Algae, Krill, Gulls and the Península Valdés Southern Right Whale Die-Off

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Introduction

In the southern right whale’s name is its tragic story. Highly regarded by South American whalers as the “right whale to hunt” because of atypical coastal breeding, slow swimming, and post-mortem floating due to its high blubber content (Briga de Morais et al 2016: 1), the southern right whale (*Eubalaena australis*) saw its historical population of about 60,000-100,000 individuals be depleted over the course of the 17th to 20th centuries to just 7,000 individuals in 1997 (NOAA 2012). Whale oil and baleen, the strainer-like plates that facilitate filter-feeding of zooplankton, were used for “corsets, buggy whips, and other contrivances” (National Geographic).

The southern right whale (hereafter referred to as “right whale,” excluding the northern subspecies) has managed to mount a comeback from the edge of extinction. International protection from whaling came in 1935, and in 1984 the Argentine National Congress proclaimed the right whale a national monument (NOAA 2012). The International Union for Conservation of Nature Red List counted 1,600 mature females in 1997 and double that number in 2007, the highest such population numbers in three generations that led to classification as least concern (IUCN Red List 2013). This number of individuals was projected to sustain up to a 7% annual population growth rate (NOAA 2012). However, the Convention on International Trade in Endangered Species lists the right whale as Appendix I as threatened with extinction, taking into consideration the small percentage to which the historical population has been recovered, as well as a slow breeding cycle in which females mature in year ten and bear only one calf in a yearlong pregnancy (National Geographic).

The precarious position of the right whale has been seriously exacerbated by historically unprecedented high mortality events at Península Valdés (PV), Patagonia, Argentina, a
UNESCO World Heritage designated site for its role as major breeding waters (UNESCO 1999). Over the course of three decades from 1971-2003, 148 dead whales were reported at PV; 605 dead whales were counted from just 2003-12, or 82% of right whale mortality at PV over the last four decades occurred over just an eight year period (Rowntree et al *Mar Ecol Prog Ser* 2013). Most devastating was the fact that 538 of the 605 were first-year calves – in just 2012 alone, 113 individuals representing 1/3 of the year’s calves born at PV died (World Conservation Society 2013), with an average of 90% annual calf mortality (NOAA 2012). These staggering numbers threaten profoundly the slowly reproducing right whale. The cumulative effect of losing female calves who won’t mature has long-lasting impact, with Rowntree speculating the annual 7% growth rate as being slashed by at least a third (World Conservation Society 2013).

Out of the many proposed mechanisms for this devastating mortality event discussed in my literature review, three emerged as some of the most probable contributors. I then sought to test the following hypotheses:

I. Biotoxins and/or other infectious disease(s);

II. Depleted availability of krill;

(Rowntree et al 2013)
III. Attacks by kelp gulls are responsible for the great southern right whale die-off.

**Biotoxins and/or Infectious Disease**

The first hypothesis to be investigated is that biotoxins and/or other infectious disease(s) are the causative agents for the right whale die-off at Península Valdés.

Biotoxins have been found to be the responsible for the majority of marine mammal mortality events over the past two decades, particularly in baleen whales (Bertellotti et al 2010: 10, Geraci et al 1989: 1895, Doucette et al 2006: 303). Two algae genera are implicated in such events, *Alexandrium* and *Pseudonitzschia*, which produce the biotoxins saxitoxin (STX) and domoic acid (DA) which cause lethargy, disorientation, seizures, and death.

Península Valdés has a history of algal blooms in these two genera. In the 1980s, several human fatalities occurred due to contamination of shellfish harvested from the area by *Alexandrium tamarense*, and “very high” risk levels of *Pseudonitzschia* have also been recorded (Wilson et al 2016: 427).

An extensive study on 118 tissue samples from 50 dead calves and one adult from PV found that only 2 out of 108 samples had detectable levels of domoic acid, and just 4 out of 105 samples had saritoxin-like activity. (Wilson et al 2016: 431-2). These results came in spite of the fact that high-risk levels of both algae genera were recorded from 2007-2013, the same time frame in which right whale mortality spiked. In addition, large magnitude algal blooms occurred more frequently (68%) in Golfo Nuevo than Golfo San Jose, and algal frustules have been found in right whale stool. Therefore, it can be concluded that although biotoxins are not the primary causative for the die-off, they may be a contributing factor.
Moving past biotoxins, another possible die-off cause to investigate is the role of other pathogens. Another extensive study at PV autopsied 212 whales. Some interesting causes of death were found (trauma/lacerations n=5, pneumonia n=4, myocarditis n=2, meningitis n=1), but proved to be more the exception than the rule as 198 whales did not have an identifiable cause of death. In addition, tests for some known culprits including cetacean morbillivirus, canine distemper virus, influenza A, apicomplexan protozoa, Brucella spp., and Toxoplasma gondii all came up negative (McAloose et al 2016: 17).

Neither biotoxins nor some other pathogen has been implicated as the driver for the right whale die-off to date, although it remains speculated that some pathological force may be playing some role. Therefore, my first hypothesis is shown to not be supported.
Krill Depletion

My second hypothesis was that krill depletion, the right whale’s primary food source, is causing the die-off.

At another right whale breeding site in southern Brazil, a positive correlation was demonstrated between the number of calves at the site and krill densities at the post-birth feeding waters off South Georgia (Seyboth et al 2016: 4). In addition, anal-dorsal region blubber thickness, an indicator of food availability, was significantly greater in years with low calf mortality than high mortality years (Thomas et al 2013: 3).
Researchers have also examined calving at Península Valdés for correlation with changes in sea surface temperatures (SST) with El Niño events. These researchers found that El Niño SST anomalies had a strong relationship with right whale calving after a lag of six years, a long-
term cycle that is consistent with similar El Niño impacts on penguin and seal populations (Leaper et al 2006: 291). The most commonly recorded breeding interval for the right whale is three years, with a year-long pregnancy, year-long lactation, and year-long recovery to build fat reserves (Seyboth et al 2016: 5), and Leaper et al speculated that longer breeding intervals of four to five years have been observed because of SST impacts on krill populations. However, this study could only assume, and not demonstrate, that krill availability was the driver for the relationship between SST anomalies and breeding success.

Krill depletion cannot be linked conclusively to the die-off, in part because the global climate change that influences krill populations is delayed by over half a decade. However, it is apparent that krill depletion will significantly impact right whale population, as models suggest a 1 degree Celsius increase of surface sea temperature over the next 100 years could destroy the Antarctic krill population by 95% (Murphy et al 2007: 3057). It’s possible that global warming is already negatively impacting krill, and the effects are just now being felt to some degree. In addition, research is still ongoing to demonstrate that krill depletion in particular is the driver for delayed breeding intervals. Therefore, my second hypothesis is partially supported.

*Kelp Gull Attacks*

My third hypothesis that I tested was that attacks by the kelp gull (*Larus dominicanus*) are causing the right whale die-off.
Kelp gull attacks are modern phenomena, first observed in 1984 but increasing in frequency five times by 1995 (Rowntree et al 1998). The behavior, in which kelp gulls land on the backs of surfacing right whales and gouge a deep lesion to eat skin and fat is seen exclusively at Península Valdés. The gulls almost exclusively target mother-calf pairs (81% vs. juveniles/adults), with 90.4% attacks on existing wounds (Sironi et al 2009). Similar behavior has been observed in Namibia, with kelp gulls gouging out the eyes of newborn Cape fur seals (Bittel 2015). The cost of kelp gull attacks is manifold, with researchers quantifying a 20% reduction in precious rest time for mother and calf, 24% of daylight hours spent evading gulls with significant metabolic stress, reduction in suckling, and expenditure of high amounts of energy performing evasive maneuvers (Rowntree et al 1998, Thomas et al 2013).

A possible mechanism for the origin of kelp gull attacks on right whales has anthropogenic influence. Rowntree et al in 1998 proposed that the opening of fish processing plants in the region led to an explosion in the gull population, which led to heightened
competition for food and some gulls to innovate. However, more recent papers have found that nearby Golfo San Matias has enough fish refuse to support up to 30,000 gulls and there are only 8,500 resident pairs (Sironi et al 2009). In addition, the behavior seems to be perpetuated by a subset of specialists who pass on the learned behavior (20% of perpetrators were observed to be juvenile), not a general tactic used by the broader population. The fact that attacks are frequently on the same wound seems to imply that the gulls favor the taste of the blubber, not the skin, possibly because of nutritive benefits that supplement their diets.

*Kelp Gull and Southern Right Whale at Península Valdés*
In the study that sought to find evidence of pathological disease in 212 dead wales, researchers found gross skin lesions in 80 whales, with 36 having confirmed ante-mortem trauma (McAloose et al. 2016: 27). One calf with gull attack wounds died of sepsis, but tests in other samples for bacteria/viruses came back negative. The mechanism of death by gull attack proposed by the researchers was fluid loss via lesion into the vascularized hypodermis. However,
the percentage of whales who could have possibly died of kelp gull attack could not be
demonstrated to be statistically significant in this particular study.

Kelp gull attacks have a profound effect on right whales at their most vulnerable, during
calving at what is supposed to be a peaceful site. It’s evident that the attacks are impacting the
whales, and the degree and mechanisms for that impact are still being studied. Therefore, my
third hypothesis was also partially supported.

**Conclusion**

The mass mortality event at the Península Valdés breeding waters is not understood by
researchers, as demonstrated by the most current literature referenced in this paper.

Biotoxins and infectious disease, both readily detectable in necropsies, had no evidence
of being the culprit in the die-off. This is in spite of high risk levels of biotoxin-producing algal
blooms in the region – a possible explanation is that the metrics used for biotoxin levels are
scaled for humans, and it seems that the much-larger right whale is able to tolerate the blooms.

Depletion of krill, thought by many to be the primary food source for the right whale,
may be contributing to the die-off. Recent global climate changes have been shown to have a
relationship via El Niño to whale population dynamics, but a mechanism via krill population is
only assumed. Correlation with blubber levels and overall trends of krill depletion with global
warming expected to take place over the course of the century heavily suggest that krill depletion
is taking place and is affecting right whale populations. However, it is clear that the PV die-off is
not being driven by a krill paucity.
Kelp gull attacks are particularly interesting as a driver for the die-off because it is observed only in Península Valdés and has increased as whale deaths increased. As a relatively recent, regional phenomenon, kelp gull attacks are not totally understood in their impacts on whales. Several costs have been assessed in the nursing of the very young calves, whose mothers must guide them in evasion rather than rest. In addition, adult whales learn to adopt a special “galleon posture” when surfacing, arcing the back so that only the head and tail are exposed above the water – calves need time to learn the technique, perhaps why they are so vulnerable to the gulls (Sironi et al 2009). Although direct death by kelp gull lesion does not explain the majority of deaths explored in the 212-size study by McAloose et al, there may be some other mechanism that explains how calves die from kelp gull attacks.

The Península Valdés right whale die-off represents an opportunity for good science to be done to make a significant impact in the recovery of a species. The problem is clear – calves
don’t survive, and none of the usual suspects seems to be responsible. An anthropogenic cause has been ruled out – vessel strikes and whale watching don’t account for 90% calf mortality. Indeed, for once human impact seems to be for the good, as the multimillion dollar whale watching industry has spurred the government to begin a cull of kelp gulls in the Chubut province, as the “unsightly” attacks have grown so common (Marón et al 2015). Something novel and insidious is at play in Patagonia, and more research is urgently needed to save the southern right whale.
Bibliography

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