How Risso's dolphins strike a balance between holding their breath and finding food

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As part of this study, some Risso's dolphins were outfitted with tags to track their movement and depth. Image courtesy of Brandon Southall (NMFS permit #19116). Credit: Monterey Bay Aquarium Research Institute

What do marine mammals eat? It's a simple question with profound implications for marine-mammal conservation and fisheries research. But it can a be tough question for scientists to answer because they can't see what these animals are doing underwater. MBARI researcher Kelly

Benoit-Bird is finding new ways to answer this question using specialized echosounders mounted on ships and undersea robots. In a recent paper, Benoit-Bird demonstrated for the first time how researchers can simultaneously measure the distribution, abundance, type, size, and movement of both predators and their prey in the deep sea.

For this study, Benoit-Bird and her collaborators focused on Risso's dolphins, a common marine predator. Risso's dolphins have historically been considered "specialist predators," eating almost nothing but relatively large deep-sea squid. But the new paper shows that the dolphins can modify their behavior to feed on less nutritious prey such as small fish and small, shallow-dwelling squid.

Such "prey switching" has previously been considered uncommon and inefficient. But Benoit-Bird's study shows that some Risso's dolphins do it all the time. The study also showed that Risso's dolphins regularly forage during the daytime as well as at night—something that biologists had not even considered before.

Risso's dolphins are found in coastal waters around the world. Since they are so common, you would think that marine biologists would already know what, where, and when they eat. But there's a lot that scientists don't know because historically they haven't been able to observe the dolphins hunting deep below the sea surface.

In the last decade, however, scientists have taken a cue from the dolphins themselves, finding new ways to see underwater using bursts of high-frequency sound. Benoit-Bird, a marine biologist and acoustics researcher, has developed echosounder techniques that allow her to see, identify, and measure individual animals underwater—not just large animals like Risso's dolphins, but also their smaller prey, whether it be deep-sea squid or small fishes and krill that live closer to the surface.

This study used two echosounders–one mounted on the research vessel New Horizon and the other on a Remus-class underwater vehicle. Credit: John Calambokidis

As described in two recent research papers, Benoit-Bird and her coauthors used two echosounders—one mounted on a ship and the other on an underwater robot—-to observe Risso's dolphins hunting near Catalina Island, off Southern California. They combined the echosounder data with data from tags attached to a few dolphins, which recorded the animals' movement and vocalizations while they were underwater.

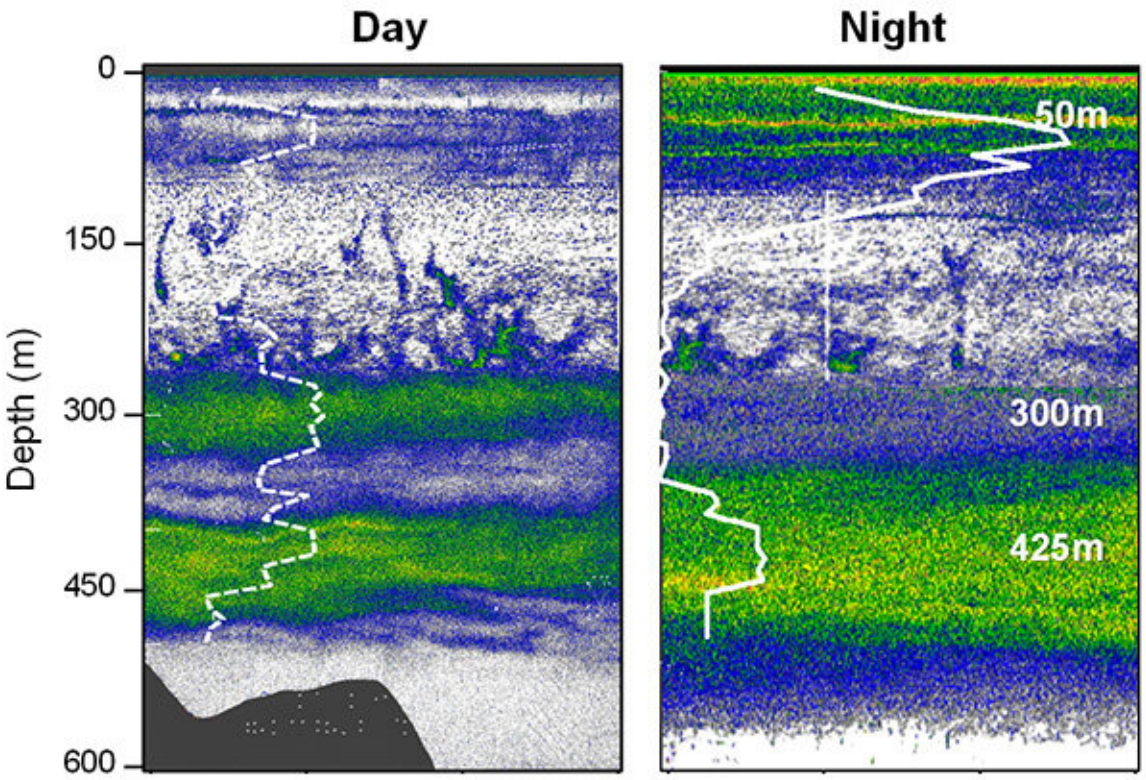
The ship-mounted echosounder revealed at least three layers of animals

(potential prey) lurking at different depths: 1) a shallow layer of animals that stayed within 50 meters (160 feet) of the surface; 2) a layer of animals that lurked about 300 meters (1,000 feet) below the surface in the daytime, but moved up toward the surface at night; and 3) a deep layer of animals (where most of the squid were found) that stayed about 425 meters (1,400 feet) below the surface both day and night.

The echosounder on the underwater robot (an autonomous underwater vehicle, or AUV) allowed researchers to identify the types and sizes of individual prey animals in each of these layers. This allowed them to determine which layers were inhabited by fishes, squids, and/or crustaceans (such as krill). The researchers confirmed the AUV echosounder observations by dragging nets though the different layers.

"By combining all these different research approaches we were able to see in detail the behavior of both predators and prey," Benoit-Bird said. "One thing we found out was that Risso's dolphins don't always forage the way people thought."

Risso's dolphins have historically been considered "specialist predators," eating almost nothing but deep-sea squid. However, Benoit-Bird's research shows that they also eat small fish and (much less often) crustaceans, especially when they are heading back toward the surface after a feeding dive. This means the dolphins, far from being locked into a single type of prey, are able to switch from one type of prey to another, even in a single dive.



These two illustrations show the depths of layers of prey animals (green and yellow bands) during the day and night. The white lines show how many dolphins were observed at different depths (values increase to the right). Credit: MBARI

"Prey switching has generally been thought of as something that happens over months or years," said Benoit-Bird. "The idea that dolphins could do this during a single dive is pretty remarkable. Our research shows that the dolphins plan their dives in advance, but also make decisions quickly during each dive. They're continually balancing their need for food in the depths with their need for oxygen at the surface."

Historically, Risso's dolphins have been thought to hunt at night, when many deep-sea animals swim up toward the surface. In theory, this

would allow the dolphins to spend less time, energy, and oxygen finding and catching prey. However, the new data clearly show the dolphins hunting both day and night. Even at night the dolphins made lots of deep dives because their preferred prey (deep-sea squid) don't migrate toward the surface, but stay in the depths all night long.

The researchers estimated that squid in the deepest layer accounted for over 60 percent of the food energy gained by the dolphins. But smaller, vertically-migrating squid and fish accounted for about one third of their food, especially at night. As Benoit-Bird explained, "It might be easier to feed at night, but you might not get enough food during that time."

During their five- to ten-minute dives, the dolphins sought out layers with the densest patches of prey, particularly squid. But they also used less-dense or nutritious prey to "fill in the corners." The authors suggest that Risso's dolphins in this study area may be "working near the edge of their energy needs, where small gains may be important to the individual's overall success."

The authors note that although "prey switching" has been considered a relatively inefficient method of foraging, it is apparently a key strategy in the survival of Risso's dolphins in this area. The researchers suggest that simple models of prey availability and nutritive value cannot explain the dolphin's behavior because the dolphins are constantly balancing prey availability with their need to breathe.

In conclusion, Benoit-Bird noted, "Because prey in the ocean are patchy and always shifting, I suspect prey switching may be relatively common among marine animals. In most cases we just don't have data from all these different sources to document this."

More information: KJ Benoit-Bird et al. Dynamic foraging by Risso's dolphins revealed in four dimensions, *Marine Ecology Progress Series*

(2019). DOI: 10.3354/meps13157

Patricia Arranz et al. Risso's dolphins plan foraging dives, *The Journal of Experimental Biology* (2018). DOI: 10.1242/jeb.165209