

RIGHT WHALE NEWS

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Are Right Whales Starving?

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(Editor's note: On March 8, Debbie MacKenzie (debimack@auracom.com) posted a message on a fisheries science email discussion list (FISH-SCI@SEGATE.SUNET.SE) to present her hypothesis that the root cause of many of the present problems seen with marine populations is that the oceans are starving - that over the centuries commercial fishing has removed so much nitrogen from marine ecosystems that overall ocean productivity has declined and all marine populations are suffering from food limitation. Over the next couple of days, an interesting exchange of ideas, discussion and criticism followed. As one line of supporting evidence, MacKenzie claimed that northern right whale populations have declined because they are starving to death, an assertion apparently based on news stories, press releases and the EWS field reports posted on WhaleNet. Dr. Robert D. Kenney subsequently posted a contribution to the discussion to comment on what he feels were misconceptions and over-simplifications both of MacKenzie's hypothesis and in the ensuing discussions. The following article is an expanded and revised version of his response. The italicized items are paraphrased summaries of points made by others in the course of the email discussions. To obtain a copy of all 25 pages of the discussions e-mail Dr. Kenney at rkenney@gso.uri.edu)

Are the right whales starving?

If what is meant by "starving" is that individuals are dying because of insufficient food, the short answer is no. In the North Pacific in 1999, there were many more strandings of gray whales than in previous years, and many of those animals were clearly emaciated and had apparently starved. Unlike that situation, I am not aware of a single North Atlantic right whale mortality where starvation has been implicated as a primary or contributing cause of death. Caswell et al. (1999) estimated based on mark-recapture modeling that mortality rate during the 1990's significantly increased over the 1980's. To date, no one, to my knowledge, has suggested that the increase in mortality estimated by their model is due to starvation. Food/energy limitation has been hypothesized as one of

the potential mechanisms which may be affecting reproductive rates (more details below).

Right whale abundance and/or survivorship has been steadily or continuously declining for an extended period.

The Caswell et al. (1999) modeling study concluded that present mortality rates have substantially increased over those during the 1980's and that the population is declining at 2.4% per year. However it is not quite correct to say that there has been a steady or long-term decline in survival. In fact, their analysis confirmed the earlier estimate by Knowlton et al. (1994), using a less sophisticated analysis method, that the population was growing at 2-3% in the 1980's.

Why haven't right whales recovered since their protection from whaling in the mid-1930's?

This is not a valid question, since there are absolutely no data on the abundance of right whales in the North Atlantic at the time the first International Convention for the Regulation of Whaling was ratified. The first available estimate of abundance was about 1980. The population was slowly growing during the 1980's, and, in fact, there seemed to be an increasing number of right whales along the Florida coast noted by observers during the 1960's and early 1970's (Layne, 1965; Caldwell & Caldwell, 1974). If there were only five or ten North Atlantic right whales in 1935, then the population has recovered fabulously. If there were a thousand, they've gone right down the drain.

The right whales' very low reproductive rate makes them extremely vulnerable.

Right whale populations may be able to reproduce and grow faster than the conventional wisdom might predict. Under optimal conditions, females can mature as young as 5-7 years old and produce a calf every 2-3 years. Some Southern Hemisphere populations are growing at 7-9% per year. This is obviously much slower than species like codfish or mice, but higher than in many odontocetes, elephants or humans.

Despite very low calving rates, the EWS surveys frequently report dead calves. The cause of death in calves is generally undetermined; since ship strike and entanglement can be easily ruled out, starvation is the likely cause.

Approximately one-third of known right whale mortalities occurs in neonates (Kraus, 1990). However, that percentage was estimated during the 1980's, at a time when the population was known to be increasing and prior to the recent decline in reproduction. A high rate of mortality in the first year of life is the usually expected pattern in wild animal populations. In addition, the frequency of neonatal mortalities in the Georgia-Florida calving ground, where the EWS surveys are flown, largely reflects the numbers of calves born. The highest numbers of neonatal mortalities have occurred in the years when the numbers of calves born were high.

Another third of known mortalities can be definitely attributed to ship collisions and fishing gear entanglements, and the final third are those in which no cause of death can be determined. The proportion of human-related mortalities may have increased in recent years. Considering the number of carcasses which are never recovered, human-caused mortality is a very significant impact. Regardless of any other sources of mortality or food stress, this is one place where active management can (and MUST) be applied.

Right whales are showing clinical evidence of skin lesions and disease caused by malnutrition.

There appears to be an increase in the occurrence of a variety of skin lesions, based on photographic evidence being studied at the New England Aquarium. There has yet been no connection demonstrated between that increase and nutritional stress. Malnutrition would be just one potential contributing cause of increasing skin lesions, which should be a testable hypothesis using Michael Moore and Carolyn Miller's ultrasound blubber thickness measurement method.

Competition from other species which feed on zooplankton, such as sei whales, basking sharks, mackerel and herring, is not a reasonable hypothesis for reduced prey availability for right whales, since the other species are too rare and/or declining in abundance.

The last available estimate suggests that there are about two thousand sei whales in the Gulf of Maine/Nova Scotia stock which overlaps in distribution with right whales. But those data are over twenty years old, and one might expect the population to have increased by today. It is clear that there is a significant overlap in prey species between right and sei whales, as well as a distributional overlap in some habitats and years. There have been no published estimates of abundance for basking sharks in the western North Atlantic, although we did derive a crude estimate of about 10,000 in continental shelf waters between Maine and North Carolina from the CETAP aerial survey data (using some possibly questionable assumptions). Herring and mackerel standing stocks in the Gulf of Maine/Georges Bank region are currently at or near all-time highs. Of course, fisheries biologists have only been conducting stock assessments for the last century or so, so there are no data for what stocks may have been when right whales were abundant several hundred years ago. That being said, I think that the current evidence for competition being an important impact on right whale foraging success is, at best, tenuous and speculative, although there may be some data in NMFS and DFO fisheries assessments which could be useful for hypothesis testing.

Long-term declines in productivity (whether or not caused by nitrogen removal) have reduced plankton abundance, reducing prey availability for right whales.

A point of clarification first—there seems to be a common misconception that right whales (and other baleen whales) are herbivores, feeding on phytoplankton. For that reason, I always make it a point to specify zooplankton rather than simply plankton when

talking about right whale food. There is no evidence for any long-term decline in productivity which might impact right whale feeding. Their preferred prey includes the older juvenile stages (copepodites) and adults of *Calanus finmarchicus*, which is the dominant zooplankton species in much of the North Atlantic. While there is some evidence of a decline in *Calanus* abundance in the eastern North Atlantic, a similar pattern has not been seen in the western North Atlantic. In fact, there has been an apparent increasing trend in total zooplankton abundance off the northeast U.S. since the early 1980's. For a right whale, however, the abundance of total zooplankton or of *Calanus* specifically over broad areas of ocean is relatively unimportant. What a right whale "cares" about is the concentration of copepods in patches the size of its mouth opening. That concentration must be exceptionally high in order to pay back the high costs of metabolism, locomotion, migration, foraging and reproduction—the highest zooplankton concentrations measured in the North Atlantic have been obtained by sampling near feeding right whales. The most important factors in determining the location and value of appropriate feeding grounds for right whales are physical-oceanographic concentrating mechanisms rather than biological productivity. Changes in circulation patterns are therefore more likely to impact right whale foraging success and nutritional status than alterations in nutrient supply, phytoplankton productivity or zooplankton abundance.

Why has the number of right whale calves decreased?

During the 1990's the most dramatic observed changes in the western North Atlantic right whale population have been in reproductive biology. The number of calves born has declined markedly (only one this year!) and there has been a large increase in the average interval between calves. In 1980-1992 the average inter-birth interval was 3.7 years (the modal interval is three years—one each for pregnancy, lactation and replenishment of energy stores). The average for 1993-1998 is over 5 years, with very few 3-year intervals and with some females apparently dropping out of the reproductive pool entirely. In a long-lived species with the expectation of multiple future reproductive opportunities, one would expect that energy allocation strategies would favor survival at the expense of reproduction. A decline in food availability for right whales might be expected to manifest itself first in reproductive effects, including an increase in the time needed to accumulate the surplus energy needed for pregnancy and lactation. In other words, a food shortage that isn't severe enough to cause actual starvation could still impact reproduction.

We can now go back to the question of supposed lack of recovery since 1935 from some unknown but possibly low abundance. Surprisingly, some recent results of genetic studies are now suggesting that the population has been maintained at a low level for a relatively long period, perhaps since the episode of intensive Basque whaling in Newfoundland in about 1530-1700. If that is true, a reasonable inference is that the population undergoes cycles of growth and decline (which may be more reasonable than expecting that the population has remained stable at about 300 whales for 300 years or more). My own research has shown correlations between the number of calves born and two different

atmospheric cycles over the last 20 years, and we know that those cycles have been occurring for centuries.

In my humble opinion, the different lines of evidence are converging on a logically-consistent scenario which fits both the long-term and recent trends. The Basque whaling in Labrador and Newfoundland, plus American and Canadian pelagic and shore-based whaling (the last of which continued into this century) wiped out most of the population, leaving only a small remnant at the southern end of the original range. (One of the most interesting questions to me is why right whales have never re-occupied what was probably the core of their range in Newfoundland/Labrador waters, which must have been good habitat if the Basques could kill some 20,000 of them in a century or two. I suspect that it is due to strong matrilineal habitat fidelity, where animals return year after year to the feeding grounds that they learned from their mothers during their first year of life.) In that peripheral habitat, the population has undergone cycles of growth and decline, probably related to coupled atmosphere-ocean patterns, e.g., the North Atlantic Oscillation (NAO). (The NAO is a pattern of alternating phases in atmospheric pressure between Iceland and the Azores, leading to different patterns of jet stream trajectory, winds and weather at both extremes of the cycle—van Loon and Rogers, 1978; Hurrell, 1995; Kenney, in press). The short-term switch in the early 1990's from a growing population with 3-year calving intervals to a declining one with 5- or 6-year intervals corresponds to major shifts in habitat use and to a shift in phase of the NAO. Beginning in about 1993, the whales abandoned their summer feeding grounds on the Nova Scotian Shelf, and many more crowded into the other known summer habitat in the Bay of Fundy. Interestingly, the few females who have calved in the last couple of years are whales who don't summer in the Bay of Fundy.

On top of this hypothesized decadal-scale cycle of alternating stretches of good years and bad years, then overlay continued anthropogenic mortality. At first it was opportunistic whaling (it may not have been economically feasible to target right whales, but it still paid to kill any which were encountered during a sperm-whaling cruise), which we have replaced in recent times by running them over with ships and drowning them in fishing gear. The population has never had a chance to recover. There's nothing we can do to change the North Atlantic Oscillation, but we can minimize, or even better, eliminate the mortality to give them a fighting chance.

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