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Chilean Blue Whales: Fidelity to Feeding Areas and Migratory Connectivity With the Eastern Tropical Pacific¹

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ABSTRACT

In the Eastern South Pacific (ESP), blue whale (*Balaenoptera musculus* subsp.) aggregations have been described for two feeding areas (in northern and southern Chile) and in the Eastern Tropical Pacific (ETP). However, despite the knowledge of these areas, little is known about the seasonal movements of blue whales between them. Comparisons of 1074 individual blue whales, photographed across these regions from 1992 to 2019, resulted in re-sightings of 107 individuals. Photo-identification comparisons were conducted using the Southern Hemisphere Blue Whale Catalog, a collaborative platform for sharing photo-identification data among 21 research groups from 7 nations. A total of 92 matches were found within the southern Chile feeding area and 13 matches within the northern Chile feeding area. High site fidelity was found for the southern Chile feeding area (return rates $\geq 43\%$). The longest interval between the first and last sighting was 17 years. There was no exchange between northern and southern Chile feeding areas. Two matches revealed long-distance connectivity and migration of blue whales from southern Chile to the Galápagos Islands in the southern ETP. There were no matches between Chile and the Costa Rica Dome, farther north in the ETP, a location known for the year-round presence of blue whales. The results highlight the importance of collaboration to understand blue whale movements and migration patterns. Our results provide valuable ESP and ETP region-wide data toward understanding population structure and informing conservation and management strategies, population assessments, and/or delineating biologically important areas.

1 | Introduction

In the Southern Hemisphere, two subspecies of blue whale are currently recognized by the Committee on Taxonomy of the Society for Marine Mammalogy:² the pygmy blue whale (*Balaenoptera musculus brevicauda*) in the Indian Ocean and western Pacific Ocean, and the Antarctic blue whale (*B. m. intermedia*) in the Southern Ocean. Additionally, the as yet formally named, subspecies known as the “Chilean blue whale” has been proposed as a separate subspecies due to its distinctive morphology (Branch, Abubaker, et al. 2007; Pastene et al. 2020), genetics (LeDuc et al. 2007, 2017; Torres-Florez et al. 2014), and acoustics (McDonald et al. 2006). Leslie et al. (2020) used drone-based photogrammetry to show that Chilean blue whales are morphologically intermediate in size (both in total body length and relative tail to body length) between pygmy and Antarctic blue whales, reinforcing the uniqueness of the Chilean population. Furthermore, using a genomic tool applied to worldwide blue whales, Attard et al. (2024) found the greatest divergence between the eastern Pacific, Indo-western Pacific and Antarctic blue whales, which is consistent with the hypothesis of three distinct subspecies.

In the Eastern South Pacific (ESP), Chilean blue whales are known to feed during the austral summer and autumn (late December to early May). Feeding whales are found in northern Chile (off Isla de Chañaral, 29° S) (Galletti Vernazzani, Carlson, et al. 2012) and in southern Chile (40° S–44° S): off western Isla Grande de Chiloé and toward northern Los Lagos (Cabrera et al. 2005; Galletti Vernazzani, Brownell Jr, et al. 2012; Gilmore 1971), in the east inlets of Isla de Chiloé (Abramson and Gibbons 2010), and in the Golfo Corcovado and Moraleda Channel (Cummings and Thompson 1971a, 1971b; Hucke-Gaete et al. 2004). Using mark-recapture analysis, ~570 (right-side) and ~760 (left-side) blue whales were estimated off the west coast of Isla de Chiloé (Galletti Vernazzani et al. 2017).

In the Eastern Tropical Pacific (ETP), blue whales have been reported at the Costa Rica Dome, an oceanographic feature centered at approximately 10° N, 110° W, at the Galápagos Islands, along the equatorial cold tongue west of the Galápagos, and in the coastal waters off Ecuador and northern Perú (Félix et al. 2007; Palacios 1997; Reilly and Thayer 1990). However, the distribution of blue whales is discontinuous between the Costa Rica Dome and the regions to the south, with a gap between 3° N and 7° N (Branch, Stafford, et al. 2007). The occurrence of blue whales broadly corresponds with two major oceanographic features within the ETP: the North Pacific Equatorial Counter Current (NECC) that stretches across the tropical Pacific Ocean, and including the Costa Rica Dome; and the Pacific Equatorial Divergence (PEQD), situated along the Equator and extending from the coast of the Americas westward to the central Pacific and including the Galápagos Islands, Ecuador, and northern Perú (Longhurst 1998). Blue whales are present year-round at the Costa Rica Dome, and Reilly and Thayer (1990) proposed three hypotheses for this: that the area may be used at different times of the year by individuals from the Northern and Southern Hemisphere populations; that the population consists of non-migrating juveniles; or that it is a distinct, resident population year-round.

Using satellite telemetry, blue whales off California were tracked southward to the Costa Rica Dome (Mate et al. 1999; Bailey

et al. 2009) and acoustic data collected at the Costa Rica Dome have provided links with the Northern Hemisphere population (Stafford et al. 1999). Recent photo-ID and satellite telemetry data from the Galápagos Islands have also provided evidence of connectivity with the Costa Rica Dome, likely corresponding to the Northern Hemisphere population (Denkinger et al. 2023; Guzmán and Estévez 2025).

In the southern part of the ETP, the waters of the PEQD have been proposed as a winter destination for Chilean blue whales (Palacios 1997; Reilly and Thayer 1990). Indeed, genetic, acoustic, photo-identification, and satellite tag data have found connections between the whales off southern Chile and the PEQD, particularly around the Galápagos Islands (Buchan et al. 2014, 2015; Hucke-Gaete et al. 2018; Torres-Florez et al. 2015). Call-types from Chilean blue whales have also been detected in the ETP, primarily from hydrophones located at 8° S but rarely from hydrophones north of the Equator (Stafford et al. 1999). Therefore, blue whales from the Galápagos Islands, in the southern ETP, are likely to be visited by individuals from both Northern and Southern Hemisphere populations. There have not been any connections found yet between Southern Hemisphere blue whales and the Costa Rica Dome.

Photo-identification data from long-term studies and a coordinated, multi-site effort can provide insight into the structure, abundance, and movements of blue whale populations in the ESP. Since 2008, the International Whaling Commission's (IWC) Scientific Committee has supported the Southern Hemisphere Blue Whale Catalog (SHBWC—www.bluewhalecatalogue.org), a collaborative, online platform for sharing individual photo-identification catalogs among blue whale research groups throughout the Southern Hemisphere (IWC 2009). Comparisons of blue whale photo-identifications have been conducted through the IWC SHBWC, with the goal of estimating population abundances using mark-recapture methods (IWC 2024).

Using the SHBWC, this study compared identification photographs of blue whales collected between 1992 and 2019 from the ESP and the ETP. This work provides the first regional assessment of population connectivity for blue whales through collaborative photo-identification efforts.

2 | Materials and Methods

2.1 | Photographic Data

Individual blue whales are identifiable from the unique pattern of mottled pigmentation on both sides of the body near the dorsal fin (Sears et al. 1990), from large scars, and from the highly variable dorsal fin shape (Gendron and Ugalde de la Cruz 2012).

As of March 2021, the SHBWC contained the identification photographs of 1074 individual blue whales from 1992 to 2019 collected in the ESP and the ETP. The collection comprised 789 left-side IDs and 784 right-side IDs (Table 1), providing the data used in this study. Photographs were contributed by seven research groups as well as independent or citizen scientists collecting photographs opportunistically.

TABLE 1 | Collections of identification photographs from the ESP and the ETP.

Geographic area	Research group	Years	No. of whale IDs	No. of left sides	No. of right sides
ETP: Perú, Ecuador, Costa Rica Dome	Southwest Fisheries Science Center (NMFS/NOAA)	1992–2009	88	64	54
All Chile	International Whaling Commission/Southern Ocean Whale Ecosystem Research 1997/98 Cruises (IWC Chile) ^a	1997–1998	21	14	9
Northern Chile and northern Perú	Opportunistic	2015–2018	5	3	2
Northern Chile—Isla Chañaral	Centro de Conservación Cetacea (CCC)	2012–2013	30	25	27
	Centro de Investigación Eutropia (Eutropia)	2006–2019	34	16	25
	Fundación Panthalassa (Panthalassa)	2010–2019	37	16	28
	Total northern Chile		101	57	80
Southern Chile	Centro de Conservación Cetacea (CCC)	2004–2015	588	443	450
	Centro Ballena Azul, Universidad Austral de Chile (CBA-UACH)	2003–2015	200	151	140
	Fundación Centro Melimoyu Ecosystem Research Institute (MERI)	2014–2017	60	48	45
	Opportunistic	2010–2018	11	9	4
	Total southern Chile		859	651	639
	Total		1074	789	784

Note: Bold values represent the total or sub-totals on the tables.

^aThe cruise covered the Chilean exclusive economic zone (12–200 nm offshore) from 18.30° S to 52° S (Findlay et al. 1998).

Identification photographs were evaluated for quality based on angle (of the whale to the photographer), exposure (lighting), and focus, and placed in one of four categories: 1 = Excellent, 2 = Good, 3 = Fair, and 4 = Poor (Olson et al. 2021). One photo-ID expert, with years of experience in blue whale photo-ID, evaluated all images. After completing the quality coding for each regional catalog, all categories were double-checked by a second photo-ID expert to ensure standardization.

Left and right-side identification photographs of individual blue whales from all sources were compared to one another (left side to left side; right side to right side) to determine the number of individuals re-sighted.

2.2 | Regional Coverage

Seven groups provided photo-ID data from the ETP and areas off northern Chile (around Isla de Chañaral—29° S, 71.5° W) and southern Chile (40° S–44° S, 72° W–74° W). Photographs collected opportunistically were contributed to the SHBWC from

various individuals working in the waters off Perú and Chile (Table 1). Locations of photo-identified blue whales included in the study are shown in Figure 1.

For the ETP, the SHBWC holds collections that include sightings from both the NECC (primarily the Costa Rica Dome) and the PEQD, including the Galápagos Islands as well as coastal waters and high seas off Ecuador and northern Perú.

Date and location were analyzed to describe individual movements and habitat use. Resightings that were both within-season (feeding season for blue whales off Chile can be considered from November to June) and within-sub-area were excluded; resightings that occurred between different sub-areas were included.

2.3 | Site Fidelity and Movements

Site fidelity may be assessed by different approaches, including annual return rate, sighting intervals of individuals, and the

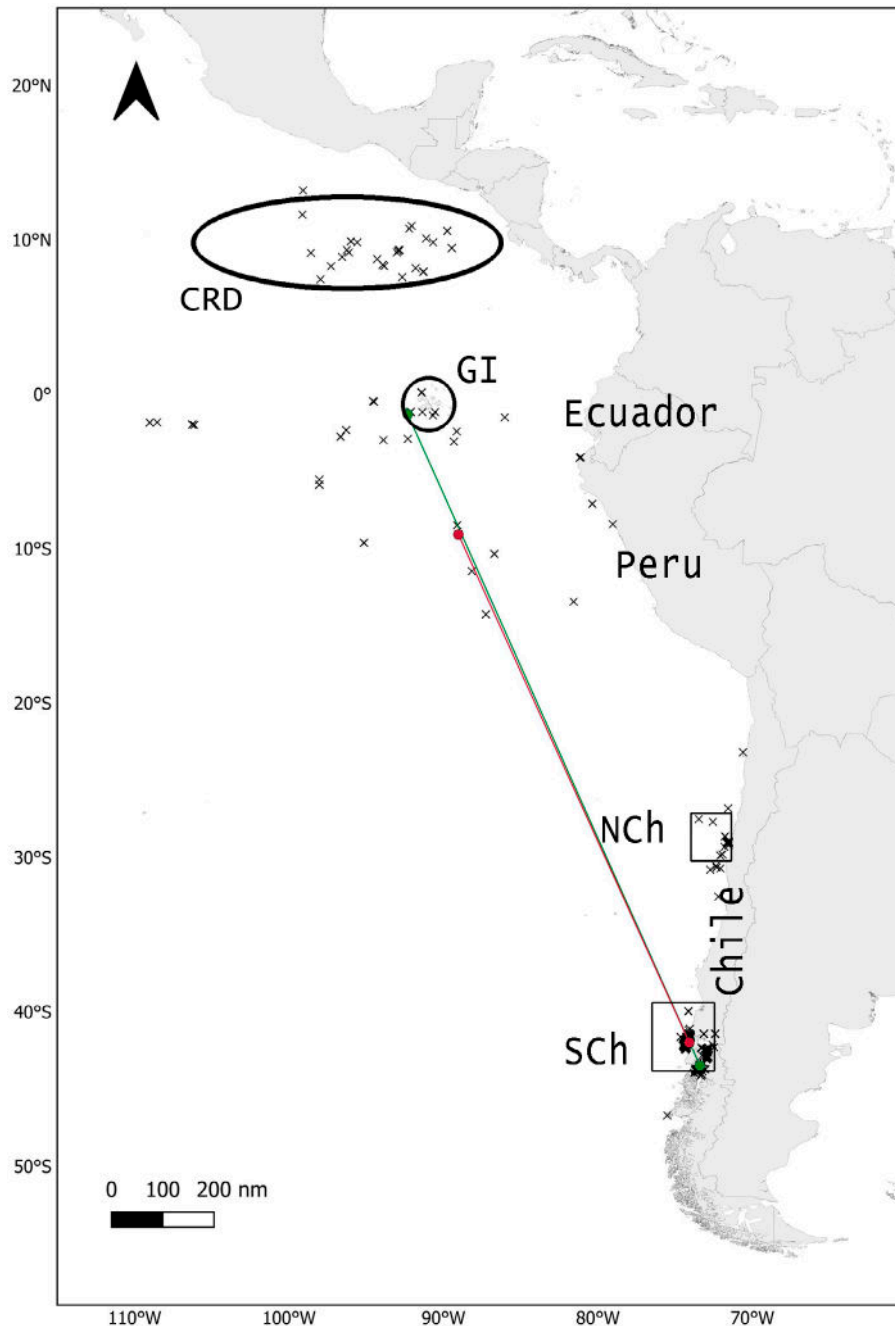


FIGURE 1 | The location of blue whale photo-identification collections in the Eastern South Pacific and the Eastern Tropical Pacific oceans. Cross: Blue whale location; CRD circle: Costa Rica Dome; GI circle: Galápagos Islands; SCh rectangle: Southern Chile feeding area; NCh rectangle: Northern Chile feeding area; Solid lines (green and red): Two migratory connections (see Results).

degree of interchange between locations (Clapham et al. 1993; Baker et al. 1986; Witteveen and Wynne 2017). In order to explore site fidelity and movements, sightings from all encounters of each individual were used.

The annual return rates were estimated as the number of whales identified in previous years and resighted within year i divided by the total number of whales photo-identified in the same year i (Clapham et al. 1993). As annual return rate depends on the number of individuals previously identified, the first year(s) are not considered when estimating average annual return rate for an area. Mann–Whitney U test was used to examine differences

between annual return rates from northern and southern Chile feeding areas.

Sighting intervals of individuals were calculated as the time, in years, between first and last photographed sightings. These provide insights into long-term site fidelity (Baker et al. 1986).

The total number and proportion of individuals resighted in each sub-area of southern Chile were calculated. The degree of interchange of individuals between southern Chile feeding sub-areas was assessed using a χ^2 test of independence. Movements

within the same season were reported only if they were between different sub-areas.

3 | Results

The comparisons of left-side (789) and right-side (784) photographs from the 1074 blue whales in the SHBWC, from the ESP and ETP, produced a dataset of 955 unique individual blue whales (706 left sides, 701 right sides) and found 119 matches for 107 different individuals (74 left sides, 76 right sides). Of the 955 individuals, 75% were seen only during 1 year and 15% in two different years. Three individuals were seen in six different years. One of them (*Valentina*, ID# CCC_043) was seen in the southern Chile feeding area, both off the west coast and in the east inlets of Isla de Chiloé over a period of 10 years. It is the most resighted whale with 11 encounters.

Most of the individual resightings (92 of 107) occurred within southern Chile; 13 occurred within northern Chile. Two matches were found between southern Chile and the ETP: one off the Galápagos Islands and another offshore northern Perú. Both locations were within the PEQD. However, there were no matches between northern Chile and the ETP, nor between Chile and the Costa Rica Dome in the NECC.

3.1 | Southern Chile Feeding Area

A total of 758 unique individuals were identified in the southern Chile feeding area (40° S–44° S). Using the dataset for each individual's encounter history, the annual return rate was estimated with 353 animals resighted inter-annually (Table 2). The average annual return rate from 2005 to 2018 was 43% (SD = 27%), with the highest rates in 2018 (100%) and 2017 (75%). Over the years, with an increasing number of individuals identified, more resights were discovered. Consequently, the annual return rate has been increasing, with only the first 6 years being less than 40%. If using data from 2010 to 2018, the average annual return rate would be almost 60%.

The longest interval between resightings was 17 years. The individual was first photographed on 5 January 1998 (40° S—ID#Ch009) and resighted (ID#CCC_315), twice, on 13 March 2008 and on 21 February 2015 off northwestern Isla de Chiloé (~42° S), approximately 220 km south from where it was first seen in 1998.

The second longest interval between resightings came from two whales, each with 11-year intervals between first and last encounters. These whales are known as *Moro* (ID# CCC_200), which traveled to Golfo de Penas (see below), and *Shimi* (ID# CCC_027).

Shimi was seen four times in 2006, 2010, and 2017 off northwestern Isla de Chiloé. When first seen in 2006, this whale exhibited a severe skin condition along its entire body. The photographs from 2017 showed that the lesions had persisted over the 11-year period (Figure 2). The appearance of the lesions has remained virtually unchanged over this period, indicating, at least in this animal, that they are stable.

TABLE 2 | The total number of unique blue whales identified in southern Chile per year and associated annual return rates.

Year	No. of total IDs	No. of new IDs	No. of resights	Annual return rate %
2003	6	6	0	NA
2004	18	18	0	0
2005	35	35	0	0
2006	107	102	5	4.7
2007	141	125	16	11.3
2008	179	127	52	29.1
2009	112	80	32	28.6
2010	121	70	51	42.1
2011	103	59	44	42.7
2012	25	11	14	56.0
2013	81	43	38	46.9
2014	38	15	23	60.5
2015	99	51	48	48.5
2016	37	14	23	62.2
2017	8	2	6	75.0
2018	1	0	1	100.0
Total	1111	758	353	

Note: Bold values represent the total or sub-totals on the tables.

Of the 92 matches found within southern Chile, 91 of them were found within the southern Chile feeding area (40° S–44° S), demonstrating the connectivity between northwestern Isla de Chiloé, the inlets east of Isla de Chiloé, and the Golfo Corcovado (Figure 3). A single resight of *Moro* (ID# CCC_200) was linked to a different area farther south in Chile, the Golfo de Penas (Figure 3). This individual was initially sighted off northwestern Isla de Chiloé (~42° S) during summers 2007, 2008, and 2014, and was last seen on 23 November 2018 in Golfo de Penas (46.7° S—75.5° W). This last resighting represents the southernmost record of a known individual blue whale from the southern Chile feeding area.

Movements between sub-areas were determined from individuals first sighted in one area and later sighted in the same or a different area (Table 3). In addition to the 353 whales resighted inter-annually in southern Chile, seven individuals were identified during the same season as having moved between sub-areas and were included in the analyses to assess spatial connectivity between sub-areas. To account for potential bias in sample size and effort, and to compare between areas, a proportion of whales was obtained (Figure 4). Although most whales sighted in a given area tended to re-occur in the same area, fidelity to and movements into west Isla de Chiloé were much higher than any other area (246 out of 360, 68%). A χ^2 test of independence ($\chi^2 = 91.08$, $df = 4$, $p < 0.001$) confirms connectivity between these sub-areas and substantiates that the southern Chile feeding area is extensive and dynamic.



(a)



(b)

FIGURE 2 | *Shimi*, a blue whale with blister-like lesions sighted off northwestern Isla de Chiloe in (a) 2006 and (b) 2017.

3.2 | Northern Chile Feeding Area

A total of 84 unique individuals has been identified in the northern Chile feeding area. The annual return rate was calculated for each year for northern Chile (Table 4). The average annual return rate from 2012 to 2019 was estimated at 8.3% (SD = 7.2%), which is significantly different from southern Chile (Mann–Whitney U test, $U = 14$, $n_{Sch} = 14$, $n_{NCh} = 7$, $z = 2.57$, $p = 0.004$, $r = 0.56$). Considering that annual return rates may increase as more identification photographs become available, the relatively low annual return rate for northern Chile may be related to sampling effort and could be expected to increase in upcoming years, similar to the results from southern Chile. For example, when considering only the first 7 years with annual return rates for both northern and southern Chile ($n_{Sch} = n_{NCh} = 7$), then the annual return rate for southern Chile would have been slightly higher (16%) than for northern Chile, though not significantly different (Mann–Whitney U test, $U = 14$, $z = 1.28$, $p = 0.099$, $r = 0.34$).

Of the 13 matches found there were only six individuals resighted inter-annually within northern Chile, all of them around Isla Chañaral (29°S, 71°W). The longest time between photographic resightings in northern Chile was 13 years. Whale ID# Azul3 was first seen on 22 January 2006 and later resighted (ID# PTHS001) on 11 and 13 January 2019. The second longest time interval was 10 years: individual (ID# Azul6) first seen on 20 December 2006 and later resighted (ID# PTHS031) on 11 February 2016.

3.3 | Movements Between the Southern ETP and Southern Chile

Two matches from southern Chile were made to individuals initially seen in the PEQD (in the southern ETP), one near the Galápagos Islands and the other offshore of Perú. These two

matches provide important evidence about migratory movements and the connectivity of blue whales between southern Chile and the southern ETP. The distances between sightings in the ETP and Chile were approximately 5200 km (Figure 1—green line) and 4500 km, respectively (Figure 1—red line).

One individual (ID# E9810) was first encountered in waters off the Galápagos Islands (1°18' S, 92°19' W) on 6 November 1998 and then resighted 8 years later (ID# CBA065) in the Golfo Corcovado, Chile (43°52' S, 73°33' W) on 23 February 2006. This whale was seen again on 2 February 2008, also in the Golfo Corcovado (43°30' S, 73°24' W).

The other long-distance match is from an individual (ID# E0318) first photographed on 21 October 2003, at 9.06° S, 89.02° W (southern edge of the ETP), 900 km south of the Galápagos Islands and 1300 km west of Perú. It was later seen (ID# CCC_058) three times off northwestern Isla de Chiloé, on 22 February 2006 (41.89° S, 74.12° W) and again on 21 and 22 February 2008 (41.99° S, 74.17° W and 42.00° S, 74.09° W).

4 | Discussion

This study, comparing identification photos of blue whales from waters off Chile, Perú, Ecuador (including the Galápagos Islands), and the Costa Rica Dome, 1992–2019, represents the first large-scale regional assessment of blue whale photo-identifications from the ESP and ETP.

4.1 | Migratory Connections

The matches between PEQD, in the southern ETP, and the southern Chile feeding area provide valuable information on the

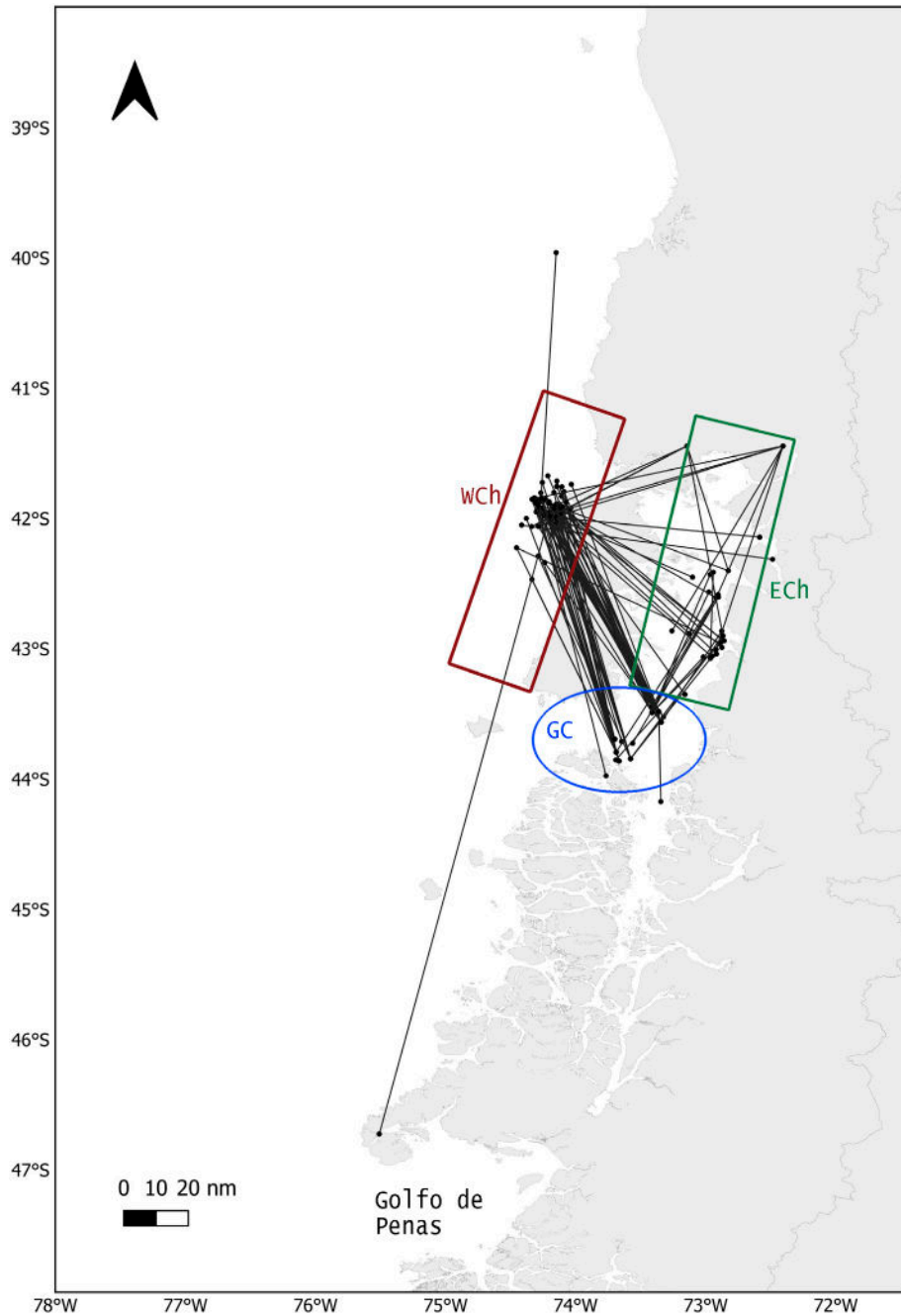


FIGURE 3 | Blue whale connectivity within southern Chile. Red rectangle (WCh): West Isla de Chiloé; green rectangle (ECh): East Isla de Chiloé; blue circle (GC): Golfo Corcovado.

TABLE 3 | Movements of blue whale individuals among different sub-areas in southern Chile (WCh: West Isla de Chiloé, ECh: East Isla de Chiloé, GC: Golfo Corcovado).

Sub-area were ID first seen	Sub-area where ID later seen			Total
	WCh	ECh	GC	
WCh	193	25	21	239
ECh	1	8	0	9
GC	52	19	41	112
Total	246	52	62	360

Note: Bold values represent the total or sub-totals on the tables.

long-distance migration of blue whales and evidence of the connectivity between these regions. These observations indicate that at least some blue whales from the southern Chile feeding ground migrate to waters located west and south of the Galápagos Islands.

One of the two whales in the present study (ID# E9810; CBA065), sighted in both southern Chile and the PEQD, was not only a photographic match but also confirmed through genetic analysis to be the same individual; a female, known as “Isabela” (Torres-Florez et al. 2015).

These photographic results are consistent with previous studies that reported connections between southern Chile and the PEQD using other methods such as acoustics, genetics,

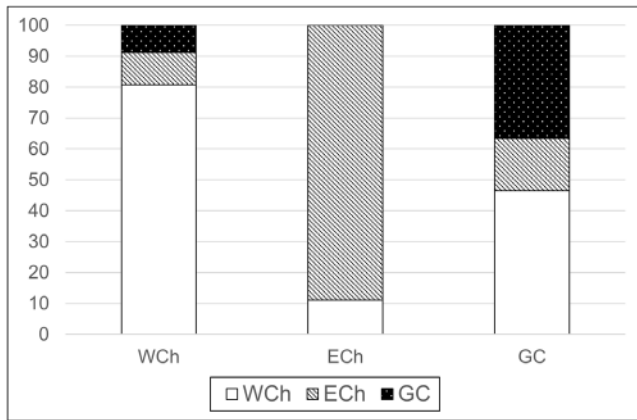


FIGURE 4 | The proportion of blue whales seen in sub-area *i*, that visited the same or different sub-areas in later years. (WCh: West Isla de Chiloé, ECh: East Isla de Chiloé, GC: Golfo Corcovado).

TABLE 4 | The total number of unique blue whales identified in northern Chile per year and associated annual return rates.

Year	No. of total IDs	No. of new IDs	No. of resights	Annual return rate %
2006	8	8		NA
2007	^a	^a		^a
2008	1	1		0
2009	^a	^a		^a
2010	1	1		0
2011	^a	^a		^a
2012	14	14		0
2013	19	18	1	5.3
2014	^a	^a		^a
2015	4	4		0
2016	16	15	1	6.3
2017	15	13	2	13.3
2018	6	5	1	16.7
2019	6	5	1	16.7
TOTAL	90	84	6	

Note: Bold values represent the total or sub-totals on the tables.

^aYears without blue whales found or without survey effort.

or satellite telemetry (Buchan et al. 2014, 2015; Hucke-Gaete et al. 2018; Torres-Florez et al. 2014, 2015). Analysis of passive acoustic data collected from southern Chile identified two ESP blue whale songs also recorded in the PEQD (8° S–95° W) (Buchan et al. 2014; Stafford et al. 1999). The analysis of Buchan et al. (2015) on the seasonal pattern of occurrence of blue whale songs from the PEQD and southern Chile suggested potential migratory seasonal movements of blue whales off southern Chile toward the PEQD during June/July and returning in December.

Moreover, five out of 10 satellite-tagged blue whales in southern Chile retained their tags long enough to track their northward routes along the ESP. All individuals departed southern Chile between April and late June. One track (5° S–104° W) reached north of Bauer Basin (10° S, 101° W) during early July, some 1500 km west-southwest of the Galápagos Islands, and two reached waters off the Galápagos Islands during late July and early September. The latter animal then moved southeast toward northern Perú during October (Hucke-Gaete et al. 2018).

Our photo-ID data reinforces the evidence of migratory connectivity between southern Chile and the PEQD, near or toward the Galápagos Islands. Notably, the two animals photographed in the PEQD were later encountered both during February 2006 and 2008 in the southern Chile feeding area. These re-sightings suggest that at least some groups of animals visit the same areas at similar time periods, a pattern consistent with the migratory behavior observed in other baleen whale species. Combining genetic and isotopic signatures, Valenzuela et al. (2009) found that female southern right whales (*Eubalaena australis*) calving at Peninsula Valdés, Argentina, showed maternally inherited site fidelity to their near-shore winter nursery ground and to feeding grounds. Their study also found that the timescale of culturally inherited site fidelity to feeding grounds was at least several generations and that this may limit the exploration of new feeding opportunities. The study suggested that southern right whale population structure may be similar to that of humpback whales (*Megaptera novaeangliae*) in the North Pacific, where the whales are genetically segregated on both the nursery and feeding grounds (Baker et al. 1998, 2013). Therefore, the connectivity of two blue whales from the southern Chile feeding area to the area adjacent to the Galapagos Islands, may also reflect a level of population structure and site fidelity to both specific feeding and breeding areas.

However, genetic data using mitochondrial and nuclear markers have indicated an absence of population structure for blue whales from the ETP and ESP (Torres-Florez et al. 2014). Furthermore, genomic analysis also suggested that eastern north and eastern south Pacific blue whales may even be part of the same subspecies (Attard et al. 2024). Therefore, understanding blue whale population structure in the eastern Pacific has been challenging and deserves more research.

In addition to blue whales from the Northern and Southern Hemispheres using the ETP, Northern and Southern Hemisphere humpback whales do so as well (Calambokidis et al. 2000; Rasmussen et al. 2007, 2012; Chereskin et al. 2019). While this unique spatial overlap occurs in populations of both species from the Northern Hemisphere and the Southern Hemisphere, their distribution in the ETP is different; humpback whales tend to occur in warmer waters and blue whales in cooler waters (Wade and Gerrodette 1993). For humpback whales, warmer ETP waters may be important for rapid calf development and growth (Acevedo et al. 2007; Rasmussen et al. 2007). Northern Hemisphere blue whales concentrate near the Costa Rica Dome (Reilly and Thayer 1990; Mate et al. 1999; Stafford et al. 1999) in the NECC, and also at the Galápagos Islands (Denkinger et al. 2023; Guzmán and Estévez 2025), in the PEQD. For blue whales, Branch, Stafford, et al. (2007) showed that they migrate in winter to low-latitude areas, which could include areas in the

ETP that are cool and feature rich upwelling systems, possibly supporting feeding.

4.2 | Summer Feeding Areas

Presented here are the results of the first large-scale comparison of blue whale identification photographs from two major feeding areas in Chilean waters, one off southern Chile (west and east off Isla de Chiloé and the Golfo Corcovado) and another off northern Chile (Isla de Chañaral). Multiple matches documented within the southern Chilean feeding ground between the western side of Isla de Chiloé, eastern inlets of Isla de Chiloé, and the Golfo Corcovado confirm that the feeding area is widespread, and that these individuals show high site fidelity to this southern Chile feeding area.

One photographic match included here (and previously reported in Galletti Vernazzani et al. 2017), showed a whale moving in the same season between Isla de Chañaral (21 December 2006) and northwestern Isla de Chiloé (22 February 2007). Another connection between southern and northern Chile during the same season is that of an animal satellite-tagged in the east inlets of Isla de Chiloé during 2015. The whale traveled close to shore northward to 30° S (near Isla de Chañaral) before changing its course northwest toward the south of the Galápagos Islands (Hucke-Gaete et al. 2018). The present study examined seven more years of photographs (2013–2019) than the previous study by Galletti Vernazzani et al. (2017) which used data from 2004 to 2012, increasing the number of individuals from 525 to 758 in the southern Chile feeding area, and from 17 to 84 in the northern Chile feeding area. However, no additional matches between northern and southern Chile feeding areas were found with the increased sample size, providing further evidence of strong site fidelity to the respective feeding areas.

It has been suggested that Chilean blue whales regularly visit multiple feeding sites along the Chilean coast during the summer season, explaining the lack of population structure between feeding sites. Genetic studies using mitochondrial and nuclear markers did not show any population structure between animals from northern and southern Chile, although the number of samples from northern Chile was relatively small ($n = 19$) (Torres-Florez et al. 2014). Site fidelity indicates that whales prefer certain feeding areas. But they still may visit different areas searching for food when there is not enough food availability, which may be inferred from the movements of seven whales reported here between different sub-areas in southern Chile during the same season. This could also explain the periodic fluctuations in abundance reported by Galletti Vernazzani et al. (2017) suggesting that use of the southern Chile feeding area varies between years.

The high annual return rate (43%) of blue whales off the southern Chile feeding area found in this study is consistent with the high annual return rate (31%) previously reported for northwestern Isla de Chiloé (Galletti Vernazzani, Brownell Jr, et al. 2012; Galletti Vernazzani et al. 2017). Annual return rates for humpback whales have ranged from 1% for breeding grounds in Brazil (Baracho-Neto et al. 2012) to 73% for feeding animals in the Gulf of Maine (Clapham et al. 1993). Rates for humpback whales in Alaska feeding areas have been estimated at 23% for the eastern

Aleutian Islands (Riley 2010), 47.2% for southeastern Alaska (Baker et al. 1986), and 34%–37% for the western Gulf of Alaska (Witteveen and Wynne 2017). The highest record of annual return rate for fin whales (*Balaenoptera physalus*) has an average of 62% (2010–2019, excluding initial low data-years) at Kitimat Fjord System, Canada (Keen et al. 2021).

Our annual return rate estimates are consistent with high rates found for other whale species at feeding areas. Annual return rates can be biased by a number of factors (Clapham et al. 1993), including survey effort and population size. Our results show that for the first few years of data for southern Chile, the annual return rate was low, increasing later in the study. Moreover, most of the studies from other populations did not take into account first or many initial year(s) of effort to reduce bias. Our estimates are conservative as only the first 2 years of effort were removed. The lower annual return rate for Isla de Chañaral (8.3%) in northern Chile is most likely explained by the low survey effort, and we show that it may be similar to southern Chile when examining only the first few years of data. Moreover, the longest sighting interval of 13 years for northern Chile provides evidence of long-term site fidelity and indicates a possible survey-effort bias on annual return rate estimates.

The match of a known individual from west of Isla de Chiloé area to the Golfo de Penas, 450 km to the south, highlights the possibility of another feeding site or an extension of the southern Chile feeding area. It is also possible that this feeding area is only temporary due to fluctuating oceanographic conditions. In any case, this record (consisting of only one sighting) provides evidence for the plasticity of annual movements and feeding ground choice in this population. Distribution of blue whales in the southern Chile feeding area has been described from aerial surveys conducted from 40° S to 44° S (Galletti Vernazzani, Brownell Jr, et al. 2012), with whale densities outside the major feeding ground being almost zero. However, the distribution has also proved to be dynamic and during 2012, the main aggregation moved 120 km further north than in previous years (Galletti Vernazzani, Carlson, et al. 2012). In northern Chile, the survey area has been monitored exclusively around Isla de Chañaral; the distribution of blue whales is likely to encompass a greater area if surveys are extended. Long-term research has been crucial for identifying these two major feeding aggregations for blue whales in southern and northern Chile, although there may be other feeding sites in the region, and oceanographic data could provide more insights to better understand the dynamics.

Finally, it is important to recognize that the photo-ID collection of the SHBWC provides the opportunity to assess other important aspects of individual and population biology such as health status (e.g., Rolland et al. 2016; Van Bresseem et al. 2014, 2015). The blister-like lesions observed on blue whales were first described by Brownell et al. (2008), using Shimi as an example. Barlow et al. (2019) conducted an analysis of skin condition in New Zealand blue whales and found 80% of the whales exhibited blister-like lesions. Individually recognized whales sustained the condition for at least 7 years. Our images of the blue whale with skin lesions over an 11-year period are a clear illustration of the value that such long-term data can have for conducting other studies such as body condition and the prevalence of scars and their condition.

This study highlights the importance of international collaborative work to better understand blue whale movements across wide areas, providing insight into blue whale migration, identifying discrete feeding areas, and documenting body condition and health status. Our results on connectivity provide important data toward understanding population structure, which is relevant for conservation and management strategies, population assessment, and delineating biologically important areas. More research to explore potential population substructure as well as to expand survey areas is needed to increase our understanding of Chilean blue whales.

Author Contributions

Barbara Galletti Vernazzani: conceptualization, investigation, funding acquisition, writing – original draft, methodology, data curation, formal analysis, software, project administration, validation, visualization, writing – review and editing. **Elsa Cabrera:** investigation, methodology, validation, formal analysis, writing – review and editing. **Paula A. Olson:** conceptualization, data curation, methodology, investigation, writing – review and editing, formal analysis, validation, funding acquisition. **Diego Cortés-Peña:** investigation, writing – review and editing. **Isabella L. K. Clegg:** investigation, writing – review and editing. **Sonia Español-Jimenez:** investigation, writing – review and editing. **Verena Häussermann:** investigation, writing – review and editing. **Rodrigo Hucke-Gaete:** investigation, writing – review and editing. **Rodrigo Moraga:** investigation, writing – review and editing. **Daniel M. Palacios:** investigation, writing – review and editing. **Guido Pavez:** investigation, writing – review and editing. **María José Pérez-Alvarez:** investigation, writing – review and editing. **Jorge Ruiz:** investigation, writing – review and editing. **Mariano Sironi:** investigation, writing – review and editing. **Frederick Toro:** investigation, writing – review and editing. **Juan Pablo Torres-Florez:** investigation, writing – review and editing. **Sheila Wright:** investigation, writing – review and editing. **Robert L. Brownell Jr.:** conceptualization, methodology, investigation, writing – review and editing, validation, funding acquisition.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Endnotes

¹This paper is respectfully and fondly dedicated to the memory of Dr. Carole Carlson and Greg Kaufman who greatly contributed to the research and studies of the Chilean blue whale population.

²<https://www.marinemammalscience.org/species-information/list-marine-mammal-species-subspecies/>.

References

- Abramson, J., and J. Gibbons. 2010. "New Records of Blue Whales *Balaenoptera musculus* (Linnaeus, 1758) in Winter Season in the Inlet Waters of Chiloe Continental – Chile." *Anales del Instituto de la Patagonia* 38, no. 2: 107–109. <https://doi.org/10.4067/S0718-686X2010000200010>.
- Acevedo, J., K. Rasmussen, F. Felix, et al. 2007. "Migratory Destinations of Humpback Whales From the Magellan Strait Feeding Ground, Southeast Pacific." *Marine Mammal Science* 23, no. 2: 453–463. <https://doi.org/10.1111/j.1748-7692.2007.00116.x>.
- Attard, C. R. M., J. Sandoval-Castillo, A. R. Lang, et al. 2024. "Global Conservation Genomics of Blue Whales Calls Into Question Subspecies Taxonomy and Refines Knowledge of Population Structure." *Animal Conservation* 27: 626–638. <https://doi.org/10.1111/acv.12935>.
- Bailey, H., B. Mate, D. Palacios, L. Irvine, S. Bograd, and D. Costa. 2009. "Behavioural Estimation of Blue Whale Movements in the Northeast Pacific From State-Space Model Analysis of Satellite Tracks." *Endangered Species Research* 10: 93–106. <https://doi.org/10.3354/esr00239>.
- Baker, C., D. Steel, J. Calambokidis, et al. 2013. "Strong Maternal Fidelity and Natal Philopatry Shape Genetic Structure in North Pacific Humpback Whales." *Marine Ecology Progress Series* 494: 291–306. <https://doi.org/10.3354/meps10508>.
- Baker, C. S., L. M. Herman, A. Perry, et al. 1986. "Migratory Movement and Population Structure of Humpback Whales (*Megaptera novaeangliae*) in the Central and Eastern North Pacific." *Marine Ecology Progress Series* 31, no. 2: 105–119. <https://doi.org/10.3354/meps031105>.
- Baker, C. S., L. Medrano-Gonzalez, J. Calambokidis, et al. 1998. "Population Structure of Nuclear and Mitochondrial DNA Variation Among Humpback Whales in the North Pacific." *Molecular Ecology* 7: 695–707. <https://doi.org/10.1046/j.1365-294x.1998.00384.x>.
- Baracho-Neto, C. G., E. Santos Neto, M. R. Rossi-Santos, et al. 2012. "Site Fidelity and Residence Times of Humpback Whales (*Megaptera novaeangliae*) on the Brazilian Coast." *Journal of the Marine Biological Association of the United Kingdom* 92, no. 8: 1783–1791. <https://doi.org/10.1017/S0025315411002074>.
- Barlow, D. R., A. L. Pepper, and L. G. Torres. 2019. "Skin Deep: An Assessment of New Zealand Blue Whale Skin Condition." *Frontiers in Marine Science* 6: 757. <https://doi.org/10.3389/fmars.2019.00757>.
- Branch, T. A., E. M. N. Abubaker, S. Mkango, and D. S. Butterworth. 2007. "Separating Southern Blue Whale Subspecies Based on Length Frequencies of Sexually Mature Females." *Marine Mammal Science* 23, no. 4: 803–833. <https://doi.org/10.1111/j.1748-7692.2007.00137.x>.
- Branch, T. A., K. M. Stafford, D. M. Palacios, et al. 2007. "Past and Present Distribution, Densities and Movements of Blue Whales *Balaenoptera musculus* in the Southern Hemisphere and Northern Indian Ocean." *Mammal Review* 37: 116–175. <https://doi.org/10.1111/j.1365-2907.2007.00106.x>.

- Brownell, R. L., C. Carlson, B. Galletti Vernazzani, and E. Cabrera. 2008. "Skin Lesions on Blue Whales off Southern Chile: Possible Conservation Implications?" Paper SC/60/SH25 presented to the IWC Scientific Committee, June 2008.
- Buchan, S. J., R. Huccke-Gaete, L. Rendell, and K. M. Stafford. 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. <https://doi.org/10.3354/esr00566>.
- Buchan, S. J., K. M. Stafford, and R. Huccke-Gaete. 2015. "Seasonal Occurrence of Southeast Pacific Blue Whale Songs in Southern Chile and the Eastern Tropical Pacific." *Marine Mammal Science* 31, no. 2: 440–458. <https://doi.org/10.1111/mms.12173>.
- Cabrera, E., C. A. Carlson, and B. Galletti Vernazzani. 2005. "Presence of Blue Whale (*Balaenoptera musculus*) in the Northwestern Coast of Chiloe Island, Southern Chile." *Latin American Journal of Aquatic Mammals* 4, no. 1: 73–74. <https://doi.org/10.5597/lajam00073>.
- Calambokidis, J., G. H. Steiger, K. Rasmussen, et al. 2000. "Migratory Destinations of Humpback Whales That Feed Off California, Oregon and Washington." *Marine Ecology Progress Series* 192: 295–304. <https://doi.org/10.3354/meps192295>.
- Chereskin, E., L. Beck, M. P. Gamboa-Poveda, et al. 2019. "Song Structure and Singing Activity of Two Separate Humpback Whales Populations Wintering Off the Coast of Caño Island in Costa Rica." *Journal of the Acoustical Society of America* 146, no. 6: EL509–EL515. <https://doi.org/10.1121/1.5139205>.
- Clapham, P. J., L. S. Baraff, C. A. Carlson, et al. 1993. "Seasonal Occurrence and Annual Return of Humpback Whales, *Megaptera novaeangliae*, in the Southern Gulf of Maine." *Canadian Journal of Zoology* 71, no. 2: 440–443. <https://doi.org/10.1139/z93-063>.
- Cummings, W. C., and P. D. Thompson. 1971a. "Bioacoustics of Marine Mammals: R/V Hero Cruise 70±3." *Antarctic Journal* X: 158–160.
- Cummings, W. C., and P. D. Thompson. 1971b. "Underwater Sounds From the Blue Whale, *Balaenoptera musculus*." *Journal of the Acoustical Society of America* 50: 1193. <https://doi.org/10.1121/1.1912752>.
- Denkinger, J., A. B. Douglas, D. Biggs, R. Sears, M. Narvaez, and D. Alarcon. 2023. "Year-Round Presence of Northern and Southern Hemisphere Blue Whales (*Balaenoptera musculus*) at the Galapagos Archipelago." *Journal of Cetacean Research and Management* 24, no. 1: 63–76. <https://doi.org/10.47536/jcrm.v24i1.387>.
- Félix, F., N. Botero, and J. Falconí. 2007. "Observation of a Blue Whale (*Balaenoptera musculus*) Feeding in Coastal Waters of Ecuador." *Latin American Journal of Aquatic Mammals* 6, no. 2: 193–197. <https://doi.org/10.5597/lajam00125>.
- Findlay, K., R. Pitman, T. Tsurui, et al. 1998. "1997/1998 IWC-Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Blue Whale Cruise, Chile." Paper SC/50/Rep2. International Whaling Commission, Cambridge, United Kingdom.
- Galletti Vernazzani, B., R. L. Brownell Jr., E. Cabrera, C. A. Carlson, and M. Sironi. 2012. "Update on 2012 Blue Whale Field Season in Chile." Paper SC/64/SH18 presented to the IWC Scientific Committee, May 2012.
- Galletti Vernazzani, B., C. Carlson, E. Cabrera, and R. L. Brownell Jr. 2012. "Chilean Blue Whales Off Isla Grande de Chiloe, 2004–2010: Distribution, Site-Fidelity and Behaviour." *Journal of Cetacean Research and Management* 12, no. 3: 353–360. <https://doi.org/10.47536/jcrm.v12i3.567>.
- Galletti Vernazzani, B., J. A. Jackson, E. Cabrera, C. A. Carlson, and R. L. Brownell Jr. 2017. "Estimates of Abundance and Trend of Chilean Blue Whales Off Isla de Chiloe, Chile." *PLoS One* 12, no. 1: e0168646. <https://doi.org/10.1371/journal.pone.0168646>.
- Gendron, D., and A. Ugalde de la Cruz. 2012. "A New Classification Method to Simplify Blue Whale Photo-Identification Technique." *Journal of Cetacean Research and Management* 12, no. 1: 79–84. <https://doi.org/10.47536/jcrm.v12i1.594>.
- Gilmore, R. M. 1971. "Observations on Marine Mammals and Birds Off the Coast of Southern and Central Chile, Early Winter 1970." *Antarctic Journal* 6: 10–11.
- Guzmán, H. M., and R. M. Estévez. 2025. "Movement Behavior of a Blue Whale Between the Galapagos Archipelago and the Frontal System Off Baja California Peninsula." *Marine Mammal Science* 41, no. 3: e13230. <https://doi.org/10.1111/mms.13230>.
- Huccke-Gaete, R., L. Bedrinana-Romano, F. A. Viddi, J. E. Ruiz, J. P. Torrez-Florez, and A. N. Zerbini. 2018. "From Chilean Patagonia to Galapagos, Ecuador: Novel Insights on Blue Whale Migratory Pathways Along the Eastern South Pacific." *PeerJ* 6: e4695. <https://doi.org/10.7717/peerj.4695>.
- Huccke-Gaete, R., L. P. Osman, C. A. Moreno, K. P. Findlay, and D. K. Ljungblad. 2004. "Discovery of a Blue Whale Feeding and Nursing Ground in Southern Chile." *Proceedings of the Royal Society of London Series B* 271: S170–S173. <https://doi.org/10.1098/rsbl.2003.0132>.
- International Whaling Commission. 2024. "Report of the Scientific Committee. Bled, Slovenia, 22 April–3 May 2024." *Journal of Cetacean Research and Management* 26: 1–90.
- International Whaling Commission (IWC). 2009. "Report of the Scientific Committee. 1–13 June 2008, Santiago, Chile." *Journal of Cetacean Research and Management* 11: 1–75.
- Keen, E. M., J. Pilkington, E. O'Mahony, et al. 2021. "Fin Whales of the Great Bear Rainforest: *Balaenoptera physalus Velifera* in a Canadian Pacific Fjord System." *PLoS One* 16, no. 9: e0256815. <https://doi.org/10.1371/journal.pone.0256815>.
- LeDuc, R. G., F. I. Archer, A. R. Lang, et al. 2017. "Genetic Variation in Blue Whales in the Eastern Pacific: Implication for Taxonomy and Use of Common Wintering Grounds." *Molecular Ecology* 26: 740–751. <https://doi.org/10.1111/mec.13940>.
- LeDuc, R. G., A. E. Dizon, M. Goto, et al. 2007. "Patterns of Genetic Variation in Southern Hemisphere Blue Whales and the Use of Assignment Test to Detect Mixing on the Feeding Grounds." *Journal of Cetacean Research and Management* 9: 73–80. <https://doi.org/10.47536/jcrm.v9i1.694>.
- Leslie, M. S., C. M. Perkins-Taylor, J. W. Durban, et al. 2020. "Body Size Data Collected Non-Invasively From Drone Images Indicate a Morphologically Distinct Chilean Blue Whale (*Balaenoptera musculus*) Taxon." *Endangered Species Research* 43: 291–304. <https://doi.org/10.3354/esr01066>.
- Longhurst, A. R. 1998. *Ecological Geography of the Sea*. Academic Press.
- Mate, B. R., B. A. Lagerquist, and J. Calambokidis. 1999. "Movements of North Pacific Blue Whales During the Feeding Season Off Southern California and Their Southern Fall Migration." *Marine Mammal Science* 15, no. 4: 1246–1257. <https://doi.org/10.1111/j.1748-7692.1999.tb00888.x>.
- McDonald, M. A., S. L. Mesnick, and J. A. Hildebrand. 2006. "Biogeographic Characterisation of Blue Whale Song Worldwide: Using Song to Identify Populations." *Journal of Cetacean Research and Management* 8: 55–65. <https://doi.org/10.47536/jcrm.v8i1.702>.
- Olson, P. A., B. Galletti Vernazzani, and J. P. Torres Florez. 2021. "Southern Hemisphere Blue Whale Catalogue Photo Quality Coding Guide." Paper SC/68C/PH/02 presented to the IWC Scientific Committee, May 2021.
- Palacios, D. 1997. "Blue Whale (*Balaenoptera musculus*) Occurrence Off the Galapagos Islands, 1978–1995." *Journal of Cetacean Research and Management* 1: 41–51. <https://doi.org/10.47536/jcrm.v1i1.451>.
- Pastene, L. A., J. Acevedo, and T. A. Branch. 2020. "Morphometric Analysis of Chilean Blue Whales and Implications for Their Taxonomy."

Marine Mammal Science 36, no. 1: 116–135. <https://doi.org/10.1111/mms.12625>.

Rasmussen, K., J. Calambokidis, and G. H. Steiger. 2012. “Distribution and Migratory Destinations of Humpback Whales Off the Pacific Coast of Central America During the Boreal Winters of 1996–2003.” *Marine Mammal Science* 28, no. 3: E267–E279. <https://doi.org/10.1111/j.1748-7692.2011.00529.x>.

Rasmussen, K., D. M. Palacios, J. Calambokidis, et al. 2007. “Southern Hemisphere Humpback Whales Wintering Off Central America: Insights From Water Temperature Into the Longest Mammalian Migration.” *Biology Letters* 3, no. 3: 302–305. <https://doi.org/10.1098/rsbl.2007.0067>.

Reilly, S. B., and V. G. Thayer. 1990. “Blue Whale (*Balaenoptera musculus*) Distribution in the Eastern Tropical Pacific.” *Marine Mammal Science* 6, no. 4: 265–277. <https://doi.org/10.1111/j.1748-7692.1990.tb00357.x>.

Riley, H. 2010. “Humpback Whale (*Megaptera novaeangliae*) Numbers and Distribution on their Summer Feeding Grounds of the Eastern Aleutian Islands.” M.Sc. thesis, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks.

Rolland, R. M., R. S. Schick, H. M. Pettis, et al. 2016. “Health of North Atlantic Right Whales *Eubalaena glacialis* Over Three Decades: From Individual Health to Demographic and Population Health Trends.” *Marine Ecology Progress Series* 542: 265–282. <https://doi.org/10.3354/meps11547>.

Sears, R., J. M. Williamson, F. W. Wenzel, M. Bérubé, D. Gendron, and P. Jones. 1990. “Photographic Identification of the Blue Whale (*Balaenoptera musculus*) in the Gulf of St. Lawrence, Canada.” *Report International Whaling Commission (Special Issue)* 12: 335–342.

Stafford, K., S. L. Nieu Kirk, and C. G. Fox. 1999. “An Acoustic Link Between Blue Whales in the Eastern Tropical Pacific and the Northeast Pacific.” *Marine Mammal Science* 15, no. 4: 1258–1268. <https://doi.org/10.1111/j.1748-7692.1999.tb00889.x>.

Torres-Florez, J. P., R. Hucke-Gaete, R. LeDuc, et al. 2014. “Blue Whale Population Structure Along the Eastern South Pacific Ocean: Evidence of More Than One Population.” *Molecular Ecology* 23, no. 24: 5998–6010. <https://doi.org/10.1111/mec.12990>.

Torres-Florez, J. P., P. A. Olson, L. Bedrinana-Romano, et al. 2015. “First Documented Migratory Destination for Eastern South Pacific Blue Whales.” *Marine Mammal Science* 31, no. 4: 1580–1586. <https://doi.org/10.1111/mms.12239>.

Valenzuela, L. O., M. Sironi, V. J. Rowntree, and J. Seger. 2009. “Isotopic and Genetic Evidence for Culturally Inherited Site Fidelity to Feeding Grounds in Southern Right Whales (*Eubalaena australis*).” *Molecular Ecology* 18: 782–791. <https://doi.org/10.1111/j.1365-294X.2008.04069.x>.

Van Bresse, M.-F., L. Flach, J. C. Reyes, et al. 2015. “Epidemiological Characteristics of Skin Disorders in Cetaceans From South American Waters.” *Latin American Journal of Aquatic Mammals* 10, no. 1: 20–32. <https://doi.org/10.5597/lajam00190>.

Van Bresse, M.-F., G. Minton, D. Sutaria, et al. 2014. “Cutaneous Nodules in Irrawaddy Dolphins: An Emerging Disease in Vulnerable Populations.” *Diseases of Aquatic Organisms* 107: 181–189. <https://doi.org/10.3354/dao02689>.

Wade, P. R., and T. Gerrodette. 1993. “Estimates of Cetacean Abundance and Distribution in the Eastern Tropical Pacific.” *Report of the International Whaling Commission* 43: 477–493.

Witteveen, B. H., and K. M. Wynne. 2017. “Site Fidelity and Movement of Humpback Whales (*Megaptera novaeangliae*) in the Western Gulf of Alaska as Revealed by Photo-Identification.” *Canadian Journal of Zoology* 95, no. 3: 169–175. <https://doi.org/10.1139/cjz-2016-0101>.