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NOTE

Marine Mammal Science

Southeast Pacific blue whale song recorded off Isla Chañaral, northern Chile

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Determining the distribution and seasonal movements of baleen whales is fundamental to the development of conservation strategies and marine spatial planning, which ensure their continued protection (e.g., Mullen, Peterson, & Todd, 2013; Pompa, Ehrlich, & Ceballos, 2011; Redfern et al., 2013a,b). One method widely used to monitor distribution and movements of cetaceans is passive acoustic monitoring (PAM) (e.g., Mellinger, Stafford, Moore, Dziak, & Matsumoto, 2007; Van Parijs et al., 2009). The loud, repetitive, low-frequency songs of baleen whales make these animals particularly good candidates for acoustically determining their occurrence and in turn their distribution (e.g., Buchan, Hucke-Gaete, Rendell, & Stafford, 2015; Cerchio, Jacobsen, & Norris, 2001; Širović, Hildebrand, Wiggins, & Thiele, 2009; Stafford, Nieukirk, & Fox, 1999a,b). Endangered (https://www.iucn.org/) blue whales (*Balaenoptera musculus*) produce distinct song types recorded in different oceanic regions with largely distinct spatial and temporal distributions (e.g., Balcazar et al., 2017; Buchan, Hucke-Gaete, Rendell, & Stafford, 2014; Buchan et al. (2015); McDonald, Mesnick, & Hildebrand, 2006 and references therein; Samaran et al., 2013; Stafford, Chapp, Bohnenstiel, & Tolstoy, 2011). Song in blue whales is assumed to serve some reproductive function as it is believed to be produced only by males (Oleson et al., 2007a) and is produced throughout the animals' migratory range (Stafford et al., 1999a; Stafford, Nieukirk, & Fox, 2001). Blue whale song remains relatively stable over time, although there is some intraannual variation in song production (Oleson, Wiggins, & Hildebrand, 2007b) and a decrease in the frequency of tonal song components has been reported over decadal timescales (Gavrilov, McCauley, & Gedamke, 2012; McDonald, Hildebrand, & Mesnick, 2009). Therefore, PAM offers a very useful method to monitor the distribution of blue whale acoustic groups worldwide.

The predominant song type of Southeast Pacific blue whales, known as the Southeast Pacific 2, (SEP2; Buchan et al., 2014) has been recorded in Chilean Patagonia (Buchan et al., 2014, 2015), off Juan Fernandez (Truong, Širović, Tripovich, & Rogers, 2016), and in the eastern tropical Pacific (Buchan et al., 2015; Stafford et al., 1999b). This acoustic presence supports a migratory range for this group between Chilean Patagonia and the eastern tropical Pacific. This migratory range is also supported by genetic sampling of the individuals within this range (Torres-Florez, Hucke

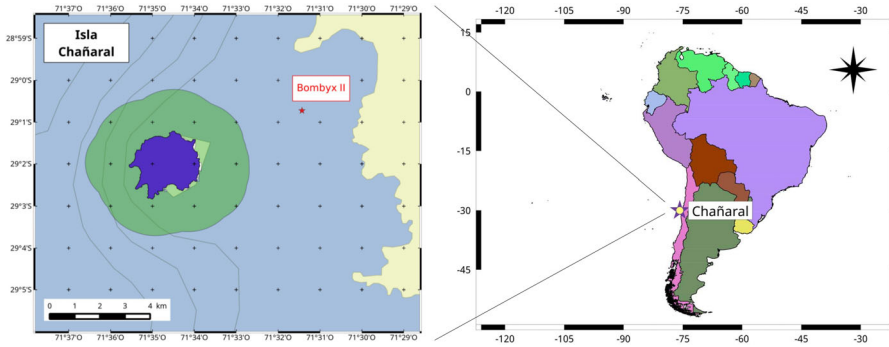

FIGURE 1 Map of the deployment zone of the BOMBYX II device (left). The green zone around the Island is a marine protected area (Reserva Marina Isla Chañaral). General location in South America (right).

Gaete, & LeDuc, 2014), photo-identification (Torres-Florez et al., 2015), and studies using satellite tags (Hucke-Gaete et al., 2018). Placed within the migratory corridor of south Pacific blue whales, Isla Chañaral is part of the Humboldt Archipelago, a series of coastal islands within the productive Humboldt Current System (Thiel et al., 2007; Figure 1). The waters surrounding Isla Chañaral, which lies 3.5 nautical miles from the mainland, are a known summer feeding ground primarily for fin whales (*Balaenoptera physalus*; Pérez-Álvarez et al., 2006; Sepúlveda, Pérez Álvarez, & Santos Carvallo, 2018; Sepúlveda, Santos, & Pavez, 2017; Toro, Vilina, Capella, & Gibbons, 2016), but also blue whales, humpback whales (*Megaptera novaeangliae*), sei whales (*Balaenoptera borealis*), and minke whales (*Balaenoptera bonaerensis*) have also been sighted (Capella, Vilina, & Gibbons, 1999; M. Sepúlveda, personal communication, 2016). This area has long since been the focus of a Marine Protected Area proposal. The acoustic identity of the blue whales that visit this area is unknown. In this study, we report the analysis of new PAM data from Northern Chile to examine whether there is evidence of southeast Pacific blue whales (SEP2 song type) in this area.

Passive acoustic data were collected within the Isla Chañaral channel, between the Isla Chañaral and the mainland, at 29°00′44″S, 71°31′26″W (Figure 1) during three periods of two weeks in January and February 2017 (see Patris, Malige, & Glotin, 2017 for details). A BOMBYX II, which includes a Cetacean Research C57 hydrophone (sensitivity of −187 dB re 1 V μPa^{-1}, flat response down to 20 Hz, omnidirectional at frequencies <10 kHz), powered by a 9V source and high-pass filtered C = 47 μF, frequency cut 0.15 Hz) and a commercial SONY PCM-M10 recording device (gain 6, Rin = 22 kOhm) equipped with a 256 GB memory card, set up in a specialized tube made by OSEAN SA (France) able to resist high pressure, was deployed between 15 and 20 m below the surface on a mooring where the maximum water column depth was 70 m. The BOMBYX II was deployed by the University of Toulon and Centre National de la Recherche Scientifique (Team DYNamiques de l'Information, Laboratoire d'Informatique et Systèmes).

Recording was done at a sample rate of 48 kHz so as to record a vast diversity of cetaceans, ranging from large whales to dolphins, and at 16 bits, allowing for high sensitivity without saturating the memory.[1] No low-pass filter (such as an anti-aliasing filter) was used for this recording, since it was not considered necessary for our purpose. Acoustic data were recorded between January 16 and February 27, 2017. No data were recorded during January 30 and 31 and during the night between February 13 and 14 because of instrument redeployment.

The SEP2 song is made up of a four-unit phrase (A, B, C, D; see Figure 2) lasting 60 s that is repeated every 2 min, in long series lasting for hours. All units are long and stable pulsed sounds; thus their power spectra show a set of discrete frequencies (Patris, Malige, Glotin, Asch, & Buchan, 2019). The energy of the spectra is generally concentrated around the 24 Hz peak. Unit A has an average duration of 22 s, unit B of 13 s, unit C of 5 s, and unit D an average duration of 13 s. Usually, not all units are visible due to low signal-to-noise ratio (SNR) and units C and D contain most of the signal's energy. In this study SEP2 song phrases were annotated whenever at least the 24 Hz frequency peak of units C and D were visible. The SEP2 songs of Southeast Pacific blue whales were annotated

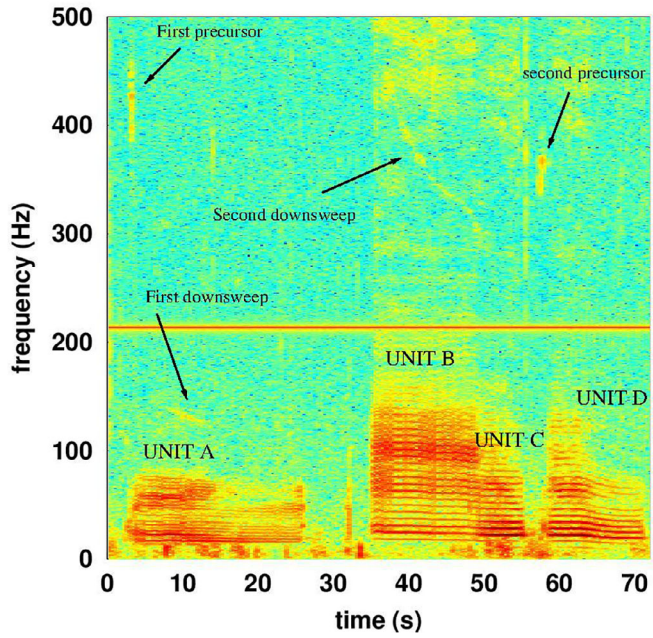

FIGURE 2 Time frequency representation of a SEP2 song recorded off Isla Chañaral, on February 2, 2017 (Fast Fourier transform, Blackman window of 65,536 points, overlapping 75%) using Octave software (Eaton, Bateman, & Hauberg, 2009). The line at 213 Hz is a constant electronic noise coming from the coupling between the hydrophone and the recording device. Units A, B, C, D are clearly visible as well as precursors and downsweeps belonging to the song.

manually, i.e., a box was drawn around the C and D units of the SEP2 song phrase, on the spectrogram visible in Raven Pro 1.5 (Bioacoustics Research Program, 2012). The following parameters were used: 8,192 sample FFT, 50% overlap, Hann window, with a Raven scale set to view 60 Hz over 200 s. Herein, we refer to all phrases with at least C and D units as SEP2 song phrases.

A nonsystematic double check of the data by another analyst showed that few phrases (with only unit B visible) were not counted by the first analyst (missed detections). Units C and D were not visible due to noise or propagation effects that mask low frequencies. Furthermore, unit A and the pair C-D are sometimes confoundable (having similar characteristics in duration and peak frequency). Thus, in some cases, unit A and the pair C-D of the same phrase were counted as two distinct occurrences of a phrase (false positive). As the second analysis was not systematic on all data but only on a portion of it (one third), it served to evaluate the importance of errors during the counting of the first analysis. Based on this double check, we estimate the error in counting SEP2 occurrences to be less than 3%.

A total of 913 hr of acoustic recordings were analyzed, over which 1,981 SEP2 song phrases were identified, annotated, and counted by the first analyst (Figure 3). We also noted the presence of two short high frequency precursors before units A (around 430 Hz) and D (around 350 Hz) (see Figure 2). Two faint downsweeps are identified in phrases with high signal-to-noise ratio: in unit A (duration of 5 s from 150 Hz to 120 Hz; n = 10) and in unit B (duration of 12 s from 450 Hz to 300 Hz; n = 10; see Figure 2). This sound may be a byproduct of the pulsed low frequency sound, a resonance artefact or sound made independently. No mechanism of sound production has been proposed to explain this superposition of two sounds, called two-voiced sounds (Brown, 2008) and this has not been described for other blue whale's song types (McDonald et al., 2006).

There was no noticeable trend in the total number of SEP2 song phrases counted over the study period although, overall, more phrases were counted in January (64 phrases/day in average) compared to February (36 phrases/day; see Figure 3). No significative difference was found between day and night in the number of phrases. Although this is a short period study, these results show low but consistent acoustic presence of Chilean blue whales throughout the months of January and February off Isla Chañaral.

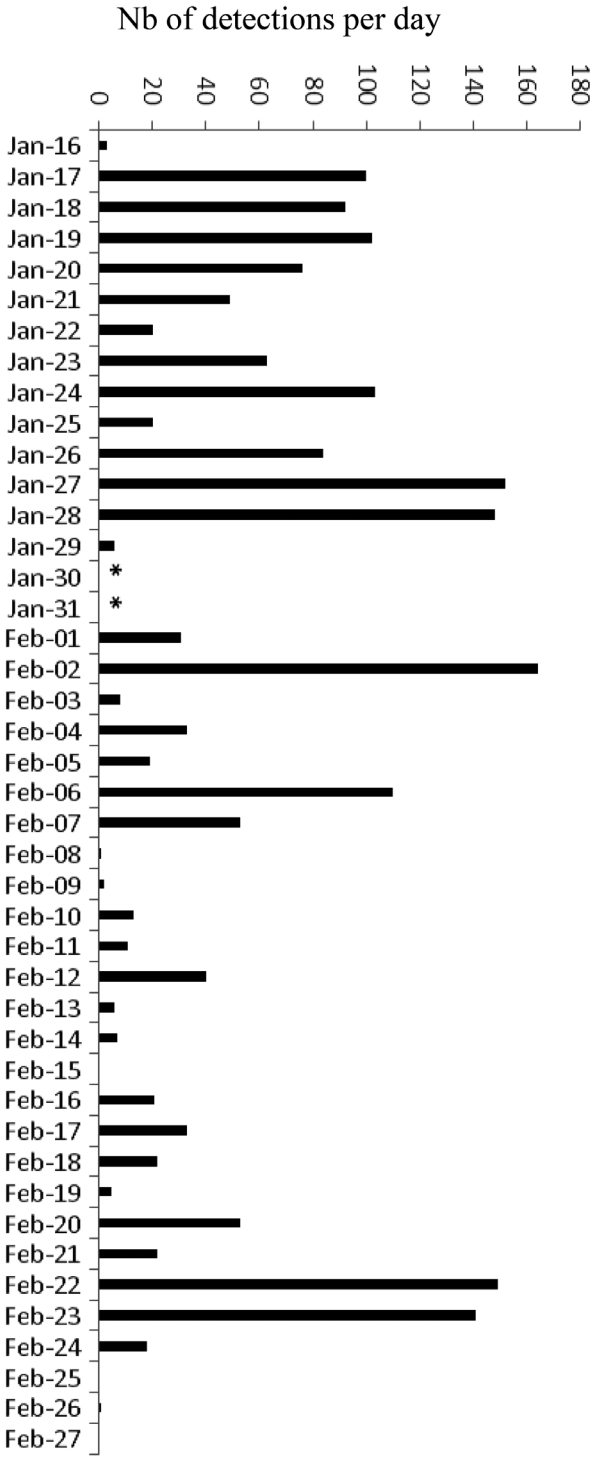

FIGURE 3 Number of SEP2 phrases counted in the first season of recording off Isla Chañaral. The device was off duty during January 30 and 31 (asterisks) and part of February 13 and 14.

From the Raven Pro selection tables, we calculated the time between SEP2 phrases, i.e., the interphrase interval (IPI), (Figure 4). The peaks at 2 and 4 min are characteristic of SEP2 individual song (Buchan, Rendell, & Hucke-Gaete, 2010) and suggest that phrases could be produced by single singers rather than multiple overlapping singers.

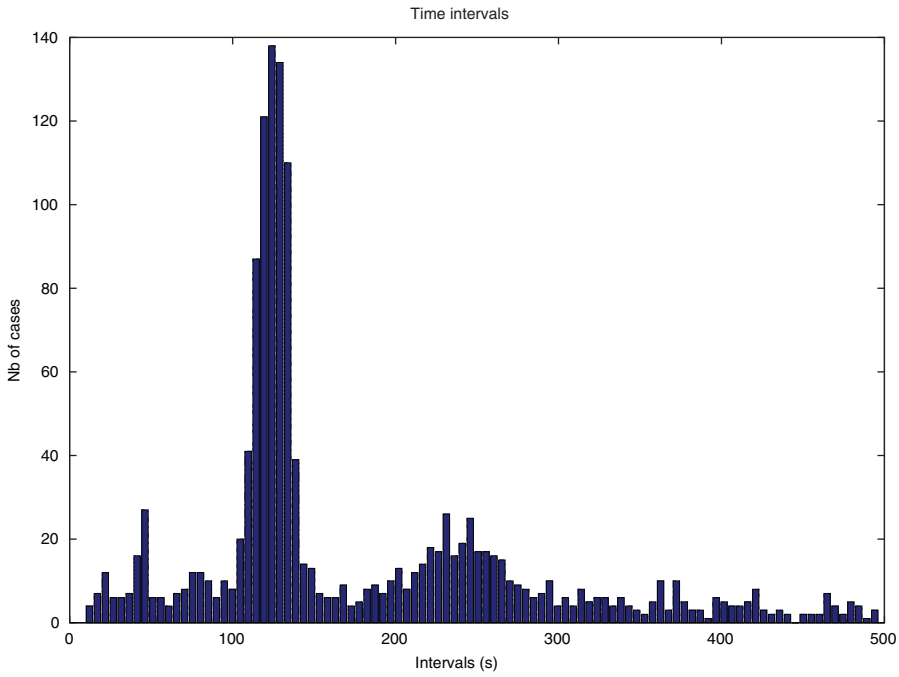

FIGURE 4 Histogram of the interphrase intervals (IPIs) between two occurrences of SEP2 phrases, from the Raven Pro selection table.

There is only one instance of song phrase overlap on January 28, 2017, reflected by shorter IPIs of 50–70 s, which might suggest the presence of two singers. This is consistent with limited opportunistic sighting observations i.e, a single blue whale performing circular dives and fluking, consistent with foraging behavior (Buchan & Quiñones, 2016), was observed by S.J.B. on February 15–17 and 23, 2017, within the Chañaral Channel and to the south of Isla Chañaral; and sightings of two blue whales together on January 16, 2017 (observed by J.P., S.J.B., and F.M.).

The number of phrases per day reported remains low compared to acoustic studies from Chilean Patagonia, where over one thousand SEP2 phrases were automatically detected per day between the months of March and May 2012–2013, which is thought to be the time of maximum abundance of animals in this region (Buchan et al., 2015; Galletti-Vernazzani, Jackson, Cabrera, Carlson, & Brownell, 2017; Hucke-Gaete, Osman, Moreno, Findlay, & Ljungblad, 2003). Since there is not yet year-round data off Isla Chañaral, it is impossible to compare seasonal trends in acoustic presence of Chilean blue whales at both sites. However, sighting data off Isla Chañaral (Sepúlveda et al., 2017) and in Chilean Patagonia (Galletti-Vernazzani et al., 2017; Hucke-Gaete et al., 2013) still suggest much higher abundance in Chilean Patagonia, which is considered the primary feeding ground for Chilean blue whales.

During visual inspection of the data set, no Antarctic blue whale song type (Ljungblad, Clark, & Shimada, 1998; Matsuoka, Murase, Nishiwaki, Fukuchi, & Shimada, 2000) has been detected, although it has been recorded in the Chilean Patagonia (Buchan, Hucke-Gaete, Stafford, & Clark, 2018) and also in low-latitude East Pacific Ocean (Stafford et al., 2004). No SEP1 blue whale's song type (Cummings and Thompson, 1971) has been detected in this data set. SEP1 has been recorded in Chilean Patagonia, off Juan Fernandez Archipelago and in the East Tropical Pacific (Cummings & Thompson, 1971; Stafford et al., 1999b; Truong et al., 2016) but is the least common of the two Southeast Pacific song types (Buchan et al., 2015; Saddler et al., 2017).

This is the first report of Southeast Pacific blue whale song (or any baleen whale call) in the coastal waters off northern Chile and in the Humboldt Current System. Given the high levels of productivity of this system, and

considering that Southeast Pacific blue whales are known to migrate between wintering grounds near Galapagos and summer feeding grounds in Chilean Patagonia (Buchan & Quinones, 2016; Buchan et al., 2015; Hucke-Gaete et al., 2003, 2018; Torres-Florez et al., 2015), it would make sense that some animals would take advantage of the available prey in the Humboldt Current System. In particular, the dense patches of Humboldt Current krill (*Euphausia mucronata*) known to be exploited by fin whales off Isla Chañaral (Toro et al., 2016) would also offer foraging opportunities for blue whales that are on their way to or from their primary feeding ground in Chilean Patagonia. The presence of southeast Pacific blue whales off Isla Chañaral is further evidence of the importance of this area for the conservation of endangered baleen whale populations.

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AUTHOR CONTRIBUTIONS

Julie Patris: Conceptualization; formal analysis; funding acquisition; investigation; methodology; project administration; supervision; writing-original draft; writing-review and editing. **Susannah Buchan:** Conceptualization; formal analysis; investigation; methodology; project administration; resources; supervision; writing-original draft; writing-review and editing. **Giselle Alosilla:** Formal analysis; investigation; methodology. **Naysa Balcazar-Cabrera:** Data curation; formal analysis; investigation; methodology. **Franck Malige:** Conceptualization; formal analysis; methodology; project administration; supervision; writing-review and editing. **Herve Glotin:** Conceptualization; funding acquisition; investigation; methodology; resources; supervision; writing-review and editing.

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ENDNOTE

[1] During the analysis, other vocalizations were found: blue whale "D-calls," fin whale (*Balaenoptera physalus*) vocalizations, bottlenose dolphin (*Tursiops truncatus*) echolocation clicks, whistles and low-frequency vocalizations, and dusky dolphin (*Lagenorhynchus obscurus*) burst of pulses (see Patris, 2019). This data set can be obtained from the authors.

REFERENCES

Balcazar, N. E., Klinck, H., Nieukirk, S. L., Mellinger, D. K., Klinck, K., Dziak, R. P., & Rogers, T. L. (2017). Using calls as an indicator for Antarctic blue whale occurrence and distribution across the southwest Pacific and southeast Indian Oceans. *Marine Mammal Science*, *33*, 172–186.

Bioacoustic Research Program. (2012). *Raven Pro: Interactive sound analysis software (version 1.5)* [Computer Software]. Ithaca, NY: Cornell Lab of Ornithology. http://www.birds.cornell.edu/raven

Brown, J. C. (2008). Mathematics of pulsed vocalizations with application to killer whale biphonation. *Journal of the Acoustical Society of America*, *123*, 28752883.

Buchan, S. J., & Quiñones, R. A. (2016). First insights into the oceanographic characteristics of a blue whale feeding ground in northern Patagonia, Chile. *Marine Ecology Progress Series*, *554*, 183–199.

Buchan, S. J., Hucke-Gaete, R., Rendell, L. E., & Stafford, K. M. (2014). A new song recorded from blue whales in the Corcovado Gulf, Southern Chile, and an acoustic link to the Eastern Tropical Pacific. *Endangered Species Research*, *23*, 241–252.

Buchan, S. J., Hucke-Gaete, R., Rendell, L. E., & Stafford, K. M. (2015). Seasonal occurrence of southeast Pacific blue whale songs in southern Chile and the eastern tropical Pacific. *Marine Mammal Science*, *31*, 440–458.

Buchan, S. J., Hucke-Gaete, R., Stafford, K. M., & Clark, C. W. (2018). Occasional acoustic presence of Antarctic blue whales on a feeding ground in southern Chile. *Marine Mammal Science*, *34*, 220–228.

Buchan, S. J., Rendell, L. E., & Hucke-Gaete, R. (2010). Preliminary recordings of blue whale (*Balaenoptera musculus*) vocalizations in the Gulf of Corcovado, northern Patagonia, Chile. *Marine Mammal Science*, *26*, 451–459.

Capella, J., Vilina, Y., & Gibbons, J. (1999). Observación de cetáceos en la Isla Chañaral y nuevo registros para el área de la Reserva Nacional Pingüino de Humboldt, norte de Chile [Observation of cetaceans at Isla Chañaral and new records at the Humboldt Penguin National Reserve, northern Chile]. *Estudios Oceanologicos*, *18*, 57–64.

Cerchio, S., Jacobsen, J. K., & Norris, T. F. (2001). Temporal and geographical variation in songs of humpback whales, *Megaptera novaeangliae*: Synchronous change in Hawaiian and Mexican breeding assemblages. *Animal Behaviour*, *62*, 313–329.

Cummings, W. C., & Thompson, P. O. (1971). Underwater sounds from the blue whale, *Balaenoptera musculus*. *Journal of the Acoustical Society of America*, *50*, 1193–1198.

Eaton, J. W., Bateman, D., & Hauberg, S. (2009). *GNU Octave version 3.0.1 manual: A high-level interactive language for numerical computations*. CreateSpace Independent Publishing Platform, 2009. http://www.gnu.org/software/octave/doc/interpreter

Galletti-Vernazzani, B., Jackson, J. A., Cabrera, E., Carlson, C. A., & Brownell, R. L., Jr. (2017). Estimates of abundance and trend of Chilean blue whales off Isla de Chiloé, Chile. *PLoS ONE*, *12*(1), e0168646.

Gavrilov, A. N., McCauley, R. D., & Gedamke, J. (2012). Steady inter and intra-annual decrease in the vocalization frequency of Antarctic blue whales. *Journal of the Acoustical Society of America*, *131*, 4476–4480.

Hucke-Gaete, R. (2004). *Distribución, preferencia de hábitat y dinámica espacial de la ballena azul en Chile: 1997–2004* [Distribution, habitat preference and spatial dynamics of the blue whale in Chile: 1997–2004] (Ph.D. thesis). Universidad Austral de Chile, Valdivia, Chile.

Hucke-Gaete, R., Bedriñana-Romano, L., Viddi, F. A., Ruiz, J. E., Torres-Florez, J. P., & Zerbini, A. N. (2018). From Chilean Patagonia to Galapagos, Ecuador: Novel insights on blue whale migratory pathways along the Eastern South Pacific. *PeerJ*, *6*, e4695.

Hucke-Gaete, R., Haro, D., Torres-Florez, J., Montecinos, Y., Viddi, F., Bedriñana-Romano, L., … Ruiz, J. (2013). A historical feeding ground for humpback whales in the eastern South Pacific revisited: The case of northern Patagonia, Chile. *Aquatic Conservation Marine and Freshwater Ecosystems*, *23*, 858–867.

Hucke-Gaete, R., Osman, L. P., Moreno, C. A., Findlay, K. P., & Ljungblad, D. K. (2003). Discovery of a blue whale feeding and nursing ground in southern Chile. *Proceedings of the Royal Society London B (Supplement 4)*, *271*, S170–S174.

Ljungblad, D. K., Clark, C. W., & Shimada, H. (1998). A comparison of sounds attributed to pygmy blue whales (*Balaenoptera musculus brevicauda*) recorded south of the Madagascar Plateau and those attributed to 'true' blue whales (*Balaenoptera musculus*) recorded off Antarctica. *Report of the International Whaling Commission*, *48*, 439–442.

Matsuoka, K., Murase, H., Nishiwaki, S., Fukuchi, T., & Shimada, H. (2000). Development of a retrievable sonobuoy system for whale sounds recording in polar region. Paper SC/52/O7 presented to the IWC Scientific Committee, Adelaide, Australia.

McDonald, M. A., Hildebrand, J. A., & Mesnick, S. (2009). Worldwide decline in tonal frequencies of blue whale songs. *Endangered Species Research*, *9*, 13–21.

McDonald, M. A., Mesnick, S. L., & Hildebrand, J. A. (2006). Biogeographic characterisation of blue whale song worldwide: Using song to identify populations. *Journal of Cetacean Research Management*, *8*, 55–56.

Mellinger, D. K., Stafford, K. M., Moore, S. E., Dziak, R. P., & Matsumoto, H. (2007). An overview of fixed passive acoustic observation methods for cetaceans. *Oceanography*, *20*(4), 36–45.

Mullen, K. A., Peterson, M. L., & Todd, S. K. (2013). Has designating and protecting critical habitat had an impact on endangered North Atlantic right whale ship strike mortality? *Marine Policy*, *42*, 293–304.

Oleson, E. M., Calambokidis, J., Burgess, W. C., McDonald, M. A., LeDuc, C. A., & Hildebrand, J. A. (2007a). Behavioural context of call production by eastern North Pacific blue whales. *Marine Ecology Progress Series*, *330*, 269–284.

Oleson, E. M., Wiggins, S. M., & Hildebrand, J. A. (2007b). Temporal separation of blue whale call types on a southern California feeding ground. *Animal Behaviour*, *74*, 881–894.

Patris, J. (2019). *Contribution en méthodes pour le suivi de mysticètes par acoustique passive* {Contribution in methods for tracking mysticetes by passive acoustics] (Ph.D. thesis). Université de Toulon, Toulin, France. http://www.theses.fr/2019TOUL0016

Patris, J., Malige, F., & Glotin, H. (2017). *Construction et mise en place d'un système fixe d'enregistrement à large bande pour les cétacés "bombyx 2" Isla de Chañaral, été austral 2017* [Construction and installation of a fixed broadband recording system for cetaceans "bombyx 2" Isla de Chañaral, austral summer 2017] (Technical Report 2017–03). LSIS CNRS, Marseilles, France.

Patris, J., Malige, F., Glotin, H., Asch, M., & Buchan, S. (2019). A standardized method of classifying pulsed sounds and its application to pulse rate measurement of blue whale southeast Pacific song units. *Journal of the Acoustical Society of America*, *146*, 2145–2154.

Pérez-Álvarez, M., Thomas, F., Uribe, F., Sepúlveda, M., Flores, M., & Moraga, R. (2006). Fin whales (*Balaenoptera physalus*) feeding on *Euphausia mucronata* in nearshore waters off North-Central Chile. *Aquatic Mammals*, *32*, 109–113.

Pompa, S., Ehrlich, P. R., & Ceballos, G. (2011). Global Distribution and conservation of marine mammals. *Proceedings of the National Academy of Sciences of the United States of America*, *108*, 600–605.

Redfern, J. V., Hatch, L. T., Caldow, C., DeAngelis, M. L., Gedamke, J., Hastings, S., … Porter, M. B. (2013a). Assessing the risk of chronic shipping noise to baleen whales off Southern California, USA. *Endangered Species Research*, *32*, 53–167.

Redfern, J. V., McKenna, M. F., Moore, T. J., Calambokidis, J., Deangelis, M. L., Becker, E. A., … Chivers, S. J. (2013b). Assessing the risk of ships striking large whales in marine spatial planning. *Conservation Biology*, *27*, 292–302.

Saddler, M. R., Bocconcelli, A., Hickmott, L. S., Chiang, G., Landea-Briones, R., Bahamonde, P. A., … Sayigh, L. S. (2017). Characterizing Chilean blue whale vocalizations with DTAGs: A test of using tag accelerometers for caller identification. *Journal of Experimental Biology*, *220*, 4119–4129.

Samaran, F., Stafford, K. M., Branch, T. A., Gedamke, J., Royer, J. R., Dziak, R. P., & Guinet, C. (2013). Seasonal and geographic variation of the southern blue whale subspecies in the Indian Ocean. *PLoS ONE*, *8*(8), 1–10.

Sepúlveda, M., Pérez Álvarez, M. J., & Santos Carvallo, M. (2018). From whaling to whale watching: Identifying fin whale critical foraging habitats off the Chilean coast. *Aquatic Conservation Marine and Freshwater Ecosystems*, *18*, 1–9.

Sepúlveda, M., Santos, M., & Pavez, G. (2017). *Whale-watching en la Reserva Marina Isla Chañaral: Manejo y planificación para una actividad sustentable* [Whale-watching in the Chañaral Island Marine Reserve: Management and planning for a sustainable activity] (Primera Edición 2017). Valparaíso, Chile: Universidad de Valparaíso.

Širović, A., Hildebrand, J. A., Wiggins, S. M., & Thiele, D. (2009). Blue and fin whale acoustic presence around Antarctica during 2003 and 2004. *Marine Mammal Science*, *25*, 125–136.

Stafford, K. M., Bohnenstiehl, D., Tolstoy, M., Chapp, E., Mellinger, D., & Moore, S. (2004). Antarctic-type blue whale calls recorded at low latitudes in the Indian and eastern Pacific Oceans. *Deep Sea Research Part I: Oceanographic Research Papers*, *51*, 1337–1346.

Stafford, K. M., Chapp, E., Bohnenstiel, D. R., & Tolstoy, M. (2011). Seasonal detection of three types of "pygmy" blue whale calls in the Indian Ocean. *Marine Mammal Science*, *27*, 828–840.

Stafford, K. M., Nieukirk, S. L., & Fox, C. G. (1999a). An acoustic link between blue whales in the eastern tropical Pacific and the northeast Pacific. *Marine Mammal Science*, *15*, 1258–1268.

Stafford, K. M., Nieukirk, S. L., & Fox, C. G. (1999b). Low-frequency whale sounds recorded on hydrophones moored in the eastern tropical Pacific. *Journal of the Acoustical Society of America*, *106*, 3687–3698.

Stafford, K. M., Nieukirk, S. L., & Fox, C. G. (2001). Geographical and seasonal variation of blue whale calls of the North Pacific. *Journal of Cetacean Research Management*, *3*, 65–76.

Thiel, M., Macaya, E., Acuna, E., Arntz, W., Bastias, H., Brokordt, K., … Vega, A. (2007). The Humboldt Current System of northern and central Chile. *Oceanography and Marine Biology*, *45*, 195–345.

Toro, F., Vilina, Y. A., Capella, J., & Gibbons, J. (2016). Novel coastal feeding area for eastern South Pacific fin whales (*Balaenoptera physalus*) in mid-latitude Humboldt Current waters off Chile. *Aquatic Mammals*, *42*, 47–55.

Torres-Florez, J. P., Hucke Gaete, R., & LeDuc, R. (2014). Blue whale population structure along the eastern South Pacific Ocean: Evidence of more than one population. *Molecular Ecology*, *23*, 5998–6010.

Torres-Florez, J. P., Olson, P. A., Bedriñana-Romano, L., Rosenbaum, H. C. R., Ruiz, J., LeDuc, R., & Hucke Gaete, R. (2015). First documented migratory destination for eastern South Pacific blue whale. *Marine Mammal Science*, *31*, 1580–1586.

Truong, G., Širović, A., Tripovich, J., & Rogers, T. (2016). Seasonal patterns in Chilean blue whale call detections between 2003 and 2015. SC/66b/SH/25, International Whaling Commission.

Van Parijs, S. M., Clark, C. W., Sousa-Lima, R. S., Parks, S. E., Rankin, S., Risch, D., & Van Opzeeland, I. C. (2009). Management and research applications of real-time and archival passive acoustic sensors over varying temporal and spatial scales. *Marine Ecology Progress Series*, *395*, 21–36.

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