the storm, but have also been helping with the recovery efforts. Their equipment is providing satellite images to disaster officials, and their emergency generators have provided electricity and hot showers to residents in nearby communities. At Cold Spring Harbor Laboratory (CSHL) on Long Island, New York, researchers posted a sign summing up that can-do attitude: "Sandy versus Science … Science Wins."

Sandy left deeper scars elsewhere. The storm dealt an especially heavy blow to New York University's (NYU's) Langone Medical Center in New York City. A loss of power forced the hospital to transfer hundreds of patients to other hospitals. Stormwater poured into the Smilow Research Center, one of several animal research facilities at the university, knocking out backup generators. "[D]ue to the speed and force of the surge," efforts to rescue more than 10,000 laboratory mice and rats housed in basement facilities were "unsuccessful," the center said in a statement. The losses included dozens of rodent variants specially bred to study neurological and physiological diseases, NYU

officials said, representing "many years of important work conducted by our researchers."
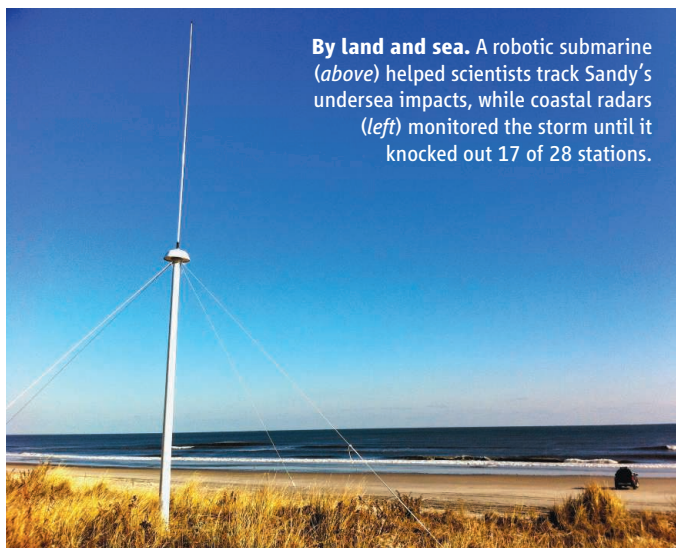
Other academic research centers quickly vowed to help NYU scientists rebuild their colonies. An online company called Science Exchange even offered to waive the fees it usually charges to arrange large-scale purchases of transgenic and other research mice. "We were obviously very upset to hear about all of the research that was lost," says Dan Knox, the company's co-founder.

Researchers at Johns Hopkins University School of Medicine in Baltimore narrowly avoided similar losses. After stormwater poured into a basement animal facility in the Koch Cancer Research Building, causing power to be turned off, "the dean and senior staff at the medical school formed a human chain, taking cages with laboratory mice to safety," says Johns Hopkins President Ronald Daniels. "It was quite an ordeal."

Sandy also hit hard at the U.S. National Oceanic and Atmospheric Administration's (NOAA's) James J. Howard Marine Sciences Laboratory in Fort Hancock, New Jersey, just north of the storm's landfall. "Word is that we are going to be closed for quite a while; there's 6 feet of sand in the road and the sewage system may be damaged," says NOAA ecologist John Manderson. Captive sea bass and flounder involved in ocean acidification studies died after generators failed, he adds. "That's a big setback."

At Cold Spring Harbor, which sits on the shore of Long Island Sound, laboratory officials were ready for Sandy. The lab had upgraded its emergency drill after Hurricane Gloria in 1985, and with Sandy approaching, staff members moved elevator cars up from basements and piled sandbags to shield against the incoming tide (which peaked at more than 2 meters above normal). With ample housing on the campus, some personnel stayed at the lab and were able to switch on eight diesel-powered generators after the power went down.

Although water seeped into one building and phone service was knocked out, staff members were able to ride out the storm. Over the next few days, they cleared away more than 100 downed trees and trucked a generator to a local gas station to fill up lab vehicles. Attracted by the lab's lights shining at night, residents queued up for meals and Internet access. (The U.S. Department of Energy's Princeton Plasma Physics Laboratory in New Jersey also offered hot showers to nearby residents.) After a 2-day delay, CSHL was even able to hold a meeting on nuclear cell receptors and disease; although some foreign scientists attended, a plenary speaker from nearby New York City couldn't make the trip.

At Rutgers, ocean researchers are upbeat despite the apparent loss of a big chunk of their high-frequency radar system. The network, which has operated since the late 1990s, stretches 1200 kilometers from Cape Hatteras in North Carolina to Cape Cod in Massachusetts and can measure ocean currents up to about 180 kilometers offshore. Poststorm surveys have revealed that at least four of the radars—which cost at least $150,000 each— "are completely gone," Glenn says, and another five are damaged. It could be weeks

By land and sea. A robotic submarine (*above*) helped scientists track Sandy's undersea impacts, while coastal radars (*left*) monitored the storm until it knocked out 17 of 28 stations.

before the rest are fully inspected. But Glenn says the radars did "great work" before succumbing, providing a detailed look at how Sandy shifted ocean currents— potentially useful information for improving forecasting models.

The Rutgers researchers are also looking forward to crunching a mountain of data collected by the submarine "glider" that swam in the ocean beneath Sandy, about 10 nautical miles off the New Jersey coast. "We wanted to be sure we were far enough offshore that the storm didn't push it back in and wreck it," says Travis Miles, a doctoral student who helps operate the submarine.

The craft's sensors collected extensive information on how the storm stirred up bottom sediments and mixed layers of cooler and warmer waters. The temperature data are important because storms can draw energy from warm surface waters. Preliminary data suggest that Sandy's winds caused mixing that cooled surface waters by several degrees Celsius; the researchers saw a similar although more pronounced pattern last year, when a glider collected data during Hurricane Irene.

Miles, who will be using the sub's findings as part of his doctoral thesis, has mixed feelings about his good fortune. "As a scientist, you want a big storm so you can get interesting data," he says. "But you don't want it to do this much damage."

Cheryl Hapke, a geologist with the U.S. Geological Survey in St. Petersburg, Florida, jumped on a plane a few days before the storm to measure beaches and dunes at the Fire Island National Seashore in New York. Then she spent days after the storm measuring the devastation. The storm "is the biggest of my career," she says, "and it's rare to get a chance to study an event with this kind of intensity." She also hopes that her run-in with Sandy will pay off for society. Her data could improve computer models used to predict which coastal areas are likely to be flooded during the next big storm, giving people a better chance to stay out of harm's way.

–DAVID MALAKOFF

With reporting by Elizabeth Pennisi, Richard Stone, and Emily Underwood.