REMUS SharkCam captures upclose encounters with great whites

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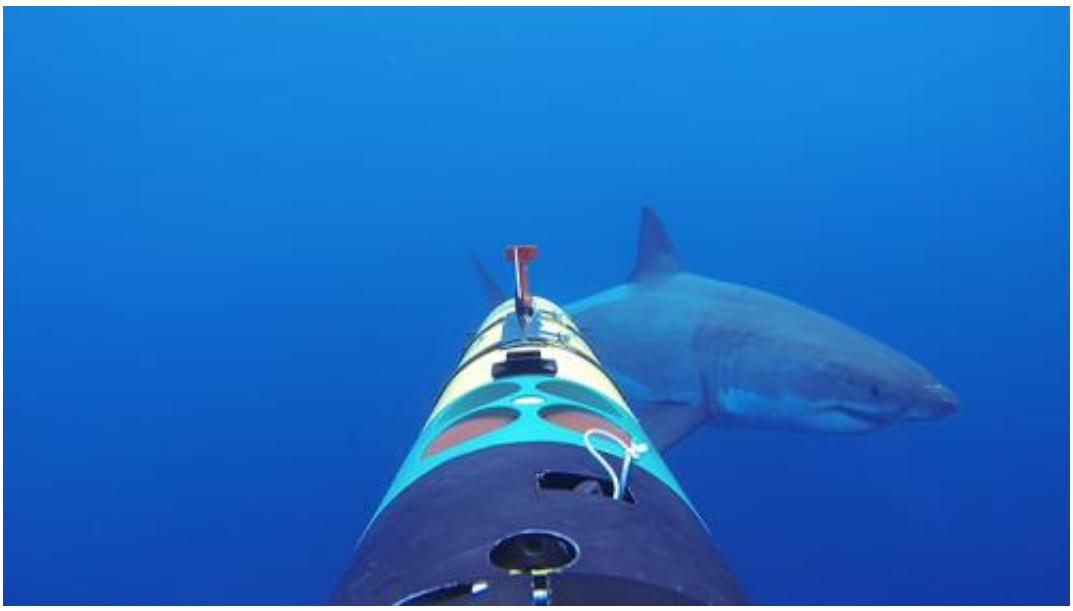

REMUS SharkCam is the first underwater robot capable of tracking and filming sharks and other marine animals up close in the wild. With six cameras total mounted on the vehicle, it recorded dramatic panoramic footage of large great white sharks attacking the underwater robot. Credit: WHOI Oceanographic Systems Laboratory

When a team from the Woods Hole Oceanographic Institution (WHOI) took a specially equipped REMUS SharkCam underwater vehicle to Guadalupe Island in Mexico to film great white sharks in the wild, they captured more than they bargained for.

With six cameras total mounted on the vehicle, REMUS SharkCam recorded dramatic panoramic footage of large great white sharks attacking the underwater robot.

The spectacular—and tense—footage is featured in the television program, "Jaws Strikes Back," on August 11 as part of Shark Week 2014 on the Discovery Channel. Excerpts can be seen now on the WHOI website in a video called "REMUS SharkCam: The Hunter and the Hunted."

Scientists know astonishingly little about the simplest of great white behavior, let alone where the ocean's top predators migrate, mate, or give birth. And until recently, researchers were limited in their ability to observe great white sharks.

With initial funding from the Discovery Channel, a team at the Oceanographic Systems Laboratory (OSL) at WHOI developed REMUS SharkCam in 2011. It's the first underwater robot capable of tracking and filming sharks and other marine animals up close in the wild.

Footage from REMUS SharkCam is helping reveal previously unknown details about the strategies that sharks use to hunt and interact with their prey. In what are most likely predatory attacks, sharks take advantage of the clear water to lurk in the darkness below the vehicle, then swim up suddenly and bite it on the tail or mid section— the same way that sharks hunt seals near Guadalupe Island.

"In the clear waters near Guadalupe Island, white sharks lurk in the depths and look for the back-lit silhouette of prey at 100 meters depth. When they spot a target, they swim up quickly and attack the hind fins or flippers in order to disable it before moving in for the kill. We discovered back in 2008 that the sharks were killing seals in deep waters,

but we did not know the exact depth until November 2013—thanks to the REMUS SharkCam," said Edgar Mauricio Hoyos Padilla, a marine biologist and the director of Pelagios Kakunja in Mexico, who worked with the WHOI team to study shark behavior. "REMUS SharkCam also tracked a 21-foot female white shark—one of the largest ever studied."

In all, REMUS SharkCam recorded dozens of interactions with great whites and survived several predatory attacks. Video from REMUS SharkCam is providing scientists with their first close-up view of predatory behavior by sharks in the wild.

"I think it's worth noting that these vehicles have been doing operations in a marine environment for 20 years, and have never been attacked by a shark before. We were purposefully trying to get close to the shark this time," said Amy Kukulya, the operations leader and a principal investigator for the REMUS SharkCam project. "It wasn't on our radar that we were going to have problems. When we recovered the vehicle, everyone's jaw dropped—there were large rake marks across the body of the vehicle."

Remote Environmental Monitoring UnitS (REMUS)—sleek, yellow vehicles that look like torpedoes—are a family of autonomous underwater vehicles (AUVs) designed to operate with a simple laptop computer. Initially created to do coastal monitoring, they can be fitted with a suite of sensors and instruments.

Different sizes and versions of the REMUS vehicles have been utilized for a variety of missions, including detecting mines in the Persian Gulf and inspecting New York City's Delaware River Aqueduct for leaks. In 2011, three REMUS 6000 vehicles were used to locate the wreckage of Air France Flight 447 in the Atlantic Ocean off Brazil's northeastern coast.

Before the development of the REMUS SharkCam—a 6-foot long version of the vehicle that can dive to 100 meters (330 feet)—none had ever been used to track a moving marine animal. REMUS SharkCam is specially outfitted with video cameras and navigational and scientific instrumentation that enable it to locate, track, and film a tagged great white shark up close.

Using an omni-directional ultra-short baseline (USBL) navigation system to determine the range, bearing, and depth of a tagged animal, REMUS SharkCam stays at a pre-determined stand-off distance and position (left, right, above, or below) from the shark in order to film it swimming and interacting with its environment with minimal interference. The vehicle communicates with scientists on the surface every 10 to 20 seconds. It can also accept commands from the surface to change relative speed, depth, and standoff distances with respect to the animals.

The innovative technology was first tested off the coast of Cape Cod in 2012 with basking sharks, then later that year in the same area with great whites.

"Before I started the project, a lot of my feelings about sharks were colored by movies like Jaws, but really I came to have a very different feeling towards them. You think of them as these ferocious predators, and certainly they are. But I think people have gotten the wrong impression," said Roger Stokey, an engineer with the WHOI OSL group. "I hope what comes out of this project is a greater respect and understanding for these animals."

Testing is currently underway to use the system to track sea turtles. Visual and numerical data from the vehicle promise to open up new ways of studying the behavior of marine animals in the wild interacting with their natural habitat.