

PREPRINT

Author-formatted, not peer-reviewed document posted on 05/10/2022

DOI: <https://doi.org/10.3897/arphapreprints.e95906>

Reencounter with the past: occurrence of sei whale (*Balaenoptera borealis*) in an old hunting area in the south-eastern Pacific Ocean

**Andrea Cisterna-Concha, Camila Calderón-Quirgas, Fernanda Silva-Andrades, Richard Muñoz, 
Heraldo V. Norambuena**

1 **Running page head: Occurrence of sei whale**

2

3 **Reencounter with the past: occurrence of sei whale (*Balaenoptera borealis*) in an old hunting**
4 **area in the south-eastern Pacific Ocean**

5

6 **Andrea Cisterna-Concha^{1,3,7}, Camila Calderón-Quirgas^{2,3,7}, Fernanda Silva-Andrades⁴,**
7 **Richard Muñoz^{1,5,7} & Heraldo V. Norambuena^{6*}**

8

9 ¹Programa de Doctorado en Oceanografía, Departamento de Oceanografía, Facultad de Ciencias
10 Naturales y Oceanográficas, Universidad de Concepción, Concepción, Chile

11 ²Programa de Magíster en Ciencias mención en Oceanografía, Departamento de Oceanografía,
12 Facultad de Ciencias Naturales y Oceanográficas, Universidad de Concepción, Concepción, Chile

13 ³Centro de Investigación Oceanográfica COPAS Sur-Austral, Universidad de Concepción,
14 Concepción, Chile

15 ⁴Turismo Chome Aventura. Biobío, Caleta Chome, Hualpén, Chile

16 ⁵Departamento de Ecología, Facultad de Ciencias, Universidad Católica de la Santísima
17 Concepción, Concepción, Chile.

18 ⁶Centro Bahía Lomas, Facultad de Ciencias, Universidad Santo Tomás, Concepción, Chile

19 ⁷Centro de Estudios de Mastozoología Marina, Concepción, Chile

20 **Corresponding author:* hnorambuena@santotomas.cl

21

22

23

24 H.V. Norambuena <https://orcid.org/0000-0003-0523-3682>. E-Mail: hnorambuena@santotomas.cl

25 **Abstract**

26

27 The sei whale (*Balaenoptera borealis*) was intensively exploited throughout its range, with about
28 110.000 individuals hunted by pelagic fleets in Antarctic waters between 1960 and 1970. In
29 addition, basic information on its distribution, migratory routes, and feeding grounds in the
30 southeastern Pacific, has been poorly documented. In the case of Chile, recent information consists
31 mainly of accidental records. This research presents the first sei whale photo-identification catalog
32 for south-central Chile. From November 2019 to January 2020, 88 individuals were recorded from
33 land-based and boat surveys at Caleta Chome. Of this, 12 individuals were photo-identified through
34 scars or distinctive notches in the dorsal fins. The peak of sightings occurred during December
35 2019; two individuals were sighted on more than one occasion.

36

37 **Keywords**

38 Sei whale, *Balaenoptera borealis*, Caleta Chome, Chile, South-eastern Pacific

39 Introduction

40 The sei whale (*Balaenoptera borealis*) is an Endangered mysticete (Cooke 2018) and the third
 41 largest whale after the blue whale (*Balaenoptera musculus*) and the fin whale (*Balaenoptera*
 42 *physalus*; Horwood 2018). This species presents a cosmopolitan distribution and pelagic with
 43 temperatures below 20 °C (Omura & Nemoto 1955, Gambell 1968, 1985). It migrates to the
 44 southern hemisphere during summer, from areas near the subtropical convergence where it
 45 reproduces, to areas near the Antarctic convergence (50 ° S-60 ° S) for feeding (Horwood 1987,
 46 Reeves et al. 1998, Rice 1998). Feeding zones are unpredictable, with a sudden influx into an area,
 47 followed by disappearance and subsequent absence for years (Gambell 1985, Reeves et al. 2002,
 48 Jefferson et al. 2008). During the summer there are high concentrations of sei whales between 40 °
 49 and 50 ° S with adult individuals reaching polar waters while juveniles or sub-adults staying north
 50 of the Antarctic convergence (Lockyer 1977, Acevedo et al. 2017). Six populations have been
 51 assumed for the southern hemisphere for management purposes; however, the scarce evidence have
 52 failed to identify separate populations within ocean basins (Kanda et al. 2006, Horwood 2018).

53 The International Whaling Commission estimated that by the 1940s the population declined
 54 from 191.000 to 37.000 individuals after the cessation of commercial catches (Gambell 1985).
 55 Although the sei whale was not a target species for hunting until the early 1960s (Acevedo et al.
 56 2017, Español-Jiménez et al. 2019) the decrease in the most profitable whales (*B. musculus*, *B.*
 57 *physalus*, *Megaptera novaeangliae* and *Eubalaena australis*) led to an increase in the hunting effort
 58 of this species. In South America, this species was heavily exploited throughout its range (Zerbini et
 59 al. 1997, Aguayo-Lobo et al. 1998a) where about 110.000 individuals were hunted by pelagic fleets
 60 in Antarctic waters between 1960 and 1970 (Horwood 2018). In Chile, it was the third most hunted
 61 whale species between 1929 and 1979 with at least 1,664 individuals captured (Aguayo 1974);
 62 however, due to the difficulty of differentiating from Bryde's whale (*Balaenoptera edeni*), its
 63 hunting numbers are probably overestimated since many Bryde whales would have been reported

as sei whales (Valdivia et al. 1981, Gallardo et al. 1983, Aguayo-Lobo et al. 1998a). There were about 25 years (between 1974 and 1999) in which there was no research on sei whales, and the few studies that were conducted during this period did not consider the sei whale as an object of study (Gallardo & Pastene 1983, Gallardo et al. 1983, Guerra-Correa et al. 1987, Aguayo-Lobo et al. 1998b). Since the moratorium on whaling there has been a considerable reduction in sei whale research (Reeves et al. 2002), currently this species is one of the least known baleen whales in the world (Prieto et al. 2012, Horwood 2018, Acevedo et al. 2017).

Caleta Chome was founded by the Macaya Hnos. whaling industry on 1948 (Quiroz & Carreño 2019). By 1954 the sei whale was already within the productivity of the whaling plant in Caleta Chome and was the first documented records of sei whales for this region. The sei whale catch data for this area were for a long time under the name "S + B", since they considered the bryde (B) and sei (S) whales together due to the similarities that existed between them, therefore there are no clear records of the number of individuals of sei whales caught in this area (Pastene 1982). In Caleta Chome, between 1951 and 1983, an active whaling was carried out by the Trinidad Whaler owned by the Macaya Family (Quiroz & Carreño 2019). Given that the sei whale is Endangered studies of its populations are crucial to support its conservation. This study presents the first sei whale photo-identification catalog in south-central Chile and information on sightings.

81

82 **Materials and methods**

83

84 *Study area*

85

86 The sightings were in Caleta Chome in the Biobio region of Chile (36°40'S; 73°15'W; Fig. 1).
87 Waters rich in nutrients from the Humboldt Current fertilize the coasts of this region in the spring
88 and summer season when the winds are favorable to coastal upwelling (Sobarzo et al. 2007,

Simpkins 2018), generating an increase in primary productivity and higher trophic levels (Thiel et al. 2007, Escribano et al. 2012, Anabalón et al. 2016). South of Caleta Chome, the freshwater discharge from the Biobío River provides nutrients, organic matter, and terrigenous particles to the adjacent coastal area, positively influencing phytoplankton biomass and primary production (Masotti et al. 2018). Bathymetric accidents such as the Biobío canyon (Sobarzo et al. 2016) and an irregular coastline (Figueroa & Moffat 2000) are essential factors in the coastal dynamics of the area.

Sighting and data base

The sighting records were collected during November 2019 to January 2020 two days per week for a total of 25 days (41 hours and 15 min) of monitoring. The surveys (search of whales) were during the morning between 08:00-12:00 AM (14 surveys) and afternoon between 06:00-09:00 PM (11 surveys). The sightings were made from a) land from a hill of 50-55 m of height using 10x42 binoculars and spotting scopes 15-45x65 (16 surveys); and b) aboard the boat El Felipe I (7.8m in length) that periodically sails in Caleta Chome (9 surveys). The number of observers varied from 2 to 4 observers. From the boat, the sightings were at a distance no greater than 20 m and the identification of the species was carried out with photographic records using a Canon EOS77D camera with 100-400 mm zoom lens, and Canon SX530 semi-professional camera. The morphology of the dorsal fin, characterized by a prominent falcate fin that rises at a steep angle from the rear and central ridge along the head, allowed species identification (Acevedo et al. 2017). The individuals were individualized based on photographs by identifying the distinctive scars, notches, or holes in the dorsal fin (Würsig & Jefferson 1990). Only images of medium to high quality (> 4608 x 3456 pixels) that allowed to highlight their distinctive characteristics were used.

Daily Sea Surface Temperature (SST) between November 2019 and January 2020 data were obtained from Multi-Scale Ultra High Resolution (MUR, [https://podaac.jpl.nasa.gov/dataset/MUR-JPL-L4 - GLOB-v4.1](https://podaac.jpl.nasa.gov/dataset/MUR-JPL-L4-GLOB-v4.1)) with a spatial resolution of 1 km². The SST for each sei whale sighting at sea was obtained from the near pixel to the sighting coordinate.

Data analysis

To have a better visualization of the results of the sightings, a detection index (Di) was established which was calculated based on the sum of the sightings made during intervals of 10 days (i.e., maximum interval between monitoring) and the effective sampling effort within that interval of days:

$$Di = \text{sightings during 10 days} / \text{sampling effort for 10 days}$$

Results

Between November 3 and January 18, we made 88 sei whale sightings. The number of sightings varied from November to January, registering a peak of sightings during December 11 and 20 (Figure. 2). We identified 17 groups of sei whale of 2 to 9 individuals (median = 4), most of these groups were registered during the month of December (10 groups). The SST range from 12,7°C to 15.1°C during the sightings, and the estimated depth of the sightings range from 16 to 137 m. On the other hand, sei whale sightings were made at mean distance of 3.6 km from the coast. We highlight one event, where the distance was c.a 0.1 km. (Table 1).

Twelve individuals were photo-identified through distinctive scars or notches on the dorsal fins (Figure. 3), 83% of the individuals have some notch and one of them have a broken fin (# 002) and other two had laceration (# 007 and # 009). Most individuals (see photographic sequence from # 009 to # 012 in Fig. 3) were photographed in December 2019. Two individuals (# 003 and # 009) were sighted more than one day in the area, individual # 003 was sighted 7 days after the first

sighting and individual # 009 on the seventh and tenth day after the first sighting. The presence of a mother with a calf was registered for 5 different days.

Discussion

With the moratorium established by the International Whaling Commission (IWC) in 1983, the cetacean records associated with hunting decreased and the only records of the sei whale for central Chile were only three reports and one scientific publication (Pastene 1982, Gallardo & Pastene 1983, Gallardo et al. 1983, Aguayo-Lobo et al. 1998a). Although there are records of sightings of this species for previous years (F. Silva obs. Pers.), a high abundance of individuals had not been recorded in this area and neither the presence of mothers with young.

The sei whale is described as predominantly found in deep waters, occupying mainly pelagic habitats at distances greater than 110 km from the coast (Best & Lockyer 2002, Prieto et al. 2012); however, many of our sightings occurred near the coast at distances no greater than 6 km (see Table 1) consistent with what was observed for populations of sei whales in the South Atlantic (Weir et al. 2020). This greater abundance of sei whale near the coast and the feeding activity during the day, agree with the results obtained by Español-Jiménez et al. (2019) on the coast of the Gulf of Penas and Tres Montes. Another data to highlight are the sightings of the same individual on more than one occasion, this suggests a stay of at least 7-10 days. In addition, the presence of mothers with young during the observation season may be giving signs of safety and good environmental conditions for rearing. More than 50% of the identified individuals had scars on their fins. Among the possible natural threats that could have damaged its dorsal fin, is predation by killer whales (*Orcinus orca*) which are considered its only significant natural predator (Jefferson et al. 1991, Springer et al. 2006).

The occurrence of sei whales in the coastal upwelling system of Chile was reported by Gallardo & Pastene (1983), who associated high primary productivity with the concentration of sightings, proposing that the coasts of the Biobío region they can be feeding areas for some

163 cetaceans during their migrations. The continental shelf off Biobío is an important upwelling zone
 164 and has been described as one of the most productive areas within the Humboldt Current System
 165 (Montecino et al. 1998, Montero et al. 2007, Thiel et al. 2007, Daneri et al. 2012, Iriarte et al.
 166 2012). Bathymetric features such as underwater canyons generate foraging areas for a variety of
 167 cetaceans, contributing to primary productivity and biodiversity (Moors-Murphy 2014). Croll et al.
 168 (2005) mention that bathymetric ruptures and the coastal upwelling process are important factors in
 169 the density of euphausiids, contributing to the formation of feeding areas. The high occurrence of
 170 individuals in Caleta Chome could be related to a migratory route close to the Biobío Canyon
 171 located to the south of the study area.

172 The oceanographic conditions in the distribution of this species are variable in relation to the
 173 migratory routes and the permanence in feeding and / or reproduction sites (Omura & Nemoto
 174 1955, Gregr & Trites 2001, Sasaki et al. 2013, Murase et al. 2014). On the coasts of Chile, the
 175 presence of sei whales has been reported in areas with sea surface temperatures of 14.5 °C in spring
 176 (Clarke et al. 1978). In the Magellan Strait Acevedo et al. (2017) reported a thermal range between
 177 5.7 and 10.9 °C. Our sightings are also within this temperature range, agreeing with the values
 178 reported for this species in other parts of the world.

179 Acevedo et al. (2017) reported sei whales in the Magellan Strait from November to May,
 180 with a peak of sightings (83.6%) occurring during December and January. They suggest that
 181 although there are records that support the hypothesis that whales forage in southern Chile, none of
 182 them provide information on systematic annual occurrences in these same areas, but this in turn can
 183 be supported by the fact that sei whales are known for their unpredictable presence in an area
 184 followed by their subsequent disappearance, as well as having a greater variation in distribution in
 185 their feeding grounds than most species of baleen whales (Tønnessen & Johnsen 1982, Horwood
 186 1987). All these records that support the presence of the sei whale on Chilean coasts are at the same
 187 time of the year (January-May) within relatively small latitudes and although they are not in
 188 consecutive years there is a certain periodicity that could support the hypothesis that the sei whale

189 forages in Chilean waters but their foraging areas change over the years (Pastene & Shimada 1999,
190 Guzmán 2006, Aguayo-Lobo et al. 2006; Acevedo et al 2017, Español-Jiménez et al. 2019. In this
191 work, the occurrence of the sei whale off the Chilean coast shows the existence of a passage zone
192 and possible feeding area within the waters near the coast. Ecological knowledge about sei whales
193 along the Chilean coast is scarce, therefore we highlight the importance of increasing sighting
194 efforts around the Hualpén Peninsula Nature Sanctuary during upwelling events to understand if the
195 presence of sei whales follows some seasonal pattern or corresponds to sporadic events.

196 **Acknowledgements**

197 We thank the Turismo Chome Aventura company for the navigation services in Caleta Chome and
198 the information provided through verbal communication of sei whale sightings and navigation
199 routes commonly used by whales. A.C.C thanks the COPAS-coastal center, Universidad de
200 Concepción, Chile and the Agencia Nacional de Investigación y Desarrollo de Chile (ANID).

201

202 **Authors' contributions**

203 AC-C, CC-Q and FS-A contributed to the conception and design of the study. AC-C performed the
204 literature search and/or organized the database. AC-C and RM produced the figures and/or tables.
205 AC-C, RM and HVN wrote the first draft of the manuscript. CC-Q and FS-A wrote sections of the
206 manuscript. Authors reviewed and/or analyzed the literature and contributed to manuscript revision,
207 read, and approved the submitted version.

References

- Acevedo C, Aguayo-Lobo A, González A, Haro D, Olave C, Quezada F, Martínez F, Garthe S, Cáceres B (2017) Occurrence of sei whales (*Balaenoptera borealis*) in the Magellan Strait from 2004–2015, Chile. *Aquat Mamm* 43:63–72
- Aguayo A (1974) Baleen whales off continental Chile. In: Schevill WE (ed) *The whale problem: a status report*. Harvard University Press, Cambridge, Massachusetts, p 209–217
- Aguayo-Lobo A, Torres D, Acevedo J (1998a) Los mamíferos marinos de Chile: 1. Cetacea. *Ser Cient INACH* 48:19–159
- Aguayo-Lobo A, Bernal R, Olavarria C, Vallejos V, Hucke-Gaete, R (1998b) Observaciones de cetáceos realizadas entre Valparaíso e isla de Pascua, Chile, durante los inviernos de 1993, 1994 y 1995. *Rev Biol Mar Oceanogr* 33:101–123
- Aguayo A, Acevedo J, Vargas R (2006) Diversidad de mamíferos marinos en las aguas del archipiélago de los Chonos (43°39'S – 45°50'S), XI región de Chile. *Cienc Tecnol Mar* 29:129–145
- Anabalón V, Morales C.E, González H.E, Menschel E, Schneider W, Hormazabal S, Valencia L, Escribano R (2016) Micro-phytoplankton community structure in the coastal upwelling zone off Concepción (central Chile): Annual and inter-annual fluctuations in a highly dynamic environment. *Prog Oceanogr* 149:174–188
- Best PB, Lockyer CH (2002) Reproduction, growth and migrations of sei whales *Balaenoptera borealis* off the west coast of South Africa. *Afr J Mar Sci* 24:111–133
- Cooke JG (2018) *Balaenoptera borealis*. The IUCN Red List of Threatened Species 2018: e.T2475A130482064 <https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T2475A130482064.en>. Downloaded on 12 June 2020
- Croll DA, Marinovic B, Benson S, Chávez FP, Black N, Ternullo R, Tershy BR (2005) From wind to whales: Trophic links in a coastal upwelling system. *Mar Ecol Prog Ser* 289:117–130

- Clarke R, Aguayo-Lobo A, Basulto del Campo S (1978) Whale observation and whale marking off the coast of Chile in 1964. *Sci Rep Whales Res Inst* 30:117–182
- Daneri G, Lizárraga L, Montero P, González HE, Tapia FJ (2012) Wind forcing and short-term variability of phytoplankton and heterotrophic bacterioplankton in the coastal zone of the Concepción upwelling system (Central Chile). *Prog. Oceanogr* 92:92–96
- Escribano R, Hidalgo P, Fuentes M, Donoso K (2012) Zooplankton time series in the coastal zone off Chile: Variation in upwelling and responses of copepod community. *Prog Oceanogr* 97:174–186
- Español-Jiménez S, Bahamonde PA, Chiang G, and Häussermann V (2019) Discovering sounds in Patagonia: characterizing sei whale (*Balaenoptera borealis*) downsweeps in the south-eastern Pacific Ocean. *Ocean Sci* 15:75–82
- Figuerola D, Moffat C (2000) On the influence of topography in the induction of coastal upwelling along the Chilean coast. *Geophys Res Lett* 27:3905–3908
- Gallardo V, Pastene L (1983) Observaciones cetológicas frente a Chile central, entre los 32°00'S y 38° 00'S. *Ciencia y Tecnología del Mar* 141–154
- Gallardo VA, Arcos D, Salamanca M, Pastene LA (1983) On the occurrence of Bryde's whale (*Balaenoptera edeni* Anderson 1878) in an upwelling area off Central Chile. *Rep Int Whaling Comm* 33:481–488
- Gambell R (1968) Seasonal cycles and reproduction in sei whales of the Southern Hemisphere. *Disc Rep* 35:31–134
- Gambell R (1985) Sei whale *Balaenoptera borealis* Lesson 1828. In: Ridgway SH, Harrison R J (eds) *Handbook of Marine Mammals*, vol. 3. The sirenians and baleen whales. Academic Press, San Diego, p 155–170
- Gregg EJ, Trites AW (2001) Predictions of critical habitat for five whale species in the waters of coastal British Columbia. *Can J Fish Aquat Sci* 58:1265–1285

- Guerra-Correa C, Van Waerebeek K, Portflitt-Kandora G, Luna-Jorquera G (1987) Presencia de cetáceos frente a la Segunda Región. *Estud. Oceanol* 6:87–96
- Guzmán A (2006) Avistamientos de ballena azul *Balaenoptera musculus* (Linnaeus, 1758) y sei *B. borealis* Lesson, 1828 en la costa nor-occidental de la isla de Chiloé Chile. *Bol Mus Nac Chile* 55:51–60
- Horwood JW (1987) The Sei whale: population biology, ecology and management. Croom Helm, Londres
- Horwood JW (2018) Sei whale *Balaenoptera borealis*. In: Würsig B, Perrin WF, Thewissen JGM (eds) Encyclopedia of marine mammals. Academic Press, San Diego, California, p 1001–1003
- Iriarte JL, Vargas CA, Tapia FJ, Bermúdez R, Urrutia RE (2012) Primary production and plankton carbon biomass in a river-influenced upwelling area off Concepción, Chile. *Prog Oceanogr* 92:97–109
- Jefferson TA, Stacey PJ, Baird RW (1991) A review of killer whale interactions with other marine mammals: predation to co-existence. *Mammal Rev* 21:151–180
- Jefferson TA, Webber MA, Pitman RL (2008) Marine mammals of the world: A comprehensive guide to their identification. Academic Press, San Diego
- Kanda N, Goto M, and Pastene LA (2006) Genetic characteristics of western North Pacific sei whales, *Balaenoptera borealis*, as revealed by microsatellites. *Mar Biotechnol* 8:86–93
- Lockyer C (1977) Some possible factors affecting the age distribution of the catch of sei whales in the Antarctic. *Rep Int Whaling Comm Spec Issue* 1:63–70
- Masotti I, Aparicio-Rizzo P, Yevenes MA, Garreaud R, Belmar L, Farías L (2018) The influence of river discharge on nutrient export and phytoplankton biomass off the Central Chile coast (33°–37° S): Seasonal cycle and interannual variability. *Front Mar Sci* 5:423
- Montecino V, Pizarro G, Quiroz D (1998). Primary production off the Chilean coast. *Proc Aha Huliko’a Hawaiian Winter Workshop: Biotic impact of extratropical climate variability in the Pacific*. University of Hawaii, Manoa p 69–76

- 284 Montero P, Daneri G, Cuevas AL, González HE, Jacob B, Lizárraga L, Menschel E (2007)
 285 Productivity cycles in the coastal upwelling area off Concepcion: the importance of diatoms and
 286 bacterioplankton in the organic carbon flux. *Prog Oceanogr* 75:518–530
- 287 Moors-Murphy HB (2014) Submarine canyons as important habitat for cetaceans, with special
 288 reference to the Gully: A review. *Deep Sea Res II* 104:6–19
- 289 Murase H, Hakamada T, Matsuoka K, Nishiwaki S, Inagake D, Okazaki M, Tojo N, Kitakado T
 290 (2014) Distribution of sei whales (*Balaenoptera borealis*) in the subarctic-subtropical transition
 291 area of the western North Pacific in relation to oceanic fronts. *Deep Sea Res II* 107:22–28
- 292 Omura H, Nemoto T (1955) Sei whales in the adjacent waters of Japan, III, Relation between
 293 movement and water temperature. *Rep Int Whaling Comm Spec Issue* 10:79–87
- 294 Pastene L (1982) Análisis de las capturas de ballenas efectuadas por la industria ballenera Nacional
 295 en el sector del Pacífico Sur Oriental correspondiente a Chile y consideraciones del Estado actual
 296 de dicha industria y su desarrollo histórico. Tesis de licenciatura, Universidad de Concepción,
 297 Concepción, Chile
- 298 Pastene L, Shimada H (1999) Report of a sighting survey in Chile's exclusive economic zone with
 299 comments on sei whale distribution. *An Int Patag Ser Cienc Nat* 27:51–62
- 300 Prieto R, Janiger D, Silva MA, Waring GT, Gonçalves JM (2012) The forgotten whale: A
 301 bibliometric analysis and literature review of the North Atlantic sei whale *Balaenoptera borealis*.
 302 *Mammal Rev* 42:235–272
- 303 Quiroz D, Carreño G (2019) Itinerarios Balleneros. De la caza tradicional a la caza moderna (... o
 304 de isla Santa María a Caleta Chome). Ediciones del Servicio Nacional del Patrimonio Cultural,
 305 Santiago
- 306 Reeves RR, Silber G, and Payne PM (1998) Draft Recovery Plan for the Fin Whale *Balaenoptera*
 307 *physalus* and Sei Whale *Balaenoptera borealis*. Silver Spring, MD: USDOC, NOAA, NMFS,
 308 Office of Protected Resources, p 65.

- 309 Reeves RR, Stewart BS, Clapham PJ, Powell JA (2002) Guide to marine mammals of the world.
310 National Audubon Society. Alfred A. Knopf, Chanticleer Press, New York
- 311 Rice DW (1998) Marine mammals of the world: systematics and distribution. Special Publication
312 Number 4. Society for Marine Mammalogy, Lawrence, KS
- 313 Sasaki H, Murase H, Kiwada H, Matsuoka K, Mitani Y, Saitoh SI (2013) Habitat differentiation
314 between sei (*Balaenoptera borealis*) and Bryde's whales (*B. brydei*) in the western North Pacific.
315 Fish Oceanogr 22:496–508
- 316 Simpkins G (2018) Humboldt upwelling. Nat Clim Change 8:272–272
- 317 Springer AM, Van Vliet GB, Pratt JF, Danner EM (2006) Whales and whaling in the North Pacific
318 Ocean and Bering Sea. In: Estes JA, DeMaster DP, Doak DF, Williams TM, Brownwell RT Jr.
319 (eds) Whales, Whaling and Ocean Ecosystems. University of California Press, Berkeley p 245–
320 261
- 321 Sobarzo M, Bravo L, Donoso D, Gárces-Vargas J, Schneider W (2007) Coastal upwelling and
322 seasonal cycles that influence the water column over the continental shelf off central Chile. Prog
323 Oceanogr 75:363–382
- 324 Sobarzo M, Saldías GS, Tapia FJ, Bravo L, Moffat C, Largier J L (2016) On subsurface cooling
325 associated with the Biobío River Canyon (Chile). J Geophys Res, C, Oceans 121:4568–4584
- 326 Thiel M, Macaya EC, Acuña E, Arntz WE, Bastias H, Brokordt K, et al. (2007). The humboldt
327 current system of Northern and Central Chile. Oceanogr Mar Biol Annu Rev 45:195–344
- 328 Tønnessen JN, Johnsen AO (1982) The history of modern whaling. University of California Press,
329 Berkeley
- 330 Valdivia J, Ramirez P, Franco F (1981) The exploitation of Bryde's whales in the Peruvian Sea.
331 Rep Int Whaling Comm 31:441–448
- 332 Weir CR, Oms G, Baracho-Neto CG, Wedekin LL, Daura-Jorge FG. (2020). Migratory movement
333 of a sei whale (*Balaenoptera borealis*) between Brazil and the Falkland Islands
334 (Malvinas). *Marine Mammal Science*, 36(3), 1050-1057.

- 335 Würsig B, Jefferson TA (1990) Methods of photo-identification for small cetaceans. Rep Int
336 Whaling Comm Spec Issue 12:43–52.
- 337 Zerbini AN, Secchi ER, Siciliano S, Simões-Lopes PC (1997) A review of the occurrence and
338 distribution of whales of the genus *Balaenoptera* along the Brazilian coast. Rep Int Whaling
339 Comm 47:407–417.
- 340

LEGENDS OF TABLE AND FIGURES

Table 1. Summary of sightings of sei whales (*Balaenoptera borealis*) in Caleta Chome during the seasons from November 2019 to January 2020.

Figure 1. Study area. B) G.A: Arauco gulf, SMI: Santa Maria Island, Llv: Punta Lavapié, Bbc: Biobio canyon, Bbr: Biobio River and Ccp: Concepción. C) Localitation of sightings in Caleta Chome. The red point shows the position of the sightings in the sea. The associated sampling number is indicated on each point (see Table 1). The black point shows the position of Caleta Chome, were sightings from land ware made. The color palet in A and C panel show the depth in meters. The bathymetric information for the area was obtained from the General Bathymetric Chart of the Ocean (GEBCO, GEBCO - The General Bathymetric Chart of the Oceans).

Figure. 2. Frequency in the detection index of the *Balaenoptera borealis* sighted during November and December 2019 and January 2020. The detection rate was calculated based on the effective sightings per day for 10 days standardized by the sampling effort. The numbers above and within each bar indicate the number of total sightings and the sampling effort in each date range, respectively.

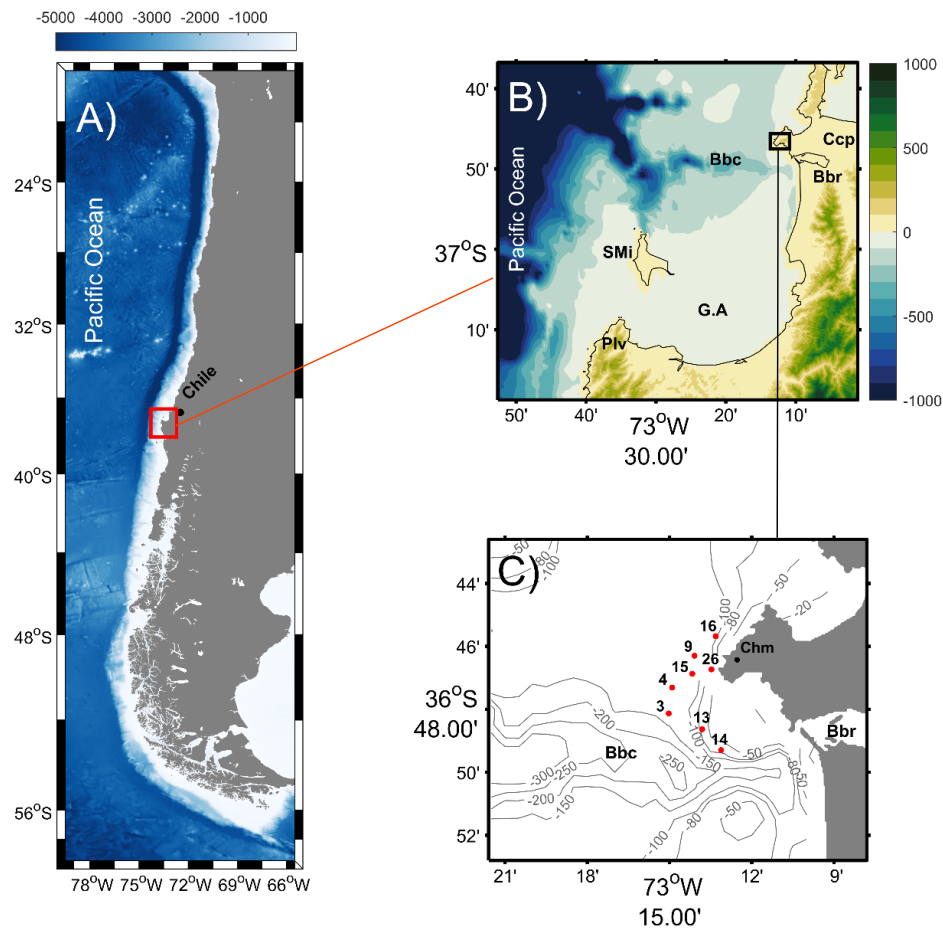
Figure. 3. Dorsal fin photographs of 12 identified sei whales (*Balaenoptera borealis*) at Caleta Chome, during the seasons from November 2019 to January 2020.

362 Table 1. Summary of sightings of sei whales (*Balaenoptera borealis*) in Caleta Chome during the
363 seasons from November 2019 to January 2020.

No.	Date (d/m/y)	Latitude (S)	Longitude (W)	Number of individuals	Sighting place	Distance from shore (km)	SST (°C)	Depth (m)
1	03-11-2019	-	-	1	Coast	-	-	-
2	06-11-2019	-	-	3*	Coast	-	-	-
3	09-11-2019	36°48'10.64"	73°13'45.58"	1	Boat	4.4	12.9	113
4	17-11-2019	36°47'18.55"	73°14'54.26"	4*	Boat	5.6	15.1	137
5	18-11-2019	-	-	5	Coast	-	-	-
6	28-11-2019	-	-	6	Coast	-	-	-
7	29-11-2019	-	-	4*	Coast	-	-	-
8	30-11-2019	-	-	4	Coast	-	-	-
9	01-12-2019	36°46'17.00"	73°13'40.75"	6	Boat	1.6	13.5	122
10	02-12-2019	-	-	1	Coast	-	-	-
11	05-12-2019	-	-	3	Coast	-	-	-
12	06-12-2019	-	-	2	Coast	-	-	-
13	07-12-2019	36°48'35.88"	73°13'30.39"	8	Boat	4.6	12.7	103
14	08-12-2019	36°49'17.70"	73°13'7.15"	4	Boat	5.4	12.8	122
15	13-12-2019	36°46'44.59"	73°13'41.02"	9*	Boat	1.1	13.3	105
16	14-12-2019	36°45'40.66"	73°13'18.85"	8	Boat	2.4	12.9	116
17	22-12-2019	-	-	3	Coast	-	-	-
18	23-12-2019	-	-	1	Coast	-	-	-
19	30-12-2019	-	-	4*	Coast	-	-	-
20	31-12-2019	-	-	4	Coast	-	-	-
21	06-01-2020	-	-	1	Coast	-	-	-
22	08-01-2020	-	-	1	Coast	-	-	-
23	09-01-2020	-	-	2	Coast	-	-	-
24	10-01-2020	-	-	1	Coast	-	-	-
25	13-01-2020	-	-	1	Coast	-	-	-
26	18-01-2020	36°46'40.98"	73°12'54.39"	1	Boat	0.1	12.7	16

364 **Note: the number of individuals with * represents those sightings in which mothers with young were recorded.**

366



367

368

369

370

371

372

373

374

Figure 1. Study area. B) G.A: Arauco gulf, SMI: Santa Maria Island, Llv: Punta Lavapié, Bbc: Biobio canyon, Bbr: Biobio River and Ccp: Concepción. C) Localitation of sightings in Caleta Chome. The red point shows the position of the sightings in the sea. The associated sampling number is indicated on each point (see Table 1). The black point shows the position of Caleta Chome, were sightings from land ware made. The color palet in A and C panel show the depth in meters. The bathymetric information for the area was obtained from the General Bathymetric Chart of the Ocean (GEBCO, [GEBCO - The General Bathymetric Chart of the Oceans](https://www.gebcoscience.org/)).

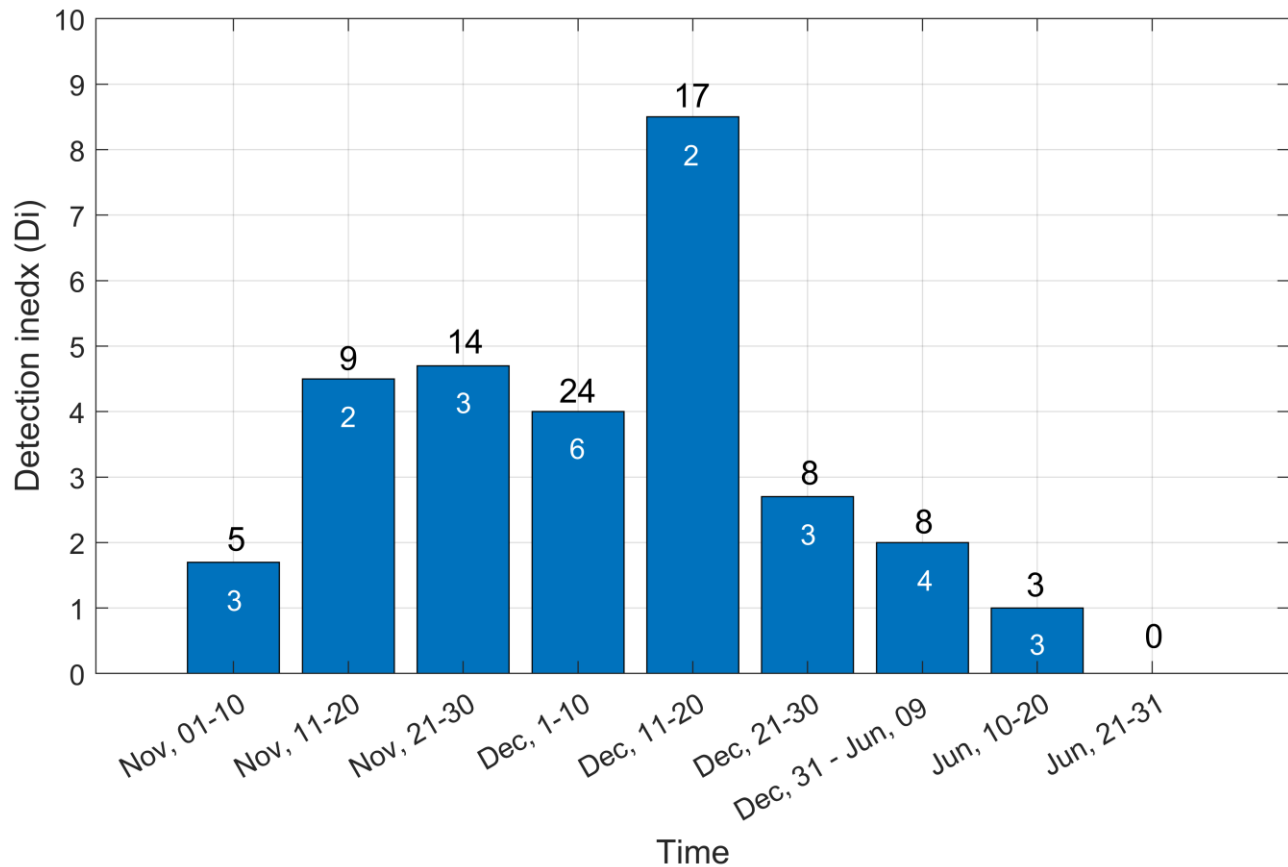
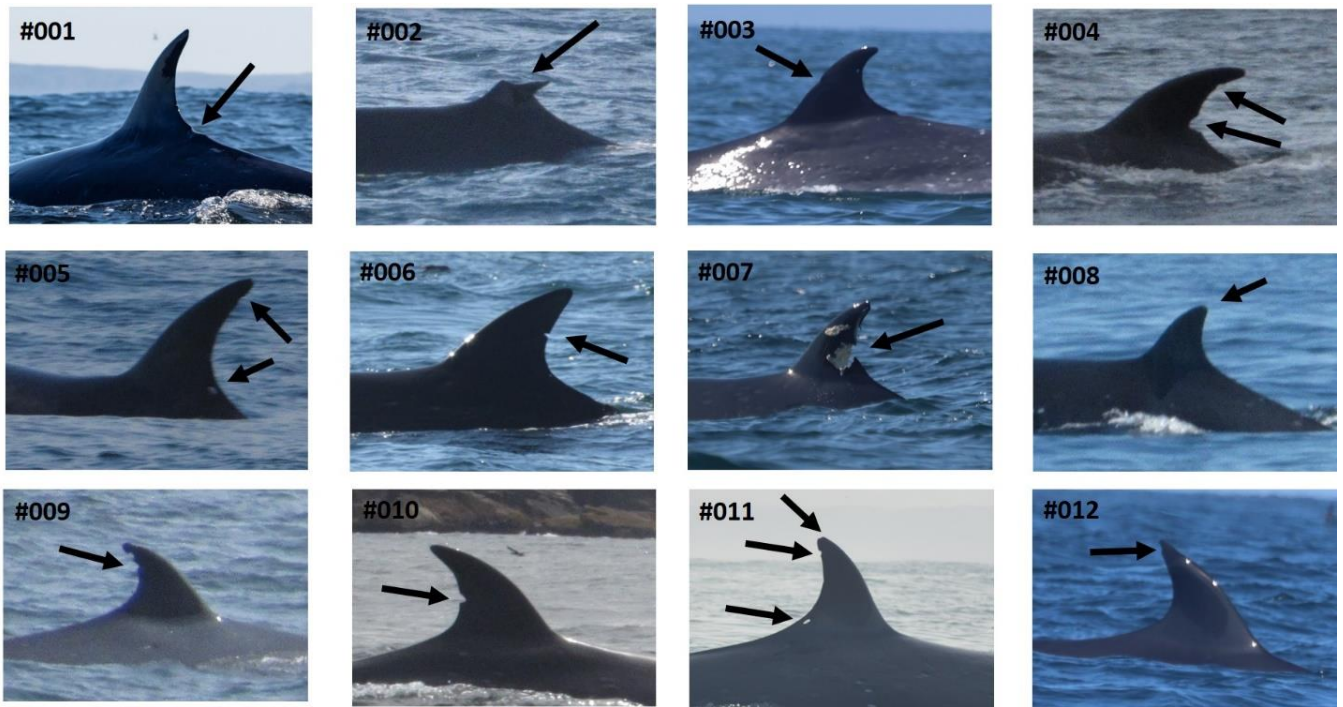


Figure. 2. Frequency in the detection index of the *Balaenoptera borealis* sighted during November and December 2019 and January 2020. The detection rate was calculated based on the effective sightings per day for 10 days standardized by the sampling effort. The numbers above and within each bar indicate the number of total sightings and the sampling effort in each date range, respectively.



380

381 Figure. 3. Dorsal fin photographs of 12 identified sei whales (*Balaenoptera borealis*) at Caleta

382 Chome, during the seasons from November 2019 to January 2020.