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The Effects of Noise on Aquatic Life II

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Chapter 99
Humans, Fish, and Whales: How Right Whales Modify Calling Behavior in Response to Shifting Background Noise Conditions

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Abstract This study investigates the role of behavioral plasticity in the variation of sound production of southern right whales (*Eubalaena australis*) in response to changes in the ambient background noise conditions. Data were collected from southern right whales in Brazilian waters in October and November 2011. The goal of this study was to quantify differences in right whale vocalizations recorded in low background noise as a control, fish chorus noise, and vessel noise. Variation in call parameters were detected among the three background noise conditions and have implications for future studies of noise effects on whale sound production.

Keywords Right whale • *Eubalaena australis* • Noise • Vocal modification

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1 Introduction

A "stereotyped" call produced by right whales, the upcall or contact call, is often used for detection in passive acoustic monitoring situations (Van Parijs et al. 2009). Previous studies of the sound production behavior of right whales indicate a variation in the average frequency range and bandwidth of upcalls. This variation has been documented both between and within species, with individual whales modifying their calls in response to noise from vessels (Parks et al. 2007, 2009, 2011).

Currently, there are three recognized species of right whales: the North Atlantic right whale (*Eubalaena glacialis*), the North Pacific right whale (*Eubalaena japonica*), and the southern right whale (*Eubalaena australis*). Both northern hemisphere species are highly endangered, with population estimates at 509 (*E. glacialis*) and 35 (*E. japonica*; Wade et al. 2011; Pettis 2012). The southern right whale has a significantly larger population, with a total estimated population in 2009 of 12,000 individuals (International Whaling Commission 2012). This population has a circumpolar distribution in the southern hemisphere, with primary calving grounds located in Argentina, Brazil, South Africa, Australia, and New Zealand (International Whaling Commission 2012). In one calving area for this population in Brazilian waters, increasing numbers of right whales have been sighted over the past decade along with an increase in anthropogenic activities such as shipping and fishing (Groch et al. 2005). This study investigated the role of behavioral plasticity in the sound production of southern right whales (*Eubalaena australis*) in response to changes in ambient background noise conditions.

2 Methods

Bottom-mounted archival acoustic recorders (DSG-Ocean, Loggerhead Instruments) were deployed in October and November 2011 in two coastal locations in central Santa Catarina State, southern Brazil. One recorder was placed off Gamboa Beach (27°56′ S, 48°39′ W) and one off Ribanceira Beach (28°11′ S, 48°37′ W). Acoustic recordings were manually browsed to identify periods dominated by three different background noise conditions: (1) fish chorus, (2) vessel noise, and (3) neither/control (Fig. 99.1). Automated detectors and noise statistic analysis tools developed for North Atlantic right whale upcalls were utilized to analyze recordings from each of these conditions (described in Urazghildiiev and Clark 2006; Parks et al. 2009; Urazghildiiev et al. 2009).

3 Results

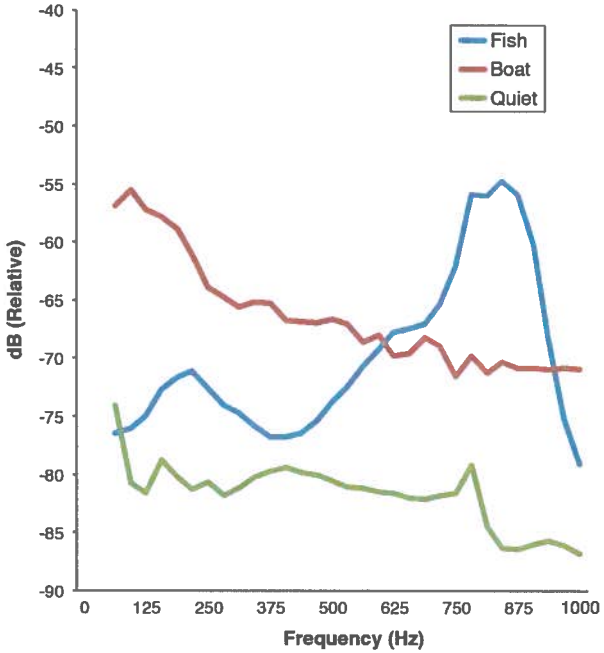
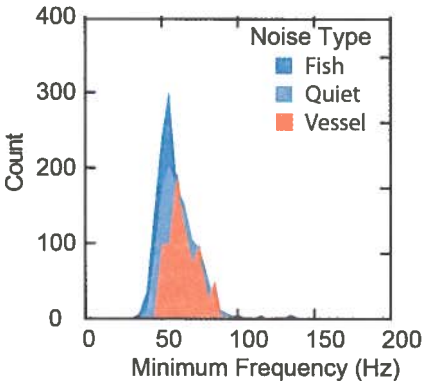


Fig. 99.1 Relative spectral density of the three noise conditions (quiet, boat noise, and fish chorus sounds) showing the relative energy distribution between 30 and 1,000 Hz

Fig. 99.2 Distribution of minimum frequency from right whale upcalls measured in each of the three noise conditions



For this analysis, we focused on a particular call type, the right whale upcall (Clark 1982), with a signal-to-noise ratio >10 dB. A comparison of the background noise levels and call parameters showed variations in right whale calling behavior that were correlated with the frequency distribution of the background noise (Fig. 99.2). Significant variation was found for the minimum frequency (f_{min}), peak frequency

4 Discussion

The frequency distribution and intensity of background noise levels varied significantly among periods of increased biological noise (from fish chorus) and increased anthropogenic noise (from boats) when compared with baseline conditions. The distribution of right whale upcall parameters also varied in different background noise conditions, consistent with short-term behavioral plasticity in response to the shifts in background noise. When the dominant background noise was lower in frequency than the whale calls, the minimum frequency shifted higher. When the dominant background noise was higher in frequency than the whale calls, the minimum frequency shifted lower. These results have implications for the description of the acoustic behavior of any sound-producing organisms, indicating that behavioral plasticity in varying background noise may introduce increased variation to stereotyped signals. It is likely that changes in the background noise conditions may impact the frequency and duration characteristics of signals produced by other species and should be taken into account when studying and quantifying parameters of signals.

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