WHAT CAN WE DO TO ENSURE HEALTHFUL HABITATS FOR RIGHT WHALES?

BY MARK BAUMGARTNER, WOODS HOLE OCEANOGRAPHIC INSTITUTION

Studies of cetacean ecology, foraging behavior, and energetics show what whales need to survive and thrive.

When Michael Moore suggested this particular title, I was initially a little queasy about it, because I don’t know the answer. I don’t know what we can actually do to ensure healthy right whale habitats. I know what we shouldn’t do. We shouldn’t hit whales with ships. We shouldn’t get whales entangled in fishing gear. My work focuses on the whales’ feeding and food distribution, and how we can help promote those things, I don’t know.

But this is a critical conservation question, and I think we really need to think hard about it. So, today, I’m going to talk about what constitutes right whale habitat; where we find right whales, and why do we think they go there.

There is a calving grounds off the Southeast United States, which a small proportion of the population visits. Mostly pregnant females go there to give birth to their calves. We don’t know where the rest of the population goes in the winter.

In late winter and early spring, Cape Cod and Massachusetts Bays are important right whale habitats. Later in the spring, the Great South Channel and the northern edge of George’s Bank become important habitats.

Then, in summer and fall, many right whales visit Roseway Basin on the southwestern Scotian Shelf and the lower Bay of Fundy. We can find right whales in each of these areas, but a significant proportion of the population doesn’t use all of these habitats, especially in the summer, and we don’t know where they go.
The take-home message is that right whales move around a lot and don’t necessarily fit the fairly static distribution model we all have in our heads. Just to illustrate their mobility, we’ve found from satellite-tracking studies that they can actually start at the Bay of Fundy, circumnavigate the entire Gulf of Maine, stop in Roseway Basin, and return to the Bay of Fundy, all in just over two weeks. As another demonstration of their long-range movements, one right whale was sighted in the Great South Channel in May of 1999, sighted again in a Norwegian fjord four months later, and re-sighted in March of 2000 in Cape Cod Bay. Just why it would undertake such a trans-Atlantic migration, we have no idea.

Why do right whales go where they go? There are a couple of classic ideas to explain why animals migrate. The first is reproduction. Certainly, reproduction is the primary reason why pregnant females visit the calving grounds off the Southeast United States.

Another reason to go to a particular place, or avoid a particular place, is predators. The killer whale is probably the right whale’s only predator, and such predation isn’t thought to be very common. So predation is probably not influencing their distribution very much, if at all.

But food is. Because right whales are such large animals and require so much food to maintain metabolism, we think that feeding is the major reason that motivates their movements throughout the northern critical habitats.

Right whales occupy a remarkable ecological niche. They are top predators that feed fairly low on the food chain. They feed on copepods, particularly their primary prey, *Calanus finmarchicus*, a small, rice-grain-
shaped crustacean. Clearly right whales need to eat a lot of *Calanus*. Such zooplankton are more or less at the mercy of the currents, so we think that right whale distribution is tightly linked to the physical and biological processes that promote the abundance and aggregation of this particular prey.

I want to share with you a couple of studies that I was involved in—research that will help you understand what a right whale needs from its habitat. The first study was done in collaboration with the Northeast Fisheries Science Center. I want to acknowledge my colleagues there, Phil Clapham and Tim Cole, and also my doctoral advisor at Oregon State, Bruce Mate, who helped with this study a great deal.

The purpose was to look at the foraging ecology of right whales' temporal scales.

![Deployment](image1.png) ![Sampling](image2.png) ![Tracking](image3.png)

To do this, we used time-depth recorders—similar to the tags that Peter Tyack talked about, only somewhat less functional—and attached them to right whales. There’s only one sensor on this tag, a pressure sensor, which we used to measure the right whale’s diving behavior. We deployed the tags from a small boat with a pole. They’re attached by suction cups. We drop them onto the whale, and they flop off after an hour or two.

Here’s the method we used. Every time a tagged whale surfaced from a long dive, we would mark the resurfacing location, bring over an oceanographic vessel, and drop instruments over the side that measured the vertical distribution of the prey, *Calanus finmarchicus*, and vertical profiles of temperature and salinity in that exact location. Each time that whale surfaced, we’d be right there to put the instruments in the water.

After about an hour and a half, the tag comes off and floats to the surface, and we can pick it out of the water and download the data. We can then relate the whale’s diving behavior to the abundance and depth distribution of copepods.
Baumgartner, M.F. and B.R. Mate.

What we found is that right whales engage in stereotypical dive behavior: They do the same things and over and over again. First, they make a rapid descent from the surface. They stay within a very narrow depth stratum for quite a while. Then they surface to breathe, recover from their dive, and go right back down to do the same thing again.

The reason we were seeing this repeated dive behavior is the vertical distribution of their prey. They’re no dummies. They were diving right to where the food was.

In the lower Bay of Fundy, where we did this study, we were also interested in understanding the coupling between the physics of the water, the distribution of *Calanus*, and diving behavior. The Bay of Fundy has very strong tidal currents. As these tidal currents move over the bottom, they create turbulence and mix everything near the ocean bottom, including temperature, and salinity. I can look at the temperature and salinity data to get an idea of the structure of the bottom mixed layer.

We found that *Calanus* aggregate in a stratum just above the bottom mixed layer, and that’s exactly where the right whales were diving—into the *Calanus* layer.
That’s what right whales were doing at a local level. How did their local behavior translate into how they distributed themselves in space, throughout the Bay of Fundy and Roseway Basin?


That was our next question, and the second study I’d like to share with you. To address this question, we traveled along transects through the study sites, looking for right whales, and from those visual observations, we mapped their spatial distribution.

We collected three years of visual survey data and found that there are some transects where right whales aggregate, and others where they don’t. Why is that? When we analyzed all our data, we concluded that the probability of encountering right whales along a transect was, in part, related to the thickness of the bottom mixed layer there. The thicker the bottom mixed layer, the greater the probability of encountering right whales.
To understand why, let’s think about that stereotypical dive again. When a *Calanus* layer is located at a greater depth, a whale’s transit time is longer, leaving it with less foraging time before it has to resurface. But, if the *Calanus* layer is closer to the surface because the bottom mixed layer is thicker, the whale’s transit time from the surface to the layer is reduced and its time within the *Calanus* layer is increased.

For a filter-feeding right whale, more time in that layer means increased ingestion rates per dive, and increased energy acquired per dive. That’s why we think this layering effect—controlled by the thickness of the bottom mixed layer—influences the spatial distribution of right whales. It appears that they need not only high prey abundance, but they also need the prey aggregated into discrete layers, created here in the Bay of Fundy by the bottom mixed layer and by copepod behavior. These copepods are in a resting part of their life cycle (called diapause), and this probably has something to do with them aggregating both horizontally and vertically into this layer.

What does all this work have to do with right whale conservation? It’s critical for us to understand the natural behavior of right whales in order to assess risks from ship strikes and fishing-gear entanglements. We really need to know how right whales are diving, what their natural diving behavior is, and how that relates to risk factors.

Let me give you just one example. When we were tagging right whales, we had the opportunity to tag a number of females with calves. Reproductively active females dove very much like all the other animals we tagged, except the time they spent on the surface were a lot longer. They took a lot more time to recover from dives. Extra time on the surface places females in greater danger from ship strikes. Coincidentally, the research of Masami Fujiwara and Hal Caswell suggests that reproductively active females represent the portion of the population experiencing the greatest decline in numbers.

One thing we haven’t talked about here is climate variability. We know from a number of studies that large-scale atmospheric forces affect processes in the ocean, including the abundance and distribution of *Calanus finmarchicus*. Given the small population of right whales, we must always worry about the kind of stochastic event that will wipe out the entire population. Accordingly, if some climate variation event were to cause the availability of *Calanus* to plunge, then because of the connections between prey and whale reproductive success, right whales could go right down the tubes.

In a slightly different vein, you’ve heard a number of speakers talk about reproductive success related to nutritional deficiency. This is one of the important things that we need to know about right whale ecology. How does prey abundance and distribution impact reproductive success?

Finally, there’s a lot of talk about efforts to mitigate ship strikes and fishing-gear entanglements. In order to do so, we really need to know a lot more about where right whales go. We need a fundamental
understanding of their ecology to be able to do this. Thank you.

**Biography**

Mark Baumgartner is a biological oceanographer who studies various aspects of cetacean ecology, including prey selection, foraging strategies, feeding ecology, energetics, and habitat selection. His current research focuses on ecological interactions between ocean physics, zooplankton, and baleen whales. Baumgartner is the Ocean Life Institute Postdoctoral Scholar at Woods Hole Oceanographic Institution.