A note on recordings of Southern right whales (*Eubalaena australis*) off the coast of Uruguay

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ABSTRACT

Passive acoustic detection has the potential to provide data regarding the location of right whales. Right whales are not known to produce songs; nonetheless, the call repertoire of *Eubalaena australis*, the southern right whale, has been exhaustively and quantitatively analysed. This paper describes sound production by southern right whales in the coast of Uruguay (35°S) in the South Atlantic Ocean. No previous study of southern right whale sounds in Uruguayan waters exists. The calls recorded were: Up call, a low tonal call with a frequency of 50Hz to 200Hz; High call, which has the most energy in a range of 200–500Hz, and Pulsive call, a complex mixture made up of amplitude modulated noise and tones, 50–200Hz. This is the first acoustic study of *E. australis* in this region and focusses on the occurrence of calls previously identified by Clark to obtain more information about the acoustic behaviour of this cetacean in Uruguayan coastal waters. Future efforts will be made to obtain more recordings in different locations along the coast of Uruguay, where annual sightings occur. Such information is essential for examining global differences between vocalisations of southern right whales.

KEYWORDS: SOUTHERN RIGHT WHALE; URUGUAY; SOUND; BIOACOUSTICS

Passive acoustic monitoring has become a popular method for studying marine mammal behaviour and distribution, especially among cetaceans (Mellinger *et al.*, 2007; Van Parijs *et al.*, 2009). Right whales are not known to produce songs; nonetheless, the call repertoire of *Eubalaena australis*, the southern right whale, has been exhaustively and quantitatively analysed (Clark, 1982). Sound production by many great whale species is thought to function as communication between individuals (Cummings *et al.*, 1971; Evans, 1967; as reviewed in Tyack, 2000), and is often related to feeding and mating behaviour (Croll and Tershy, 2002; Oleson *et al.*, 2007).

Southern right whale sounds have been described by Payne and Payne (1971) and Cummings *et al.* (1972; 1971; 1974). Clark (1982) analysed the repertoire of southern right whales on their calving grounds using principal component analysis with ten acoustic features, which indicated that the vocal repertoire of these whales formed a continuum. Six call types where identified by Clark within this continuum. Four of these call types (up, down, constant, and high) were tonal. Pulse sounds were composed of low-frequency pulses and Hybrid calls had a combination of tonal and pulsive elements. Clark (1983) analysed the relationship of these sounds as a function of group activity. He divided the repertoire into two groups: a set of discrete calls (up, down, and constant) produced when whales were swimming and a set of highly variable calls (high, hybrid, and pulsed) related to high social activity.

The southern right whale is a migratory species distributed between 20° and 60°S. In early winter, the whales migrate to medium and low latitudes, where calving takes place (Best, 1990; Burnell, 2001; Rowntree *et al.*, 2001). One feeding ground extends from False Banks (Brazil) to Falkland Islands (Malvinas) off Argentina and is considered a corridor offshore Brazil, Uruguay and Argentina, between 30° and 55°S and west of 40°W (IWC, 2001; Tormosov *et al.*, 1998). Historical accounts, incidental sightings and recent survey data suggest that the Uruguayan coast may host to a number of southern right whales (Acosta y Lara, 1987; Costa *et al.*, 2005; Diaz de Guerra, 2003; Townsend, 1935), but the role of the Uruguayan Atlantic Coast in the ecology of southern right whales is unclear (Costa *et al.*, 2007).

In recent years, systematic studies have been conducted along the Uruguayan coast to examine species status and habitat use, spatial-temporal distribution and photo identification, and behaviour during winter and spring in the region. These studies present evidence that the Uruguayan Atlantic coast is an important winter aggregation area for southern right whales (Costa *et al.*, 2007; Garcia and Sabah, 2000).

This paper describes a study of sound production by southern right whales off the coast of Uruguay (35°S) in the South Atlantic Ocean. No previous study of southern right whale sounds in Uruguayan waters exists, potentially due to the limitation of many instruments for capturing sounds. Given the relationships that have already been determined between call characteristics and stock identity in southern right whales, acoustic data are an important addition in understanding the nature of the Uruguayan coastal population. Here we present the results of an initial attempt to collect this data.

During the austral winter-spring (July–November) of 2006, 2007 and 2008, acoustic monitoring was conducted in a 30km study area located in Piriapolis on the eastern coast of Uruguay (Punta Imán and Punta Negra, 34º53´S, 55º16´W; Fig. 1). The data were collected on board a 6-m sailboat as well as from shore due to the proximity of individuals to the coast.

Under the direction of a land-based team of experienced marine mammal observers, southern right whales were identified visually with binoculars and the naked eye.

Acoustic monitoring took place with right whales in sight and never in the presence of other cetaceans. Single

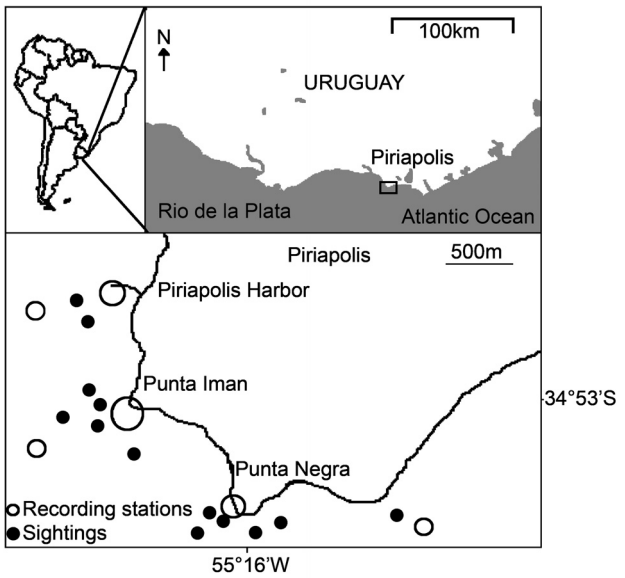

Fig. 1. Map of the Piriapolis, study area.

Table 1

Date, sightings, total individuals per sightings (n = 35), recording in each sighting (1 = recording, 0 = no recording) and sound type selected for analysis.

				Sound type		
Date	Sightings	Total individuals	Recording	Up call	Pulsive call	High call
11/10/06	1	4	1	2	–	3
12/10/06	2	4	0	–	–	–
13/10/06	3	4	1	3	–	–
09/07/07	4	2	0	–	–	–
10/07/07	5	2	1	1	–	–
20/08/07	6	3	0	–	–	–
09/09/07	7	3	1	–	–	–
19/09/07	8	2	1	–	–	–
25/09/07	9	3	1	4	2	–
26/07/08	10	3	1	–	–	1
27/07/08	11	2	1	1	1	1
31/07/08	12	3	0	–	1	–
29/08/08	13	3	0	–	–	–

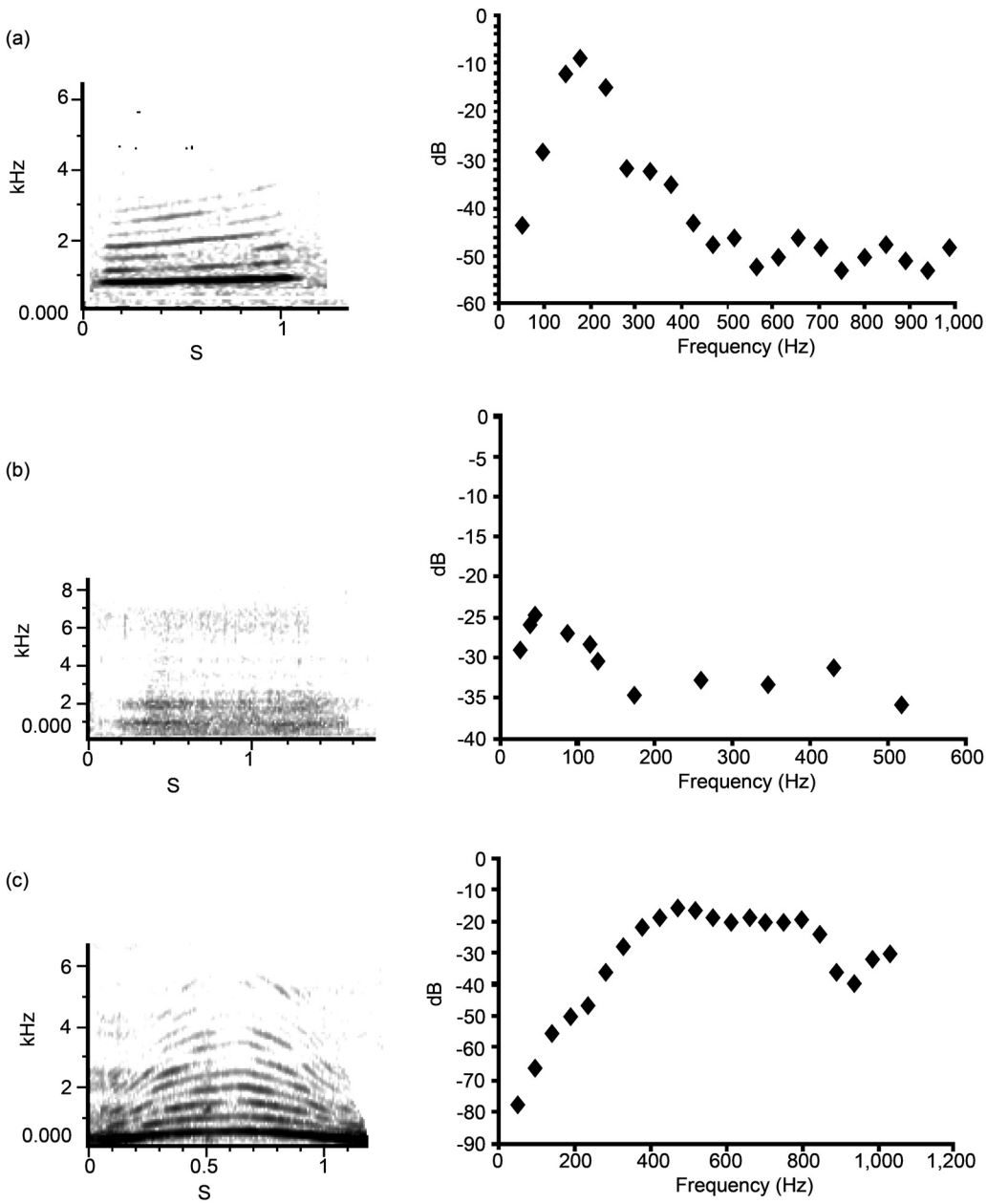

Fig. 2. Southern right whale sound types recorded, a = Up call, b = Pulsive call and c = High call.

Table 2
Sound types for different behaviours.

Sound type	Activity		
	Resting	Swimming	Sexual activity
Up call	4	5	0
Pulsive call	0	1	4
High call	0	0	6

hydrophone recordings were made with a custom built hydrophone (*Tellechea-Bouvier*; sensitivity – dB re 1 V/μPa, linear from 20Hz to 60KHz). The recordings were made on a digital recorder TASCAM HD-P2, with a sampling frequency of 44.1kHz. Sound analysis was performed using *Audacity* free software, version 1.2.3 (Mazzoni, 2006), and *Raven Lite* 1.0 (free license). Power spectra were calculated using a 1024 point Fast Fourier Transform (FFT) with a Hanning window.

The hydrophone was deployed at either end of the vessel. The bearing of the animal closest to the vessel, as well as its direction of movement and distance from the vessel, was noted at each surfacing of the animal. A total of 28h 15min of recordings were made, of which just over 4 h contained southern right whale vocalisations and twenty sounds were selected for analysis (Table 1). Sounds were recorded from the thirteen sightings (n = 35) and then sorted and classified (Table 2) according to auditory acoustic repertoire by different behaviours as described by Clark (1982).

The calls recorded were: Up call, a low tonal call with a frequency of 50Hz to 200Hz; Pulsive call, a complex mixture made up of amplitude modulated noise and tones, 50–200Hz, and High call, which has the most energy in a range of 200–500Hz (Clark, 1982) (Fig. 2).

According to Clark (1982), the high and pulsed calls are associated with complex social interactions (Table 2).

Up calls are sounds with physical characteristics that allow communication over long distances (Clark, 1982) and are the most common discrete call. Up calls were recorded from groups of two and three individuals; these calls were recorded during resting and swimming activity (Table 2). Table 3 shows the range in variability of the duration, fundamental frequency at the beginning and end and maximum value from the calls recorded.

The calls recorded in this study belong to the so-called discrete call category (Clark, 1982) by the characteristics of physical parameters and their association with observed behaviour at the time of vocalisation.

This is the first acoustic documentation of *E. australis* in the coast of Uruguay; we focused on the occurrence of the calls identified by Clark to obtain more information about the acoustic behaviour of this cetacean in Uruguayan coastal waters. Future efforts will be made to obtain more recordings in different locations along the coast of Uruguay, where sightings occur every year. Inter alia, this is essential for examining global differences between vocalisations of southern right whales.

ACKNOWLEDGMENTS

We thank Diego Bouvier for his help in the construction of the hydrophone, and comments from the two anonymous reviewers.

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Table 3
Variability of the duration, fundamental frequency at start and end and maximum value in the time from up call, pulsive call and High call recorded (FF = Fundamental frequency).

Up call	Duration (s)	FF Maximum value (Hz)	Start FF (Hz)	End FF (Hz)
1	1.2	188	80	177
2	1	183	68	155
3	1.6	190	67	176
4	1.7	200	73	172
5	1	180	59	173
6	1.4	192	61	184
7	1.5	197	77	176
8	1.2	181	62	169
9	1.2	190	65	173
10	1.8	187	87	171
11	1.4	193	66	181
Pulsive call	**Duration (s)**	**FF Maximum value (Hz)**	**Start FF (Hz)**	**End FF (Hz)**
1	2	120	57	97
2	1.7	147	66	101
3	2.4	133	54	89
4	1.6	178	72	66
High call	**Duration (s)**	**FF Maximum value (Hz)**	**Start FF (Hz)**	**End FF (Hz)**
1	1.3	466	234	337
2	1.6	434	281	402
3	1.8	403	245	343
4	1.1	458	214	321
5	1.4	473	222	412

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