

Current State of North Atlantic Right whale Status and Biology

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ABSTRACT

The North Atlantic right whale population has been variously categorized in recent past decades as critically endangered or on the brink of extinction (e.g. Kraus et al. 2005). Recent analyses and reports have demonstrated that, although the western North Atlantic stock has far from fully recovered from a precipitous population decline likely caused by pre-industrial whaling (Reeves et al. 2007), small population that was extant in the 1960's has undergone a slow relatively constant increase in abundance. Herein, I report analyses demonstrating this increase and review some related recent management actions attempting to increase the conservation status of what is likely the most studied large whale population on the planet.

Status of a Right Whale Catalog

A catalog of individually identifiable North Atlantic right whales and records of dates and locations of their resightings is curated by the New England Aquarium (NEAq, Boston, Massachusetts, USA). Quality control over final identifications and recordings of individual whales are provided by NEAq personnel and based primarily on photo-identification using natural markings (Kraus et al. 1986, Hamilton et al. 2007) and supplemented with genetic markers (Frasier et al. 2007). Recapture histories of individuals are continuously accumulated during various survey efforts conducted in 5 principal geographic regions along the Atlantic coast of North America (Brown et al. 2007). Although several individual whales were identified and sighted multiple times prior to 1980, annual data acquisitions since 1980 are more abundant, acquired more systematically and have received the most analysis from other researchers. Spatial coverage has varied considerably since 1980, but for each year from 1980 to 2011 sightings data were available nearly year round from across much of the known range of the species (Brown 2007).

Due to the diligence required to process the large number images taken during multiple surveys searching for North Atlantic right whales, a significant lag currently exists before the sighting records of each individual whale are resolved and available for review. The data base can be extracted at anytime, and the information that I provide on population status was derived from an extraction provided to the National Marine Fisheries Service by NEAq on 25 October 2013. At that time, an appreciable number of photographic captures taken during 1 December 2011-25 October 2013 had not been fully processed, but the database consisted of over 700,000 slides, prints, and digital images collected during the 63,527 sightings of 680 individual right whales photographed since 1935 (Petis 2013). Subsets of sightings data are available can be used to prepare capture histories of individual for purposes of estimating or indexing population parameters.

Abundance and Trends

The general perception among right whale researchers is that nearly all members of the western stock of North Atlantic right whales are subject to photographic recapture although there is likely considerable capture heterogeneity among individuals due to their differing habitat use patterns (Brown et al. 2001). Although several statistical models of abundance are possible using the MRR data, the high annual recapture rates (Figure 1) and near completeness coverage of the stock's range make a simple annual accounting procedure high quality index to abundance and trends. Based on an analysis of minimum number alive (whales with permanent individual catalog numbers and calves of the year not yet cataloged), the minimum number alive index to abundance has shown a relative consistent albeit slow exponential increase (Figure 2). The stock has increased at an average (geometric mean) annual growth rate of 2.7% between 1990 and 2011 (Figure 3).

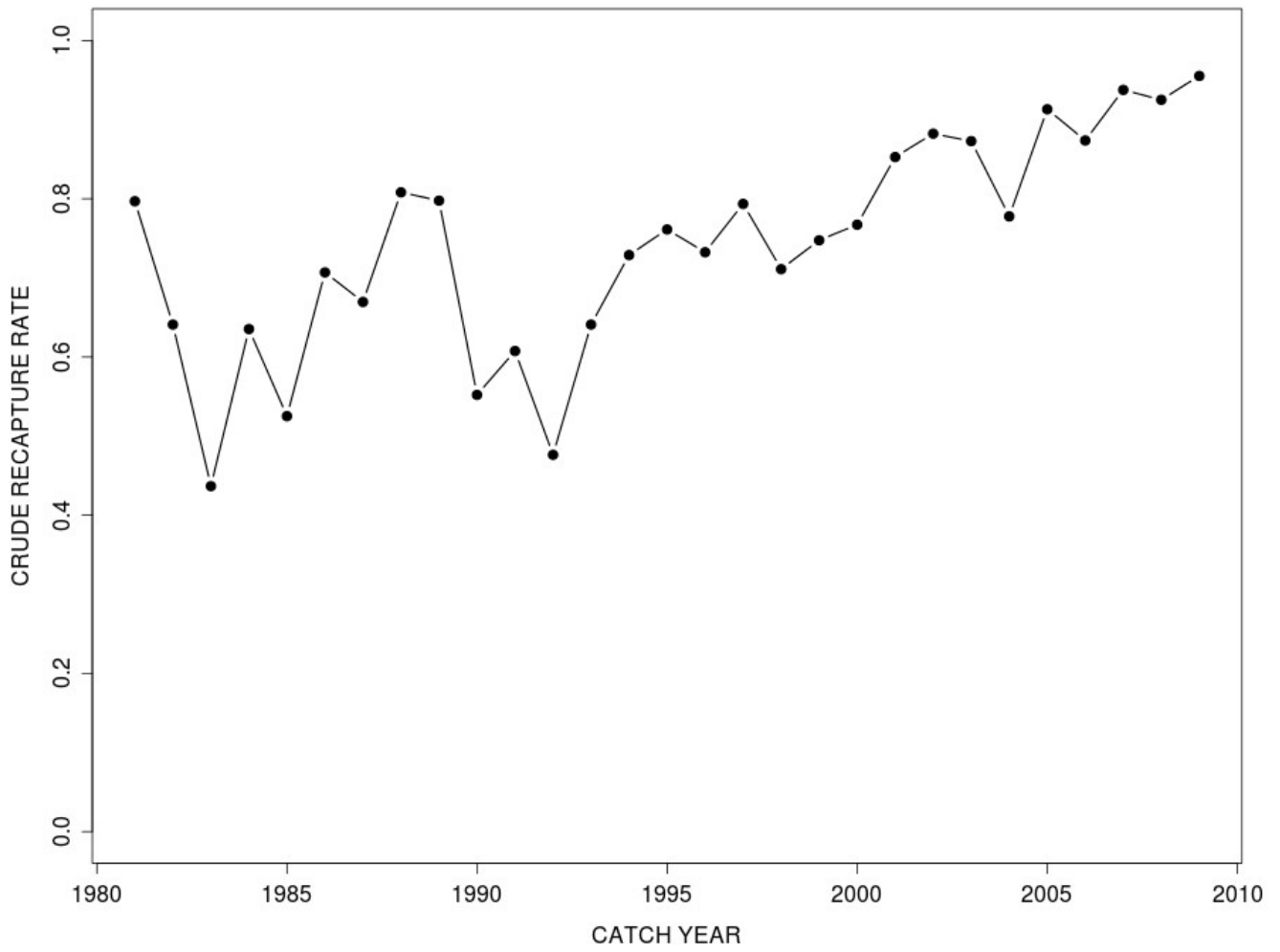


Figure 1. Crude annual recapture rate calculated as the ratio of whales sighted in a given year divided by the number of whales known to be alive that year.

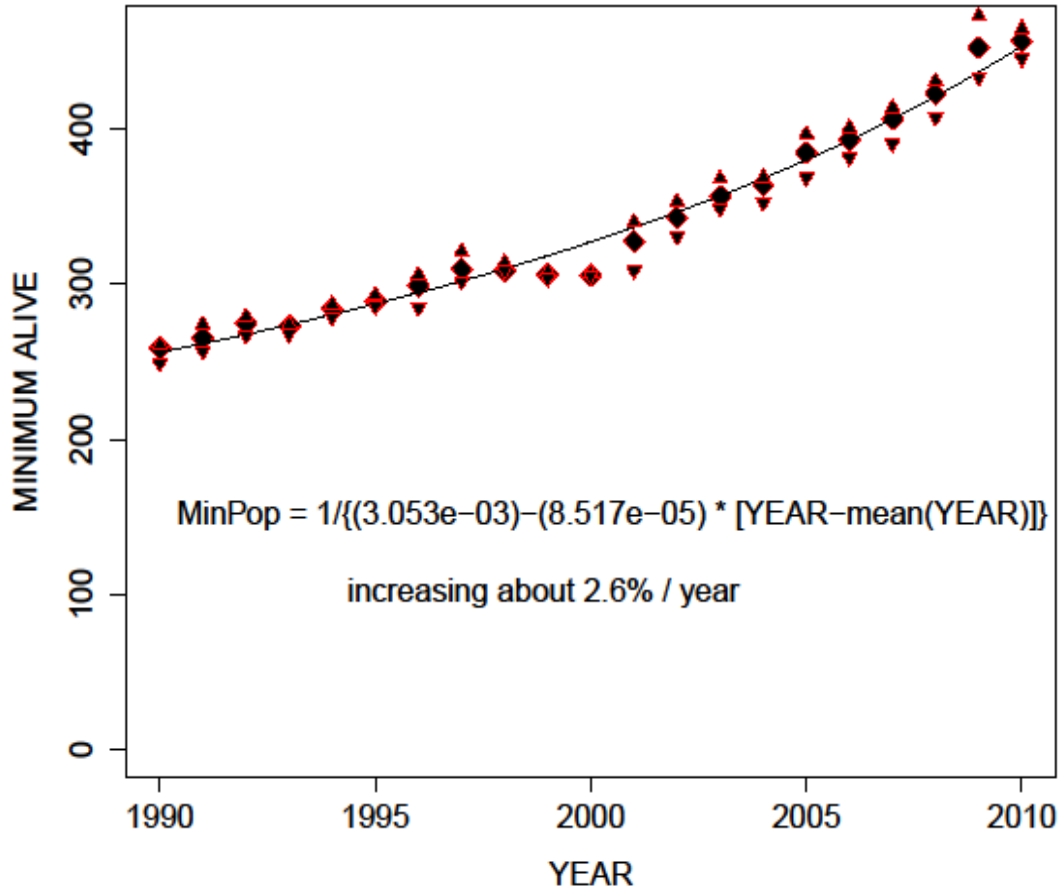


Figure 2. Minimum number alive for cataloged North Atlantic right whales. Minimum number (N) of cataloged individuals known to be alive in any given year includes all whales known to be alive prior to that year and seen in that year or subsequently plus all whales newly cataloged that year. Cataloged whales may include some but not all calves produced each year. Bracketing the minimum number of cataloged whales is the number without calves (below) and that plus calves above, the latter which yields Nmin for purposes of stock assessment.

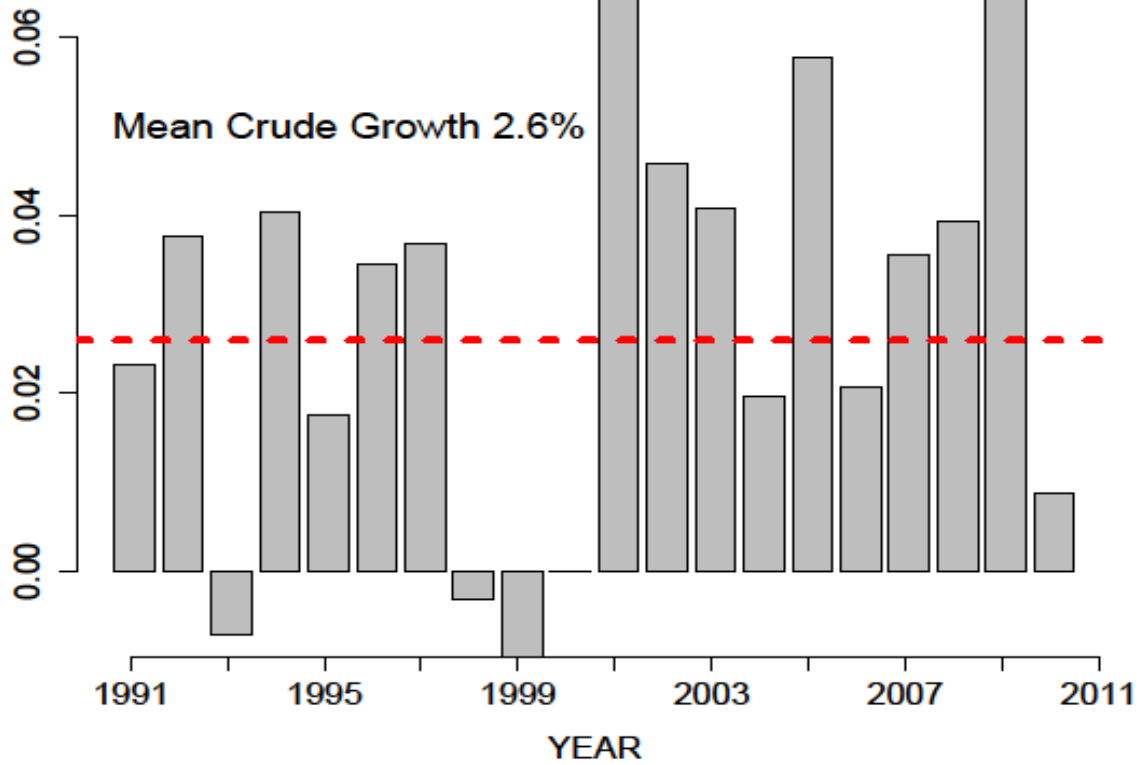


Figure 3. Crude growth rate of North Atlantic Right whale abundance index to abundance calculated as proportional differences in adjacent values of minimum number of cataloged individuals known to be alive in any given year. Mean crude growth rate (dashed line) is the exponentiated mean of $\log_e [(N_{t+1} - N_t)/N_t]$.

Annual Survival

For use in a recent Population viability paper (Pace in review), I calculated annual sex-specific apparent survival rates for right whales using the sightings data described above. Because I was concerned that lower survival rates of the youngest animals would add appreciable heterogeneity to the data used in a CJS model, I excluded all capture records for animals known to be <4 years of age. A priori, I suspected different capture and survival probabilities for each sex. In the southeast US (SEUS), recaptures are primarily of calving females, a few of which are not seen elsewhere, their calves and young animals. Behaviors such as participation in surface active groups (Parks et al. 2007) are male dominated, highly visible and offer good photographic opportunities of the participants. In addition, some evidence suggests that sighting probabilities may differ among age groups and because of differential use of survey areas (Brown et al. 2001). Adding to possible differences in 'catchability', several aspects of sex-related behavior (calving, calf protection, male competitions for mates) expose sexes to different hazards and could result in different mortality schedules. For example, females normally migrate and endure an extended fast while calving and through the first few months of their calf's life (Kraus et al. 2007). Therefore, I considered 3 sex groups when estimating annual capture and survival rates: male, female and unknown sex (a significant fraction of cataloged animals). The unknown sex group was problematic in that it was composed of individuals that provided fewer opportunities to determine their sex (i.e., shorter lived, younger, or seen infrequently), but failure to consider them could bias the estimated rates (Nichols et al. 2004). The best (*sensu* information theoretic realistic) Cormack-Jolly-Seber (see Lebreton et al. 1992) model of survival included a heuristic catchability coefficient, and additive effects of sex and time on both apparent survival (Figure 4) and recapture rates.

Detected Recruitment

Likely unrelated to any variance in survey effort, the number of calves detected for North Atlantic right whales shows greater variance than would be expected by chance and accounted for by an increasing population (Kraus et al. 2007 & Figure 5). Because the callosity patterns of right whales are not stable until about age 6 mos., only those calves seen in feeding areas and still associated with their mothers will be recruited to the catalog as known aged animals. Each year, a few animals of unknown age are recruited to the catalog, presumably from a fraction of the calves not seen with their moms on the feeding grounds, but well photographed some time later.

Quick Management Notes

When first implemented in 2008, the US Administrative rule creating both mandatory seasonal speed restriction zones near certain Atlantic coast ports and voluntary temporary speed restriction zones in the vicinity of feeding whale aggregations included a 5-year sunset provision. In 2013 the rule was re-established without any sunset provision relying on some evidence that the rule has been locally effective (Silber and Bettridge 2012, van der Hoop et al. 2013). The National Marine Fisheries

Service has been implementing rules in an attempt to reduce right, humpback and fin whale mortality due to entanglement in commercial fishing gear for more than a decade. The most contentious of prior rules was a requirement that pot gear in areas of federal waters seasonally used by right and humpbacks was required to use sinking ground lines. Although not enough time had passed before that rule could be evaluated for effectiveness, an analysis by van der Hoop et al. (2013) found no population level effect for the combined measures to mitigate anthropogenic mortality. Further modification of fishing practices are in the final phases of being implemented that are designed to reduce the amount of buoy (vertical) lines in areas where whales aggregate.

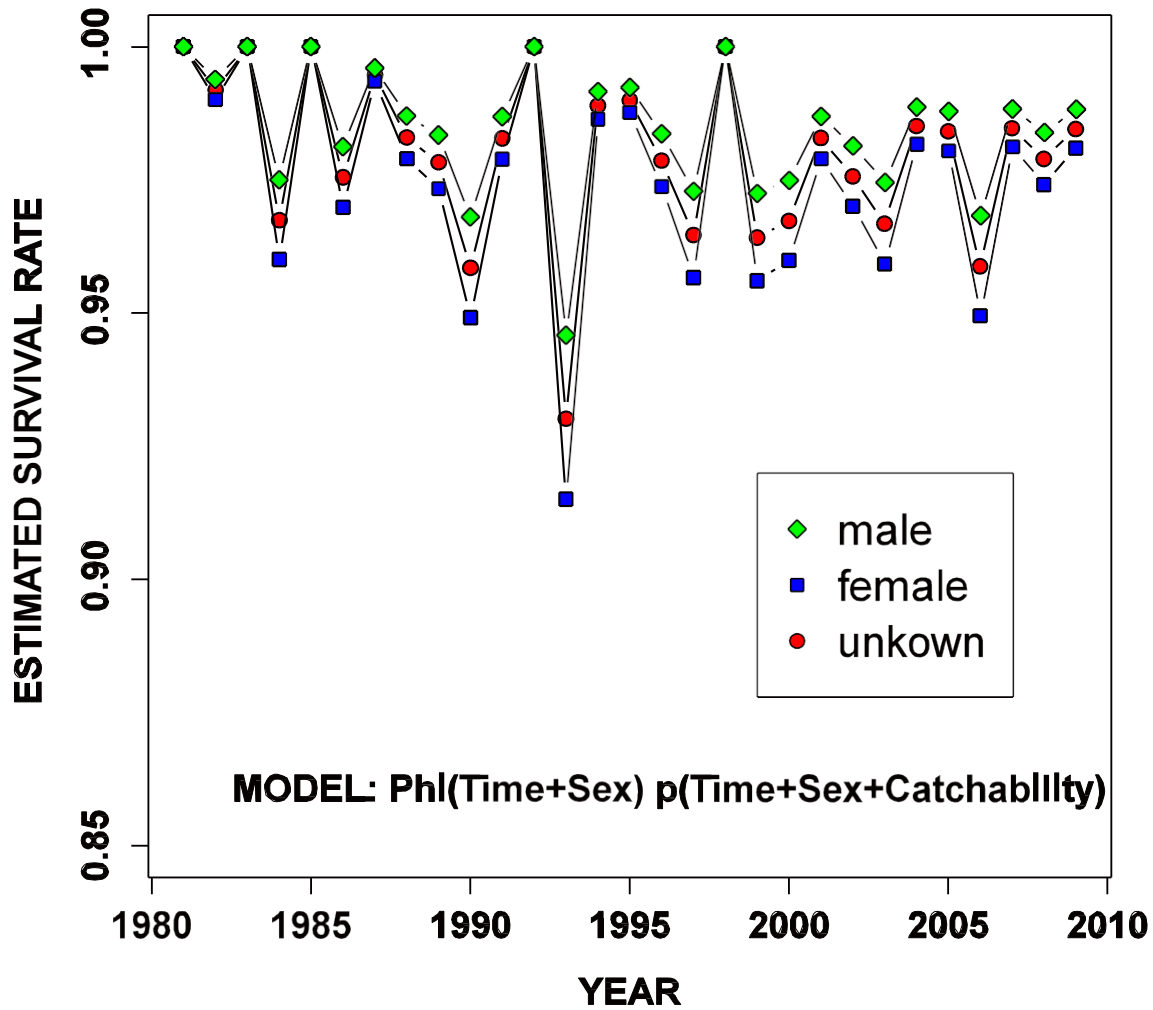


Figure 4. Estimated survival rates of North Atlantic Right Whales as calculated from a multinomial likelihood model following the Cormack parameterization of the Jolly-Seber open population mark recapture experiment. Shown are the estimates shrunk toward the mean based on variance components estimates.

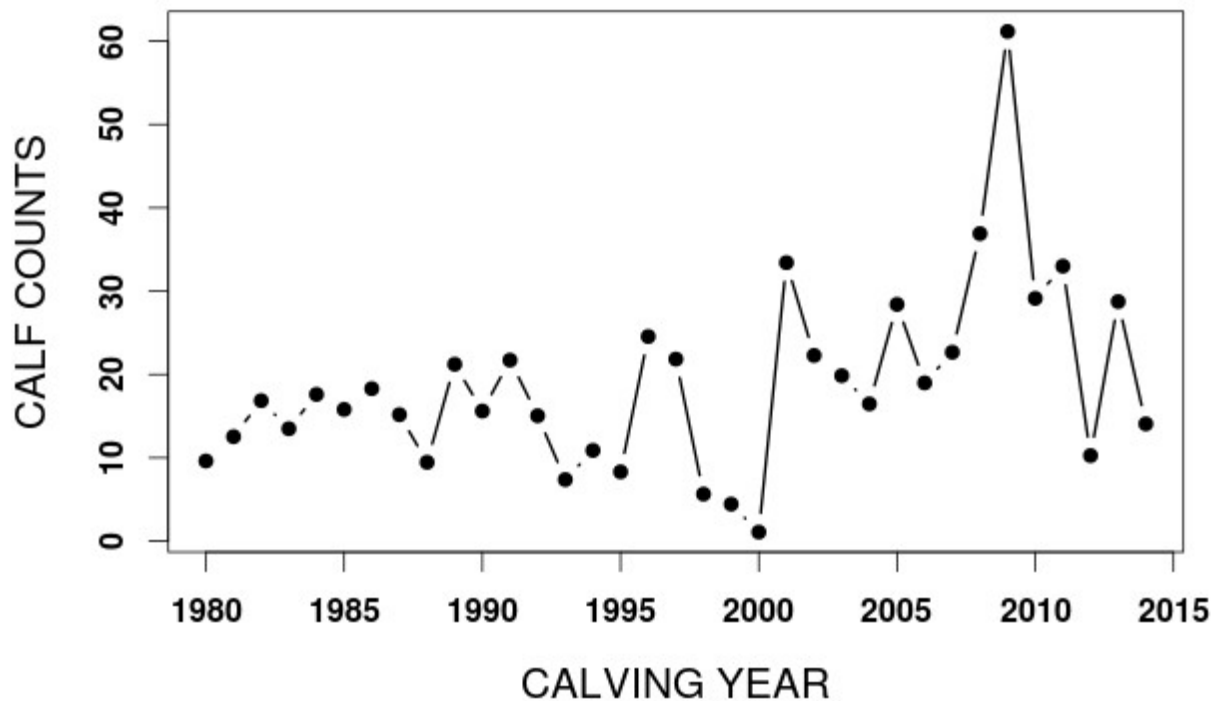


Figure 5. Counts of North Atlantic right whales calves tallied by photo-identification of adults in close association with a calf of the year primarily sighted within the primary calving grounds off the GA-FL coast.

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