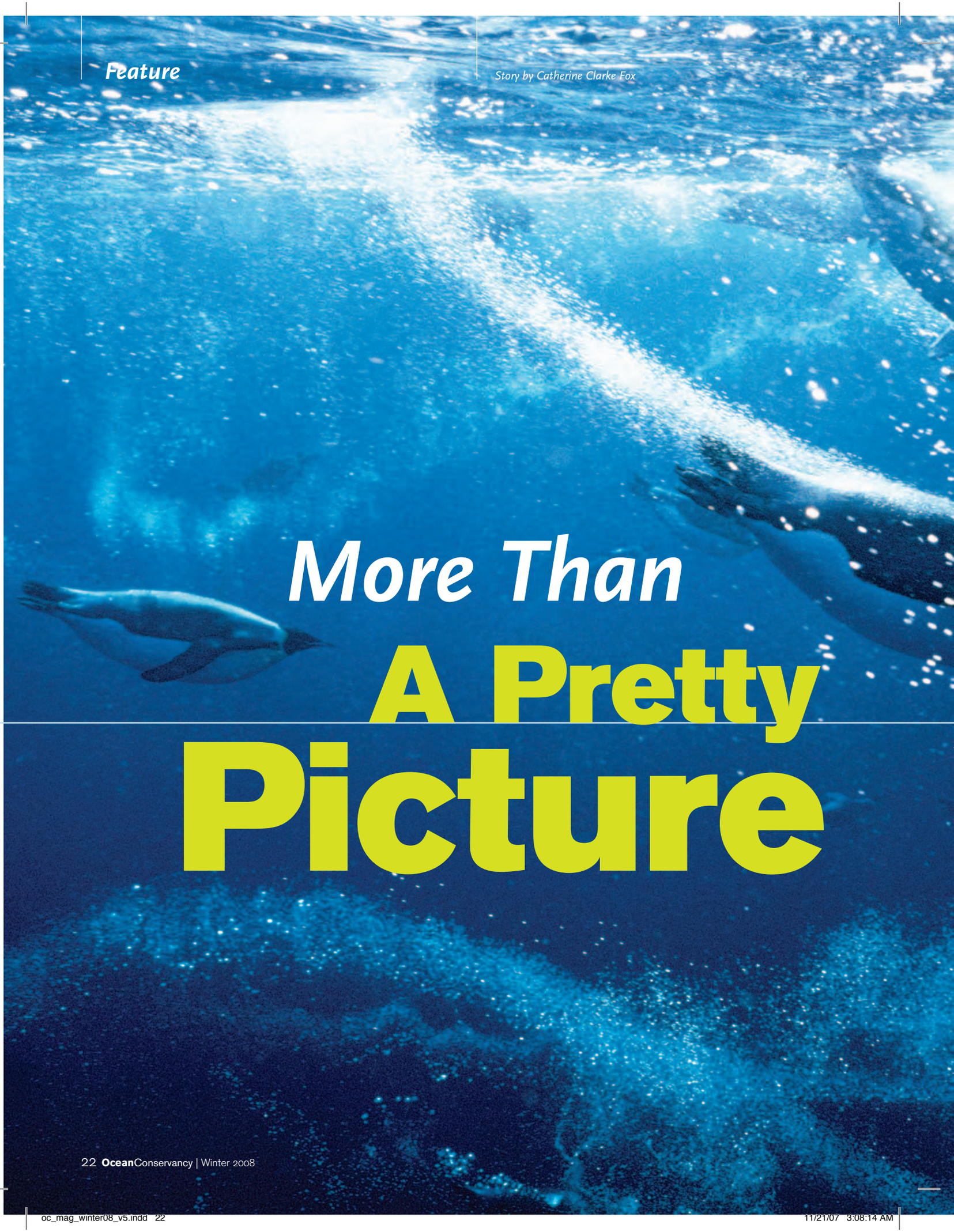
Story by Catherine Clarke Fox



More Than A Pretty Picture

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CRITTERCAM PROVIDES SCIENTISTS WITH MORE THAN MEETS THE EYE

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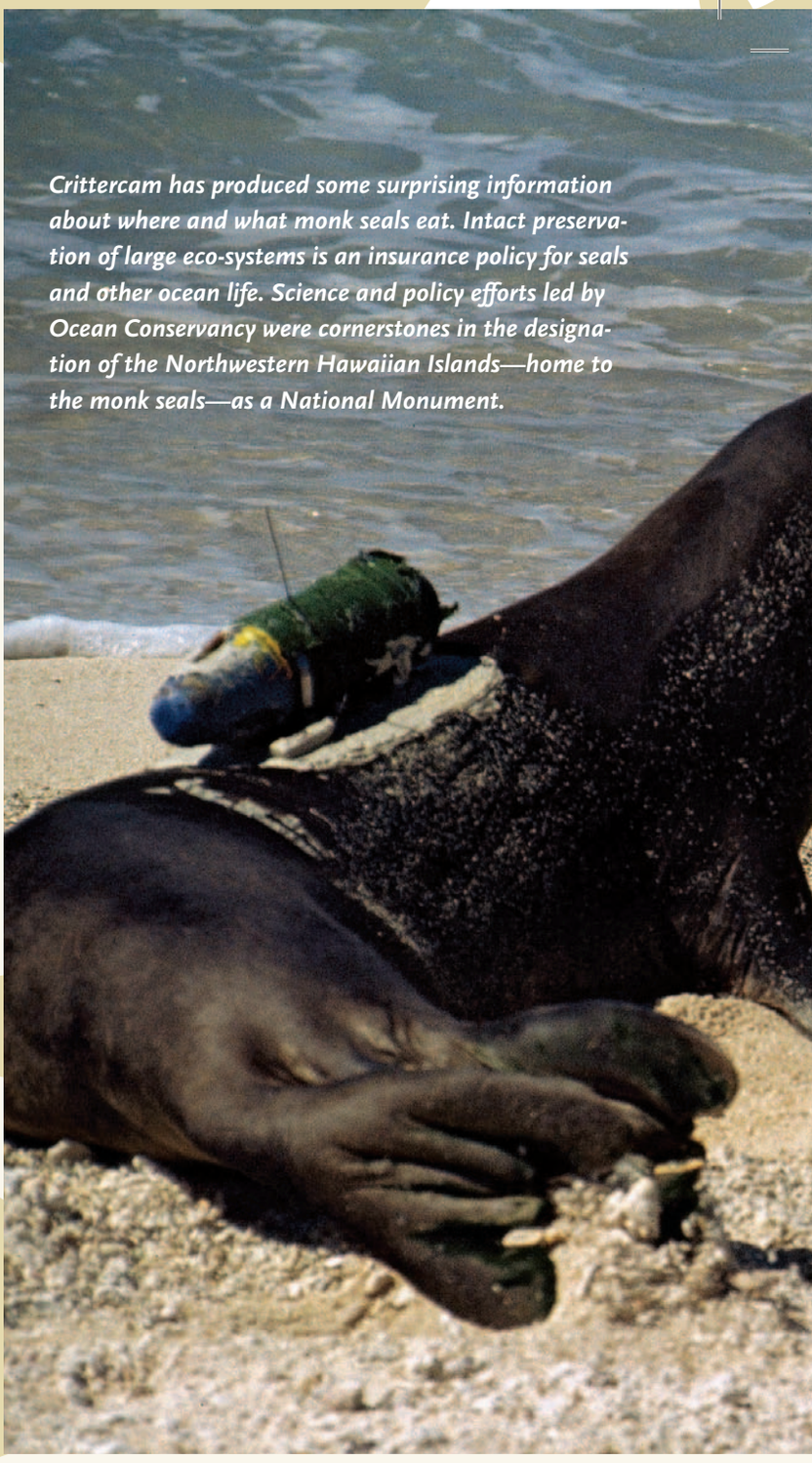

Crittercam has produced some surprising information about where and what monk seals eat. Intact preservation of large eco-systems is an insurance policy for seals and other ocean life. Science and policy efforts led by Ocean Conservancy were cornerstones in the designation of the Northwestern Hawaiian Islands—home to the monk seals—as a National Monument.

On land, Hawaiian monk seals (*Monachus schauinslandi*) are ungainly things. They lumber about heavily on the sand or just laze in the sun like shimmering lumps of onyx. But once they heave themselves into the water and dip from our sight, they transform into one of the world's most graceful and streamlined animals. For scientists studying these rare seals, this dividing line between our world and the seals', between the seen and the unseen, is a great scientific challenge. How can you describe accurately what cannot be seen? Imagine, however, if you were able to see as if through the eyes of a seal as it glides in the water, dipping and turning like an aerialist, scattering bright schools of reef fish as it goes. You're right there with the seal as it scoots beneath a rock to catch an underwater rest, keeping a watchful eye for the sharks that lurk beyond. You hear a whoosh as the seal emerges from its hiding place for more playful dives or begins an acrobatic quest for food.

An amazing research tool, known as Crittercam, is allowing scientists to see what's never been seen and to replace educated guesswork with fact. Part camcorder and part data recorder, Crittercam hitches a ride on the backs of some amazing creatures and provides humans with an unprecedented perspective on what life under the sea is really like.

Researchers on land and in the sea often rely on direct observation to learn about basic biology and behavior, but the approach is sorely limited when it comes to marine animals that can move fast and far underwater. Even the most adept human diver is no match for the speedy Hawaiian monk seal.

Scientists know that starvation is a major threat to the shrinking population of 1,300 seals, and have been studying their feeding habits for clues as to why. Before the advent of Crittercam, "We'd watch the seals on the beach, and pick up their scat on the sand for analysis," says Frank Parrish of the National Oceanographic and Atmospheric Administration (NOAA). "That told us what they were eating, but we didn't know where or how. We thought they were foraging mainly in the shallow waters along the reefs." The picture changed dramatically with the deployment of Crittercam. "It gave us the ability to look over a seal's shoulder," recalls Parrish. And what they saw was astounding.

The very first films showed seals swooping along the colorful coral reefs–and, for the most part, ignoring the plentiful schools of fish. The surprises continued as the seals swam away from the reefs into deeper water. Researchers watched the powerful animals diving to the ocean floor, flipping huge rocks and reaching into caves to find prey like fish and octopus. "Some of the seals went offshore and fed at 200 meters among the whip corals, and we could see them feeding on the eels out in the water column," says Parrish. "It was an amazing sight."

Crittercam led the scientists to a paradigm shift. "I had spent seven years in the shallows counting reef fish. We thought the seals foraged mostly in the shallows and went offshore sometimes, but we had it backwards," says

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Parrish. He likens Crittercam to a compass that pointed researchers directly where they needed to focus their attention. Once they were able to pinpoint the true feeding grounds, a broad range of tools from SCUBA to submarines came into play, greatly expanding knowledge about one of the planet's most imperiled animals.

Last year marked the designation of the Northwest Hawaiian Islands as Papahanaumokuakea Marine National Monument, the largest marine reserve in the world. When it comes to protecting monk seals in the Northwestern Hawaiian Islands, "Crittercam revelations have shifted the focus from the nearly pristine coral reefs to deep-water habitats," says Dennis Heinemann, senior scientist for Ocean Conservancy. Recent research conducted by Sara Iverson, Dalhousie University, and NOAA has provided information on the key prey in monk seal diets, including two species of snapper. "Now we need to understand fully the impact of the one remaining active fishery in the Northwest Hawaiian Islands on monk seals and their survival." >

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Near right: Greg Marshall with his creation. Center: Tracey Rogers of the Australian Marine Mammals Research Center homes in on her research subject, a leopard seal. Far right: Crittercam as formal attire?

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Crittercam is the brainchild of marine biologist and Emmy-award-winning filmmaker Greg Marshall, who was diving off the coast of Belize in 1986 when inspiration struck. A shark approached, and he was able to watch it for just one tantalizing moment before it turned and disappeared. As the shark moved out of sight, Marshall noticed a remora (sucker fish) riding on its underside. It occurred to him that if only he could attach a camera so unobtrusively, he could readily observe the shark without affecting its behavior with his presence.

Marshall soon built the prototype of what would become a revolutionary research tool. "It took the skeptics a while to realize that this work is not about getting pretty pictures," says Marshall. "The point is science." With some calling him crazy, Marshall persevered, collaborating with many other experts to develop the streamlined system used today. In the early days, Crittercam was the size of a hefty bread loaf; today it is smaller than a can of shaving cream. Ever more sophisticated, it can withstand pressure at 1,000 meters and amplify light in the darkest depths.

Researchers around the world have deployed Crittercam almost 500 times on some 50 species of marine animals including sharks, sea turtles, penguins, and whales. Marshall, director of Remote Imaging for the National Geographic Society since 1995, says the department's team of engineers and technicians is making progress that will exponentially increase Crittercam's ability to collect data. The transition to solid state technology has made the unit more durable and compact; Marshall will soon debut a new version that is half the volume of the previous unit. "The smaller we can make it, the more certain we can be that it is not affecting the animals," says Marshall. "Now we're going for the cigar size we imagined twenty years ago."

Crittercam can be customized for each scientist, recording not only audio and video but also information like depth, velocity, and temperature. And the method of attachment is customized for each species. Suction cups work well on whales and leatherback turtles, while dorsal fin clamps suit sharks best. In many cases, researchers can trigger a release mechanism remotely so they need not approach the animal for retrieval; Crittercam floats to the surface emitting a radio or satellite signal that alerts researchers to its location. Some animals, particularly seals and sea lions, must be captured by carefully trained teams; Crittercam is then attached with a harmless adhesive. In Antarctica, researchers have trained Emperor penguins (*Aptenodytes forsteri*) to wear Crittercam on a harness in an experimental set-up on the ice. While most animals seem to show no outward reaction to Crittercam, some questions remain among scientists as to effects on animal hydrodynamics, maneuverability, and even changes in reproductive performance, among others.

Nonetheless, Crittercam has helped fill gaps in research from the Arctic to Antarctica, providing details about animal behavior ranging from how animals breed to predator-prey interactions. A better understanding of how different species live in their habitat now will underpin future research about their response to growing challenges like trash and fishing debris in the ocean as well as climate change.

In Antarctica, where an environment so inhospitable to humans offers particular research challenges, Crittercam images have revealed stunning behavior in Emperor

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penguins. Research physiologist Paul Ponganis of the Scripps Institution of Oceanography deployed Crittercam on the birds in a controlled setting and says, "It was very exciting, because we'd been working for almost ten years and didn't know the actual feeding behavior of the birds at all." Tiny depth recorders attached to the penguins had indicated that the birds dive deep and come up under the ice, but the researchers were puzzled about this pattern. Why were they approaching the underside of the ice? Were they seeking air through cracks in the ice?

"On the very first films we got back, it just all fell into place," says Ponganis. The birds were not feeding on the bottom, but diving to depths of 30–50 meters, looking up and spotting fish silhouetted against the ice surface, then shooting up to surprise and catch their prey. Ponganis says this strategy is successful for several reasons. First, the penguins use less energy cruising at depth because they are less buoyant under pressure. They can also scan a large area from below while remaining invisible to the ice fish, their black feathers camouflaged against the dark ocean depths.

This kind of basic information on feeding, breeding, and survival provides an extremely useful point of comparison going forward, particularly with regard to conservation. Crittercam has the potential to help take the guesswork out of how animals are beginning to react to climate change. Brendan Kelly of the National Science Foundation says that while polar bears seem to get the most press, countless Arctic species are faced with changes in habitat that will impact their behaviors. "The dramatic and rapid change in ice and snow cover in the Arctic impacts the entire ecosystem," says Kelly. "All the plants and animals that live on and about the ice have tremendously varied relationships with that environment. Understanding how they are adapted now is very important to us in understanding the consequences to them of its loss."

Ring seals (*Phoca* or *Pusa hispida*), for instance, spend the vast majority of their lives under the ice. And when they breed on the ice, they and their pups are concealed in snow caves, unobservable to researchers. (See *Ocean Conservancy* Spring '07) Without a tool like Crittercam, says Kelly, "We have only those inferences we can make through indirect observation."

In the Pacific Ocean off the coast of Baja California lies an area with one of the highest bycatch rates in the world for endangered loggerhead turtles (*Caretta caretta*). Commercial fishermen inadvertently catch about 2,000 a year; all of them die. Wallace "J." Nichols, senior scientist for Ocean Conservancy, says a lot of science has already gone into understanding the situation, but future Crittercam deployments will add an up-close dimension: "Imagine that you've tracked the turtles by satellite, you have an understanding of what they are eating, and you've worked with fishermen to understand when and where they fish. But it's like doing all of that with a blindfold on. Seeing what the turtles are seeing and how they interact with the nets will provide extremely valuable information."

While contributing to scientific knowledge has been Marshall's primary goal, it's no surprise that the exciting research translates into engaging films that educate and inspire the general public. National Geographic researcher and film producer Birgit Buhleier, wife of Greg Marshall, says the animal's-eye view delivers a compelling sense of empathy for viewers.

Buhleier, veteran of more than 100 deployments around the globe, still recalls with awe her first viewing of some especially surprising monk seal footage: "At first, the seal was lollygagging around in the shallows and you could see all the coral and reef fish. Then we saw nothing but blue: open water," she says. The filming continued over many hours. "He kept going and going, and all you could see was the head of the seal he was following out in front. We had no idea where they were headed." Frank Parrish later determined that the seals were swimming out as far as 200 kilometers (120 miles) to feed.

That's the allure of Crittercam: Researchers and movie-viewers alike never know for sure where an individual animal will take them, or what exciting revelations they will see along the way.

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