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Whither the North Atlantic Right Whale?

Scientists explore many facets of whales' lives to help a species on the edge of extinction

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For millions of years, the North Atlantic Ocean has been home to right whales. In winter months, they gave birth to calves off the shores of West Africa in the eastern Atlantic and off Florida and Georgia in the western Atlantic. In the spring, they migrated north along the coasts as far as the Gulf of St. Lawrence and the seas north of Iceland to feed in plankton-rich northern waters in summer and fall.

In 1150 King Sancho the Wise granted privileges to Navarre, a Basque province in northern Spain, to charge a duty on whalebone. So began centuries of whale hunting in which tens of thousands of right whales on both sides of the Atlantic were killed.

Today only a remnant of the population survives, no more than 350 whales clustered in calving and feeding grounds along the eastern seaboard of North America. Only occasional right whale sightings in the Gulf of St. Lawrence or in the waters between Iceland, Greenland, and Norway give echoes of their once substantially greater range.

To help a vulnerable population

Since whaling ceased, other related and similarly decimated species, such as the Southern Ocean right whale, have demonstrated spectacular recoveries. Despite seven decades without whaling, however, the North Atlantic right whale population has not rebounded.

Too few are being born. Too many are dying—often in accidents induced by human activities such as shipping and fishing. In 1999, a study by Hal Caswell of Woods Hole Oceanographic Institution, Solange Brault of the University of Massachusetts, and then-MIT/WHOI graduate student Masami Fujiwara warned that unless this dire population trend is reversed, the species is headed quickly toward extinction.

But to know how to help this dwindling population, we need to know much more about the factors preventing its recovery. We need to learn much more about the lives of whales, whose vast watery domain has made them far more difficult and inaccessible to study than terrestrial animals.

"The Hunt" (American School), Courtesy of The Boston Art Club

Slaughtered over centuries

Right whales dwell along coastlines, which has always made them convenient and vulnerable to whalers. The Basque began hunting them in 1150, taxed by royal decree, and continued for nearly 600 years.

By the 1500s, the Basques had exterminated the right whale population on the eastern side of the North Atlantic Ocean, and too few whales remained for worthwhile hunting. In the latter part of the 16th century, Basque whalers expanded their hunting grounds westward, particularly to the waters off southern Labrador.

Then New England shore-based whalers took over, seeking oil and baleen for energy and commercial products. Their catches peaked in the early 1700s, but high-seas Yankee whalers continued to pursue this species whenever opportunity afforded.

Even into the 20th century, right whales were hunted near Iceland and Scotland. The last animals to be taken intentionally were a mother and calf off Madiera in 1967, although they had been protected from hunting since 1935.

Now researchers are working together, using a variety of new techniques and instruments, to study the whales' habitats, health, physiology, endocrinology, and genetics; their mating, feeding, and diving behaviors; their migration patterns and routes; their response to sounds, and their population changes over time. This basic knowledge can provide the foundation to devise efficient and effective management and conservation strategies that can enhance the specie's chances of survival.

Too many deaths

A critical factor in the North Atlantic right whale's population decline is human-induced mortality, caused by collisions with ships and by entanglement in fishing gear. Unlike the recovering Southern Ocean right whale population, which travel in far less populated and trafficked waters, North Atlantic right whales are exposed to gauntlets.

The right whales' north-south migration between calving and feeding grounds sets up a dangerous intersection with intensive east-west shipping traffic through many of the worlds' busiest ports on the North American East Coast. Resulting collisions cause fatal trauma to whales, including propeller lacerations, and fractured jaws, brain cases, ribs, and vertebrae. Ship collisions kill an average of two North Atlantic right whales per year, though more undocumented fatalities probably occur.

East Coast waters are also prime fishing grounds. Right whales run into fixed lobster, crab, and other trap fishery gear, and anchored gill nets. They get fishing lines around their tail, flippers, or in the worst-case scenario, through their baleen plates as they filter water for long periods with their mouths open. As they struggle, the whales' flippers, body, and tail stock can get wrapped in ever tighter circles. Many right whales can free themselves from less severe entanglements, but others can't. They may die rapidly, or swim for months with the gear attached, only to die several months later.

Swimming in traffic

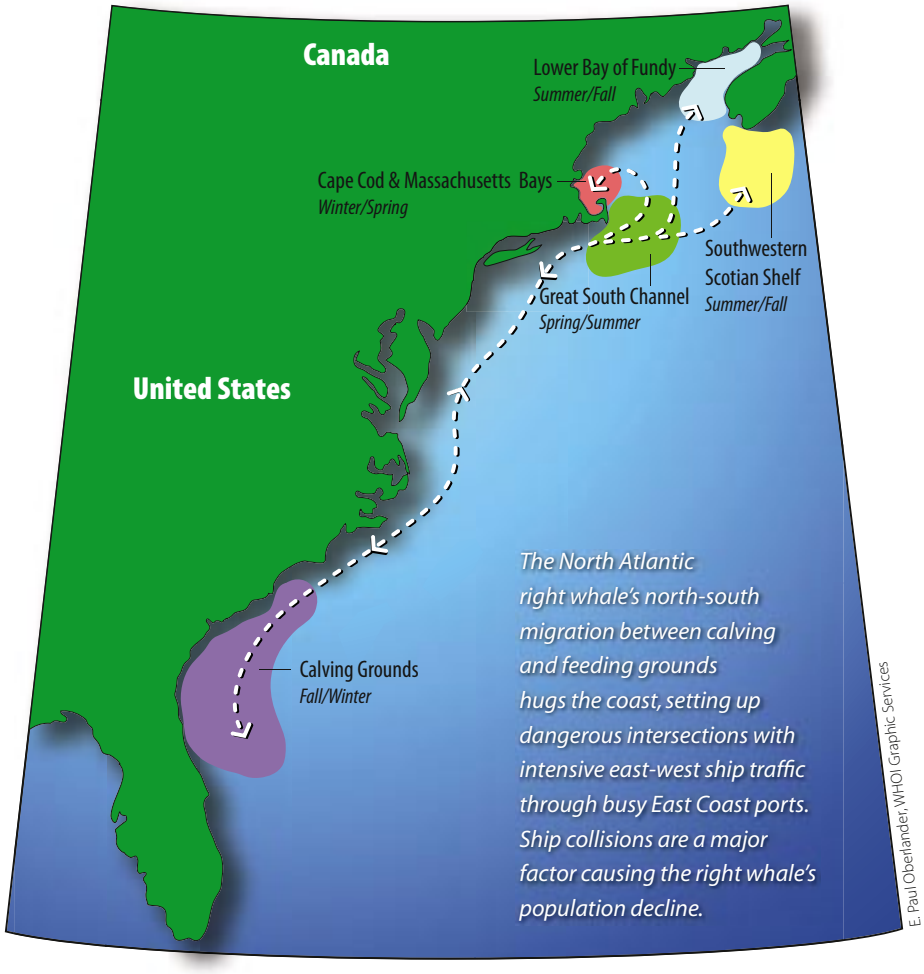
Reducing collisions between ships and whales is enormously difficult. At times, right whales appear to be unable to detect, or at least to avoid, large ships. We know very little about the physiology of whale's ears and what they can hear.

At WHOI, scientists Darlene Ketten and Susan Parks have done seminal research on right whale hearing. To investigate the behavior of right whales in response to noise, WHOI biologist Peter Tyack and his colleagues have developed sophisticated digital, suction-cupped tags that can be placed temporarily and harmlessly on the whales. The tags record the whales' diving, surfacing, and swimming movements in response to ships, natural noises, and alarm stimuli—the latter in the hope that some system to warn whales of approaching ships could be developed.

Are the whales so habituated to ubiquitous ship noise that they don't distinguish ships? Do ships exert hydrodynamic forces as they travel through water, which the whales are unable to evade? More research must be done to answer these fundamental questions.

There has been one significant recent advance in the effort to reduce ship strikes. Moira Brown, of the New England Aquarium (NEAq) in Boston, and a group of collaborators from industry, science, and government in Canada have made it possible to relocate a major shipping lane away from a prime right whale habitat in the Bay of Fundy. In addition, efforts have begun to educate international maritime professionals to the risk of whale-ship strikes, and ships traveling

Migratory routes of the North Atlantic right whale



E. Paul Oberlander, WHOI Graphic Services

in right whale habitats in U.S. waters are now required to report whenever they are transiting such waters.

Lethal entanglements

There are only two ways to mitigate the fishing gear problem: to reduce the number of whales entangled, or to disentangle animals seen trailing fishing gear.

Disentanglement efforts, led by the Center for Coastal Studies (CCS) in Provincetown, have at times been spectacular but will never be a solution. Numerous animals have been successfully disentangled, using modified small-boat whaling methods to slow down the animals and make strategic cuts in entangling gear. But despite heroic efforts and the development of physical and chemical restraint systems, a significant number of cases have been intractable: The whales were impossible to free, and they died.

Even the best disentanglement technique will never remove the ongoing flow of new cases. Many of these are only evident in new rope scars on previously unscarred individuals. Avoiding entanglement is the true solution and a critical current research focus.

Researchers in academia, government, and industry are all seeking modifications to fishing gear that attempt to decrease or eliminate entanglement. These include developing weak links in fixed fishing gear so that lines break rather than obstruct a colliding whale, and changing the buoyancy of lines to reduce their exposure in areas where whales dive. Other potential modifications include gear with less friction to reduce abrasion and laceration with whale flesh, and with better visibility, so that whales have a better chance of avoiding them. Some seasonal fishing regulations have also been established with the aim of minimizing encounters between right whales and fixed fishing gear.

None of these efforts has yet decreased the mortality rate. Most are controversial because commercial fishermen question the value of required changes and the selection of restricted fishing areas.

Photo courtesy of the New England Aquarium

Scientists distinguish individual right whales by black horny protuberances on their heads, called callosities, which are highlighted by intensely colored whale lice.

Distinguishing a "face" in a crowd

We know how many North Atlantic right whales exist, where they go, and even the life histories of individuals in the population because of four decades of research. This has included extensive efforts to photograph the population in boats and airplanes, and painstaking record-keeping.

WHOI biologists Bill Schevill and Bill Watkins launched modern-day studies of the North Atlantic right whale population in the 1960s with aerial surveys of whales in Vineyard Sound, Cape Cod Bay, and the Great South Channel off Nantucket. They and other whale research pioneers began to distinguish individuals by using distinctive, black horny protuberances, called callosities, on the whales' head. The callosities are highlighted by intensely colored whale lice.

Photographs of callosity patterns and other distinctive body scars allow us to recognize individuals. Over the past 25 years, colleagues at the New England Aquarium and the University of Rhode Island, led by Scott Kraus and Bob Kenney, have catalogued right whale sightings from a broad consortium of institutions and individuals to build uniquely detailed databases that include individual histories for the majority of whales in the remaining population.

These databases include information on individual whales' sightings, feeding, calving, toxic chemical exposure, genetics, and, sadly, deaths. This shared database provides researchers with essential, fundamental information that undergirds most ongoing North Atlantic right whale research.

Callosity patterns, like fingerprints, give researchers the ability to identify and keep track of the life histories and movements of individual whales.

Photo and drawing courtesy of the New England Aquarium

Too few births

Part of the shortfall of North Atlantic right whale population growth is a reproductive failure: Not enough calves are born.

Over recent decades, researchers have observed several disturbing trends: Mature females are having a declining number of calves. About 25 percent of mature females have never been sighted with calves. The age at which females have their first calf appears to be increasing. Intervals between pregnancies have increased. Overall, the species' calving rate is about one-third what it should be, which is all the more distressing in an already small population subjected to other stresses.

Once again, the inherent difficulties of tracking, monitoring, and sampling such large animals over a vast, remote region has limited our ability to understand why the North Atlantic right whale reproduction is so inconsistent. Suspected, and probably interrelated, causes include disease, pollutants, and poor food supplies.

Only recently, Rosalind Rolland at NEAq and colleagues have developed pioneering techniques to analyze whale fecal samples to obtain previously unobtainable biomedical data on whales. These are providing a novel, non-invasive window to reveal the whales' genetic makeup and their levels of contaminants and hormones (both reproductive and stress).

These biomedical data, along with other studies of whale body conditions and nutrition, will help assess the myriad factors that may be compromising right whales' health and ability to reproduce. Recent studies by my colleague Carolyn Miller and I, for example, show evidence that Southern Ocean right whales may have higher birth rates than their northern cousins because they have better food resources and higher body fat reserves.

Protecting feeding grounds

The issue of nutrition leads directly to questions of whale food supplies: Where they are and how they might be protected?

Much of the research and management of the North Atlantic right whales in U.S. waters today is driven by the federal Endangered Species and the Marine Mammal Protection Acts. Independent, federal, and state agencies currently carry out large-scale annual surveys to count right whales and find where they go in which season.

The surveys show year-to-year variation in the whales' travel patterns, which scientists think are governed by differences in food availability. Whales, like other animals, follow their food. They feed on dense patches of zooplankton, especially small crustaceans called copepods. They strain mouthfuls of water through a fibrous filter in their mouths, known as baleen, which retains copepods that the whales swallow.

Right whales today feed in the Great South Channel, Cape Cod Bay, the Bay of Fundy, and the banks south of Nova Scotia. But there must also be other important feeding areas of which we are unaware.

Stormy Mayo of the CCS has demonstrated a critical need for conserving habitats where copepod patches are dense, such as in Cape Cod Bay in the winter and early spring. The location of these patches is probably determined by myriad factors: local phytoplankton productivity, the presence of other copepod predators, local oceanographic features, such as water temperatures and fronts separating different water masses—all of which may, in turn, be affected by climate changes from year to year, or over decades.

WHOI biologist Mark Baumgartner and colleagues have begun to explore the

Courtesy Florida Wildlife Research Institute, taken under NOAA-Fisheries permit 932-1489 with authority from the U.S. Endangered Species and Marine Mammal Protection Acts. Photographer: Katie Jackson (FWRI).

LIBERATING LEVIATHANS—A rescue team from the Center for Coastal Studies attempts to free a right whale with fishing lines wrapped around it. Fishing gear entanglements kill a significant number of North Atlantic right whales.

Photo courtesy of the New England Aquarium

GENERATIONS NOT FORTHCOMING—Fewer new North Atlantic right whale calves are being born, threatening the species' ability to survive. Scientists are seeking to understand the reasons for their low and inconsistent birth rate, which may be linked to pollution or declining food supplies.

factors that govern where, when, and why whale prey aggregates. Using tags and sensors, they have been collecting and correlating data on copepod abundances, oceanographic conditions, and whale feeding and diving behaviors. This fundamental knowledge on whale habitats is an essential first step to devise strategies to manage and protect them.

"Whale-safe" consumer products

Current and planned research at WHOI and elsewhere are aimed at several research fronts. (See "Scientists Muster to Help Right Whales.") Seeking ways to reduce human-caused deaths, researchers are analyzing the factors that prevent right whales from avoiding ships and working to develop whale-friendly fixed fishing gear. They are gaining better understanding of the role of nutrition, chemical exposure, and infectious agents in reproductive success. And they are using computer models of right whale demographics to pinpoint the most critical factors, among many, that threaten the species' survival. This information, in turn, helps identify the most effective conservation strategies.

Will all this effort result in saving the North Atlantic right whale? Possibly. It depends largely upon our society's will to do what it takes to reduce human-induced whale deaths. This will involve very hard decisions. Major maritime industries will have to alter their practices in a way that our consumer-driven society is loath to allow.

An important and successful model to follow is that of the tuna fishery in the eastern tropical Pacific in recent decades. Tuna fishers used to target tuna by setting their nets around groups of dolphins. Overwhelming public opinion against this practice made the cost of "dolphin-safe" tuna acceptable.

If we can develop the same willingness to pay for right-whale-safe shipping and fishing practices, then the North Atlantic right whale has a chance to survive. The job facing the science and engineering community is to develop the tools and knowledge necessary to enable a "whale-safe" stamp on all lobster claw bands and other fishing products and on products shipped in containers and tankers to North Atlantic ports.

It's a Herculean task, and could lead to much higher consumer costs. But the alternative is acceptance that humans exterminated a great species that plays powerful roles in human history and the natural history of the ocean.

Michael Moore grew up in England, where he trained as a veterinarian. He began his career as a marine mammalogist, concurrently in Newfoundland and the Caribbean. Moore then pursued his wife-to-be, Hannah, back to her New England home. He spent two years acquiring U.S. veterinary licences, before gravitating to Woods Hole in 1985, where he was first at the Marine Biological Laboratory and then at WHOI. As a WHOI/MIT Joint Program student in the laboratory of John Stegeman in the Biology Department, his research first focused on tumors in flatfish exposed to Boston Harbor sewage. His interest therein endures, but since becoming a Research Specialist at WHOI, it has expanded to encompass other man-made impacts on marine vertebrates such as right whales and other marine mammals. He is also the veterinarian for the Cape Cod Stranding Network, which responds to single and mass strandings of marine mammals on Cape Cod.