

Antofagasta Region in northern Chile, a potential nursing ground for the Southern right whale *Eubalaena australis*

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Abstract

The Chile-Peru subpopulation (CPe) of the Southern right whale (*Eubalaena australis*) is classified as Critically Endangered following intense whaling in past centuries. Due to their very low abundance, information on breeding and feeding grounds is also scarce. Unmanned aerial vehicles (UAVs) are increasingly applied in marine mammal research thanks to their low cost and relative ease of use. This case study documents a Southern right whale nursing in Bahía Moreno (23° S), Antofagasta, in northern Chile through high-resolution images taken by UAV of an adult in July 2019 and the same, photo-identified, whale with a neonate in August 2019. Combined with earlier data we hypothesize that the Antofagasta Region may be a potential calving and nursing ground for the CPe subpopulation. Given the intense shipping traffic and fishing activities around the Mejillones Peninsula and Antofagasta port, priorly recommended marine spatial planning to help avoid net entanglements and vessel collisions of fin and humpback whales may also contribute to the conservation of the CPe stock.

Keywords: breeding, drone, Humboldt Current System, mark-recapture, nursery ground

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The Southeast Pacific population of the Southern right whale (*Eubalaena australis*), also referred to as the Chile-Peru subpopulation (CPe), experienced a detrimental decline due to intense commercial whaling conducted between 1789 and 1976 with around 9,000 individuals hunted (Clarke, 1965; Aguayo-Lobo *et al.*, 1998; Pastene and Quiroz, 2010). Despite an international moratorium established in 1936 prohibiting the hunting of Southern right whales (SRW), in Chile hunting continued for another 40 years, with the last SRW taken in 1976 (Aguayo-Lobo and Torres, 1986). The unsustainable exploitation led them to near extinction and currently the CPe subpopulation of SRW is considered Critically Endangered with fewer than 50 mature individuals (Reilly *et al.*, 2008; Cooke, 2018). In contrast, the geographically closest western South Atlantic SRW subpopulation has experienced strong growth over the past few decades in the shallow coastal waters of Argentina and Uruguay (Cooke *et al.*, 2001; Piedra *et al.*, 2006).

On the west coast of South America, the CPe subpopulation of SRW is distributed from Lima, central Peru (12°11' S) to Gulf of Penas, austral Chile (47°58' S) (Aguayo-Lobo, 1974; Van Waerebeek *et al.*, 1992; 2009; Orihuela and Cortegana-Arias, 2013; Galletti-Vernazzani *et al.*, 2014). Off Chile two main aggregation areas have been recognized, one in the Antofagasta Region, northern Chile (centered around 23° S) and another in central-south Chile (33°S to 42° S) (Guerra-Correa *et al.*, 1987; Galletti-Vernazzani *et al.*, 2014). Extensive shipboard and shoreline surveying in Chile's Fuegian and Patagonian channels and fjords in 1997-2008 indicated that SRW were mostly distributed at the eastern entrance and the central part of the Strait of Magellan and the eastern Beagle Channel, suggesting these whales belong to the SW Atlantic population (Gibbons *et al.*, 2006; Belgrano *et al.*, 2008). The CPe whales are thought to migrate annually from feeding grounds at high latitudes off the Antarctic Peninsula to breeding and nursing grounds at low latitudes in Chile and Peru (Mackintosh, 1942; Aguayo-Lobo *et al.*, 1992; 2008; Van Waerebeek *et al.*, 1998; 2009). However, based on geographical considerations Gibbons *et al.* (2006) proposed that SRW found off the Antarctic Peninsula correspond to individuals from the Southwest Atlantic population. Aguayo-Lobo *et al.* (2008) suggested the Magallanes Region and Antarctic waters as feeding grounds for, respectively, the Argentina and the CPe

subpopulations, but much uncertainty remains¹ (see Galletti-Vernazzani *et al.*, 2014). Moreover, the classic paradigm of obligate seasonal migrations of baleen whale species for feeding purposes is under increasing controversy as new studies (e.g. Frisch-Jordán *et al.*, 2019; Weerdt and Ramos, 2019) support earlier findings of occasional non-migrating humpback whales (*Megaptera novaeangliae*) in upwelling areas and feeding on breeding grounds (Papastavrou and Van Waerebeek, 1998). Also, some fin whales (*Balaenoptera physalus*) in the Gulf of California were found not migrating to higher latitudes to feed (Jiménez-López *et al.*, 2019). As the SRW CPe subpopulation has not recovered from whaling and sightings are scarce, their migratory paths, breeding and nursery grounds in the Southeast Pacific are poorly known.

Mother-calf pairs have been observed along the Peruvian and Chilean coasts on several occasions² (Van Waerebeek *et al.*, 1998; 2009; Santillán *et al.*, 2004; Galletti-Vernazzani *et al.*, 2014). With five cases of mother-calf (neonate) pairs among seven confirmed occurrences, southern and central Peruvian coastal waters are now firmly established as native for SRW (Van Waerebeek *et al.*, 2009). The northernmost mother-calf pair was observed off Chorrillos, Lima (12°11' S) on 21 August 2012 (Orihuela and Cortegana-Arias, 2013) and the southernmost about 18 nmi north of Isla de Chiloé (41°27' S) in October 2010 (Galletti-Vernazzani *et al.*, 2014). Mother-calf pairs have been reliably reported in Bahía Moreno, also called San Jorge Bay (23°28' S), indicating the Antofagasta Region as a potential nursing ground for the CPe subpopulation¹ (Cárdenas *et al.*, 1986; Guerra-Correa *et al.*, 1987; Galletti-Vernazzani *et al.*, 2014). The breeding season is suggested to last from June to October (Aguayo-Lobo *et al.*, 2008) and a maximum residency time of three months is recorded in Chile (Canto *et al.*, 1991). Parturition has not been documented on potential nursing grounds of the CPe subpopulation. However, locals in Atico, Peru, convincingly described a nearshore parturition in early August, when (postpartum) bleeding was noted at the moment a calf first appeared. The mother-calf pair then stayed in the area for 66 days (Van Waerebeek *et al.*, 1998). Here we present a new case of a SRW mother-calf pair, observed before and after parturition and documented by an unmanned aerial vehicle (UAV) in 2019. It adds evidence to the notion of the Antofagasta Region as a nursing ground for the CPe subpopulation¹ (Galletti-Vernazzani *et al.*, 2014).

The recreational use of UAVs is increasing rapidly among citizens due to its low cost and ease of use³. UAVs are also becoming effective tools for wildlife research and monitoring considering their friendly and safe handling (Nowacek *et al.*, 2016). Launched from land or sea, they have the potential to collect high-resolution images and videos of inaccessible and elusive wildlife such as marine mammals (Koski *et al.*, 2013) where they have been deployed to monitor abundance, photo ID, photogrammetry, body condition and to collect breath samples for disease monitoring (Christiansen *et al.*, 2019). Although it has been demonstrated that UAVs may negatively affect the behavior of sea otters (*Enhydra lutris*) and pinnipeds due to noise-levels (Richardson *et al.*, 1995), negative effects have not been found in

the behavior of baleen whales (Acevedo-Whitehouse *et al.*, 2010). Thus, UAVs are considered a non-invasive tool to successfully implement photo-identification and photogrammetry of baleen whales (Koski *et al.*, 2013; Christiansen *et al.*, 2019; 2020).

On 6 July 2019, inhabitants of Antofagasta city (23°39' S, 70°24' W) reported (to Garcia-Cegarra) an adult whale moving slowly south of the city, so close to shore that its blows were readily seen from land. The species was identified as a SRW thanks to its unmistakable external morphology including a broad back, callosities on the head and the lack of a dorsal fin. On 8 July 2019, a single adult SRW was observed south of Antofagasta city by local citizens during the Antofagasta Body Board Festival. In small populations SRW sightings in close proximity, both time and locations, are considered same individuals (Patenaude, 2003). Hence, the individual observed on 8 July (Fig. 1, #1) was probably the same individual seen on 6 July. With the use of an UAV the locals obtained high-resolution images, which allowed us to photo-identify the whale by the characterization of the head callosities and the location and shape of a large white blaze on its dorsum (Fig. 2a). The unaccompanied individual was observed swimming slowly during consecutive days in or near Bahía Moreno (Fig. 1). The sighting on 10 July (Fig. 1, #3) that consisted of an adult SRW at Juan López (23.4 km from #2 position) observed by a local citizen was not photo-identified, but was assumed to be the same individual following the parsimony principle (Patenaude, 2003). However, the potential simultaneous occurrence in the bay of a second adult cannot be disproven.

The photo-identified whale was last observed alone on 11 July 2019 (Fig. 1, #4). Twenty-eight days later, on 8 August, a local citizen informed us about the presence of a whale with a calf very close to shore north of Antofagasta city (Fig. 1, #5). Pictures were taken from land by local citizens. On 12 August we deployed a UAV DJI Phantom 4 Pro (DJI Innovation, Shenzhen, China) equipped with a gimbaled camera (1" CMOS, 20M effective pixels). Fitted with a flight controller and equipped with an Android system tablet, 5.5-inch screen, the two intelligent batteries (LiPo 4S, 15.2 V, 5870 mAh) allow a maximum flight time of 25 min each. During 45 min, high-quality photographs of mother and calf performing typical nursing behavior were registered by the

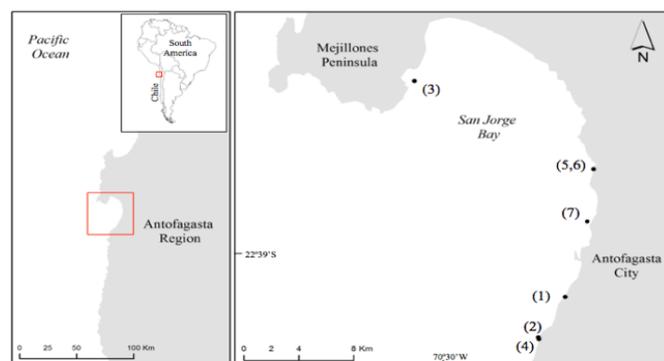


Figure 1. Study location map showing geographic positions of a SRW seen over a period of 49 days in Bahía Moreno (San Jorge Bay), Antofagasta Region, northern Chile. Black dots indicate positions of the SRW initially (July 2019) observed without calf: (1) 8 July, UAV deployed; (2) 9 July; (3) 10 July; (4) 11 July; and subsequently (August 2019) with calf: (5) 8 August; (6) 12 August, UAV deployed; (7) 25 August.

1. Galletti-Vernazzani, B., Brito, J.L., Cabrera, E., Cardenas, J.C. and Brownell Jr, R.L. (2011) Sightings of Southern right whales (*Eubalaena australis*) off Chile and Peru from 1975 to 2010. Paper SC/S11/RW22 presented to the Scientific Committee, International Whaling Commission, Southern Right Whale Assessment. Anchorage, Alaska, September 2011. Unpublished, 12 pp. [Available from the Office of the International Whaling Commission, The Red House, 135 Station Road, Impington, Cambridge, Cambridgeshire CB4 9NP, UK.]

2. Cárdenas, J.C., Torres, D., Oporto, J. and Stutzin, M. (1986) Presencia de la ballena franca (*Eubalaena australis*) en las costas de Chile. Pages 28-31 in Resúmen, 2ª Reunión de Trabajadores de Especialistas em Mamíferos Aquáticos da América do Sul, 4-8 August 1986, Rio de Janeiro, Brazil. Available at <https://www.dropbox.com/s/deg36so999bapey/2rt.pdf>

3. Teal Group Corporation (2011) World Unmanned Aerial Vehicle Systems: Market Profile and Forecast. Report from the Teal Group Corporation, Fairfax, VA.



Figure 2. Mark-recapture of a Southern right whale as photographed by UAV near Antofagasta, Chile: (A) lone adult south of Antofagasta city on 8 July 2019 (photograph courtesy of Arturo Soto); (B) the same individual observed with her calf near Trocadero beach on 12 August 2019; (C) perpendicular image used to assess relative size of calf according to head measures of mother and calf SRW observed on 12 August 2019 when the neonate was maximum one month old.

UAV steered from shore (Fig. 1, #6). Mark-recapture analysis allowed us to identify unequivocally the mother as the same whale observed a month earlier, due to the presence of the unique white blaze on its dorsum and the callosities pattern (Fig. 2b). In order to estimate the relative size of the calf we selected the best frame from available UAV videos recorded on 12 August where the heads of both mother and calf were clear in perpendicular view (Fig. 2c). The distance from the tip of the rostrum to the posterior border of the blowholes in the calf divided by the equivalent distance in the adult female, resulted in a relative size ratio of the neonate calf (0.43). This agreed with frames of three other surfacings (0.41-0.43). We deduce that parturition occurred sometime between 11 July and 8 August when the calf was first spotted. It is the use of UAVs by both locals and scientists that provided the high-quality images in July and August 2019, allowing positive photo-identification and size estimation. Multiple sightings and the mark-recapture of an adult SRW, initially alone and later accompanied by a neonate, in the Antofagasta area, provide strong evidence of *in situ* calving.

Rare SRW encounters, due to the 'Critically Endangered' conservation status of the CPe subpopulation, hinder understanding of their true distribution, including potential site fidelity. Migratory paths have not been documented but Galletti-Vernazzani⁷ *et al.* proposed that the CPe SRW breeds in two calving areas: one in central and southern Chile (30° S to 37° S) and another in northern Chile (22° S to 26° S). Our findings and earlier observations (Cárdenas *et al.*, 1986; Guerra-Correa *et al.*, 1987) are consistent with the latter. The combined evidence suggests that nearshore coastal areas of the Antofagasta Region may be a habitual calving and nursing ground for CPe SRW. The whales typically remain just a few days at the same coastal location before moving on, whereas a few reported residency patterns lasted longer than a month (Van Waerebeek *et al.*, 1998; Santillán *et al.*, 2004; Galletti-Vernazzani *et al.*, 2014). The fact that the SRW recently observed near Antofagasta remained in the area during minimum 49 days suggests some residency during the early nursing phase, further supported by a 66-day stay of a mother-calf pair in Atico, Peru (Van Waerebeek *et al.*, 1998).

The Antofagasta Region is characterized by the presence of strong coastal upwelling cells, within the Humboldt Current System. The two most important upwelling cells are part of

the Mejillones Peninsula Upwelling System (MPUS, around 23° S) (Escribano *et al.*, 2000). Frontal and upwelling systems represent foraging opportunities for cetacean species due to their high productivity and prey concentration (Papastavrou and Van Waerebeek, 1998; Acha *et al.*, 2015). Whereas feeding grounds of the CPe subpopulation are poorly documented, at least some SRW from the Argentina breeding ground are known to feed around South Georgia, the Patagonian shelf and waters of the Polar Front (Leaper *et al.*, 2006; Valenzuela *et al.*, 2018). Historic whaling records of stomach contents of SRW captured in the South Atlantic Ocean showed whales captured north of 40° S contained mostly copepods (92%) while those whales captured south of 50° S contained mostly krill (99%) (Rowntree *et al.*, 2008). This latitudinal shift in diet could be related to the high abundance of krill (Euphausiidae) in the Polar Front during austral summer (Atkinson *et al.*, 2004). A recent study of stable isotopes in SRW from Argentina also revealed euphausiids and copepods as main prey in diets and the presence of three feeding areas for this population at high latitudes (Valenzuela *et al.*, 2018). However, an earlier study of stable isotope C¹³ in SRW from Argentina showed some whales having high C¹³ signature values from baleen plates, which could be interpreted as sporadic feeding in breeding grounds (Rowntree *et al.*, 2008). In northern Chile, the most intense upwelling cells occur in austral spring months (Escribano *et al.*, 2000) and the presence of krill (*Euphausia mucronata*) along the Humboldt Current System is well known (Riquelme-Bugueño *et al.*, 2016). Hence, it should be verified whether the calving of SRW in highly productive areas around 23° S is merely coincidental, or might be linked to the bonus option of sporadic opportunistic feeding.

Little information is published on coloration in CPe SRW. An individual resighted on two different years off Isla de Chiloé showed an unusual gray-morph coloration pattern (Galletti-Vernazzani *et al.*, 2014). However, the adult female documented here represents the only published SRW record in the SE Pacific with a coloration that includes a large white dorsal blaze contrasting with the otherwise blackish dorsum (Fig. 2). None of the animals observed in Peru had such a dorsal blaze (Van Waerebeek *et al.*, 2009; KVW, unpublished data). However, both the mother and calf from Atico showed a pure white ventral blaze in the umbilical area (Van Waerebeek *et al.*, 1998), which

is a common feature in the species (Best, 2007). Dorsal white blazes have been reported mainly from the SRW populations in Argentina (1.9%) and South Africa (7.1%) (Payne *et al.*, 1990; Schaeff *et al.*, 1999). Either some CPe SRW also have white blazes or, alternatively, the whale in Bahía Moreno may be of SW Atlantic origin and if so, may be 'recolonizing' the SE Pacific coastal habitat. Recolonization of pre-whaling historic habitats of SRW has been observed in the SW Atlantic population, thus we could expect this from the CPe subpopulation⁴ (Arias *et al.*, 2018). More comparative research (e.g. Carroll *et al.*, 2020) including photo-identification and phylogenetic studies of SRW from South Africa, South Georgia, Argentina, and Chile-Peru will be needed to understand migratory paths, genetic flux between (sub)populations and degree of philopatry.

Due to slow swimming and nearshore distribution in the breeding season, globally SRW is the fourth cetacean species most prone to die or be severely injured from vessel collision⁵. In the Southern Hemisphere of 119 large whales reported killed by vessel strikes, 56 (47%) were SRW (Van Waerebeek *et al.* 2007). Although most lethal collisions occur with vessels that navigate faster than 14 knots (Vanderlaan and Taggart, 2007), this is not exclusive. Entanglement in fishing nets is another major threat for the SRW CPe subpopulation⁶. One stranded individual in Chile showed both propeller scars and evidence of net entanglement (Canto *et al.*, 1991), another whale died from a severe entanglement⁷ and a mother-calf pair barely escaped a near-collision incident with an industrial purse-seiner at Pucusana, Lima (Van Waerebeek *et al.*, 2009). Antofagasta Region hosts one of the most important marine traffic routes in northern Chile due to the growth of the (mostly copper) mining industry in the last decade (García-Cegarra and Pacheco, 2019). Recently recommended marine spatial planning to mitigate potential collision risk between ships and fin and humpback whales for waters off the northern part of Mejillones Península (Pacheco *et al.*, 2015; García-Cegarra and Pacheco, 2019), if adapted to cover the entire peninsula, might benefit also the CPe. Large cargo vessel speeds in the area exceed the limit of 10 knots allowed in Chilean bays (García-Cegarra and Pacheco, 2019). The nursing of SRW in Bahía Moreno, just north of the major seaport of Antofagasta, hypothetically could endanger their lives. Apart from their proximity to the coast and slow swimming, nursing SRWs typically may not notice, or pay attention to, the presence of speed boats or large cargo vessels (Laist *et al.*, 2001; Nowacek *et al.*, 2004; Van Waerebeek *et al.*, 2009). In Chile at-sea whale-watching of the Critically Endangered SRW is not allowed and they may only be observed from land (according to *Reglamento General de Observación de Mamíferos Reptiles y Aves Hidrobiológicas y del Registro de Avistamiento de Cetáceos D.S. No 38-2011*).

In conclusion, this study provides the first evidence of parturition of a SRW in the Antofagasta Region. Furthermore, it lends strong support to earlier reports that the coastal

waters around Antofagasta are an important winter habitat and potentially a key calving/nursing ground for the CPe SRW subpopulation with boundaries yet to be determined. It is not known if the observed nursing of SRW in coastal waters near Antofagasta should be interpreted as an isolated or a recurrent event. Finally, it needs to be investigated whether maritime traffic by artisanal and industrial fishing boats, motor boats, speed boats and large cargo vessels in and around the Antofagasta port could jeopardize the physical integrity and breeding success of visiting SRW. In Chile local citizens and NGOs are increasingly becoming involved in, and contribute to, marine fauna research through citizen science. Their efforts promote the importance of marine conservation and may lead to increased reporting of SRW and other rarely observed marine mammal species.

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References

- Acha, E.M., Piola, A., Iribarne, O. and Mianzan, H. (2015) *Ecological Processes at Marine Fronts. Oases in the Ocean*. Springer International Publishing.
<https://doi.org/10.1007/978-3-319-15479-4>
- Acevedo-Whitehouse, K., Rocha-Gosselin, A. and Gendron, D. (2010) A novel non-invasive tool for disease surveillance of free-ranging whales and its relevance to conservation programs. *Animal Conservation* 13: 217-225.
<https://doi.org/10.1111/j.1469-1795.2009.00326.x>
- Aguiayo-Lobo, A. (1974) Baleen whales off continental Chile. Pages 209-217 in Schevill, W.E. (ed.) *The whale problem: A status report*. Harvard University Press, Cambridge, Massachusetts.
- Aguiayo, A. and Torres, D. (1986) Records of the Southern right whale, *Eubalaena australis* (Desmoulins 1822) from Chile between 1976 and 1982. *Reports of the International Whaling Commission* (Special Issue) 10: 159-160.
- Aguiayo, A., Cárdenas, J. and Torres, D. (1992) Análisis de los avistamientos de *Eubalaena australis* (Desmoulins, 1822) en aguas chilenas desde 1983 hasta 1989. *Series Científicas*
4. Crespo, E.A. and Coscarella, M.A. (2020) The Southwestern Atlantic Southern right whale, *Eubalaena australis*: updated population rate of increase. Paper SC/68/B presented to the Scientific Committee, International Whaling Commission, Cambridge, UK, 12-20 May 2020. [Available from the Office of the International Whaling Commission, The Red House, 135 Station Road, Impington, Cambridge, Cambridgeshire CB4 9NP, UK.]
5. Van Waerebeek, K. and Leaper, R. (2008) *Second report of the IWC Vessel Strike Data Standardisation Working Group*. Document SC/60/BC5, Scientific Committee of the International Whaling Commission, Santiago de Chile. 8 pp. https://iwc.int/document_1797
6. Galletti-Vernazzani, B. (2015) Progress on the IWC Conservation Management Plan for the Critically Endangered Eastern South Pacific Southern Right Whale Population. Paper SC/66a/BRG/15 presented to the Scientific Committee, International Whaling Commission, San Diego, USA, May 2015. Unpublished, 4 pp. [Available from the Office of the International Whaling Commission, The Red House, 135 Station Road, Impington, Cambridge, Cambridgeshire CB4 9NP, UK.]
7. Galletti-Vernazzani, B., Chirife, A., Cabrera, E., Sironi, M. and Brownell Jr, R.L. (2017) Entanglement and death of a Critically Endangered Eastern South Pacific southern right whale (*Eubalaena australis*) in Chile. Paper SC/67a/HIM/14 presented to the Scientific Committee, International Whaling Commission, Bled, Slovenia, May 2017. Unpublished, 10 pp. [Available from the Office of the International Whaling Commission, The Red House, 135 Station Road, Impington, Cambridge, Cambridgeshire CB4 9NP, UK.]

- Instituto Nacional Antártico Chileno 42: 77-91.
- Aguayo-Lobo, A., Torres, D. and Acevedo, J. (1998) Los mamíferos marinos de Chile: I. Cetacea. *Serie Científica Instituto Nacional Antártico Chileno* 48: 19-159.
- Aguayo-Lobo, A., Acevedo, J., Brito, J.L., Olavarría, C., Moraga, R. and Olave, C. (2008) La ballena franca del sur, *Eubalaena australis* (Desmoulins, 1822) en aguas chilenas: análisis de sus registros desde 1976 a 2008. *Revista de Biología Marina y Oceanografía* 43(3): 653-668. <https://doi.org/10.4067/S0718-19572008000300024>
- Arias, M., Coscarella, M.A., Romero, M.A., Sueyro, N., Svendsen G.M., Crespo, E.A. and González, R.A. (2018) Southern right whale *Eubalaena australis* in Golfo San Matías (Patagonia, Argentina): evidence of recolonisation. *PLoS ONE* 13(12): e0207524. <https://doi.org/10.1371/journal.pone.0207524>
- Atkinson, A., Siegel, V., Pakhomov, E. and Rothery, P. (2004) Long-term decline in krill stock and increase in salps within the Southern Ocean. *Nature* 432: 100-103. <https://doi.org/10.1038/nature02996>
- Belgrano, J., Iñiguez, M., Gibbons, J., García, C. and Olavarría, C. (2008) South-West Atlantic right whales *Eubalaena australis* (Desmoulins, 1822) distribution nearby the Magellan Strait. *Anales del Instituto Patagonia* (Chile) 36(2): 69-74.
- Best, P.B. (2007) *Whales and dolphins of the Southern African Subregion*. Cambridge University Press, Cambridge, UK. 338 pp.
- Canto, J., Ruiz, P. and Cárdenas, J.C. (1991) Necropsia de ballena franca austral *Eubalaena australis* y consideraciones para el manejo de la especie. *Boletín del Museo de Historia Natural de Chile* 42: 105-111.
- Cárdenas, J.C., Torres, D., Oporto, J. and Stutzin, M. (1986) Presencia de la ballena franca (*Eubalaena australis*) en las costas de Chile. Pages 28-31 in Resumen, 2ª Reunión de Trabajo de Especialistas em Mamíferos Aquáticos da América do Sul, 4-8 August 1986, Rio de Janeiro, Brazil. Available at <https://www.dropbox.com/s/deg36so999bapey/2rt.pdf>
- Carroll, E.L., Ott, P.H., McMillan, L.F., Galletti-Vernazzani, B., Neveceralova, P., Vermeulen, E., Gaggiotti, O.E., Andriolo, A., Baker, C.S., Bamford, C., Best, P., Cabrera, E., Calderan, S., Chirife, A., Fewster, R., Flores, P., Frasier, T., Freitas, T., Groch, K., Hulva, P., Denny, A., Leaper, R., Leslie, M., Moore, M., Oliveira, L., Seger, J., Stepien, E., Valenzuela, L.O., Zerbini, A. and Jackson, J.A. (2020) Genetic diversity and connectivity of Southern right whales (*Eubalaena australis*) found in the Brazil and Chile-Peru wintering grounds and the South Georgia (Islas Georgia del Sur) feeding ground. *Journal of Heredity* 111(3): 263-276. <https://doi.org/10.1093/jhered/esaa010>
- Christiansen, F., Sironi, M., Moore, M.J., Di Martino, M., Ricciardi, M., Warick, H.A. and Uhart, M.M. (2019) Estimating body mass of free-living whales using aerial photogrammetry and 3D volumetrics. *Methods in Ecology and Evolution* 10(12): 2034-2044. <https://doi.org/10.1111/2041-210X.13298>
- Christiansen, F., Dawson, S.M., Durban, J.W., Fearnbach, H., Miller, C.A., Bejder, L., Uhart, M., Sironi, M., Corkeron, P., Rayment, W., Leunissen, E., Haria, E., Ward, R., Warick, H.A., Kerr, I., Lynn, M.S., Pettis, H.M. and Moore, M.J. (2020) Population comparison of right whale body condition reveals poor state of the North Atlantic right whale. *Marine Ecology Progress Series* 640: 1-16. <https://doi.org/10.3354/meps13299>
- Clarke, R. (1965) Southern right whales on the coast of Chile. *Norsk Hvalfangst-Tidende* 54(6): 121-128.
- Cooke, J.G. (2018) *Eubalaena australis* Chile-Peru subpopulation. *The IUCN Red List of Threatened Species* 2018. <https://doi.org/10.2305/IUCN.UK.2018-1.RLTS.T133704A50385137.en>
- Cooke, J.G., Rowntree, V.J. and Payne, R. (2001) Estimates of demographic parameters for Southern right whales (*Eubalaena australis*) observed off Península Valdés, Argentina. *Journal of Cetacean Research and Management* 2: 125-132.
- Escribano, R., Marin, V.H. and Iribarren, C. (2000) Distribution of *Euphausia mucronata* at the upwelling area of Peninsula Mejillones, northern Chile: the influence of the oxygen minimum layer. *Scientia Marina* 64(1): 69-77. <https://doi.org/10.3989/scimar.2000.64n169>
- Frisch-Jordán, A., Ransome, N.L., Aranda-Mena, O. and Romo-Sirvent, F. (2019) Intensive feeding of humpback whales (*Megaptera novaeangliae*) in the breeding ground of Banderas Bay, Mexico. *Latin American Journal of Aquatic Mammals* 14(1): 27-33. <https://doi.org/10.5597/00251>
- Galletti-Vernazzani, B., Cabrera, E. and Brownell, R. (2014) Eastern South Pacific Southern right whale photo-identification catalog reveals behavior and habitat use patterns. *Marine Mammal Science* 30(1): 389-398. <https://doi.org/10.1111/mms.12030>
- García-Cegarra, A.M. and Pacheco, A.S. (2019) Collision risk areas between fin and humpback whales with large cargo vessels in Mejillones Bay (23° S), northern Chile. *Marine Policy* 103: 182-186. <https://doi.org/10.1016/j.marpol.2018.12.022>
- Gibbons, J., Capella, J.J., Kusch, A. and Cárcamo, J. (2006) The Southern right whale *Eubalaena australis* (Desmoulins, 1822) in the Strait of Magellan, Chile. *Anales del Instituto de la Patagonia* (Chile) 34: 75-80. <https://www.researchgate.net/publication/264549530>
- Guerra-Correa, C., Van Waerebeek, K., Portflitt, G. and Luna, G. (1987) The presence of cetaceans off northern Chile coast. *Estudios Oceanológicos* 6: 87-96. <http://www.vliz.be/nl/datasets-belgische-kust-en-zee?module=ref&refid=222425>
- Jiménez-Lopez, M.E., Palacios, D.M., Jaramillo-Legorreta, A., Urbán, J. and Mate, B.R. (2019) Fin whale movements in the Gulf of California, Mexico, from satellite telemetry. *PLoS ONE* 14(1): e0209324 <https://doi.org/10.1371/journal.pone.0209324>
- Koski, W.R., da-Silva, C.Q., Zeh, J. and Reeves, R.R. (2013) Evaluation of the potential to use capture-recapture analyses of photographs to estimate the size of the Eastern Canada – West Greenland bowhead whale (*Balaena mysticetus*) population. *Canadian Wildlife Biology Management* 2(1): 23-25. <http://cwbm.name/evaluation-of-the-potential-to-use-capture-recapture-analyses-of-photographs-to-estimate-the-size-of-the-eastern-canada-west-greenland-bowhead-whale-balaena-mysticetus-population/>
- Laist, D., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. (2001) Collisions between ships and whales. *Marine Mammal Science* 17(1): 35-75. <https://doi.org/10.1111/j.1748-7692.2001.tb00980.x>
- Leaper, R., Cooke, J., Trathan, P., Reid, K., Rowntree, V.J. and Payne, R. (2006) Global climate drives Southern right whale (*Eubalaena australis*) population dynamics. *Biology Letters* 2: 289-292. <https://doi.org/10.1098/rsbl.2005.0431>
- Mackintosh, M.A. (1942) The southern stocks of whalebone whales. *Discovery Reports* 22: 197-300. <https://doi.org/10.1038/153569a0>

- Nowacek, D., Johnson, M.P., and Tyack, P.L. (2004) North Atlantic right whale (*Eubalaena glacialis*) ignore ships but respond to altering stimuli. *Proceedings of the Royal Society of London Series B, Biological Science* 271: 227-231. <https://doi.org/10.1098/rspb.2003.2570>
- Nowacek, D.O., Christiansen, F., Bejder, L., Goldbogen, J.A. and Friedlaender, A.S. (2016) Studying cetacean behaviour new technological approaches and conservation applications. *Animal Behavior* 120: 235-244. <https://doi.org/10.1016/j.anbehav.2016.07.019>
- Orihuela, M. and Cortegana-Arias, D. (2013) Registro de un par madre-cría de ballena franca austral (*Eubalaena australis*) en la costa de Lima, Perú. *Revista Peruana de Biología* 20(2): 187-188.
- Pacheco, A.S., Villegas, V.K., Riascos, J.M. and Van Waerebeek, K. (2015) Presence of fin whales *Balaenoptera physalus* in Mejillones Bay, a major seaport area in northern Chile. *Revista de Biología Marina y Oceanografía* 50(2): 383-391. <https://doi.org/10.4067/S0718-19572015000300017>
- Patenaude, N. (2003) Sightings of Southern right whales around mainland New Zealand. *Science for Conservation* 225. 43 pp. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc225.pdf>
- Papastavrou, V. and Van Waerebeek, K. (1998) A note on the occurrence of humpback whales (*Megaptera novaeangliae*) in tropical and subtropical areas: the upwelling link. *Reports of the International Whaling Commission* 47: 945-47. <https://www.researchgate.net/publication/234825770>
- Pastene, L.A. and Quiroz, D. (2010) An outline of the history of whaling in Chile. Pages 73-98 in International Center for Folk Culture Studies, *Human Culture from the perspective of traditional maritime communities*. International Symposium Report No. 1. Kanagawa Shimbun Press, Kanagawa, Japan. https://www.academia.edu/1871805/An_Outline_of_the_History_of_Whaling_in_Chile
- Payne, R., Rowntree, V.J. and Perkins, J.S. (1990) Population size, trends and reproductive parameters of right whales (*Eubalaena australis*) off Peninsula Valdes, Argentina. *Reports of the International Whaling Commission* (Special Issue) 12: 271-278. https://ballenas.org.ar/descargas/publicaciones-cientificas/1990/18.Population_size_trends_and_reproductive_parameters_of_right_whales_%28Eubalaena_australis%29_off_Peninsula_Valdes_Argentina.pdf
- Piedra Puig, M., Costa Urrutia, P.R.C. and Franco-Fraguas, P.I. (2006) Ballena franca (*Eubalaena australis*) en la costa atlántica uruguaya [Southern right whales (*Eubalaena australis*) off the Atlantic coast of Uruguay]. Pages 585-590 in Menafra, R., Rodríguez-Gallego, L., Scarabino, F. and Conde, D. (eds) *Bases para la conservación y manejo de la costa uruguaya*. Vida Silvestre Uruguay (Sociedad Uruguaya para la Conservación de la Naturaleza), Montevideo.
- Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr, R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urban, J. and Zerbini, A.N. (2008) *Eubalaena australis* (Chile-Peru subpopulation). In: *IUCN Red List of Threatened Species* Version 2012.2. Available <http://iucn.redlist.org>
- Richardson, W.J., Greene, C.R., Malme, C.I. and Thomson, D.H., eds. (1995) *Marine Mammals and Noise*. Academic Press, San Diego, CA.
- Riquelme-Bugueño, R., Gómez-Gutiérrez, J., Escribano, R., Ruz, P., Hidalgo, P. and Schneider, W. (2016) First measurements of euphausiid growth rates in the northern Humboldt Current (23° S). *Revista de Biología Marina y Oceanografía* 51(2): 435-440. <https://doi.org/10.4067/S0718-19572016000200020>
- Rowntree, V.J., Valenzuela, L.O., Franco-Fraguas, P. and Seger, J. (2008) Foraging behaviour of southern right whales (*Eubalaena australis*) inferred from variation of carbon stable isotope ratios in their baleen. *Journal of Cetacean Research Management* SC/60/BRG233. https://ballenas.org.ar/descargas/publicaciones-cientificas/2008/49.Foraging_behaviour_of_southern_right_whales_....pdf
- Santillán, L., Roca, M., Apaza, M., Oliveira, L.R. and Ontón, K. (2004) New record of mother-calf pair of Southern right whale, *Eubalaena australis*, off the Peruvian coast. *Latin American Journal of Aquatic Mammals* 3(1): 83-84. <https://doi.org/10.5597/lajam00053>
- Schaeff, C.M., Best, P.B., Rowntree, V.J., Payne, R., Jarvis, C. and Portway, V.A. (1999) Dorsal skin color patterns among Southern right whales (*Eubalaena australis*): genetic basis and evolutionary significance. *Journal of Heredity* 90(4): 464-471. <https://doi.org/10.1093/jhered/90.4.464>
- Valenzuela, L.O., Rowntree, V.J., Sironi, M. and Seger, J. (2018) Stable isotopes ($\delta^{15}\text{N}$, $\delta^{13}\text{C}$, $\delta^{34}\text{S}$) in skin reveal diverse food sources used by Southern right whales *Eubalaena australis*. *Marine Ecology Progress Series* 603: 243-255. <https://doi.org/10.3354/meps12722>
- Vanderlaan, A.S.M. and Taggart, C.T. (2007) Vessel collisions with whales: the probability of lethal injury based on vessel speed. *Marine Mammal Science* 23(1): 144-156. <https://doi.org/10.1111/j.1748-7692.2006.00098.x>
- Van Waerebeek, K., Reyes, J.C. and Aranda, C. (1992) Southern right whales (*Eubalaena australis*) off southern Peru. *Marine Mammal Science* 8(1): 86-88. <https://doi.org/10.1111/j.1748-7692.1992.tb00129.x>
- Van Waerebeek, K., Reyes, J.C. and Van Bresseem, M.F. (1998) Sighting of a mother-calf pair of Southern right whale *Eubalaena australis* in Peruvian waters. *Estudios Oceanológicos* 17: 105-107. <https://www.researchgate.net/publication/234168488>
- Van Waerebeek, K., Baker, A.N., Félix, F., Gedamke J., Iñiguez, M., Sanino, G.P., Secchi, E., Sutaria, D., van Helden, A. and Wang, Y. (2007) Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment. *Latin American Journal of Aquatic Mammals* 6(1): 43-69. <https://doi.org/10.5597/lajam00109>
- Van Waerebeek, K., Santillán, L. and Suazo, E. (2009) On the native status of the Southern right whale *Eubalaena australis* in Peru. *Boletín del Museo Nacional de Historia Natural, Chile* 58: 69-76. <http://publicaciones.mnhn.gob.cl/668/w3-article-64569.html>
- Weerd, J. and Ramos, E.A. (2019) Feeding of humpback whales (*Megaptera novaeangliae*) on the Pacific coast of Nicaragua. *Marine Mammal Science* 36(1): 285-292. <https://doi.org/10.1111/mms.12613>