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Passive Acoustic Monitoring of Bottlenose Dolphins (*Tursiops truncatus*) on the Uruguayan Coast: Vocal Characteristics and Seasonal Cycles

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Abstract

Little is known of the sounds produced by bottlenose dolphins (*Tursiops truncatus*) along the coast of Uruguay, South America. The small population that inhabits the Atlantic Uruguayan coast has been estimated at approximately 40 individuals, with a substantial decrease in occurrence in the estuarine coast of Uruguay over the last two decades. A total of 4,152 whistles and 409 clicks were recorded from free-ranging bottlenose dolphins in five locations along the Atlantic coast of Uruguay with five Passive Acoustic Monitoring (PAM) buoys. Bottlenose dolphins emitted a varied repertoire of whistles. They were categorised as ascending in their contour pattern as the most common, corresponding to 44% of all whistles, whereas multi-looped (more than one inflection point) represented 23%. Ascending-descending (12%) and descending (8.1%) whistles were also frequently documented, while descending-ascending (7.5%) and constant (5.5%) whistles were less frequent. Whistles recorded had a wide frequency range, between 1.6 and 22.4 kHz, and whistle duration was 628 ± 293 ms. Click train duration had a mean of 1,105 ± 59.6 ms, and the mean click number per train was 11.4 ± 1.64. Mean click duration was 63.2 ± 4.06 µs, and the interclick interval was 129.4 ± 3.94 ms. Click trains had a mean peak frequency of 52.02 ± 12.09 kHz. Overall, bottlenose dolphins seemed to be more vocal during the summer months, and declined in vocalizations during the winter months. Whistles showed strong seasonal variability associated with fluctuation in sea surface temperatures (SST). During the winter and early spring (SST < 15° C), the average number of whistles was low. Coincident with water temperatures warming from 16º to 20º C in mid-spring and early summer, the average number of whistles increased to reach maximum values in summer. Meanwhile, a decreasing trend in whistle numbers was found in late summer (N = 1,279) and early autumn (N = 660). In autumn, the water temperature decreased, and the average number of whistles dropped sharply. This study provides the first description of the acoustic characteristics of bottlenose dolphins on the coast of Uruguay, which also assists conservation management efforts for this species that is disappearing from the Uruguayan coast.

Key Words: *tonina*, whistles, clicks, bottlenose dolphin, *Tursiops truncatus*, southwestern Atlantic Ocean

Introduction

Throughout their global range, bottlenose dolphins (*Tursiops truncatus*) are commonly found in shallow, coastal habitats and offshore (Leatherwood & Reeves, 1983; Bearzi et al., 2009). In the southwestern Atlantic Ocean, bottlenose dolphins have a discontinuous distribution from the Amazon River estuary of Brazil to Tierra del Fuego of Argentina and the Falkland (Malvinas) Islands (Bastida et al., 2007). The population that inhabits the Atlantic Uruguayan coast was initially estimated at approximately 40 individuals (Laporta et al., 2008a). There has been a substantial decrease in occurrence of the bottlenose dolphin along the estuarine coast of Uruguay (Lázaro & Praderi, 2000). The cause for this decrease in sightings remains unknown but could be explained by overfishing. On the Atlantic Uruguayan coast, the bottlenose dolphin occurs off the coast of open beaches with a few preferred areas (Laporta, 2004). Previous studies in Uruguay indicate that there is frequent occurrence of this species in two coastal zones: (1) La Coronilla-Cerro Verde (33° 38' S, 53° 24' W) and (2) Cabo Polonio (34º 23' S, 53º 46' W) (Figure 1) (Laporta, 2004; Laporta et al., 2008a). Bottlenose dolphins occur year-round in these areas, using the coastal zone mainly for feeding, socializing, and reproduction. Groups are variable in number of individuals and age composition, ranging from one to 30 individuals, with larger groups also including calves (Laporta, 2004; Laporta et al., 2008a, 2008b).

The bottlenose dolphin produces a wide variety of vocal signals to respond to and interact with group members and their environment. These vocalizations can be grouped into three different categories: (1) broad-band echolocation clicks, (2) broad-band burst pulsed sounds, and (3) frequency-modulated narrow-band whistles (Caldwell et al., 1990; Tyack, 1997; Nowacek, 1999, 2005; Tyack & Clark, 2000; Acevedo-Gutiérrez & Stienessen, 2004; Quick & Janik, 2008; Janik, 2009; Simard et al., 2011).

Many studies of cetaceans rely purely on behavioural observations during surfacing, but details on behaviour can be difficult to accurately identify from visual observations above the water's surface (Evans & Hammond, 2004; Nuuttila et al., 2013). As cetaceans are only visible at the surface for 1 to 10% of their time (Tyack & Miller, 2002), classification of animal activity based on their vocalizations is often a more appropriate method to address their varied activities (Martin & Reeves, 2002; Nuuttila et al., 2013). Due to the difficulties in conducting visual surveys during winter months, when days are shorter and the weather and sea conditions tend to be less favourable, the use of the Uruguayan coast by bottlenose dolphins during this season is poorly known.

Whereas traditional survey techniques describe the distribution and occurrence of animals during daylight hours, with reasonable weather and over short time periods, acoustic data loggers can continue monitoring for up to several weeks at a time in all weather and light conditions. Use of acoustic data collection can therefore provide a more continuous record of the occurrence of animals over longer periods of time. Passive Acoustic Monitoring (PAM) is used on a broad scale to document presence of vocal marine mammals (Carstensen et al., 2006; Mellinger et al., 2007; Koschinski et al., 2008; Simon et al., 2010; Nuuttila et al., 2013). To date, there are no studies about the sounds of bottlenose dolphins off the coast of Uruguay.

Bottlenose dolphins are not the only cetaceans seen regularly in this area of the Uruguayan coast. The Franciscana (*Pontoporia blainvillei*) also lives in this coastal region (Praderi et al., 1989), and southern right whales (*Eubalaena australis*) use the Uruguayan Atlantic coast as an important winter aggregation area (Costa et al., 2007; Tellechea & Norbis, 2012a). The vocal signals of bottlenose dolphins (Caldwell & Caldwell, 1965, 1968; Au et al., 1986; Caldwell et al., 1990; Au, 1993), Franciscana (Busnel et al., 1974; Melcón et al., 2012; Tellechea & Norbis, 2014), and southern right whales (Clark, 1982; Tellechea & Norbis, 2012a) have distinctive acoustic characteristics that are easily distinguished from each other.

To more fully understand the acoustic ecology of bottlenose dolphins, we also considered other sources of sound in their environment. One very important biological source is soniferous fishes in this area (Tellechea et al., 2010, 2011a, 2011b; Tellechea & Norbis, 2012b), many of which are bottlenose dolphin prey (Mermoz, 1977; Barros & Wells, 1998; Gannon et al., 2005). The objectives of this study were to (1) characterize the physical parameters of whistle and pulsed calls emitted by bottlenose dolphins on the Atlantic Uruguayan coast, and (2) describe the daily and seasonal cycles of sound emissions using five PAM buoys deployed along the study site.

Methods

Study Area

Data collection was conducted on 13 nonconsecutive days between August 2011 and August 2012, recording sounds 1 d/mo at each buoy along the Atlantic coast of Uruguay. Recordings were conducted using five PAM buoys placed at five locations along the coast where sightings of bottlenose dolphins are relatively frequent (Laporta, 2004; Laporta et al., 2008a): Cerro Verde, Punta del Diablo, Valizas, Cabo Polonio, and La Paloma (Figure 1). All five buoys were deployed at the same time.

Acoustic Monitoring

Acoustic monitoring was conducted with a PAM buoy, an acoustic self-contained data logger, comprising a hydrophone, digital memory, and power source (Figure 2). These PAM buoys are commonly used in acoustic monitoring of several fish species in Uruguay (Tellechea et al., 2010, 2011a, 2011b; Tellechea & Norbis, 2012b) and were set to continuously monitor the acoustic environment for 24 h at frequencies ranging between 20 Hz and 96 kHz (sample rate = 192 kHz) with a calibrated omnidirectional hydrophone (built by *Tellechea-Bouvier*, -40 dB Newton m^{-2} re 1 μPa, and linear from 20 Hz to 100 kHz). The calibration was carried out in tanks and open water, where simultaneous recordings of synthetic sounds (created with a Digital Function Generator, Digital Recordings, www.digitalrecordings.com and www-dfg/www-dfg-products.html), including pure tones, frequency sweeps, and pulses of varying duration, were made to test for accuracy in recording frequency, amplitude, and temporal characteristics of underwater sounds registered by our hydrophones.

Recordings were analysed using *Audacity* free software, Version 1.2.3 (Mazzoni, 2006) and *Raven Lite*, Version 1.0 (free license). Power

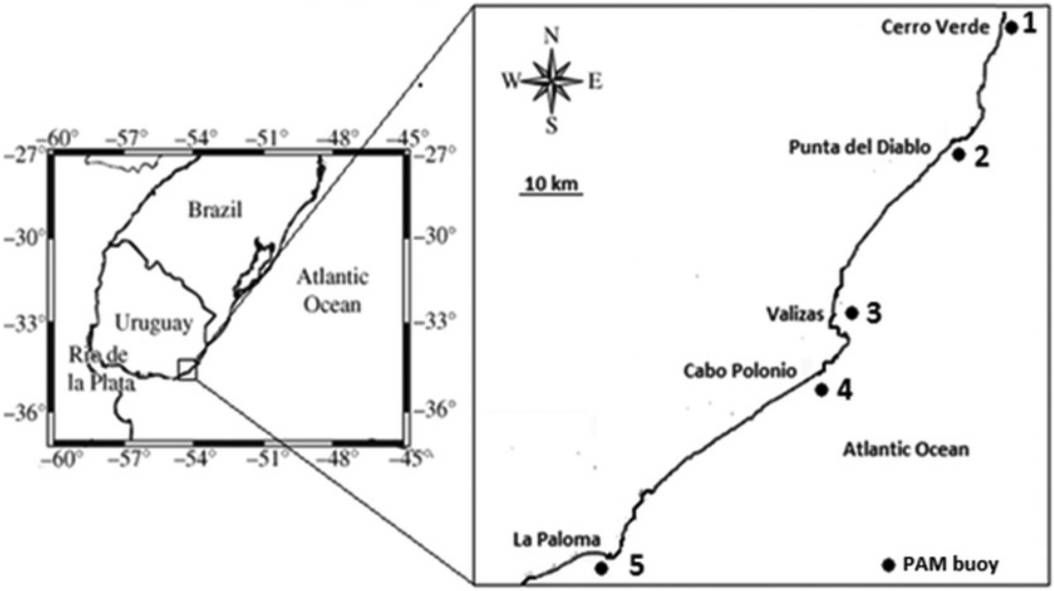

Figure 1. Map of Uruguay and the Atlantic coast of Uruguay showing the position of the PAM buoys from which acoustic recordings of bottlenose dolphins (*Tursiops truncatus*) were obtained

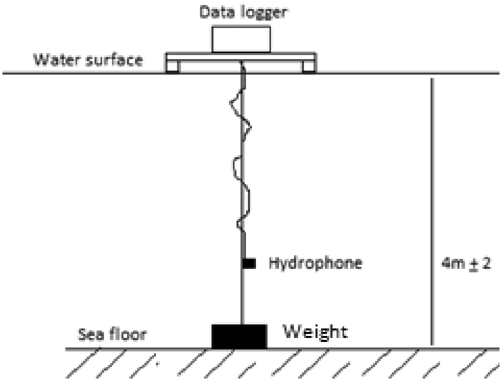

Figure 2. Schematic illustration of the deployment used in this study

spectra were calculated using a 1,024-point Fast Fourier Transform (FFT) with a Hanning window. At each of the five locations (Figure 1), the PAM buoys were placed 300 m from shore to a depth of 4 ± 2 m and exposed to similar weather conditions with Beaufort sea states of ≤ 2 in each location.

Sound Detection and Measurements

Whistles—Seven acoustic parameters from the fundamental component of each whistle were measured: (1) starting frequency (SF), (2) ending frequency (EF), (3) minimum frequency (MinF), (4) maximum frequency (MaxF), (5) the average frequency, (6) duration (DUR), and (7) number of inflection points (defined as points when whistle contours changed slope). Frequency variables were measured in kHz and duration in ms. We calculated the average frequency (MeF) as the averages of SF, EF, MinF, and MaxF (Azevedo et al., 2007). These whistle parameters were chosen based upon previous studies of bottlenose dolphins (Ding et al., 1995; Morisaka et al., 2005; Azevedo et al., 2007) and other dolphin species (Bazúa-Duran & Au, 2004; Azevedo & Van Sluys, 2005). For this analysis, we included only whistles for which all parameters of a spectral contour were measurable.

Pulses—Click trains produced by bottlenose dolphins were analysed manually using the previously mentioned acoustic software. We obtained peak frequencies with a FFT size of 1,024 points, an overlap of 50%, and a Hanning window. High-quality click trains were chosen for the analysis by considering the waveform and by avoiding an oversampling of clicks. Four standard click variables were measured from the waveform: (1) click train duration, (2) click number, (3) click duration, and (4) click interval (Au, 1993), despite the fact that we were unable to distinguish which clicks were on-axis (Au & Hastings, 2008).

Statistical Analysis

We used descriptive statistics to examine all whistle variables, including minimum values, maximum values, average, and standard deviations. For the entire set of whistles, distributions were calculated for start frequency, end frequency, frequency range, and duration (Zar, 1999). A paired-sample *t* test (Zar, 1999) was used to verify whether the mean start frequency was different from the end frequency for all whistles analysed. For all echolocation variables, we calculated the mean, standard deviation, maximum, and minimum values for each click train dataset. The selection of parametric or nonparametric tests was determined via Shapiro-Wilk tests (SW) for normality of data and by Levene's tests (LV) for homogeneity of the variance.

A two-way Analysis of Variance without replication was used for comparing the whistles and the click trains recorded by buoys among months (Quinn & Keough, 2002). In both cases, data were transformed using $ln\ (x + 1)$. Multiple comparison *post-hoc* pairwise Tukey tests were performed to test significant differences among the five buoys and across all months.

Mean sea surface temperatures (SST) for each month were obtained from publically available datasets at a resolution of 1° of latitude-longitude for the quadrant 34.5° S, 53.5° W (Reynolds & Smith, 1994; Reynolds et al., 2002). The nonparametric Spearman's Rank Correlation Coefficient was used to analyse the relationship between whistle parameters and SST (Conover, 1999). In all cases, the significance level considered was $p = 0.05$. The statistical software *PAST* was used for all statistical analyses.

Results

Whistles

Based on their contour pattern, whistles categorised as ascending were the most common, representing to 44% of all whistles, whereas multi-looped (with more than one inflection point) comprised 23%. Ascending-descending (12%) and descending (8.1%) whistles were also recorded, while descending-ascending (7.5%) and constant (5.5%) contour whistles were less frequent.

We estimated that groups of approximately six to 30 bottlenose dolphins were acoustically recorded, based on opportunistic sightings of individuals and groups around the buoys. As a result, multiple recordings of the same individual likely occurred. A total of 4,890 whistles were recorded during the entire acoustic deployment period of 805 min. In total, 4,152 whistles (84.9%) had adequate signal-to-noise ratio for acoustic analysis of which 1,245 (30%) were tones with harmonics. Whistles presented up to 11 inflection points, while 90% displayed zero to three inflection points (Figure 3).

Average whistle duration was 628 ± 293 ms, with 58.3% of the whistles lasting < 700 ms. The average minimum frequency was 6.12 ± 2.29 kHz, and 74.2% of whistles had a minimum frequency between 1.8 and 10 kHz. Average maximum frequency was 9.72 ± 4.22 kHz, with 77.7% of the whistles ranging between 8.4 and 14.0 kHz. The average frequency was 7.89 ± 3.17 kHz, and 84.1% of the whistles had MeFs ranging from 7.33 to 10.6 kHz. Descriptive statistics of all whistle parameters are shown in Table 1. There was no significant difference ($t = 0.604$, df = 256, $p = 0.699$) between the start frequency (5.89 ± 1.78 kHz) and the end frequency (6.24 ± 3.44 kHz).

Pulses

Click train characteristics were described based on N = 409 clicks recorded during the deployment period. The data logged on each click were insufficient to calculate a reliable estimate of intensity. Click train duration had an average of 1,105 ±

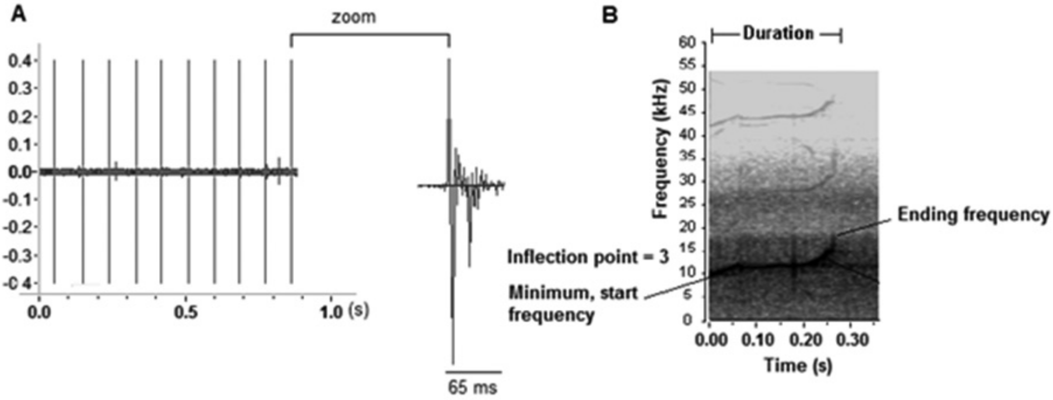

Figure 3. (A) An example of a bottlenose dolphin click train; and (B) an example of bottlenose dolphin whistles showing the fundamental frequency (whistle contour) and two harmonics.

Table 1. Descriptive statistics of bottlenose dolphin (*Tursiops truncatus*) whistle parameters detected by PAM buoys along the Atlantic coast of Uruguay during the entire acoustic deployment period (range, average, and SD are shown; N = 4,152)

Whistle parameters	Range	Average	± SD
Starting frequency kHz	3.2-22.4	5.89	1.78
Ending frequency kHz	2.9-18.1	6.24	3.44
Minimum frequency kHz	1.6-20.3	6.12	2.29
Maximum frequency kHz	2.9-20	9.72	4.22
Average frequency kHz	3.1-19.6	7.89	3.17
Durations (ms)	41-2,879	628	293
Inflections (ms)	0-12	0.76	1.10

59.6 ms, and the average click number per train was 11.4 ± 1.64 clicks. Average click duration was 63.2 ± 4.06 µs, with an interclick interval of 129.4 ± 3.94 ms. Click trains had an average peak frequency of 52.02 ± 12.09 kHz (Table 2). A typical train of high-frequency clicks is shown in Figure 3.

Clicks and Whistles Tallied During the Sampling Period

Whistle and click sounds were recorded and counted from bottlenose dolphins for each PAM buoy (N = 5 buoys; Figure 4) during the entire acoustic deployment period. These data show how the sounds are distributed across all months of the study (Figure 4), using all recorded sounds (N = 4,152 whistles; N = 409 clicks).

Whistles showed a strong seasonal variation associated with changes in SST (Figure 4). There were a lower number of whistles in winter months (June, July, and August) and early spring (September), when water temperature reached the colder phase (less than 15° C), compared to summer months. With warming waters (from 16° to 20° C) in the spring (October and November) and early summer (December), the number of whistles recorded increased and eventually peaked in December and January, followed by a decline in February and early autumn (March). Also during this period, a decrease in the whistle coefficients of variation was found (Figure 4). In autumn (April and May), water temperature decreased in coincidence with a sharp drop in the average number of whistles and an increase in the coefficients of variation of them (Figure 4).

The error distribution of whistle data was non-normal (SW = 0.86; $p = 0.023$), but variance was homogeneous (LV= 0.8407; $p = 0.161$) and varied significantly throughout the months analysed ($F = 2.83$, $F_{12,48;\,0.05} = 1.96$, $p = 0.0053$), but not among buoys ($F = 1.147$, $F_{4,48;\,0.05} = 2.565$, $p = 0.346$). *Post-hoc* pairwise comparisons between all months of the study showed that December 2011 and January 2012 were significantly different ($p < 0.05$) from the following months: August, September, and October 2011 as well as April, May, and June 2012. February 2012 was significantly different ($p < 0.05$) from September 2011 and April, May, and June 2012. Finally, March 2012 was significantly different from April, May, and June 2012 for all buoys.

The clicks were also non-normal (SW = 0.641; $p = 0.0024$), but variances were homogeneous (LV = 1.223; $p = 0.311$). Nonsignificant differences among buoys ($F = 1.163$, $F_{4,48;\,0.05} = 2.565$, $p = 0.339$) and between months ($F = 0.7533$, $F_{12,48;\,0.05} = 1.961$, $p = 0.693$) were found.

A positive relationship ($r_s = 0.53$; $p = 0.031$) was found between whistles and SST, and a nonsignificant relationship ($r_s = -0.191$; $p = 0.534$) was documented between clicks and SST.

Discussion

This study provides the first known recordings of bottlenose dolphin sounds from the Atlantic coast of Uruguay. Our recordings describe the clicks and varied repertoire of whistles emitted by these bottlenose dolphins. The call characteristics

Table 2. Descriptive statistics of bottlenose dolphin echolocation click parameters detected by PAM buoys along the Atlantic coast of Uruguay during the entire acoustic deployment period (range, average, and SD are shown; N = 409)

Click parameters	Range	Average	± SD
Click train duration (ms)	989-3,220	1.105	59.6
Click number in train	6-32	11.4	1.64
Click duration (µs)	56-70	63.2	4.06
Interclick intervals (ms)	65-115	129.4	3.94
Peak frequency (kHz)	27-73	52.02	12.09

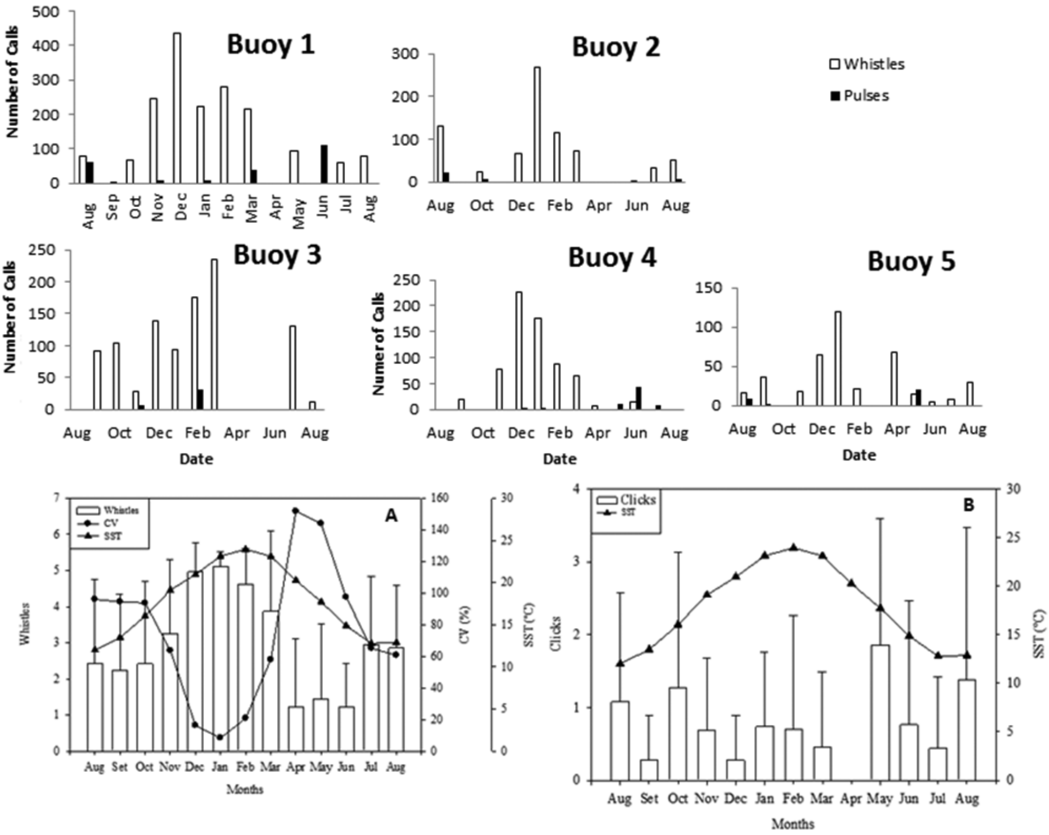

Figure 4. Total number of whistles and clicks tallied during each sampling period (buoys are labelled as one to five. (A) Mean number of whistles (ln [X+1]) with standard deviations and coefficients of variation (CV) as percentages and SST across all months between August 2011 to August 2012. (B) Mean number of clicks (ln [X+1]) with standard deviations and SST plotted across all months for the deployment period of August 2011 to August 2012.

described herein are very similar to those presented by previous studies of the vocalizations of free-ranging bottlenose dolphins (Caldwell et al., 1990; Tyack, 1997; Nowacek, 1999, 2005; Tyack & Clark, 2000; Acevedo-Gutiérrez & Stienessen, 2004; Quick & Janik, 2008; Janik, 2009; Simard et al., 2011).

The most frequently documented whistles had more than one inflection point (90% displayed between 1 to 3 points) as has also been found in previous studies of free-ranging bottlenose dolphins (Steiner, 1981; Morisaka et al., 2005; Azevedo et al., 2007). Whistle frequency was also similar to published frequency ranges for this species, reaching a minimum of 0.8 kHz (Schultz & Corkeron, 1994) and a maximum of 22.3 kHz (Azevedo et al., 2007) (Table 3). The range for whistle duration documented in this study (0.62 ± 0.29 ms) is also consistent with previous studies that showed a minimum duration of 0.37 s (Morisaka et al., 2005) to a maximum of 1.30 s (Ding et al., 1995). For comparative purposes, we included data from Azevedo et al. (2007) in Table 3.

Whistle data collected in this study show both similarities and differences from values previously reported for *Tursiops* spp. Whistle data closely resemble those reported by Azevedo et al. (2007) from Laguna de los Patos in Brazil (Table 3). This regional similarity in all whistle parameters analysed could be a result of recording the same individuals from the Patos Lagoon estuary in the area studied herein as regional movements of identified individuals between Uruguay and southern Brazil have been observed (Laporta et al., 2008b).

With regard to click sounds, the click duration described in the literature ranges from 8 to 72 µs with peak frequencies of 30 to 150 kHz (Au, 1993; Au & Hastings, 2008; Wahlberg et al., 2011). The click sounds recorded during this study were well within these previously published ranges, averaging 63.2 ± 4.06 µs and displaying a mean peak

Table 3. Means and standard deviations of whistle parameters for bottlenose dolphins from this study and previous studies (data obtained from Azevedo et al., 2007); an asterisk indicates data not reported by authors.

	SF	EF	MinF	MaxF	DUR	I	N	
Location	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		Study
Atlantic coast of Uruguay	5.89 (1.78)	6.24 (3.44)	6.12 (2.29)	9.72 (4.22)	0.62 (0.29)	0.76 (1.10)	4,152	This study
Patos Lagoon estuary, Brazil[a]	8.28 (3.11)	8.37 (3.70)	5.96 (2.15)	12.21 (3.20)	0.55 (0.39)	1.42 (1.85)	788	Azevedo et al., 2007
Argentina[a]	9.24 (2.74)	6.63 (2.29)	5.91 (1.50)	13.65 (1.54)	1.14 (0.49)	1.58 (1.24)	110	Ding et al., 1995
Texas, USA[a]	8.01 (2.81)	8.16 (3.78)	5.77 (1.84)	11.32 (3.31)	0.68 (0.40)	2.09 (2.54)	2,022	Ding et al., 1995
North Atlantic Ocean[a]	11.26 (3.99)	10.20 (3.65)	7.33 (1.66)	16.24 (2.69)	1.30 (0.63)	2.86 (2.45)	858	Steiner, 1981
Sado estuary, Portugal[a]	5.8 (1.8)	12.1 (4.4)	15.0 (2.7)	5.4 (1.2)	0.86 (0.40)	--	735	dos Santos et al., 2005
Gulf of California[a]	12.10 (2.89)	9.19 (3.44)	6.91 (2.11)	13.68 (1.72)	0.66 (0.35)	1.15 (1.32)	110	Ding et al., 1995
Eastern Tropical Pacific Ocean[a]	11.2 (4.6)	9.0 (3.7)	7.4 (2.2)	17.2 (3.1)	1.4 (0.7)	3.7 (3.0)	157	Oswald et al., 2003
Moreton Bay, Australia[b]	--	--	--	--	0.38 (0.21)	--	404	Schultz & Corkeron, 1994
Shark Bay, Australia[b]	3.84 (1.42)	7.56 (3.80)	3.57 (0.97)	10.57 (3.02)	0.68 (0.35)	1.63 (1.53)	658	Ding et al., 1995
Japan[b]	10.33 (2.41)	8.87 (2.21)	7.37 (1.54)	11.62 (2.00)	0.62 (0.34)	0.88 (0.79)	215	Ding et al., 1995
Mikura Island, Japan[b]	7.17 (2.85)	9.82 (4.18)	5.98 (2.44)	12.21 (3.20)	0.39 (0.33)	1.22 (1.39)	851	Morisaka et al., 2005
Ogasawara Island, Japan[b]	6.91 (3.12)	10.35 (4.86)	5.61 (2.06)	12.34 (4.93)	0.44 (0.44)	1.19 (1.50)	247	Morisaka et al., 2005
Amakura-Shimoshima Island, Japan[b]	6.74 (2.82)	8.06 (3.80)	5.63 (2.21)	9.39 (3.90)	0.37 (0.25)	0.78 (0.88)	515	Morisaka et al., 2005

[a] *Tursiops truncatus*

[b] *Tursiops aduncus*

frequency of 52.02 ± 12.09 kHz, respectively, although our equipment would not record greater than 96 kHz. The interclick intervals produced by bottlenose dolphins vary with behavior, such as during navigation and prey localization, as these intervals are known to steadily decrease with decreasing distance to a target (Jensen et al., 2009). The interclick intervals recorded here (129.4 ± 3.94 ms) were within the range previously published for this species in other coastal regions (Au, 1993; Au & Hastings, 2008; Jensen et al., 2009; Wahlberg et al., 2011). The relatively fewer recordings of clicks as compared to whistles documented in this study may be explained by differences in foraging/feeding behaviour in this area; or it could also be that the animals were not facing the PAM units, which therefore did not capture all the clicks emitted by the animals. Click train characteristics have been associated with foraging/feeding by bottlenose dolphins in other locations (Au et al., 1974; Au, 1993; Tyack, 1997; Mann et al., 2000; Jensen et al., 2009), but this species is also known to use passive listening for foraging/feeding (Gannon et al., 2005; Berens et al., 2010). Gannon et al. (2005) found that bottlenose dolphins use passive listening extensively during the search phase of foraging in Sarasota Bay, Florida. By listening, bottlenose dolphins may obtain useful information on the identity, number, size, and location of soniferous prey. Once bottlenose dolphins discover the prey by passive means, they then appear to use echolocation to track the prey during pursuit and capture phases. Such judicious use of echolocation suggests that this sensory modality incurs significant energetic or ecological costs.

This study was developed within a limited geographic region, and the knowledge of cetacean habits along the Uruguayan coast related to its behavior and availability of near-shore waters is scarce (Laporta, 2004; Laporta et al., 2008a, 2008b; Tellechea & Norbis, 2012a). Species-specific habitats along its distribution area remain largely undefined, and the variability on one of the more important oceanographic features (SST) can be compiled to understand the ecology and behavior of the species. In the region, the SST, which controls seasonal stratification over the continental shelf, describes a pronounced seasonal cycle typical of temperate areas, reaching a maximum in summer and a minimum in winter (Podesta et al., 1991; Provost et al., 1992; Guerrero et al., 1997). The more abundant and dominant species of sciaenid fishes in the region—the whitemouth croaker (*Micropogonias furnieri*) and striped weakfish (*Cynoscion guatucupa*) (Norbis et al., 2006)—spawn in the Rió de la Plata estuary and Uruguayan Atlantic coast in spring-summer (Vizziano, 2002; Vizziano et al., 2002a, 2002b; Macchi et al., 2003; Militelli & Macchi, 2006; Jaureguizar et al., 2006, 2008; Jaureguizar & Guerrero, 2009). Seasonal and annual variability in the water temperature affect various fish biological behaviors, particularly the timing of reproduction in sciaenids (Vizziano et al., 2002a, 2002b; Macchi et al., 2003; Norbis & Verocai, 2005; Militelli & Macchi, 2006). Advertisement call choruses found by these principal and more abundant sciaenids species, take place during spring and summer spawning season (Tellechea et al., 2010, 2011a, 2011b; Tellechea & Norbis, 2012b). Knowledge about spawning of soniferous fish species may provide a means of directly measuring the availability of some potential prey species, and the bottlenose dolphins have a significant positive selection of soniferous fishes, particularly sciaenids (Berens et al., 2010).

These species are food items for the bottlenose dolphin in this area (Mermoz, 1977; Pinedo, 1982; Mehsen et al., 2005). Additionally, the majority of click activity by bottlenose dolphins occurred outside the austral summer, during which sciaenid species generally do not emit sounds associated with reproduction (Tellechea et al., 2010, 2011a, 2011b; Tellechea & Norbis, 2012b). As such, the low number of clicks in summer months could be explained by the use of passive listening rather than echolocation as a primary means of prey detection by bottlenose dolphins as has been proposed by Berens et al. (2010). In contrast, in the winter, when other soniferous fishes are largely absent, bottlenose dolphins may increase use of clicks to locate prey. Alternatively, whistles were largely recorded during the summer, suggesting that whistles could be used for individual recognition or group cohesion (Caldwell et al., 1990; Sayigh et al., 1990, 2007; Janik & Slater, 1998; Watwood et al., 2004). Nonetheless, our method of data collection did not permit identification of the whistler, and, as such, we could not evaluate individual whistle recognition or a group cohesion hypothesis. The observed increase in whistles could also be associated with foraging/feeding behaviour as described by Acevedo-Gutiérrez & Stienessen (2004).

Based on our findings, we suggest that the low number of click trains and increased whistle activity during the summer months may be due to the use of passive listening during foraging activity. In contrast, bottlenose dolphins may move or migrate to Brazil (Laporta et al., 2008b) in search of warmer waters in winter. Further studies with playback experiments, surveys of the actual animals, and behavioural studies would be necessary to test this hypothesis. In conclusion, this study provides the first description of acoustic data obtained and the acoustic seasonal cycles from a small population of bottlenose dolphins observed along the Atlantic coast of Uruguay.

This new data will contribute to the preservation of this species that actually could be at risk from high maritime traffic, overfishing in fishery resources that are a food item of this species of dolphin, and future port construction on the Atlantic coast.

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