PART 4

Why does a whale's feeding behavior matter?

By Polly Shulman

"The whale behavior is only half the story," says marine biologist David Cade. "If you want to study feeding, you also want to look at how much prey there is, and where is it located, and how is that influencing what the whale is going to do."

To learn about krill distribution, the Stanford team built an instrument called a multifrequency echosounder system. They attached it to the back of their boat. The system is made up of two or more instruments called echosounders. They use echolocation. "It's like how a bat or a dolphin senses its environment," says Cade. Each echosounder sends pings of sound into the water. They bounce off whatever they encounter on their way down, making echos. The echos come back to the instrument. It measures the amplitude (loudness) of the echoes and the time it takes for them to come back. The louder the echo, the more stuff is in the water. The longer the wait, the farther down the stuff is.

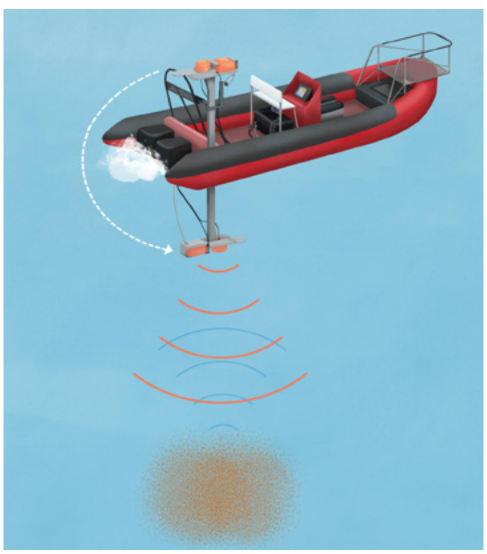

Figure 1. Echosounder. The instrument sends down pings of sound (orange curves). They bounce off whatever they encounter. Then they return to the instrument. It measures the loudness of the echoes (blue curves). It also measures the time it takes for them to return. Louder echoes mean there's more material. Longer waits mean it's farther away. Illustration by Alex Boersma

Different types of objects produce different echoes. That lets the scientists tell krill apart from, say, fish or squid. They move the boat forward, pinging as they go. They create a map of krill depth and density along that path. Think of it as a cross-section of the ocean sliced along the boat's path. (Remember, the path might curve. So you might have to imagine a curved knife doing the slicing.) The map shows the krill distribution and density beneath that path. (By density they mean how many krill are packed together in space.) But the scientists aren't just measuring krill density underneath any old path. What they really care about is how the krill situation looks where the whale is feeding. So they follow the whale as closely as possible. They ping the water with their echosounder to learn what's under the whale's path.

Let's look at the graph we saw in Part 2 showing a single dive. Here it is with prey data layered on. The yellow line shows where and when a whale dives. The red patches are where the krill is denser. And the green dots are feeding events. That's where the whale opens its mouth and takes a big gulp of krill.

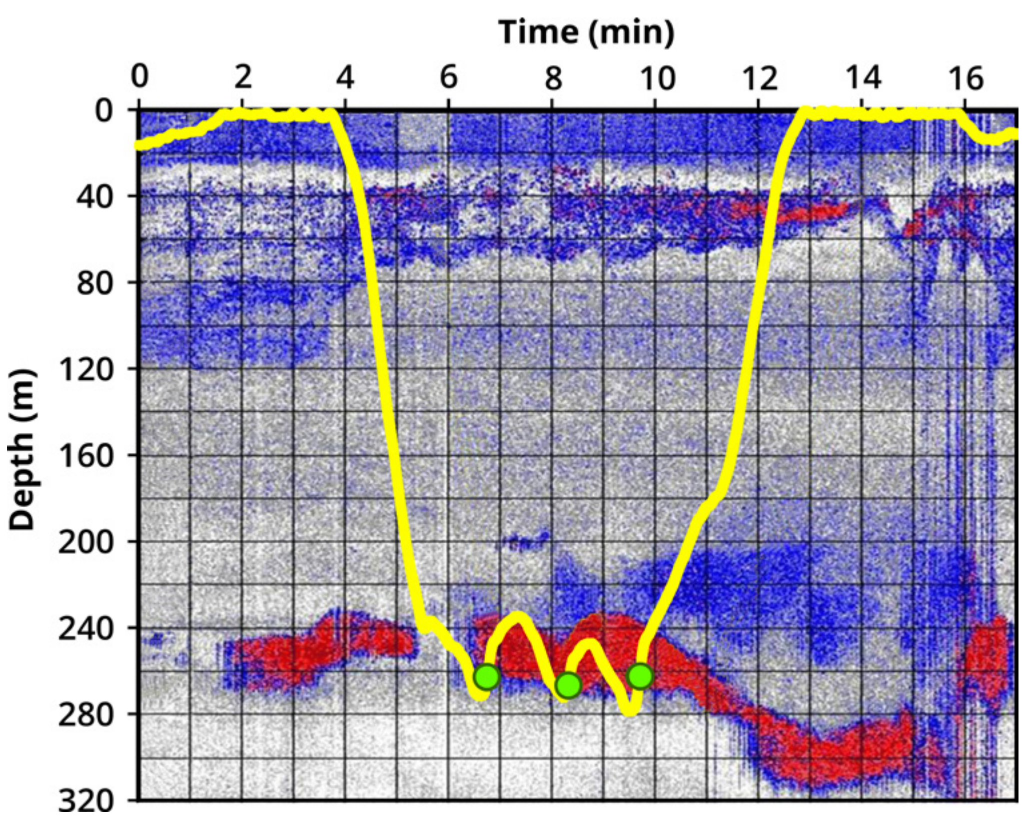

Figure 2. Prey distribution with dive profile. Yellow line: whale dives. Red areas: denser krill patches. Green dots: feeding events. © Jeremy Goldbogen

Goldbogen and his colleagues wanted to find out how prey density and distribution affect the whales' feeding behavior. They analyzed tag data from 55 adult blue whales foraging off the coast of California over the course of several years. This group of whales included 14 animals they had followed in their boat with their echosounder. The whales were looking for prey patches—areas with lots of krill crowded together. Depending on the prey patches, the whales used different foraging strategies. When they found patches with fewer prey, they spent a shorter period underwater. They took fewer gulps (two to three). They returned to the surface before they really ran out of breath. But when they found dense prey patches, they stayed down much longer. They took as many gulps as they could cram in (four to eight). They didn't come up until they really ran out of breath. And a few whales really pushed the limits when they found dense prey patches. They stayed down even longer, so they could eat even more.

Holding their breath for a long time is probably hard for whales. The scientists think it makes it take them longer to refill their oxygen supply at the surface. "But it may be worth it overall if the prey quality is very high," says Goldbogen. So having different foraging behaviors gives blue whales flexibility, the scientists think. That allows the whales to get enough calories for their big bodies and their long migrations.

Going in for the Krill

Krill migrate vertically on a daily basis. Many marine predators feed near the ocean's surface during the day. Those include birds, seals, and some fishes. Sunlight makes food easier to see. To avoid those predators, krill spend their days hiding out far beneath the surface. They form dense patches down there. Most of their predators single out individual krill to target. Dense patches confuse the predators. But krill need to eat too. Their own food source—plankton—lives near the surface. It's sunny up there, so phytoplankton can perform photosynthesis. And zooplankton go there to eat phytoplankton. At night, krill rise to the surface and spread out. There they feed on plankton (both zooplankton and phytoplankton).

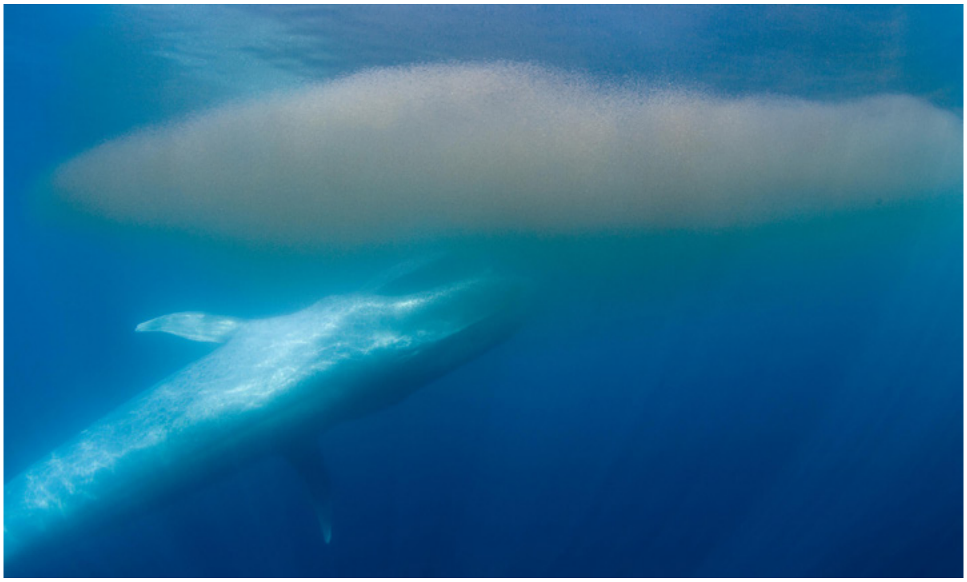

Figure 3. Dense krill patch. A whale opens its mouth to begin a gulp.
© Richard Herrmann/Minden Pictures

Hiding in the deep during the day helps krill avoid their usual predators. But the dense swarms they form down there make perfect meals for roquals. The krill's dense patchiness during the day offers an astonishing concentration of calories. That's just what blue whales need to fuel their gigantic bodies. The whales appear to have evolved foraging strategies that take advantage of it.

Why does it matter?

Blue whales have no predators besides humans. They're just too big! But that doesn't mean they're not vulnerable. Like a lot of whale species, blue whales were hunted in the 19th and 20th centuries. Hunters killed so many that blue whales almost went extinct. Blue-whale hunting has not been allowed for the past four decades, but they still haven't recovered. Their extremely low numbers and slow reproduction make it hard.

Many human behaviors continue to threaten these giants of the deep.

Ship strikes: Blue whales aren't the only giants in "our increasingly urbanized oceans," says Goldbogen. They cross paths with mechanical giants—ships. Modern cargo ships can be ten times the length of a blue whale. Sometimes the shipping lanes go through areas where blue whales feed most often. That's a problem. It increases the chance of a ship strike. (That's when a ship hits a whale, injuring or killing it.) We don't know exactly how often ship strikes happen. "If you have a ship strike and kill a blue whale, sometimes those blue whales end up on the bows of ships, and they can be counted. But probably they sometimes fall off," Goldbogen says. More international commerce means more shipping. And more shipping means more chance of ship strikes.

Figure 4. Close encounter. When shipping routes cross blue whale migration paths, there's a risk of deadly collisions. © John Calambokidis, Cascadia Research

Entanglement: Whales can get caught in fishing gear, such as ropes and nets. "It's very, very difficult and dangerous to try and disentangle a whale. And the result, if the whale can't shed that gear on its own, is typically a very slow death over weeks to months," says Goldbogen.

Pollution: In their huge gulps, blue whales take in everything in the water. That includes pollutants such as microplastics. How much do they retain? How much do they expel? The biologists' research on how whales feed may help them answer those questions. They're using other research methods too. For example, they use crossbows to take small samples of blue-whale blubber. They measure the chemicals in the blubber to see how much plastic the whale digested. “As an animal that lives a very long time and also processes a huge amount of the ocean, they might be sentinels for ocean pollution,” says Goldbogen.

Noise: Humans fill the ocean with sounds such as military sonar and ship noise. The researchers have been studying how those sounds affect blue whales. The whales, they’ve found, sometimes stop foraging when it’s noisy. And noise may have other consequences too. For example, it might disturb whales’ communications by drowning out their calls.

Changes in krill distribution with climate change: As we’ve seen, blue whales depend on a single food source—krill. But climate change is altering the ocean environment, and that will likely affect where the krill live. For example, warmer surface waters may change the way currents flow. That could cause more cold water to upwell. Upwelling is when water moves up from the ocean’s depths to the surface. That cold, deep water has lots of nutrients in it. Upwelling would bring the nutrients to the surface. On the other hand, warmer surface water could keep the cold, nutrient-rich water from flowing up to the surface. Either way, warmer surface waters will change the levels of nutrients at the surface. That’s what phytoplankton need to grow. And krill themselves feed on phytoplankton. They also feed on the zooplankton that eat phytoplankton. So more or less phytoplankton will probably

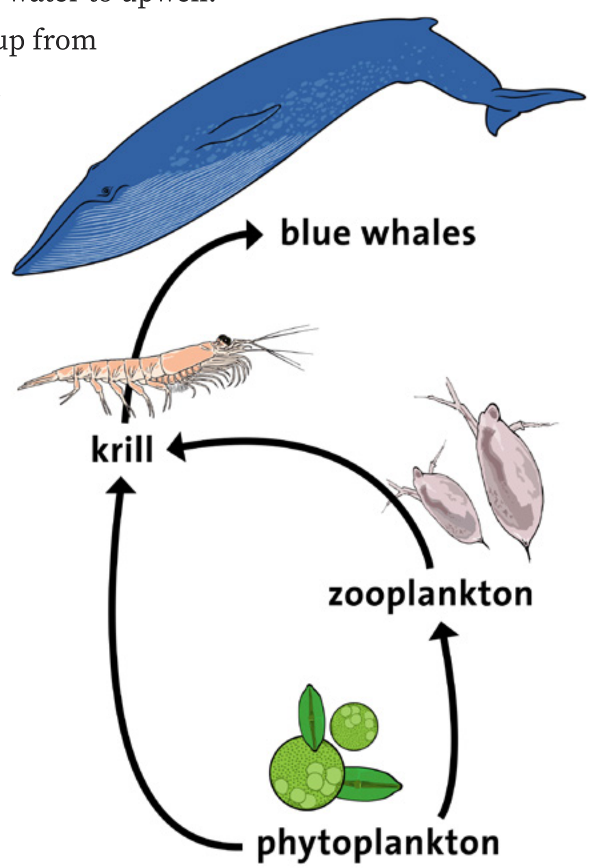

Figure 5. Blue whale food chain. © AMNH

have a big effect on krill. That will have a big effect on blue whales—and on everything else in the food web, says Cade. To make things worse, blue whales count on their memories to find food. What if they return to spots where they expect to find dense prey patches, only to discover that the food isn't there? "Unless blue whales can adapt their thinking or adapt the way they feed, they may be more susceptible to changes in prey conditions," says Cade.

Changes in whale migration with climate change: As the climate changes, so does the ocean. Factors like temperatures, currents, and sea ice are changing. These changes are likely to affect whale migration. So are changes in krill distribution. Whales may take different paths across the ocean in search of food and breeding grounds. That may affect their encounters with other dangers, such as ships and pollution.

The more we know about where and when blue whales eat, says Goldbogen, the better we can adapt our conservation efforts. For example, we can make sure shipping routes avoid prey areas during feeding season. That can reduce ship strikes. We can limit sonar and other noise in the times and places where the whales are trying to feed. That would help the whales get the calories they need to survive.

Blue whales travel vast distances, live long lives, and eat huge amounts. That makes them a valuable source of information about the ocean and its ecosystems. With human activity changing the climate so fast, it's more important than ever to understand how blue whales live right now. Such knowledge will help us anticipate what will happen to them in tomorrow's oceans.

Stop and Think

1. Return to the 12 hour graph that showed data for two different whales on two different days. Knowing what you know now, why do you think the two whales were diving to different depths during the days they were tracked? Explain your answer.

2. Based on what you've learned through the readings, videos, and data analysis, discuss how blue whales have evolved to be the largest animals that have ever lived. Use what you know about their environment, what they eat, and how they eat in your discussion.

3. How might this research be used to help in the conservation of blue whales? What lessons can be applied in studying other ocean organisms?