Tag team

High-tech animal tagging offers abundant new information about many species

By Richard A. Lovett
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The tiny hawk's heart trembled against my hands as I held the bird as gently as possible without letting it escape. It was a full-grown sharp-shin, a small species that seemed to be made of nothing but air and feathers.

Minutes before, a team of biologists had lured it into a net on a remote ridge top in Nevada's Goshute Mountains. With the practice of long experience, they had examined it, measured it and tagged it. Now, it was my privilege to release it back to the wild.

DAN COSTA
UC Santa Cruz researchers apply a dive tag to an elephant seal at Año Nuevo Reserve in San Mateo County. The tags are glued on with five-minute epoxy.

"Toss him up, so he has time to fly before he falls," said my guide, a wildlife biologist named Liz Moseman. "A couple of feet is plenty."

I complied, and the bird exploded into motion, carrying with it a bright-colored tag telling future biologists how to access the data about this bird's visit to the Goshutes.

Traditional animal tagging is the scientific equivalent of betting on long-shot racehorses. The dream is that someone will recapture the same animal and retrieve a snapshot of where it's been and how its size and weight have changed in the interim. All too often, though, the tagged animal is never seen again.

But technology is revolutionizing the field of animal tagging with a new breed of rugged, electronic tags that provide detailed telemetry of each animal's movements.

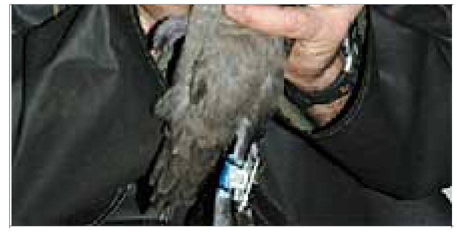
The simplest are satellite tags small enough to be carried by a large bird. In fact, Moseman's group, a conservation organization called HawkWatch, has been placing satellite tags on golden eagles, red-tails and northern goshawks since 1999.

These units emit brief radio pulses, using only enough power for a satellite to get a fix on their location. The ones used by HawkWatch pulse once a minute for a few hours at pre-programmed times of the week – more frequently during migrating season.

Unfortunately, battery weight imposes severe limits on this technology. "Three percent of the bird's weight is the maximum we can go," says Jeff Smith, the organization's science director. Since bigger birds can carry bigger batteries, he adds, "we can track for seven to 11 months on northern goshawks, two to 2-½ years with red-tails and four years with golden eagles."

The tags cost several thousand dollars apiece, making it impossible to track large numbers. But the ability to track even a few birds' day-to-day movements gives new insight into their behavior. Red-tailed hawks, for example, don't like to cross big mountain ranges like the Sierra Nevada. They pick one side and pretty much stick to it. Not so with the eagles. "Crossing a mountain range isn't a big thing for them," Smith says.

Then there's the occasional hawk that adds new meaning to the term birdbrain.



UC Santa Cruz
Scott Shaffer with a tagged sooty shearwater, a bird that migrates more than 40,000 miles a year.

“Some are amazing,” Smith says. In one case, a red-tail tagged in New Mexico made two round trips to Mexico before returning to settle down near the original site.

Even dead birds reveal information. The satellite tags are expensive enough to be worth retrieving, so the biologists go in search of them when a bird quits moving.

On one occasion, Moseman says, they found an eagle that had been killed by a falling rock – not normally thought of as a hazard for birds. “It must have been chasing a rabbit or something and loosened a rock,” she said. “We found it with its skull crushed by the rock.”

Other researchers are studying marine animals. Stanford University and UC Santa Cruz are part of a consortium of institutions engaged in a project called TOPP, for Tagging of Pacific Pelagics, which has been tracking everything from sharks, tuna and giant squid to elephant seals and albatrosses. Some work has used satellite tags, but many of the more recent experiments have used extremely lightweight data loggers that record a great deal more information.

In a paper published this August in the Proceedings of the National Academy of Sciences, for example, UC Santa Cruz researcher Scott Shaffer tracked the motions of 19 sooty shearwaters, using data loggers that weighed less than half an ounce apiece.

Scientists have long known that the birds breed in New Zealand and Chile before migrating to summer homes in California, Alaska and Japan. What the tags revealed is that the birds migrate nearly 40,000 miles per year, flying in figure-eight patterns that take advantage of the Pacific Ocean's prevailing winds.

The tags used in this study didn't need heavy batteries because they didn't send radio pulses to orbiting satellites. Rather, they contained sensors that detected the times of sunrise and sunset. Using methods long known by sailors, this information can be used to determine the birds' day-to-day latitude and longitude. Additional sensors recorded the water temperature whenever the birds settled onto the ocean. These temperatures could then be compared to satellite maps of sea-surface temperatures to further fine-tune each tag's track of a bird's motion.

Since none of this information is beamed to a satellite, it's necessary to recover this type of tag in order to retrieve the data. But in the case of the sooty shearwaters, that was easy because the researchers tagged the birds at a rookery in New Zealand. A year later, most of them came back.

“We got tracks from 80 percent of the birds we deployed,” says Daniel Costa, of UC Santa Cruz.

In other research, the TOPP team has tagged tuna, hoping that if the fish are later caught, fishermen will return the data-logger to claim a reward. In addition to using a daylight sensor to track each fish's movements in a manner similar to that used for sooty shearwaters, the tuna tags also measure the depths at which the fish swim. The tags showed that while the fish feed in cold, deep waters, the fish return to warm surface waters to prevent becoming too chilled.

Similar studies have also been done with sharks, using tags designed to release and float to the surface after a few months. On the surface, this type of tag emits a locator pulse that allows it to be retrieved.

Marine animal tags can also be equipped with sensors that record salinity, depth, temperature and light levels – in effect, converting the animals into mobile oceanography laboratories.

Data from tagged elephant seals, for example, have indicated that El Niño, a warming of the tropical ocean that can have a dramatic effect on California's weather, also affects the animals' ability to hunt a quarter-mile or more below the surface.

"What is surprising is that the elephant seals responded to an El Niño event – which we tend to think of as a surface phenomenon," Costa said.

Perhaps, he added, the altered surface temperatures make it hard for the seals to find good hunting grounds. Or perhaps their prey are affected by El Niño.

Another discovery is the manner in which ocean predators interact with places in the ocean where there are sharp changes in salinity or temperature, somewhat akin to atmospheric weather fronts. In one case, Costa said, a new, high-precision tag allowed the researchers to track a sea lion as it hunted right along the edge of the steep drop-off of Monterey Canyon, an underwater feature of Monterey Bay.

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A digital tag (or D-tag) is yet another type developed at Woods Hole. It can be attached to a whale or other large marine mammal via a suction cup.

Invented by Mark Johnson and Peter Tyack, it is about the size of a cell phone. Once attached, it monitors the whale's depth and body motions in one or more dives. After a few hours, the tag releases and floats to the surface, where it emits a radio beacon that allows it to be retrieved.

In addition to measuring the whale's movements, says Ari Shapiro, a Woods Hole Ph.D. student, the devices have a hydrophone that allows researchers to record any sounds the animals make or hear – a feature he has used to eavesdrop, close up, on the vocalizations of Arctic narwhals (a small whale with a unicornlike tusk).

Other researchers are using the tags to determine how whales emit sonarlike pulses to locate their prey, much as bats do when foraging for insects.

Another use for such tags is monitoring the effects of offshore oil exploration on whales. Such exploration involves the repeated firing of underwater air guns designed to create loud pulses for sonarlike mapping of seabed rock strata. Biologists are concerned that the racket may be detrimental to marine mammals.

Last May, a team led by Tyack and Patrick Miller of Britain's University of St. Andrews presented D-tag logs from eight sperm whales in the Gulf of Mexico that had been tagged during seismic operations. The researchers found that even though air guns are designed to beam sound waves downward, not sideways, the whales encountered substantial decibel levels at distances as far as seven miles away. But they found no indication that the animals attempted to flee.

Tyack and Miller's team found that the loud noises appeared to make the animals more lackadaisical (and apparently less successful) in their efforts to find prey.

The air gun sounds may be interfering with the whales' hunting ability, but with only eight whales, the study is by no means conclusive.

Miller also thinks that dive logs from D-tags could be used to track the general health of an entire population of whales. The tags measure the whales' motions so precisely that it's possible to count the number of fluke strokes. This has allowed the researchers to divide the animals into two types, based on whether they have to work harder to descend or ascend.

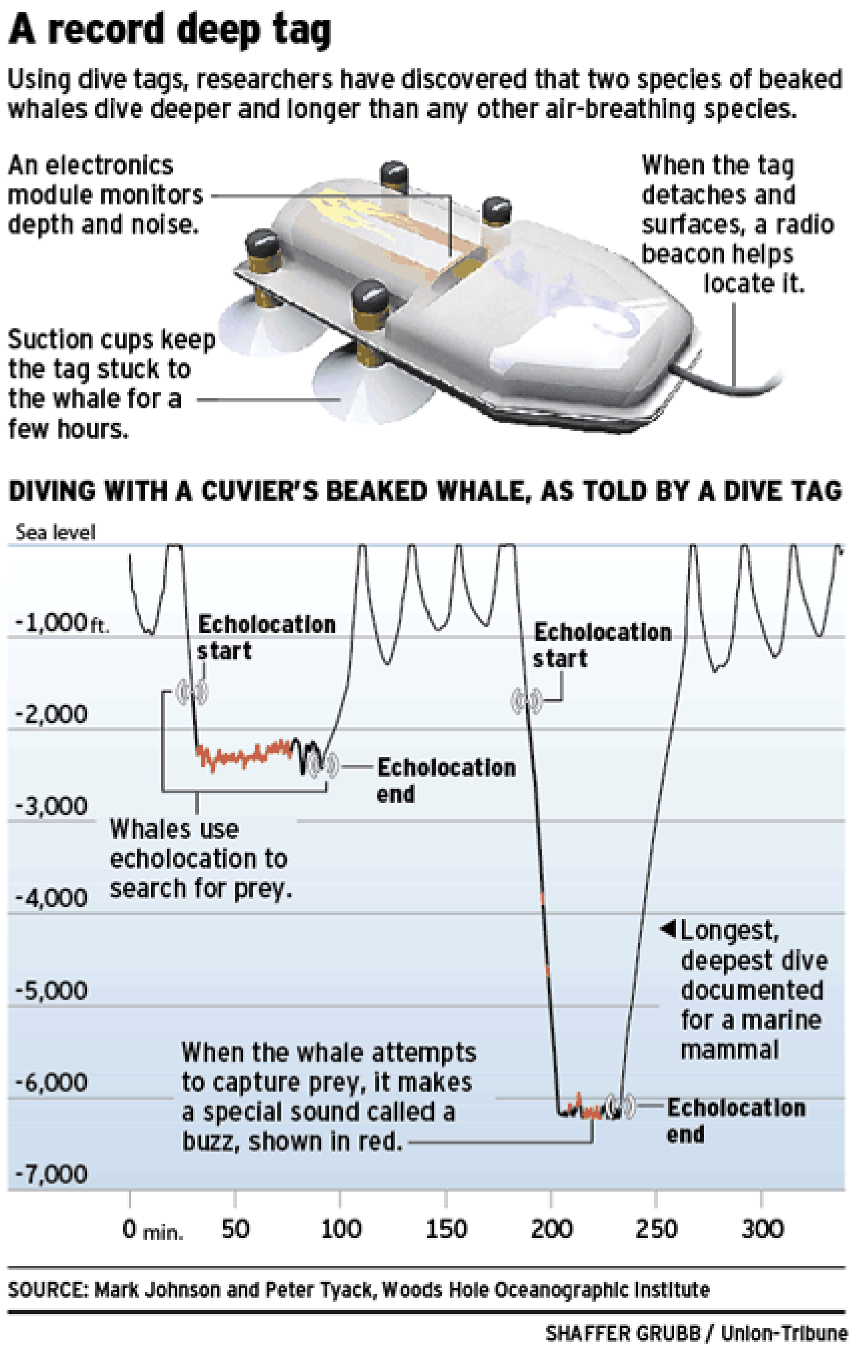
"Fat floaters," Miller said, have to fluke hard on the descent, but can glide a lot on the way back up, getting a free ride from their buoyancy. The opposite are "skinny sinkers," which descend easily, but require a lot more fluke strokes to ascend.

Unlike humans, fat whales are healthy whales. Skinny ones might not be getting enough to eat, perhaps because of human interference. Thus, Miller suggested, ecologists can track early signs of changes in the health of the whale population as a whole.

Even D-tags aren't the ultimate form of animal tracking. Already, Costa's group is working with high-precision GPS-based tags. They're also trying to develop a pill-like transponder that can be used to monitor an animal's stomach temperature, which changes, for example, whenever the animal ingests a large, cold meal, such as a fish.

Beyond that? Who knows. But the days of old-fashioned animal banding may soon be on the wane.

▪Richard Lovett is a frequent contributor to Quest and a freelance writer in Portland, Ore.



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