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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-

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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 all years, at least one mother-calf pair was followed on multiple occasions in multiple habitats, with sightings separated by three-six months, allowing us to assess developmental changes in the behavior of the calf. Very low vocalization rates were detected from the mother-calf pairs in the southeastern U.S. in all three 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 contrast, in all years mother-calf pairs regularly vocalized while separated, during reunion events after separation, and while socializing with conspecifics in the Cape Cod spring and Bay of Fundy summer habitats, when the calf was older and more independent from the mother.

RESULTS

Southeastern U.S. – Data collection was conducted between 20 January and 25 February, 2014. Additional tagging efforts were conducted in collaboration with a team from the Duke Marine Lab at Duke University between 9 and 25 of February, 2014. A total of 12 days of behavioral observations

and acoustic recordings were collected between the two teams, with a total of 5 successful tagging deployments on a mother or calf. Over 31 hours of recordings were made from 7 mother-calf pairs, 2 of which were recorded on multiple occasions. One mother, Catalog #2040, was successfully tagged this year and had also been recorded with her calf in both the southeast and Cape Cod Bay in 2011. Vocalizations were detected on the tag both this year and from the recordings in Cape Cod Bay in 2011. Right whale vocalizations were detected on four separate days with a total of 159 calls. Behavioral state of call production was variable and vocalizations were detected while surface active, resting, nursing, and traveling. A higher number of calls was recorded this year than in any previous years and this may be the result of using the acoustic tags, which may be better able to detect the calls of mother-calf pairs.

Cape Cod Bay – Data collection took place on 21 April 2014, where a tag was successfully deployed for ~30 minutes on the calf of Catalog #2040. Unfortunately, while many vocalizations were recorded from the pair in the southeast just 2 months prior, no calls were recorded from the pair in Cape Cod Bay in 2014.

Bay of Fundy – The field season took place between 20 August and 17 September, 2014, however no right whale mother-calf pairs were encountered during that time.

Summary and Future Directions - Overall consistent trends in behavior are emerging from data collected from 2011-2014. 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 recorded involved interaction between the mother-calf pair and either another whale or a novel object in the environment that elicited a curious approach. 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 of limited use to detect right whale mother-calf pairs in the Southeastern U.S. during daylight hours, though further data on sound production behavior at night are needed.

Trends are also beginning to emerge from the behavioral data collection, with distinct variation in energy expenditure and activity budgets among habitats. Calves were 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 behavior likely puts them at increased risk for collisions with vessels in the southeastern U.S.

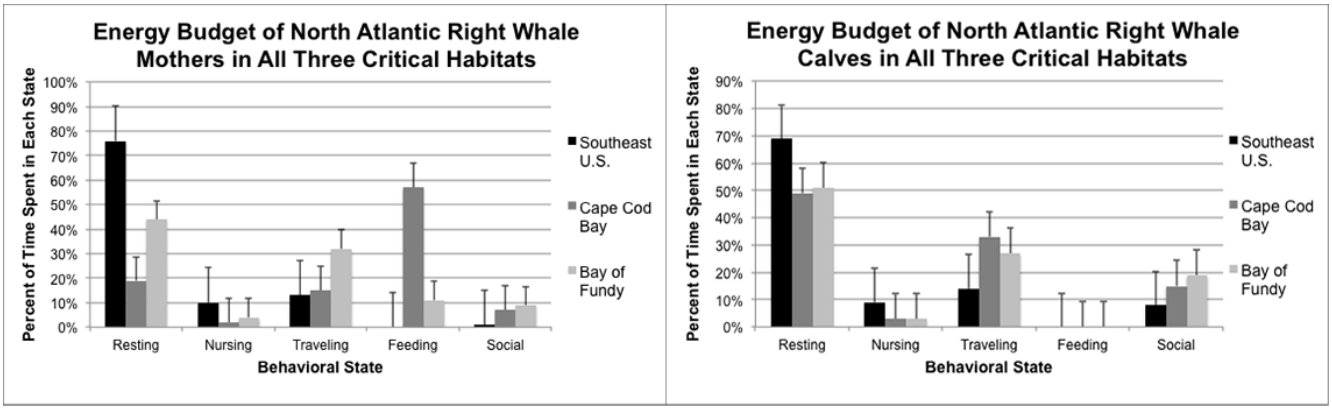

Figure 1: Comparison of time spent in five major behavioral states by the mother (left) and calf (right) in each of the three study habitats. The predominant activity in all habitats for calves was resting, with an increase in active behaviors with increasing calf maturity.

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 collection prior to January 2012 was funded by this related award.