Ear to the sea

Aided by modern technology, marine researchers heed the call of the wild to learn more about elusive whales

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JOHN GIBBINS / Union-Tribune
In March 2000, Erin Oleson was off the coast of Martinique studying the songs of humpback whales, the waves of the Caribbean gently rocking her small inflatable boat.

Without much room in the tiny craft, Oleson was forced to leave acoustic instruments designed to record the whales back on ship.

So, Oleson, a graduate student at the Scripps Institution of Oceanography, did the next best thing.

"I just felt compelled to stick my head in the water and hear them," Oleson said.

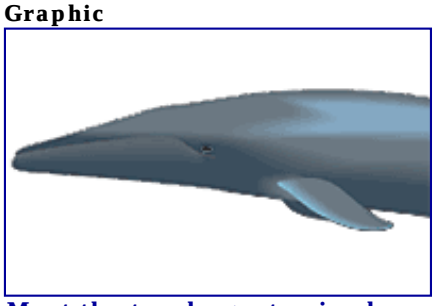
Leaving one world and entering another, Oleson immersed herself in a symphony of whale song. The moment, fixed by the air she could hold in her lungs, was fleeting.

Photo gallery
Union-Tribune photographer John Gibbins spent time at sea with Scripps whale researchers.

"I had been hearing the same humpback whale calls in the lab, sitting in my chair in front of a computer screen, but to hear it directly was pretty cool," Oleson said.

Three years later, the 26-year-old scientist is one of several Scripps oceanographers for whom modern technology is redefining what we know about the largest creatures on the planet.

Graphic



Meet the two largest animals on the planet

Sophisticated instruments unheard of less than a decade ago are taking Oleson and her colleagues to the whales. They record every song; every 1,000-foot dive; every gaping lunge for food; every powerful thrust to the surface to empty their great lungs and breath in the sea air.

Modern oceanography is driven by modern technology as never before. On the eve of Scripps' 100-year anniversary, here is a profile of one trip, 100 nautical miles off the coast of San Diego, where human ingenuity keeps opening new windows on the sea.

Tuesday, Aug. 19
32^{8} 40.2' N, 119^{8} 19.45' W
Scripps Institution of Oceanography Nimitz Marine Facility (MARFAC)

The destination is Cortez and Tanner banks, shallow waters west of San Diego and directly south of the Channel Islands.

For marine biologists, the banks are rich regions of the Southern California Bight, where the California Current courses over the continental shelf from Point Conception near Santa Barbara and heads south, bringing cool ocean water rich with nutrients. Plankton blooms fill the seas with microscopic life in the spring. Krill and other zooplankton follow.

By summer the whales come to feed.

Erin Oleson is part of a team working on contract with the Navy, which trains over the banks in a larger area called the Southern California Off-Shore Range, or SCORE. The Marine Mammal Protection Act and other federal laws require the Navy to do everything it can to protect the whales, dolphins and other sea life there.

Three years ago, the Navy hired Scripps under a four-year, $1.2 million contract to develop new ways to combine visual observations of whales with acoustic recordings of their calls, to learn more about the whales that frequent the range.

The Navy's SCORE project is the subject of Oleson's doctoral thesis. Marshaling the technical expertise of her colleagues at Scripps, professional whale observers from a Washington state group called Cascadia Research and instrument technicians and acoustics experts, Oleson hopes to learn more about blue-and fin-whale calls and how listening for them can help scientists estimate their abundance.

"Using acoustics to study the whales is a pretty new field ..... and it has, in some ways, revolutionized what you can learn about whales," Oleson says.

As Scripps' 125-foot Robert Gordon Sproul leaves San Diego Bay, Kristin Rasmussen, a 33-year-old researcher with Cascadia, takes a group of observers to the bridge to show them how to record whale positions.

The Cascadia observers will take two-hour shifts throughout the four-day trip, from sunrise to sunset, scanning the sea with binoculars. They will note the number and type of whales seen, the time, the bearing and distance of the animals from the ship, and weather and sea conditions.

Just before 8 p.m., as the Sproul heads toward a darkening and overcast sky, Rasmussen spots a whale's spout off the bow, not 200 yards away. Then she spots three more. A good sign, say the observers, for the next day's research on the banks.

Wednesday, Aug. 20
32^{8} 45.1' N, 119^{8} 13.7' W
Cortez Bank

Scripps scientist John Hildebrand, Oleson's adviser and an expert in whale acoustics; Bill Burgess of Greeneridge Sciences, a Santa Barbara company that develops whale instrument tags; and Joe Evenson, an observer with Cascadia, transfer from the Sproul to Scripps' Floating Instrument Platform, or FLIP.

Oleson and other scientists are already aboard FLIP, a 355-foot floating platform that sits vertically in the water – its 60-foot bow pointing straight up and nearly all of its cylinder-shaped stern beneath the water.

At Cortez and Tanner banks, the whales most often seen are blues and fins, two of the largest marine mammals on Earth. Acoustic instruments anchored on the sea floor more than 1,000 feet beneath FLIP have shown that blue whales are present here most prevalently in May and June. Visual observations suggest they are present from June to October. Acoustic and visual studies of fin whales suggest they reside year-round.

This is the first time FLIP has been parked right above the sea floor instruments, and the platform is giving Oleson and her colleagues a stable and quiet base from which to listen to the mammals as they feed around them.

The Scripps' study has already suggested significant differences in fin- and blue-whale behavior, says Oleson. Fin whales, which Oleson calls the "Ferraris of whales," are sleek and fast. The mammals' vocalizations can vary, and they frequently call and counter-call to one other, keeping in touch as they travel through the ocean. The cacophony can make it difficult for scientists to correlate the number of calls of individual animals, she says.

Blue whales, more slow moving and solitary, are simpler to study because their calls are more consistent.

"They also make very few (types of) calls, so when you hear them, they are unmistakable," she says. "That makes them a clean model for understanding other species."

The scientists have found that the number of blue-and fin-whale calls increases in the fall when they breed. Also, blue whale calls come almost exclusively from males, suggesting the vocalizations may play a role in competition for mates.

Instrument tags attached to the mammals have provided scientists with graphic profiles of whale dives, showing how they dive deep to reach layers of krill, their primary food source, then swim up through the layers and engulf the tiny animals.

The few fin whales that have been tagged show that they lunge repeatedly through layers of krill as they feed. Blue whales also appear to do this. "We don't have very many (dive) profiles from blue whales, so every one we get gives us something new to learn," says Oleson.

As technology improves, Oleson says sensors added to the tags will measure temperature, salinity and other facets of the ocean. Global positioning systems will provide scientists more detailed information about where the mammals go.

"Within a few years, we'll have the ability to do ... all that stuff on the back of the whale," she says.

The Sproul, meanwhile, spots few whales today, although a pod of Pacific white-sided dolphins visits the vessel, racing along the bow of the ship and jumping in pairs over the waves.

As the day wanes and the ship makes its way toward FLIP, somebody spots four whales cresting over the waves and blowing.

The Cascadia observers on the bridge fix their binoculars on them, calling out their positions to Rasmussen, who records the sightings on a chart in the pilot house.

The darkening sky robs the scientists of a clear view, but the mammals' arching black backs clearly rise and fall through the waves.

Thursday, Aug. 21
32^{8} 38.23' N, 119^{8} 06.81' W
Cortez Bank, aboard FLIP

From FLIP's middle deck, about 20 feet above the ocean, Hildebrand and Scripps engineer Sean Wiggins lower a line more than 300 feet into the water. Attached at 50-feet intervals are eight hydrophones, sensitive listening devices that record the calls of whales. Linked together, the instruments make a vertical array of underwater "ears," recording whale calls at different depths.

But there's a problem. Salt water is seeping into one of the hydrophones. Getting it back operating is a priority. At a small

workbench in FLIP's tiny science lab, Wiggins spends the afternoon soldering severed wires and resealing components, so it is ready to go again the next morning.

On a lower platform, Oleson pulls up a CTD, an instrument that measures salinity and temperature at different depths. Sitting cross-legged, she downloads the data from the instrument into her laptop. She does this several times a day, in order to calculate how fast sound moves through the water – crucial information for pinpointing the origin of whale calls.

Computer screens in FLIP's science lab show a continuous record of what the hydrophones hear. Whale calls are heard at different frequencies. Calls from blue whales range from 15 to 90 hertz – a combination of staccato notes followed by a sustained bellow.

Calls from a fin whale – repeating, brief groans – are at much lower frequencies, around 20 hertz. On a spectrograph displayed on a computer screen, the fin's call looks like short, downward sloping curves spaced about 10 seconds apart.

Oleson first studied sound in the ocean as a UCSD undergraduate, while working at Hubbs-SeaWorld Research Institute studying how to use pingers to keep seals and dolphins out of fishing nets. Her acoustic studies, in a sense, run in the family – albeit at opposite ends of the sound spectrum. Her father has studied high-frequency acoustics for the microwave industry.

"I work in the 10s of hertz, but he works in the hundreds of thousands of hertz," she says.

Outside on the water, John Calambokidis, founder of Cascadia, and Mark McDonald, an acoustics expert based in Colorado, are chasing whales.

While Calambokidis drives a small, inflatable boat called a rhib, McDonald holds a radio antenna into the air, homing in on the radio signal of a whale they have just tagged.

The pair fall silent as they listen to the ping-ping-ping of their radio receiver. They find the tag floating nearby and McDonald leans over the side and grabs it.

The tags, sealed in water-tight polyurethane tubes about 6 inches long, encase a hydrophone, a pressure sensor to record changes in depth and an accelerometer that acts like a gyroscope to record the whale's orientation – head up or down – as it travels through the ocean. From this, scientists can obtain profiles of each whale's dive, plotting how far down it goes and how it moves through the water.

Scientists attach tags with a long pole. Two suction cups stick onto the back of the whale for a few minutes to a few hours, sometimes longer. Once it falls off, a float brings the tag to the surface and a radio transceiver issues a signal to scientists.

Calambokidis is eager to reach the whale that has shed the tag. He'd like to dart the whale, in order to obtain a tissue sample.

Suddenly, the massive bodies of two fin whales rise to the surface some 20 yards away, their broad backs plowing through the swells like gun-metal gray submarines. They exhale through their blowholes, spraying water skyward and then inhaling with loud rushes of air.

Then they disappear.

Calambokidis shuts down the engine and he and McDonald casually pause to eat some lunch.

Fifteen minutes later, the two fin whales rise from the water behind the rhib and Calambokidis starts the engines and heads for them. Near the controls is a crossbow armed with a small dart. With one of the whales off the starboard bow, Calambokidis fires the dart and it bounces off the animal. The whale dives.

The researchers pick up the floating dart and Calambokidis cuts a plug of skin and blubber from it into two pieces and places them carefully into two plastic vials filled with preservative.

From the skin, scientists can identify the whale's gender and its relationship to other tested animals. From the blubber, they can tell whether the animal is pregnant and identify contaminants in the animal's body.

Friday, Aug. 22

32^{8} 48.64' N, 119^{8} 22.73' W

En route from San Nicolas Island to Cortez and Tanner banks

Under a bright, blue sky on a sparkling Pacific, Calambokidis and McDonald head toward a huge blue whale, dropping a sonobuoy over the side so those on the Sproul can begin recording its calls.

The sonobuoy, donated by the Navy, is a cylindrical instrument programmed to float at a specific depth and record whale calls for up to eight hours. In combination, or in concert with instruments anchored on the sea floor, the sonobuoys also fix where the calling whales are.

The whale submerges, then 11 minutes later, surfaces. Only a fraction of its gigantic body is visible, but it still rises at least 5 feet out of the water and stretches at least 50 feet from front to back.

Two minutes later, it's down again. The chase continues throughout the afternoon, but this blue whale remains elusive. There will be no tag on it today.

By evening, one tag is missing, unrecovered from a blue whale and floating somewhere in the ocean. At $8,500 each, the tags are worth some extra effort to find, so the scientists decide to head toward San Nicolas Island 35 nautical miles to the north to find it.

The scientists work shifts throughout the night, taking turns checking a radio receiver every 45 minutes for the telltale signal.

Sherwin Cotler, a 62-year-old clinical psychologist from Olympia, Wash., sits in the lab listening for the tag. On one of his first trips as a Cascadia volunteer, he accompanied Calambokidis on an evening chase of a whale off Santa Barbara. Without lights and navigating by dead reckoning, Calambokidis and Cotler eventually found themselves directly over the animal.

"We were in this 18-foot rhib and this 85-foot animal came right underneath us and arched his belly, its cream-colored underside facing us in the moonlight," Cotler said.

"It was a humbling experience, to watch (Calambokidis) follow the whale in the dark, anticipating where it would be. It was uncanny how he tracked it."

By morning, the blue-whale tag is still missing as the Sproul heads toward FLIP to rendezvous for a final day of research.

Saturday, Aug. 23
32^{8} 41.09' N, 119^{8} 16.73' W
Just north of Cortez and Tanner banks

The ocean is rough, with whitecaps over 6-foot swells and 17-knot winds out of the northeast. Evenson, from Cascadia, spots the body of a whale off the ship's port beam. It's a blue.

"You might want to head over there," he radios Calambokidis, in the rhib, with inexplicable understatement.

"Go, John, go!" blurts Rasmussen.

Now there are two whales, 235 degrees off the Sproul's bow.

"Come on, guys. Do it. Come on, come on, come on," Rasmussen said, encouraging the chase.

The rhib heads for the blows, dropping a sonobuoy into the water.

Everyone on the Sproul is lined up on the port bridge, watching the chase. Calambokidis and McDonald are maybe 100 yards behind the spot where the whale has now disappeared.

It rises again.

"Did we get any acoustics?" Calambokidis asks over radio.

"I have, but not a blue," says Ana Sirovic, a Scripps graduate student aiding Oleson, over the radio from the Sproul.

The whales, hidden below the whitecaps and rough swells, surface once

again – too far away for Calambokidis to get there in time.

"By the time we get (Calambokidis) there, it's down," Rasmussen says in frustration.

"There's a blow behind you, John, on your ... argh, what side is it? On your port side," Rasmussen says.

Calambokidis takes off, bobbing up and down in rough seas, but the blues evade him.

While this blue whale and others proved elusive on this trip, the scientists have amassed many tens of gigabytes of data, and it will take months to process and interpret them.

Altogether, they tagged 10 fin whales and three blue whales, and collected additional acoustic records from FLIP's vertical array, sea floor instruments and sonobuoys.

Oleson says it has been a successful expedition. After 14 days on FLIP and several days of help from the Sproul, she should have enough information to conclude her dissertation and wrap up the whale studies for the Navy's SCORE project.

"We hadn't actually focused very much on getting fin-whale behavior data until it kind of just fell in our laps this last trip," she said.

"So now we'll learn a lot about diving and feeding behavior from those tags. I don't know what it is yet, but (it will be) something."

Today in Food: Divergent interests come together for a forum on sustainable seafood during the Scripps centennial.

Next week in Quest: Looking back at Scripps' 100 years of oceanographic research and vision.
