

Acoustic Behavior of North Atlantic Right Whale (*Eubalaena glacialis*) Mother-Calf Pairs

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LONG-TERM GOALS

The long-term goal of this project is to quantify the behavior of mother-calf pairs from the North Atlantic right whale (*Eubalaena glacialis*) to determine a) why mothers and calves are more susceptible to collisions with vessels and, b) determine the vocal behavior of this critical life stage to assess the effectiveness of passive acoustic monitoring to detect mother-calf pairs in important habitat areas.

OBJECTIVES

The primary objectives of this project are to: 1) determine the visual detectability of right whale mother-calf pairs from surface observations, 2) determine the acoustic detectability of right whale mother-calf pairs, 3) determine the acoustic detection ranges of mother-calf calls through propagation modeling, 4) assess the ontogeny or changes in behavior with calf development, and 5) assess the individual distinctiveness of right whale vocalizations.

APPROACH

This proposal involves a detailed behavioral study of endangered North Atlantic right whale mother-calf pairs to document their activity budgets, movement patterns, and sound production in two critical habitat areas in U.S. waters and a designated conservation area in Canada over the course of the entire migration corridor from the Southeastern United States through the Gulf of Maine to the Bay of Fundy. These data will be collected using a combination of passive acoustic recording and monitoring methods coupled with detailed behavioral observations in five months of the year for a period of 5

years (January-February off the coast of Florida, April in Cape Cod Bay, Massachusetts, and August-September in the Bay of Fundy, Canada). These data will be used to assess the effectiveness of visual and passive acoustic monitoring in detection and tracking of individual whales and how these parameters may change with the development of the calves.

Year 1 will involve preliminary field seasons to test the feasibility and logistics of focal follow methods in each of the three key habitat areas off the coast of Florida, in Cape Cod Bay and in the Bay of Fundy, Canada. Years 2, 3, 4 and 5 will involve more extensive field seasons in each of the three habitat areas to collect behavior on individual mother-calf pairs with the goal of collecting repeated samples from individual pairs in multiple habitat areas and on different days to look at changes in behavior as the calves develop. Analysis of data will begin after the first preliminary field seasons and propagation modeling will start at the end of the first year with the recruitment of a graduate research assistant. It is anticipated that ongoing analysis and presentation of results will continue through the study, with urgent topics (e.g. - call types and parameters for passive acoustic detection of mother-calf pairs) analyzed and published first, and other more detailed behavioral analyses being published as adequate sample sizes are obtained (e.g. surface behavior, ontogeny of behavior, individual recognition of calls).

WORK COMPLETED

During the first year of the project, preliminary data were collected in the Bay of Fundy in August. A female graduate student was recruited to conduct research on the project as part of her doctoral research. In the second, third, and fourth years of the project full field seasons for data collection were carried out in each of the three main habitat areas to determine typical mother-calf behavior. In 2011, we were able to assess the best methods for a standardized data collection protocol that will allow for consistency between the diverse habitats as the mother-calf behavior changes with the calf's growth. In 2012 and 2013, we focused on behavioral observations and passive acoustic recordings of mother calf pairs from a small boat in each of the habitat areas using these protocols. In 2014, we broadened our methodology to include non-invasive acoustic recording tags attached via suction cups to either the mother or calf to assess vocal behavior without the need for a vessel in close proximity.

In 2011, we collected ~40 hours of acoustic data from 16 mother-calf pair follows representing 11 different individuals. In 2012, we collected ~30 hours of acoustic data from 10 mother-calf pair follows representing 4 different individual mothers. In 2013, we collected ~48 hours of acoustic data from 22 mother-calf pair focal follows representing 12 different individual mothers. In 2014, we obtained ~31 hours of acoustic data from 11 unique mother-calf pairs over 12 days of data collection. In the first three years, at least one mother-calf pair was followed on multiple occasions in multiple habitats, with sightings separated by three to six months, allowing us to assess developmental changes in the behavior of the calf. For the years 2013 and 2014 however, no sightings of mother-calf pairs occurred in the Bay of Fundy habitat, so comparison were limited to two habitats during those years. Very low vocalization rates were detected from the mother-calf pairs in the southeastern U.S. in all four years. In 2011, no calls were detected from mother-calf pairs that were alone, while in 2012 and 2013 calls were detected by a pair alone but only during a curious approach to the boat by a calf. In 2014, a higher number of calls were recorded than in previous years in this habitat, but calls were still most commonly produced in social interactions either within the pair or with other marine mammals. In the other two main habitat areas, mother-calf pairs regularly vocalized while separated, during reunion events after separation, and while socializing with conspecifics.

RESULTS

Southeastern U.S. – Data collection was conducted between 6 January and 8 February, 2015. A team from the Duke Marine Lab at Duke University contributed additional tagging efforts between 9 of February and 8 of March, 2015 as part of another study. Ten mother-calf right whale pairs were encountered over a total of 8 days between both teams, and behavioral and acoustic data were obtained from 4 of these pairs. Three tags were successfully deployed on three different animals, two of which were calves. Over 24 hours of recordings were made from a combination of tag and towed hydrophone data. No right whale vocalizations were detected on the tags or on the towed hydrophone recordings.

Cape Cod Bay – Data collection occurred on 9 days between 6 April and 30 April 2015. Mother-calf pairs were encountered 9 times on 7 of those days. Eleven tags were successfully deployed on right whales: 5 on calves, 5 on mothers, and one tag on an unknown individual. Three mother-calf pairs were worked on more than one day during this field season, and two mothers were successfully tagged twice on separate occasions. Over 9 hours of acoustic recordings were made from a combination of the tags and the towed hydrophone and a total of 67 calls were detected.

Bay of Fundy – No Bay of Fundy Field season was undertaken in 2015 due to lack of right whale sightings in the Bay of Fundy for the past three seasons.

Overall consistent trends in behavior are emerging from data collected from 2011-2015. Mother-calf pairs produced few sounds that were detectable (at ranges of ~100 m or more) in the Southeastern U.S. when the calf was less than four months in age. Instances when sounds were documented most often involved interaction between the mother-calf pair and either another whale or a novel object in their environment that elicited a curious approach. In contrast, right whale vocalizations produced in bouts were commonly detected in Cape Cod Bay and the Bay of Fundy during reunion events between mothers and their calves, when calves were alone at the surface, and during social interactions with other individuals. These results indicate that passive acoustic detection may be an unreliable tool to detect right whale mother-calf pairs in the Southeastern U.S..

Trends are also beginning to emerge from the behavioral data and clear differences in energy expenditure and activity budgets can be seen between habitats. Calves were also consistently in much closer proximity to their mothers in the Southeastern U.S. than in the Cape Cod Bay or Bay of Fundy habitats and spent more time at the surface. This puts them at an increased risk to collisions with vessels in this critical habitat.

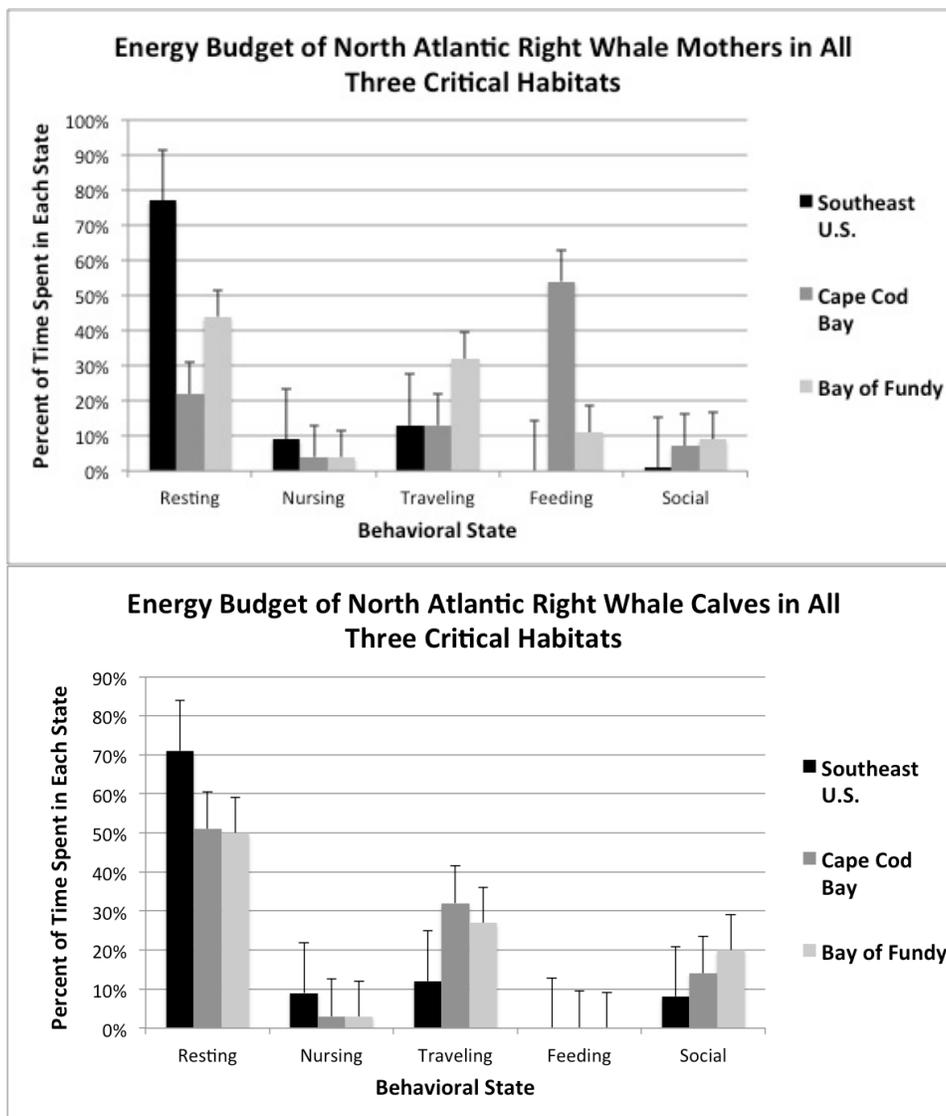


Figure 1: Behavioral state energy budget of right whale mothers (top panel) and calves (bottom panel) observed during this study in the three critical habitat areas studied (Southeast, U.S.; Cape Cod Bay, MA; and the Bay of Fundy, CA) the activity state in which North Atlantic right whale mothers and their calves spend the majority of their time varies between the three critical habitats.

IMPACT/APPLICATIONS

The outcomes of this study will be identification of behaviors that increase the risk for vessel strike of mothers and calves and quantification of the swimming and vocal behavior of mothers with calves. Then we will be able to assess both the visual and acoustic detectability of these individuals to mitigate the potential for serious injury to this critical segment of the right whale population from collision with vessels.

RELATED PROJECTS

Award Number: N00014-10-1-0507, “Acoustic Behavior of North Atlantic Right Whale (*Eubalaena glacialis*) Mother-Calf Pairs” at Penn State was the previous counterpart to this award. Data collected in Florida in 2012 was funded by this related award.

Award Number: 14-HDR-1040, “Tagging and Tracking of Endangered North Atlantic right whales in Florida Waters”, a subcontract award to Syracuse University from Duke University contributed additional tag data from the Southeast, U.S. habitat in 2014 and 2015.

PUBLICATIONS

McCordic, JA, Root-Gutteridge, H., Cusano, D.A., Denes, S.L., Parks, S.E. (*submitted*). Calls of North Atlantic right whales (*Eubalaena glacialis*) contain information on age, sex and individual identity. *Endangered Species Research*. [refereed]