High-Tech Monitoring Of a National Marine Sanctuary

Divers, Scientists and NOAA Keep Tabs on a Civil War Shipwreck via a Technologically Advanced Collaboration

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Jeff Johnston briefing divers. (Photo courtesy of Deep Explorers)

When it took to the seas in 1862, the USS *Monitor* was a paragon of advanced technology. The Civil War ironclad was nearly impervious to artillery fire with its thick metal shell. Its rotating gun turret allowed the crew to shoot from any direction, negating the need to turn broadside before a battle. Much of its body was underwater, taking away from the enemy's target area. And just the sight of it was fearsome—engine-propelled submarines were not yet patrolling the seas, so sailors had not seen anything like it.

In spite of its impressive features, it foundered in a storm after only about nine months in service, and the wreckage of the *Monitor* was discovered in 1973 and was designated the first National Marine Sanctuary by NOAA.

It is only appropriate, then, that the wreck is managed using today's most advanced technology.

This summer, a collaboration of technical divers and scientists teamed up with NOAA for a weeklong data-gathering expedition to the wreck.

Participants surveyed deterioration, noted the location of artifacts and assessed marine life on the wreck using state-of-the-art technologies, including an autonomous underwater vehicle (AUV) and high-definition (HD) underwater cameras. They used rebreathers rather than open-circuit scuba. And they communicated their work to the public every day via an advanced multimedia effort that was made possible only with the latest in video and editing gear.

"The theme of this expedition is technology," said Dan Crowell, a mission organizer and chief executive officer of Deep Explorers (Brick, New Jersey).

Jeff Johnston, a historian for the *Monitor* National Marine Sanctuary, said the high-tech collaboration is a "valuable tool" for managing the sanctuary.

"The data will help NOAA decide what it will do with the *Monitor* site over the next five to seven years," he said. "And using state-of-the-art technology on a warship that was state-of-the-art for her day is a nice twist."

On June 20, the first day of the expedition, the scientists and divers checked their gear in preparation for the week's missions, and the mood at the base of operations in Hatteras, North Carolina, was optimistic and eager. All they could do was hope for good weather—never a guarantee in the waters 16 miles off Cape Hatteras, where the *Monitor* sank.

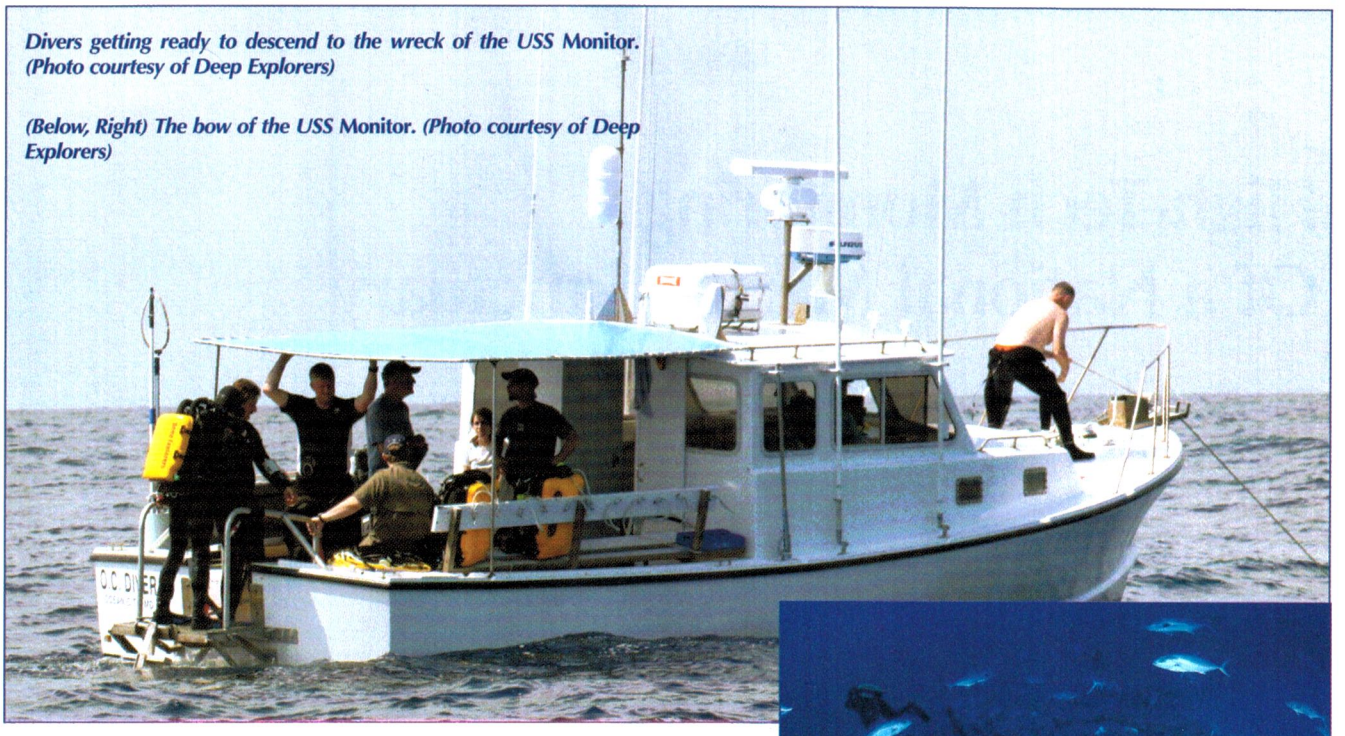
REMUS

Tom "Motz" Grothues studies fish populations in the Hudson River around New York City. The marine scientist from the Institute for Marine and Coastal Sciences at Rutgers knows just how murky those waters can be. That's why the AUV REMUS 100 (Remote Environmental Measuring Units) acts as his underwater eye, providing detailed sonar images of fish populations in the river.

For the *Monitor* expedition, REMUS was tasked with compiling a sonar image of the wreck. The five-foot-long, 85-pound AUV is equipped with two sonar units—one on each side. Images from both side scan units are merged into one to reveal relief, fish populations and other small but important details.

Divers getting ready to descend to the wreck of the USS Monitor. (Photo courtesy of Deep Explorers)

(Below, Right) The bow of the USS Monitor. (Photo courtesy of Deep Explorers)



"We like to use robots in areas that are dangerous or potentially dirty or potentially boring or tedious," Grothues said. "[REMUS] has the special capability of being free of any kind of tether. It can make decisions on its own, it can react to conditions on the bottom ... and it's not jerked around by surface waves that are experienced by ships."

Joe Dobarro, a Rutgers marine scientist who is the chief operator of the AUV, programs REMUS's mission using computer software and then downloads the data gathered during missions.

REMUS can do a linear survey, but more commonly it runs alternating transects, which the scientists have termed "mowing the lawn." The process entails canvassing a square area back and forth, one row at a time, for a complete picture of a specific area.

The AUV finds its way using a pair of transponders placed at two separate points in the water that enable it to decipher its location. If that fails for any reason, REMUS can surface and get a global positioning system fix to determine its whereabouts. Its propeller pushes it through the water, and its rudders and fins steer it as it reaches a top speed of about five knots.

A paired set of acoustic Doppler current profiler (ADCP) sensors use sound echoes to measure the movement of the vehicle through the water and also collect data on current direction, velocity, echo intensity and bathymetry. Its "wet sensors" measure water conductivity, temperature and depth.

The vehicle can also gather important data using its many light sensors, one of which determines levels of oxygen in the water. Another, called the ecotriplet, measures the amount of chromatic dissolved organic material, while a blue light sensor measures chlorophyll A, an important component of algae.

Rutgers has also used REMUS for conducting hydrographic surveys, environmental monitoring and water quality monitoring. Their REMUS 100 is one of 120 deployed, according to parent company Hydroid (Pocasset, Massachusetts). Many are used by the U.S. Navy to scout mines. Other models reach greater depths than REMUS 100 (100 stands for a maximum depth of 100 meters); REMUS 600 and REMUS 6000 dive much deeper.

Closed-Circuit Diving

Nearly all 13 technical divers used rebreathers for the mission rather than steel tanks, for a host of reasons. The *Monitor* rests in 230 feet of water, which translates into significant decompression times for 30 minutes of bottom time, the length needed to carry out artifact and marine life surveys.

The divers would need to carry lots of extra tanks, and that would be unwieldy while battling the currents of the Gulf Stream, which reached speeds of two knots during the weeklong expedition. Plus, filling so many tanks for multiple divers every day would be a burden on both the divers and the dive shops around Hatteras, a fairly remote area. A bonus of using rebreathers was that no bubbles would appear in footage of artifact locations and daily news updates.

While much recreational diving is still done on tanks, many divers are turning to rebreather systems as the technology becomes more widespread and less expensive. Essentially, the closed-circuit system sends carbon dioxide-rich air exhaled by the diver back into the unit, where a calcium carbonate matrix scrubs out the carbon dioxide. Finally, oxygen is added back into the loop so the diver can have an optimal breathing mix at the given depth.

Most divers on the expedition were using Ambient Pressure Diving Ltd.'s (Helston, England) Inspiration rebreathers, which weigh about 29 kilograms and measure 65 by 45 by 35 centimeters. The unit's yellow casing held two three-liter steel cylinders, one of which contained oxygen and the other, calcium carbonate.

Capturing the Mission

Once the divers descended to the wreck, they would need HD cameras to document deterioration, location of artifacts and marine life. While many divers used their own underwater photography gear, expedition leaders were equipped with the Sony HVR-Z7U HD video camcorder, fit with an Amphibico (Montreal, Canada) housing.

Topside, Crowell and mission videographer Bjørn Kils used XDCAMs given to the expedition by sponsor Sony. The HD cameras record to an optical disc and solid-state compact flash memory cards rather than standard videotape formats.

That made creating daily news videos much simpler, as Kils was able to instantly access specific clips without having to spend hours rewinding or fast-forwarding through tapes.

"Shooting with tapeless acquisition really expedited the post-production

process," Kils said. "We were out on the boat shooting for 12 hours, and once back at expedition headquarters we could start editing immediately without having to waste time capturing tape. That enabled us to get daily video reports up on the Web on a tight deadline."

Both XDCAMs were outfitted with Fujinon (Tokyo, Japan) 13x HD wide-angle lenses. The team needed this type of lens to capture the full scope of scenery and action on the crowded dive boat.

"Having the latest in HD equipment would be useless without having a good eye for the camera," Crowell said.

Final Results

High seas and sweeping currents prevented the divers from getting down to the wreck on all but one day of their weeklong expedition.

But on that day, nearly all 13 of them fought the 1.3-knot current and worked their way steadily above and alongside the wreck to provide NOAA with HD documentation of the *Monitor*. All of the images that were collected during the trip were handed to NOAA to use as part of its updated sanctuary planning.

Johnston said images certainly aid in the recovery and preservation process. Video of the *Monitor* that Crowell had taken in 1994, for example, eventually assisted in the recovery of the ship's engines.

The team created a total of seven daily video updates, which drove traffic on NOAA's Web site. The videos can now be found at http://sanctuaries.noaa.gov/missions/2009monitor.

Unfortunately, the five- to seven-foot seas proved too rough for the Rutgers scientists to deploy their AUV.

"Conditions for us were marginal," Dobarro said. "It's very hard to get REMUS out of the water" in such rough seas.

The current also shifted the vehicle's transponder buoys, which would have prevented REMUS from easily determining its location within the water column. Rutgers plans to go back to the site another time for side scan sonar imaging of the wreck.

Johnston, who accompanied the team to the site, said the seas certainly were treacherous.

"I didn't want to tell them that conditions were similar to what they were when the *Monitor* foundered 150 years ago," he said. ■

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