

Spatial distribution and abundance of baleen and sperm whales in the Peruvian sea: a historical review

Sarai Cortez-Casamayor^{1*}, Chiara Guidino^{1,2} and Aldo S. Pacheco³

¹Facultad de Biología Marina, Universidad Científica del Sur. Carretera Panamericana Sur 19, Villa El Salvador 15067, Lima, Peru

²Prodelphinus. Calle José Galvez 780, Miraflores 15074, Lima, Peru

³Facultad de Ciencias Biológicas, Universidad Nacional Mayor de San Marcos. Av. Carlos German Amezcaga 375, Cercado de Lima 15081, Lima, Peru

*Corresponding author: saraivaleriacc@gmail.com

Abstract

Historical accounts of large whales in Peruvian waters existed before modern commercial whaling. Research on baleen and sperm (*Physeter macrocephalus*) whales was intense during whaling, thus producing essential knowledge on these species. The populations of large whales have declined considerably with whaling pressure since 1925 in Peruvian waters. After the whaling moratorium in 1985, research on these species decreased, and a considerable gap in knowledge exists until nowadays. This review aims to conduct a historical analysis of the spatial distribution and abundance of baleen and sperm whales in the waters of Peru. During whaling, sperm whale distribution and abundance received most of the research effort as this species was the most important target of the whaling fleet. Also, blue (*Balaenoptera musculus*) and Bryde's whale (*B. edeni brydei*) were considered abundant in Peru. Changes in their distribution and abundance

were evaluated mainly based on captures or climatic events. Following the cessation of whaling, sightings of these species were restricted to occasional surveys, limiting the assessment of possible current changes in their distribution and abundance, as well as the updating of existing information. Humpback whales (*Megaptera novaeangliae*) were considered overexploited at the beginning of commercial whaling. After the moratorium, this species population started to grow, expanding its distribution along the northern coast. Currently, the humpback whale is the most studied species due to the onset of whale-watching activities in 2009. This allowed us to update and increase the knowledge about its distribution and abundance in northern Peru. The findings of this study point at a need to considerably increase the research effort on large whales, particularly surveys to estimate population sizes of the species inhabiting the waters of Peru.

Keywords:

Conservation, large whales, mysticetes, population recovery, Southeast Pacific, whaling.

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Introduction

Whaling has been practiced since the Prehistoric era, mainly along the North Pacific Rim and adjacent Arctic regions (Savelle & Kishigami, 2013). Modern commercial whaling began in Norwegian waters with the use of the explosive harpoon in 1864 and the introduction of steam-powered factory ships in 1903 (Tønnessen & Johnsen, 1982). Whaling became more efficient because of the increased ship autonomy and capacity (Ruffle, 2002), leading to a rapid reduction of baleen (suborder: Mysticeti) and sperm (*Physeter macrocephalus*) (suborder: Odontoceti) whale populations (Clapham et al., 2002). With abundances declining in the Northern Hemisphere, whaling fleets from the United States (US), Canada, United Kingdom (UK), Norway, Germany, Russia, and Japan searched for whaling grounds away from their territorial waters, reaching the Southeast (SE) Pacific Ocean off the coasts of Chile, Peru, and Ecuador (Flores, 2010).

The first descriptions of whales in waters of Peru were made around 1599, often referring to the high abundance and the ease of encountering whales (Cobo, 1964). In 1960, early references of oil use from stranded whales in Peru were reported (Cobo,

1964). Later, Tschudi (1844a, b) described the presence of sperm whales (*Catodon macrocephalus*) and mysticetes such as bowhead whales (*Balaena mysticeta* = *Balaena mysticetus* Linnaeus, 1758) or North Pacific right whale (*B. lunulata* = *Eubalaena japonica* Lacepède, 1818) (Serrano-Villavicencio et al., 2020), although this was a misidentification since both species are not distributed in the Southern Hemisphere (Cooke & Clapham, 2018; Cooke & Reeves, 2018).

Subsequently, British and US whalers began to arrive at the Peruvian coast in 1790 (Flores, 2010). Relative calm waters, the presence of several ports, and abundant whales made the Peruvian coast a strategic location for whalers (Coker, 1908; Gunther, 1936). In 1925, commercial whaling began in Peru, led by fleets from Norway and the UK (Clarke, 1962). Foreign whaling ended with a presidential declaration of sovereignty of Peruvian territorial waters extending 200 miles in 1947 (Supreme Decree N°781). Since 1951, whaling operations were exclusive to the Peruvian fleet (Schweigger, 1964).

The creation of the International Whaling Commission (IWC) on 02 December 1946 aimed to manage whale stocks to ensure the sustainability of populations, which became scarce due to whaling pressure (Mazzoldi et al., 2019). On 23 July 1982, the IWC established a global moratorium on commercial whaling for the 1985 season (Donovan, 1984), which is still in force today in most countries. Simultaneously, worldwide concern for conserving cetaceans has increased progressively, promoting new international agreements and national legislation to ensure species conservation. Currently, large whales maintain iconic status for conservation due to their charismatic appearance, behavior, size, ecological importance, and global distribution, which strongly appeal to human society for their protection (Thomas et al., 2016; Mazzoldi et al., 2019).

Almost 37 years after implementing the moratorium, the effects of overexploitation persist for most species (García-Godos, 2006). Population recovery of whales is expected to be slow; however, there is evidence that some populations are recovering at a steady pace (Clapham et al., 2002). For example, the humpback whale (*Megaptera novaeangliae*) is currently classified as “Least Concern” by the International Union for Conservation of Nature (IUCN) Red List because of encouraging population growth (Cooke, 2018a). However, the former overexploitation has negatively affected the abundance of other whale species and hindered their recovery (Reeves, 2003). Blue (*Balaenoptera musculus*) and sperm (*P. macrocephalus*) whales are still classified as “Endangered” and “Vulnerable”, respectively, and their global population status is unknown (Cooke, 2018b; Taylor et al., 2019). Additionally, anthropogenic disturbances such as fishery interactions (bycatch and entanglements), marine traffic (*i.e.* mortality by collision), pollution, and climate change still affect whales’ survival (Meyer Gutbrod & Greene, 2018).

This situation has encouraged conservation efforts to ensure the protection of whales, which calls for evaluation of the current state of their populations (Burgman et al., 1993). However, to set realistic conservation goals, it is mandatory to understand population dynamics before and during the commercial whaling period (de Moraes et al., 2017). In Peru, the status of most species after the ban is unknown due to the lack of research. Historical reconstruction of spatial distribution and abundance estimations must be attempted before, during, and after the commercial

whaling period (Baker & Clapham, 2004). Using this basis, it is possible to determine whether populations are recovering (Jackson et al., 2016).

Before modern commercial whaling, the distribution and abundance of large whales in Peru were mainly related to the Humboldt Current’s productivity and the abundant prey availability (Coker, 1908; Saetersdal et al., 1963). However, early reports do not detail with exactitude abundances in the area. At the onset of commercial whaling, since reporting was mandatory, data of the biological and ecological aspects of whales were made available by the whaling companies to the Peruvian scientific committee of the IWC and the South Pacific Permanent Commission (CPPS, Comisión Permanente del Pacífico Sur) (Saetersdal et al., 1963). Distribution information was limited to the whaling areas and correlated with sea surface temperature (SST) changes or prey availability (Townsend, 1935; Bini, 1951; Ramirez, 1990). Although there was a clear reduction in the abundance of the species, estimates were made for only one of the five target species for whaling (Valdivia et al., 1983). At present, despite recognizing the serious conservation problems of target whale species as their populations decline, their trends from the historical context have not been reviewed, and it is still necessary to recognize the aspects that remain to be investigated.

The objective of this review is to evaluate the historical trends of spatial distribution and abundance of baleen and sperm whales in Peruvian waters, considering their presence before, during, and after commercial whaling. It is expected to collect adequate information to identify gaps of knowledge that will aid conservation actions for the recovery of these species.

Materials and methods

Literature review

Literature focus on studies of large whales were collected from digital repositories including Google Scholar, Scopus, ScienceDirect, EBSCOhost, Wiley Online Library, SciELO, Redalyc, and the IWC library. Any type of information that had scientific validity was considered within the research, including cartographic maps or bulletins. The following keywords and combinations thereof were used in Spanish and English: “cetaceans”, “large whales”, “mysticetes”, “whales”, “Peru”, “International Whaling Commission (IWC)”, “Peruvian Sea Institute (IMARPE, Instituto del Mar del Perú)”, “South Pacific Permanent Commission (CPPS)”, “capture”, “whaling”, “whaling industry”, “whaling operations”, “spatial distribution”, “abundance”, “ecology”, “management”, “conservation”; as well as scientific and common names of whale species reported in the Peruvian sea: blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), Bryde’s whale (*B. edeni brydei*), sei whale (*B. borealis*), Antarctic minke whale (*B. bonaerensis*), humpback whale (*Megaptera novaeangliae*), Southern right whale (*Eubalaena australis*), and sperm whale (*Physeter macrocephalus/P. catodon*). Additionally, the IMARPE library and the journal “Boletín de Lima” were contacted to access old documents not available online. All relevant information before commercial whaling from 1844 to 2021 was compiled. The selection of the studies used in this review was carried out according to the following criteria: (1) studies reporting whales’ spatial distribution and/or abundance in Peru, (2) historical catch and/or sightings in Peru, and (3) studies

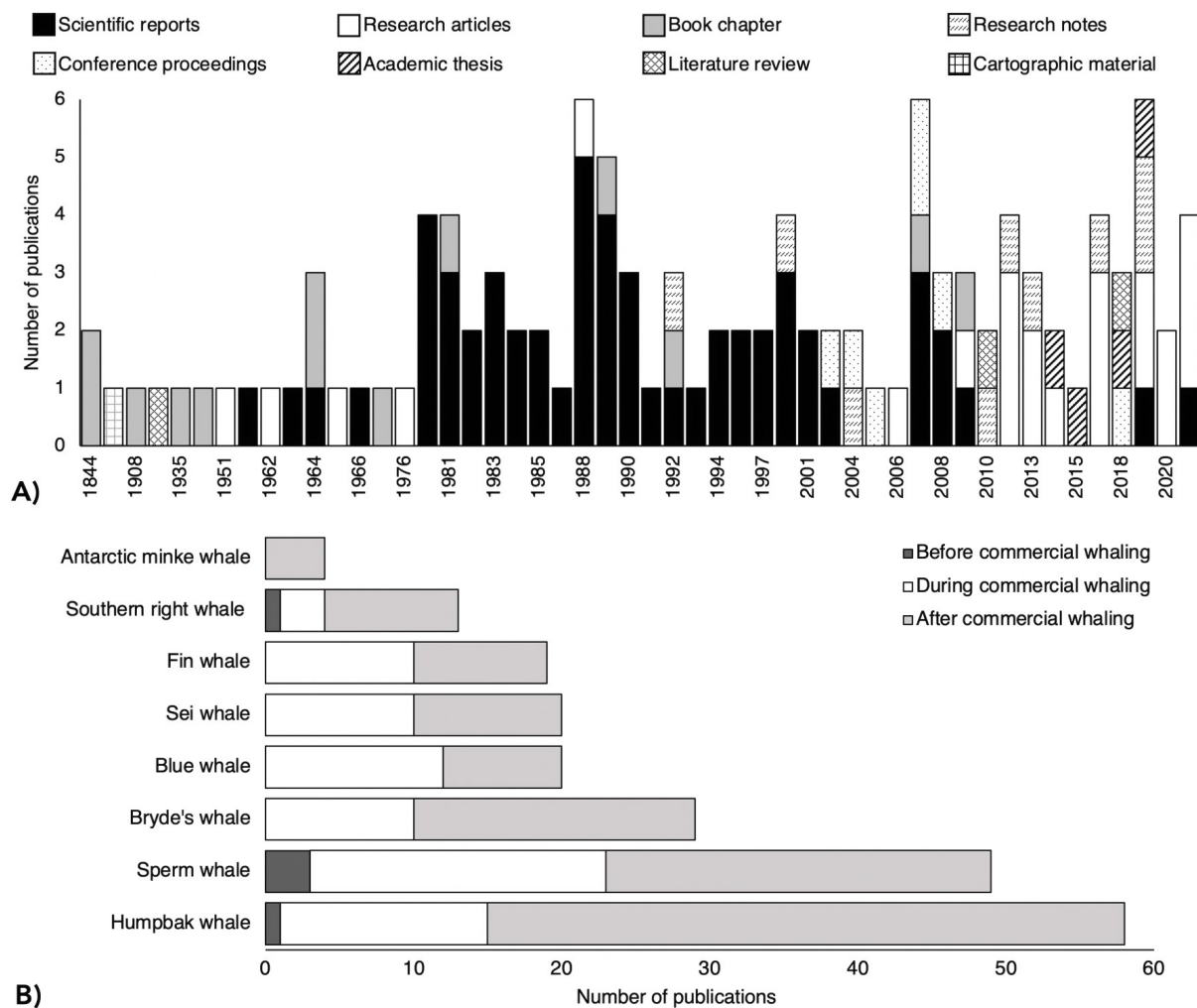


Figure 1. (A) Number and type of publications over time reporting the spatial distribution and abundance of large whales in the Peruvian sea. (B) Total number of documents with information on each baleen and sperm whales before, during and after commercial whaling.

on broad ecological aspects of baleen and sperm whales that could provide insights about past and/or current distribution and abundance trends.

Catches and sightings during commercial whaling

Catch and sighting statistics of baleen and sperm whales in the Peruvian sea from 1925 to 1985 were analyzed from the IWC (2013) report. Also, reports submitted by the Peruvian scientific committee, gathering information taken by whalers and observers aboard the Peruvian whaling companies located in Pisco, Ica (13°48' S, 76°14' W), Chancay, Lima (11°35' S, 77°16' W), and Paita, Piura (05°04' S, 81°08' W), established in 1951, 1954, and 1957 (Ramírez, 1989a), respectively, were reviewed. Additionally, the information available from IMARPE cruises around the Peruvian coast that reported the presence of large whales was revised.

Results and discussion

The literature search yielded 118 documents from 1844 to 2021 (Fig. 1A). The most abundant sources of information were scientific reports submitted to the IWC and IMARPE by their respective scientific committees. This was followed by research

articles, book chapters, scientific notes, conference proceedings, academic theses, literature reviews, and cartographic material. While most scientific reports (gray literature) were published from 1980 to 2002, research articles increased from 2006 onwards. The available material mainly describes sperm whales' biology during the whaling period until the moratorium. Research documenting humpback whales' ecology has become predominant recently (Fig. 1B).

During whaling, descriptions of the spatial distribution were considered only in reports since September 1976, with most studies occurring around Pisco, Chancay, and Paita, where whaling stations were located (Fig. 2) (Ramírez, 2001; Reyes, 2009). However, information on the current distribution of large whales is scarce and scattered (Pacheco et al., 2009).

Abundance data on large whales in Peru based on captures from 1925 to 1985 are available from the IWC and reports from whaling companies and other sources (Table 1). The evaluation of catch data was performed with caution, as sometimes the records do not agree because of differences in numbers presented by whalers (Cooke, 1983; Van Waerebeek et al., 1997). Since the correct inspection of catches and sightings did not occur until the introduction of the International Observer Program in 1971

Table 1. List of references reporting catches and/or sightings of large whales in Peru until the onset of the ban in 1985.

Reference	Years	Species					
		Humpback	Sei	Bryde	Fin	Blue	Sperm
IWC (2013)	1925-1983	X	X	X	X	X	X
Other sources							
Arriaga (1981)	1974-1976		X		X		X
Clarke (1980)	1936-1975	X	X		X	X	X
Cooke (1983)	1968-1981		X	X	X		
Donovan (1984)	1976-1983					X	
Garret (1980)	1936-1954						X
Garret (1980)	1963-1964						X
Mejía & Poma (1966)	1966						X
Ramírez & Urquiza (1985)	1981-1983	X		X	X	X	X
Ramírez (1983)	1961-1982					X	X
Ramírez (1985)	1983	X		X		X	X
Ramírez (1988a)	1961-1985	X					
Ramírez (1988b)	1961-1977				X		
Ramírez (1988d)	1974-1978		X	X			
Ramírez (1989a)	1951-1985	X	X	X	X	X	X
Ramírez (1989b)	1976-1981			X			X
Ramírez (1989d)	1976-1985			X			X
Ramírez (1990)	1983-1985	X	X	X		X	X
Ramírez (2001)	1957-1981		X	X			X
Ramírez (2007a)	1968-1985		X	X			
Saetersdal et al. (1963)	1947-1961						X
Valdivia & Ramírez (1981)	1968-1980		X	X	X		X
Valdivia et al. (1981a)	1968-1978		X	X	X		X
Valdivia et al. (1981b)	1980			X			
Valdivia et al. (1982)	1968-1981	X	X	X	X	X	X
Valdivia et al. (1983)	1961-1982	X		X		X	X
Valdivia et al. (1984)	1968-1983	X	X	X	X	X	X
Van Waerebeek et al. (1997)	1983						X

(Clapham & Ivashchenko, 2016), real exploitation numbers were altered on several occasions (Clapham et al., 2007). Arguably, this happened to obtain benefits from catch quotas or to avoid bans. In this study, catches and sightings of large whales differ by ca. 4,000 individuals between the information provided by the IWC and data from whaling companies and research cruises (Table 2). Despite this difference, a decline in abundance toward the whaling ban in 1985 was evident in both catches and sightings (Figs 3-4).

As time progressed, after the whaling season, the implementation of more sophisticated and accurate methods allowed a more precise recording of sightings, and robust estimates of spatial distribution and abundance. Despite the differences between methods, the analysis of the results allows the identification of broad changes in the distribution and relative abundance of the species.

The following information sections for each species are presented: historical data collected and analyzed about spatial distribution

Table 2. Summary of catches and sightings of large whales in Peru from 1925 to 1985. Sources: IWC records and information from whaling expeditions provided by whaling companies (WC) and research cruises (RC) (see Table 1).

Reports	Sperm	Bryde	Blue	Sei	Fin	Humpback	Total
Catches between 1925 and 1985							
IWC	71849	3589	930	2974	1952	835	82129
WC	75502	3759	938	2978	1985	906	86068
Sightings between 1975 and 1985 from WC and RC							
	22038	6284	5221	49	24	493	34109
Total catches and sightings between 1925 to 1985							
IWC	93887	9873	6151	3023	1976	1328	116238
WC	97540	10043	6159	3027	2009	1399	120177
Difference	3653	170	8	4	33	71	3939

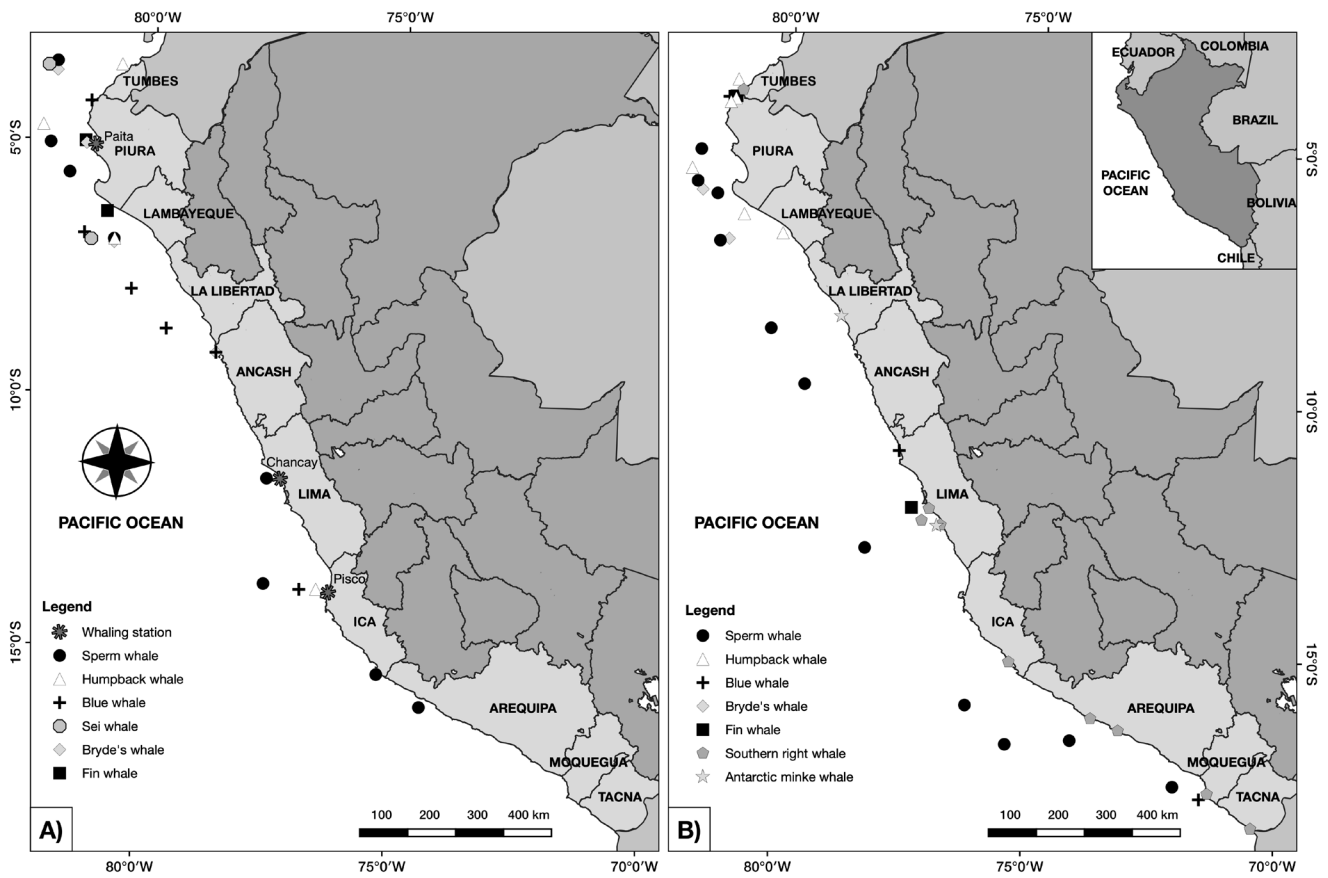


Figure 2. Maps showing the main locations where large whales have been reported in Peruvian waters (A) during and (B) after commercial whaling. Elaborated based on the locations described in this study.

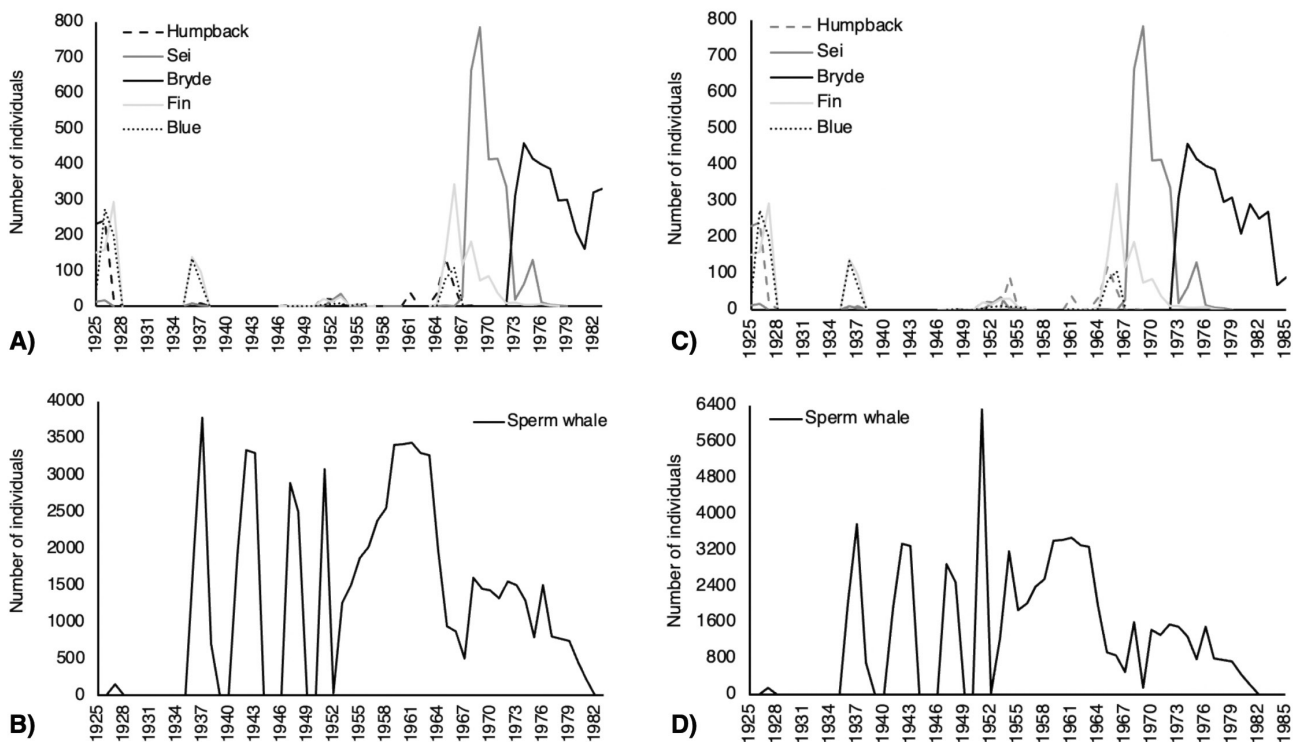


Figure 3. Temporal variation of the catches of baleen and sperm whales reported in Peru. Elaborated from the IWC reports from 1925 to 1983 (A) and (B), and from the information of the whaling expeditions provided by the whaling companies and research cruises (see Table 1) (C and D).

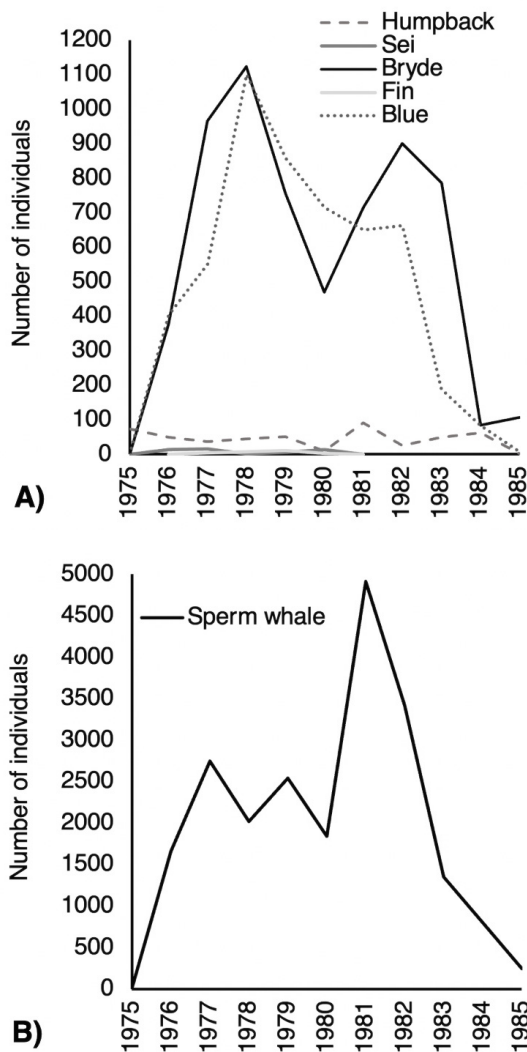


Figure 4. Temporal variation in large whale sightings reported in Peru from 1975 to 1985: (A) baleen whales and (B) sperm whales. Elaborated from the information of the whaling expeditions provided by the whaling companies and research cruises (see Table 1).

and abundance as well as an assessment of changes observed before the 1985 whaling moratorium, continuing with information after that date, and updates to 2021.

Sperm whale (*P. macrocephalus*)

Early descriptions of the presence of sperm whales in Peru were given under the name *Catodon macrocephalus* (Tschudi, 1844a, b). This odontocete was considered the only large whale easy to recognize because of its physical appearance (*i.e.* massive nasal complex) and oblique blow (Bini, 1951). Early distribution descriptions indicated a northern range limit at 12° S in central Peru extending toward the south (Gunther, 1936; Clarke, 1962). First sighting locations included Chala Morro, Arequipa (15°52' S, 74°14' W) and San Juan de Marcona, Ica (15°22' S, 75°12' W) (Fig. 2A) (Schweigger, 1964). Later, sperm whales were recorded offshore of Pisco and northern locations, including Lobos de Afuera Island, Lambayeque (06°56' S, 80°42' W), Cabo Blanco (04°14' S, 83°25' W), Sechura Bay (05°34' S, 81°02' W), Paita (05°01' S, 81°07' W) in Piura, and Tumbes (03°30' S,

83°45' W) (Fig. 2A) (Coker, 1908; Mejía & Poma, 1966).

Although British and US whalers arrived at the Peruvian coast in 1790, sperm whale hunting in the SE Pacific probably started earlier in 1761 (Townsend, 1935). By 1835, the port of Paita was used by whalers to supply their ships with water and food for sperm whale hunting (Clarke & Paliza, 2008). However, at the beginning of commercial whaling in 1925, sperm whale catches in Peru decreased because whalers targeted humpback, blue, and fin whales (Fig. 2) (Clarke, 1962). During World War II (1941-1943), British factory ships increased sperm whale captures in Peru¹, and their maximum catches occurred during 1936-1938 (2,021, 3,776, and 700 individuals), 1941-1943 (1,913, 3,342, and 3,299 individuals), 1947-1948 (2,887, and 2,497 individuals), 1951 (6,317 individuals), and 1954 (3,182 individuals) (Clarke, 1980). The highest catch was obtained in 1951 (Fig. 3D) because the capture effort increased due to the beginning of whaling operations at the coastal station at Pisco (Ramírez, 1989a). After 1954, factory ships were discontinued, and whaling was exclusive to the coastal stations fleet (Saetersdal et al., 1963; Arriaga, 1981).

Whaling operations from Peruvian coastal stations were dedicated to hunting sperm whales due to their high abundance and the high economic value of ambergris and spermaceti oil (Kostritsky, 1952; Majluf & Reyes, 1989). Their products satisfied the needs of the market at the time, and the storage capacity was limited to capture other baleen whales (Clarke, 1962; Arriaga, 1981). Whaling from coastal stations declined in 1961, and sperm whale populations were considered overexploited (Figs 3B and 3D) (Saetersdal et al., 1963). Differences in sex ratio and size reflected the dynamics of whaling and sperm whale abundance (Ramírez, 1989a, 2001). At the beginning of sperm whale hunting, large males over 12 m in length were targeted, but as these individuals were depleted, whalers targeted smaller individuals, usually below the minimum hunting length of 10.7 m (Ramírez, 2001). Since males are larger than females, the latter accounted for most of the catch recorded after 1956 (Saetersdal et al., 1963; Ramírez, 1989b). From 1959 to 1962, the lack of males induced a decline in the pregnancy rate (Clarke et al., 1980). Although the absence of males was arguably attributed to the migration to Antarctic waters (Jonsgård, 1960), the effect on the population recruitment was negative (Ramírez, 1989a; Reyes, 1992).

The reduction in the sperm whale stock led to the closure of the Pisco and Chancay whaling stations in 1964, leaving only the station in Paita operational (Arriaga, 1981; Ramírez, 1989a). The catch effort moved toward baleen whales such as sei, fin, and Bryde's whales (Fig. 3) (Grimwood, 1968; Valdivia et al., 1981a). Analysis of Catch Per Unit Effort (CPUE) from 1958 to 1976 confirmed the reduction in sperm whale abundance (Saetersdal et al., 1963; Mejía, 1964; Arriaga, 1981). Given the scarcity of males, the temporal comparison of CPUE in the year when males were abundant was erroneous because it overestimated a population that only considered females (Saetersdal et al., 1963). However, pregnancy rates between 1975 and 1977 decreased because of the lack of males, allowing CPUE comparisons to confirm the decrease in catches, despite the increase in hunting effort (Clarke et al., 1980; Ramírez, 1989a). Although sightings increased around 1981, the CPUE continued to decline (Ramírez, 1989b).

¹Whaling by factory ships, operating at sea or anchored, was known as "pelagic whaling", although it was not described whether the hunting area was coastal or oceanic (CPPS, 1955).

The analysis of individual weights also showed a decline in the yield number of individuals per boat/day, from 87 tons in 1957 to 31 tons in 1981 (Ramírez, 1989b). This evidence of over-hunting was presented to the IWC in 1980 (Clarke et al., 2002), and a sperm whale ban was established in the SE Pacific in 1982, and Peru abided (IWC, 1982). Later that year, the specimen catch and sightings continued to decline, probably due to the 1982/1983 El Niño event (Figs 3B and D, 4B) (Ramírez & Urquiza, 1985).

Variation in sex/size classes of sperm whales could be attributed to the arrival of individuals from the Northern Hemisphere (Clarke, 1962), but the presence of mixed populations in Peru remains unknown (Ramírez, 2001). This species was reported at a mean SST of 20.3°C (range = 16 to 24.4°C) (Clarke, 1962), but with spatial segregation depending on sex and maturity stage. Adult males were distributed in SST ranging from 15 to 17°C, while juveniles were present at 16 to 18°C. Females were found from 17°C to warmer SST near the coast (Clarke, 1962). During El Niño 1982/1983 sperm whales moved 600 km southwards of the hunting area off Paita because temperatures reached 31°C (Ramírez & Urquiza, 1985; Ramírez, 1990).

Sperm whale captures occurred mostly between 18° to 08° S and 82° to 85° W, during summer, fall, and spring (Ramírez, 1989b, 2001). Movements between Pisco and Paita recorded by identified tagged whales suggested a seasonal migration between central and northern Peru (Clarke, 1962; Ramírez, 1988a). Thus, aggregations were found in winter, between June and August off Pisco; and in summer, between January and March off Paita (Fig. 2A) (Saetersdal et al., 1963; Ramírez & Urquiza, 1985). SST above 17°C, suitable for birth, allowed the presence of adult females, juveniles, and calves in these zones (Ramírez, 2001; Reyes, 2009).

Identification tagging studies also confirmed that the northward migration began in June (Mejía, 1964; Mejía & Poma, 1966), and the southward migration started in September, which agrees with the high captures of sperm whales (no sex/size class difference) in December in Antarctic waters (Arriaga, 1981). However, stomach content analysis of individuals that migrated to northern Peru during summer showed beaks of squid species such as *Gonatus antarcticus* and *Mesonychoteuthis hamiltoni*, distributed south of 40° S. This indicates that sperm whales would also migrate from the subantarctic and Antarctic regions during these months (Clarke et al., 1976), since their preferred prey in waters off Peru was the Humboldt giant squid (*Dosidicus gigas*) (Clarke et al., 1988).

Stomach content analysis (between 1958 and 1962) indicated that sperm whales in the Peruvian sea fed almost exclusively on Humboldt giant squid, consuming up to 8.69 million tons per year (Clarke et al., 1988, 1993). Industrial fishery fleets for giant squid from Japan, Korea, and China began to operate in 1989, which probably hampered sperm whales from finding their preferred prey and recovery from commercial whaling (Clarke et al., 2002). The few sightings of sperm whales during IMARPE cruises between March and May 1998 and their absence during the "Ballenas Libres" expeditions off northern Peru and Ecuador in 2001 were suggested to be caused by the scarcity of giant squid (Sánchez et al., 1998; Clarke et al., 2002). Also, it was hypothesized that SE Pacific sperm whales migrated to the Northern Hemisphere seeking prey (Clarke et al., 2002), although they could have also

moved southwards to Chile. Nonetheless, their absence is still explained by whaling overexploitation.

Further stomach samples (between 1959 and 1961) and feces analysis (during 1985, 1987, 1988, 1989, and 1991) detected other cephalopod species; *Histioteuthis boylei*, *Ancistrocheirus lesueuri*, and *Octopoteuthis deletron*, with fish and crustacean remains (Clarke et al., 1976; Smith & Whitehead, 2000). These findings indicate that sperm whales do not rely exclusively on Humboldt giant squid (Clarke & Paliza, 2001), and fishing of this squid arguably does not affect sperm whales' abundance (Smith & Whitehead, 2000; García-Godos, 2006). Although further research is still needed, the high correlation between sperm whale relative abundance and CPUE of Humboldt giant squid in Peru suggests a predator and prey relationship (García-Godos, 2006).

Between 1995 and 2002, 38 sightings of 133 individuals were obtained in 21 surveys covering neritic and oceanic waters of Peru with a maximum-calculated sighting rate of 0.324 sightings/100 nm (García-Godos, 2006). These relatively high numbers of sightings suggested a natural population increment (García-Godos, 2006). However, it is worth mentioning that the spatial sampling effort conducted by García-Godos (2006) covered a larger area than previous expeditions (*i.e.* Sánchez et al., 1998; Sánchez & Arias-Schreiber, 1998; Clarke et al., 2002), hindering comparisons with previous data.

Sightings from IMARPE cruises between 1995 and 2002 corroborated that sperm whales were distributed in waters with SST of 20.23 ± 3.31°C (range = 16.02 to 29.1°C) (García-Godos, 2006). In contrast to the observations during El Niño 1982/1983 (Ramírez & Urquiza, 1985), sightings of sperm whales increased during El Niño 1997/1998 (García-Godos, 2006), although the increase has not been discussed, it may also be due to the advancement and improvement of research techniques. Additionally, although there were records along the Peruvian coast, a significant concentration occurred mainly in the north, from 7° S to the border with Ecuador (03°23' S), and in the south, from 16° S to the border with Chile (18°21' S) (Fig. 2B), which were former whaling grounds (García-Godos, 2006).

During two cruises in the summer and spring of 2003, 13 sightings composed of 63 individuals were recorded (García-Godos & Santillán, 2004). Sperm whales were sighted in southern oceanic waters mainly at temperatures above 20°C during summer. This increase in sightings indicated the presence of sperm whales off Peru and may provide some insights about their potential recovery. However, anthropogenic activities are further threatening this species. From 58 large whale strandings recorded from 1997 to 2017, 14% (n = 8) were sperm whales (Bachmann et al. 2018), entangled with fishing gear or showing evidence of collisions with vessels (Pizarro-Neyra, 2010; García-Godos et al., 2013).

In Peru, research on sperm whales after whaling is limited (*e.g.* García-Godos & Santillán, 2004; García-Godos, 2006; García-Godos et al., 2013; Pizarro-Neyra, 2017). The most recent reports are encouraging, but it is necessary to increase the research effort, mainly in oceanic waters, and clarify their current situation, considering the previous abundance before and during the commercial whaling period (Saetersdal et al., 1963).

Humpback whale (*M. novaeangliae*)

This species was initially described in Peru as *Megaptera nodosa*

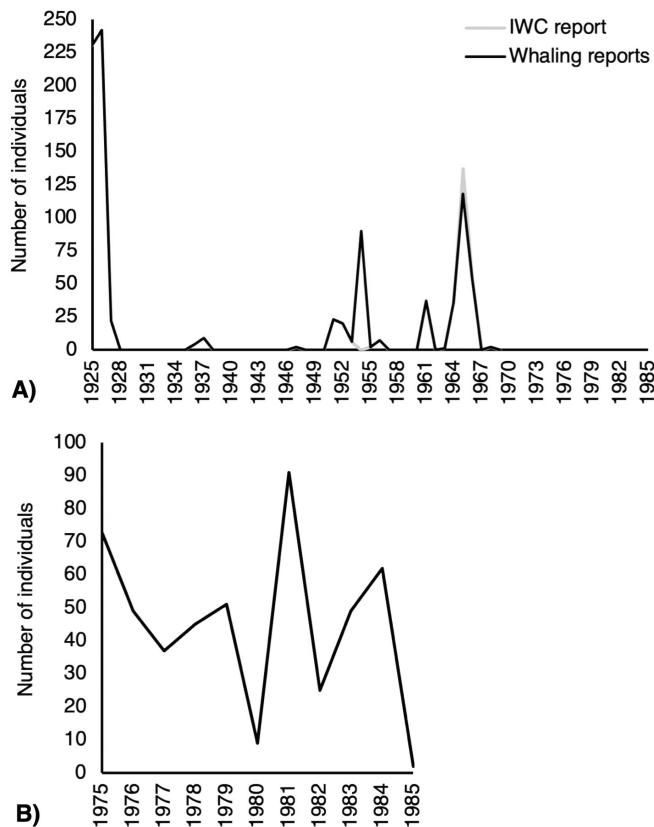


Figure 5. Temporal variation in humpback whale (*M. novaeangliae*) (A) catches and (B) sightings reported in Peru from 1925 to 1985. Elaborated from the IWC report and whaling expedition information provided by the whaling companies and research cruises (see Table 1).

(Bini, 1951; Kostritsky, 1952). The species was present in warm waters on the north coast from the surroundings of Lobos de Afuera Island (Schweigger, 1964), Cabo Blanco in Piura to the Gulf of Guayaquil, Ecuador (Fig. 2A) (Coker, 1908; Bini, 1951). Observations between 1852 and 1853 indicated that abundant humpback whales arrived during winter/spring seasons for breeding between July and November (Townsend, 1935; Clarke, 1962). The species was captured by Peruvians and foreign whalers, and landed in Puerto Pizarro, Tumbes (03°29' S, 80°23' W) (Fig. 2A), and in another whaling station in Ecuador (Clarke, 1962). In Tumbes, there was a small whaling activity with catches of 10 to 14 individuals per season (Coker, 1908). The population quickly declined, and only four individuals were caught in 1907, yielding a production of 6,500 oil gallons, valued in \$USD 1,300 (Coker, 1908). Hunting for humpback whales stopped in the early 20th century (Schweigger, 1964), but it was later resumed with the onset of commercial whaling.

Between 1925 and 1927, 495 humpback whales were caught, compared with only 166 sperm whales (Fig. 3). Apparently, these captures occurred in Paracas Bay (13°47' S, 76°15' W) (Fig. 2A) during September and October (Harmer, 1928; Clarke, 1962). Their high abundance was related to the El Niño event (Clarke, 1962), but this assertion was later dismissed since no evidence of population increments with high temperatures has been demonstrated (Van Waerebeek et al., 1996). Additionally, the location of Paracas was questioned because it was the place where a factory ship received and processed meat and oil from captured whales (Van Waerebeek et al., 1997). Based on

the information above, it is possible that the catch of these 495 specimens occurred elsewhere.

After that, humpback whale catches did not exceed 250 individuals per year (Fig. 5A). In 1961, an increment in catches was motivated by an unsuccessful attempt to introduce whale meat for human consumption (Ramírez, 1988b, c). Between 1963 and 1966, 118 individuals were captured to complete the quota offered to the market, not covered by sperm whales, the main target of whalers at the time (Ramírez, 1988c).

A ban on humpback whales in the Southern Hemisphere began in 1964, but hunting in Peru continued until 1968 (Majluf & Reyes, 1989). Later, from 1975 onwards, only sightings were recorded which remained stable (Fig. 5B). The decline in sightings in 1980 was attributed to the decrease in whaling time effort due to the hunt seasons established by the IWC for other species (Ramírez, 1988c). Without continuous surveys throughout the year, humpback whale sightings were occasionally recorded, and not as frequently as in previous years. Sightings near northern Peru continued to decline, probably because of the shift in the distribution caused by El Niño 1982/1983 environmental anomalies (Ramírez & Urquiza, 1985). Between 1983 and 1985, sightings during the breeding season increased again with the return to normal thermal conditions (Ramírez, 1990). Observations Per Unit Effort (OPUE) values of humpback whales progressively increased (Ramírez, 1988c), and although surveys did not continue after 1985, it is possible that their abundance continued increasing due to the population recovery observed today (Van Waerebeek et al., 1996; Félix et al., 2021).

As mentioned previously, humpback whales were observed between July and November (Townsend, 1935). Further information extended their presence from May to December, with catches peaking from September to November; and occasional catches in January and February (Ramírez, 1988c, 1990). This species showed a preference for a mean SST of 19°C (range = 15.2°C to 24.2°C) (Ramírez & Franco, 1982; Valdivia et al., 1983; Sánchez et al., 1998). The El Niño 1982/1983 seemed to be responsible for their distribution around the central and south coast off Peru, where the usually cold waters of the Humboldt Current became warm (Ramírez & Urquiza, 1985). After their breeding season, they migrate back to their feeding grounds in Antarctic waters (Gambell, 1987; Acevedo et al., 2017a).

After commercial whaling, only opportunistic sightings were recorded from 1985 onwards. IMARPE cruise data suggested that aggregations occurred from ~5° S to the border with Ecuador (Fig. 2B) (Bello et al., 1998; Sánchez & Arias-Schreiber, 1998; Flórez-González et al., 2007). Beginning in 2009, studies from whale-watching platforms in northern Peru increased research on this species with better navigation equipment and prepared researchers (Pacheco et al., 2009, 2011). Sightings of numerous mother and calf pairs confirmed the functionality and extension of the breeding area of the stock G toward the Peruvian northern coast (García-Godos et al., 2008; Pacheco et al., 2009, 2011; Santillán, 2011; Guidino et al., 2014).

Records are available between May and June at Lobos de Tierra Island (06°25.96' S, 80°52.27' W) (García-Godos et al., 2008). Also, along the coast between Cabo Blanco and Los Órganos (04°10' S, 08°8.27' W) and Sechura Bay (Fig. 2B), during winter/spring from July to November (Pacheco et al., 2009; Santillán, 2011; Guidino

et al., 2014). The peak abundance occurs between September and October, toward the end of the breeding season (Pacheco et al., 2009; Santillán, 2011; Guidino et al., 2014). During the breeding season, 3,115 humpback whales were sighted in 1,426 different groups between 2010 and 2019, with a total observation effort of 1,056.6 h (Pacheco et al., 2021). Sightings occur at a mean SST value of 21.5°C (range= 18.5 to 23°C) (Guidino et al., 2014; Pacheco et al., 2021).

Pacheco et al. (2009) recorded the movement directions of humpback whales in Los Órganos (Fig. 2B), and found that whales moved in either northeast or southeast direction, but some individuals did not show a consistent movement direction, suggesting constant displacement within the area. Additionally, there is a segregated distribution in respect to depth and distance from shore, depending on age and group size (Pacheco et al., 2011, 2021; Santillán, 2011; Guidino et al., 2014). Groups with calves are found close to shore (2 to 50 km) in shallow waters (Pacheco et al., 2021). Adults and/or subadults, either in pairs or solitary, are distributed in areas from 20 to 50 m in depth, and groups made of three to more individuals can be found over the continental shelf break (200-m depth) (Guidino et al., 2014; Pacheco et al., 2021). Either groups or solitary individuals can be located at a distance ranging from 20 km offshore to the continental shelf break (Santillán, 2011; Guidino et al., 2014). As the season progresses, humpback whales move away from the coast, possibly taking migration routes to return to their feeding grounds (Pacheco, 2019).

Humpback whales in the SE Pacific are experiencing population recovery after the moratorium. The species has expanded into (or returned to) breeding (Pacheco et al., 2009, 2021) and feeding grounds (Acevedo et al., 2013; Hucke-Gaete et al., 2013), where they were rarely sighted or captured in the past. The daily rate of successful sightings during whale-watching tours in northern Peru suggests this species is abundant during the breeding season (Pacheco et al., 2011). This coincides with solid evidence of recovery from population estimates, made with photo-identification recapture data and mathematical models for population size estimation (Félix et al., 2011; 2021). Félix et al. (2011) calculated a population size of ca. 6,500 individuals, and recently Félix et al. (2021) estimated ca. 11,784 individuals with a 5.07% annual rate of increase. However, humpback whales' preference for coastal habitats and their tendency to concentrate in defined areas expose them to entanglements with fishing gear, vessel collision, and unregulated whale-watching (Flórez-González et al., 2007; García-Godos et al., 2013; García-Cegarra et al., 2019; Villagra et al., 2021). It is important to improve the management of the species in Peru (and elsewhere) and to reinforce the protection measures to reduce the threats to the population recovery.

Blue whale (*B. musculus*)

Blue whales were reported in Peru before commercial whaling as the 'best recognized' and 'largest of all' because of their lengths of up to 33 m (Bini, 1951; Yochem & Leatherwood, 1985). Blue whales were not considered abundant in Peruvian waters due to the intensive whaling in Antarctic waters since 1904 (Clarke, 1962; Schweigger, 1964; Williams et al., 2011). Between 1925 and 1927, 509 individuals were captured, a number higher than the

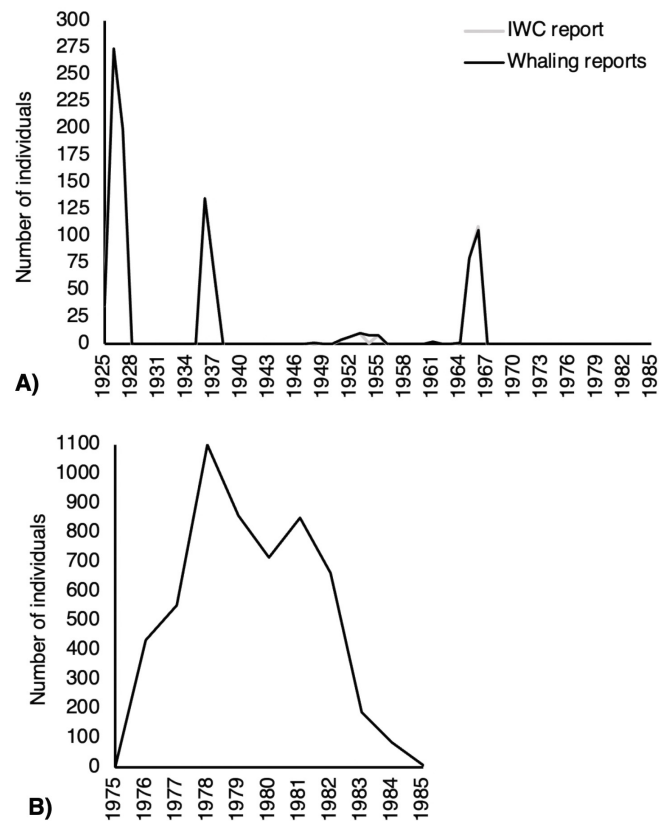


Figure 6. Temporal variation in blue whales (*B. musculus*) (A) catches and (B) sightings reported in Peru from 1925 to 1985. Elaborated from the IWC report and whaling expedition information provided by the whaling companies and research cruises (see Table 1).

sperm whales caught during the same period (Fig. 6A) (Majluf & Reyes, 1989). British expeditions from 1936 to 1937 captured 202 individuals, and in 1948, only one individual was caught (Clarke, 1980). After 1951, whaling for blue whales was sporadic, and captures did not exceed ten individuals per year (Fig. 6A) (Ramírez, 1983). During 1965/1966, whaling efforts increased to 106 catches because sperm whales were scarce, and another unsuccessful attempt to introduce whale meat for human consumption was proposed (Grimwood, 1968; Ramírez, 1988b, c).

In 1966, blue whales were protected by the IWC (Majluf & Reyes, 1989). Since 1975, sightings were recorded during whaling operations (Ramírez, 1983). Sightings were considerably higher than the 938 individuals captured between 1925 and 1966, and just in 1978 about 1,100 sightings² were made (Fig. 6B) (Valdivia et al., 1982, 1983; Donovan, 1984). Sightings suggested a population recovering, but in 1982/1983 a decline was attributed to El Niño event (Ramírez & Urquiza, 1985; Ramírez, 1990). Between 1983 and 1985, the SST decreased significantly, but no increments in sightings occurred (Donovan, 1984; Ramírez, 1990).

From 1925 to 1927, Paracas Bay was considered the capture site of blue whales (Fig. 2A) (Harmer, 1928). However, as in the case of humpback whales, it was revealed that whales were processed only in a factory ship installed there (Van Waerebeek et al., 1997), and the catch may have occurred at different locations. Blue whales were reported off Chimbote, Ancash (09°07' S, 78°37' W), La Libertad (07°55' S, 80°21' W), and further north off Cabo Blanco, Piura (Fig. 2A) (Bini, 1951; Ramírez, 1983; Donovan, 1984). The distribution toward the central coast of Peru

²Authors' observation: considering the records of previous years, this high number of blue whale sightings raises doubts about its accuracy.

Table 3. Population estimates of Bryde's whale stock in Peru.

Year	Total	Reference
1968	14,687	Valdivia et al. (1981a)
1968	17,388	Ramírez (2007a)
1973	13,703	Valdivia et al. (1981a)
1978	12,409	Valdivia et al. (1981a)
1980	11,651	Valdivia et al. (1981b)
1981	11,370	Valdivia et al. (1982)
1982	10,281	Ramírez (1985)
1983	9,725 to 10,177	Ramírez (1985)
1983	12,776	Ramírez (1985)
1985	11,325	Ramírez (2007a)

remained unknown until 1997, when a stranded individual was reported at Don Martin Island, Lima (11°02' S, 77°39' W) (Fig. 2B) (Reyes, 1992; Arias-Schreiber, 1996; Van Waerebeek et al., 1997). This record constituted the southern limit in Peru, however blue whales are distributed further south in Chile (Cooke, 2018b). Blue whales have shown a preference for a mean SST value of 22.9°C (range = 16.6 to 28.2°C) (Ramírez, 1983). During IMARPE cruises in 1998, 30 individuals were recorded at an SST ranging from 18 to 24°C (Sánchez et al., 1998; Sánchez & Arias-Schreiber, 1998).

Early descriptions of Schweigger (1964) indicated that blue whales migrated from feeding grounds in Antarctic waters to breed in tropical waters in northern Peru from June to late October. Observations from 1976 to 1983 suggested a modification in timing; sightings were more frequent from November to May, peaking in February, with scarce sightings from June to September (Donovan, 1984). Donovan (1984) proposed changes in the timing of sightings because individuals from the northern Pacific would be entering Peruvian waters. Blue whales could stay year-round in Peruvian waters because of the high availability of small euphausiids (Ballón et al., 2011), their preferred prey (Reyes, 1992).

Currently, two blue whale subspecies are recognized to occur in Peru: Antarctic (or true) (*B. musculus intermedia*) and pygmy (*B. m. breviceuda*) (Donovan, 1984; Kato et al., 1995; Williams et al., 2011). Antarctic blue whales were considered the most abundant in the SE Pacific (Branch et al., 2007), but a decline to < 1% of their original abundance led the species to concentrate in cold polar regions where krill is abundant (Branch et al., 2004, 2007). Pygmy blue whales are found during the austral summer in Antarctica and migrate northward for breeding during winter, reaching the Equator in the SE Pacific (Branch et al., 2007; Pastene et al., 2020). Recently, the possibility of a new subspecies called "Chilean blue whale" has been proposed, whose population would be resident off Chile and Peru (Cooke, 2018b).

Considering the population decline, it is likely that the Chilean subspecies has faced the same fate due to overexploitation during commercial whaling (Van Waerebeek et al., 1997; Williams et al., 2011). In Peru, blue whales were already considered scarce (Donovan, 1984; Van Waerebeek et al., 1997), and since the presence of subspecies was unclear, it would be wrong to assign their current population status. Recent sightings of this species on the northern and southern coast (e.g. Pacheco et al., 2019; Testino et al., 2019) (Fig. 2B) indicate that this species is still observed in Peru. Research should be conducted to correctly identify subspecies to better characterize their distribution and abundance.

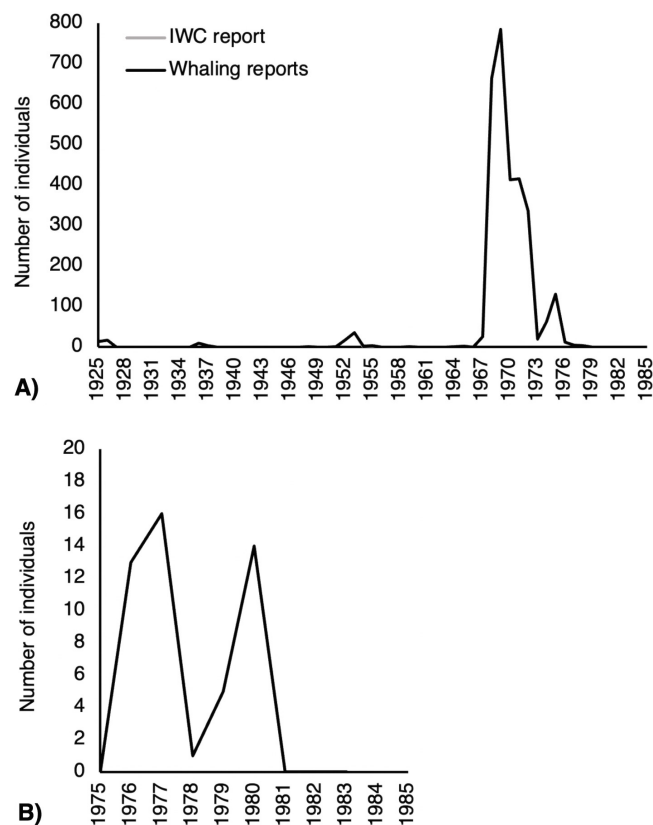


Figure 7. Temporal variation in sei whales (*B. borealis*) (A) catches and (B) sightings reported in Peru from 1925 to 1985. Elaborated from the IWC report and whaling expedition information provided by the whaling companies and research cruises (see Table 1).

Sei whale (*Balaenoptera borealis*)

Before commercial whaling, sei whales occurred in the Peruvian sea but without further details on their distribution or abundance (Gunther, 1936; Bini, 1951). Catch numbers were not high, and the species was not considered abundant (Ramírez, 1988d). From 1925 to 1966, 107 individuals were captured in Peru (Fig. 7A) (Clarke, 1962). The speed and elusiveness of sei whales did not make them a preferred species for whalers (Español-Jiménez et al., 2019). However, catches increased after 1964, with 664 and 784 individuals caught in 1968 and 1969, respectively, after the decline of sperm whales (Grimwood, 1968; Arriaga, 1981; Valdivia et al., 1981a). Despite the relatively high catches from 1968 to 1972, Valdivia et al. (1981a) estimated negative CPUE trend, suggesting depletion and scarcity in Peru.

Catch data of sei and Bryde's whales were pooled together because of the difficulties distinguishing them at sea (Clarke, 1962), making it challenging to extract species-specific information. In August 1972, Dr. Nishiwaki (a Japanese whale expert) could identify and separate both species (Clarke, 1980; Ramírez, 1988d). However, it was impossible to estimate the proportion of catches of each species in previous years (Valdivia et al., 1981a). The correct identification indicated that more Bryde's whales were hunted than sei whales, so their catches decreased drastically since 1976 (Valdivia et al., 1981a, b). A ban was established for sei whales in June 1978 due to a notorious population decline (Ramírez, 1988d). Sightings after the ban did not exceed ten individuals, and no sei whales were recorded after 1981 (Fig. 7B).

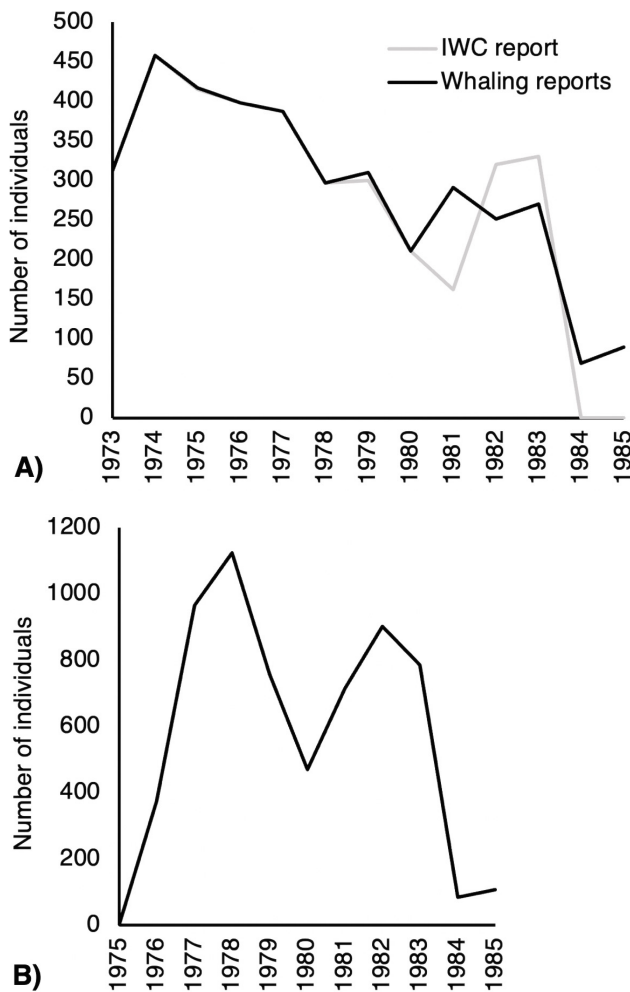


Figure 8. Temporal variation in Bryde's whale (*B. edeni brydei*) (A) catches and (B) sightings reported in Peru from 1973 to 1985. Elaborated from the IWC report and whaling expedition information provided by the whaling companies and research cruises (see Table 1).

Sei whales inhabit deep and oceanic waters (Acevedo et al., 2017b). In Peru, the main whaling areas were located off Paita, between 3° and 8° S, approximately 200 nm off Lambayeque, Piura, and Tumbes (Fig. 2A) (Arriaga, 1981; Ramírez, 1988d; Arias-Schreiber, 1996). Whalers have observed this species feeding on euphausiids occasionally (Ramírez, 1985). Sei whales migrate from Antarctica to Peru during winter/spring from August to October, searching for SST below 20.8°C (Ramírez, 1988d; Reyes, 1992); it is not well understood whether this migration is related to their breeding season.

After the moratorium, no further research has been conducted on sei whales in the Peruvian sea. Their current distribution and abundance remain largely unknown throughout the Southern Hemisphere (Prieto et al., 2012; Español-Jiménez et al., 2019). IMARPE cruises during the 1990s report either "*Balaenoptera* sp." and/or "*Balaenoptera borealis/edeni*" (i.e. Márquez & Arias-Schreiber, 2001; Sánchez & Arias-Schreiber, 1998). Thus, the problem of combining both species during sightings persists even after the whaling period. Hamilton et al. (2009) highlighted the absence of sei whales throughout the SE Pacific from 1986 to 2005, and the closest information to Peruvian waters of this species comes from Chile (Acevedo et al., 2017b; Häussermann et al., 2017). Further research is required to reveal the status of this species in Peru.

Bryde's whale (*B. edeni brydei*)

Whalers provided early reports of Bryde's whales in the SE Pacific from Gorgona Island, Colombia, and Isla de la Plata, Ecuador, in 1914 (Clarke & Aguayo, 1965). However, because they were constantly mistaken for sei whales, the first confirmed record after analysis of baleen's keratin occurred in Iquique, northern Chile (Clarke, 1962; Clarke & Aguayo, 1965). The proximity of these locations suggested that their distribution included Peru (Clarke, 1980). In August 1972, proper identification was made to separate the catch from sei whales (Clarke, 1980; Clarke et al., 1980; Ramírez, 1988d), but it is possible that their exploitation began in 1968 because reports pooled specimens under the "sei+Bryde" label without further details to differentiate the species (Valdivia et al., 1981a). After the differentiation, Bryde's whales dominated the catch, positioning them as the second most exploited species and the last large whale captured in Peru (Reyes, 1992). However, catches of this species did not exceed 500 individuals per year (Fig. 8A).

Being the last species targeted by whalers, more efforts were made to evaluate its population (Valdivia et al., 1983). Population size estimates were made for Peru using CPUE values (Table 3). The values presented by Valdivia et al. (1981a, b, 1982) and Ramírez (1985, 1989a, 2007a) showed an apparently stable stock throughout time unaffected by the hunting effort. Valdivia et al. (1982) revised the estimations and suggested that there was no observable trend in decline or increments in CPUE because the DeLury method (1947) was not performed correctly. The effort series of this method included catcher days worked (CDW) (1973-1980) and catcher-searching hours worked (CSW) (1977-1981). Other parameters were a natural mortality value of 0.07 and a recruitment age of 10 years. However, recruitment age was considered the time of first sexual maturity, implying an excess over natural mortality (Cooke, 1983). For this reason, Cooke (1983) performed a CPUE analysis using three different effort series: gross catcher days worked (1968-1980), estimated searching hours (1969-1980), and recorded searching hours (1977-1981). The re-estimation used natural mortality of 0.07 and a recruitment age of ten and five years. A population of 4,008 individuals for 1968 was estimated using the DeLury method, with a decrease of 1,135 individuals in 1983. Consequently, Cooke (1983) concluded that the Bryde's whale population in Peru was substantially depleted, and there was an overestimation in previous studies.

Since 1980, the IWC has regulated whaling and established catch quotas and whaling seasons of six months, from October to March (Ramírez, 2007a). After the sperm whale ban in 1982, whalers targeted Bryde's whales (Ramírez, 1989a), but because the catch quotas were low, the catches decreased, and sightings increased (Fig. 8) (Valdivia et al., 1982; Ramírez, 1989a). The abundance of this species peaked in November, December, and January from 1980 to 1985. In 1981/1982, the IWC established a whaling season from November to March, and the whaling quota was obtained just one and a half months earlier. In 1983, the quota was gathered in only two and a half months. For this reason, it was thought that Bryde's whales were abundant (Ramírez, 1985; Ramírez & Urquiza, 1985). Size and sex ratio evaluations corroborate the high abundance because although males decreased slightly since 1974, the groups considered as "recruits", "adults", and "elders" were stable (Valdivia et al., 1981a). Sightings decreased in 1982/1983, probably due to El Niño event

Table 4. Records of Southern right whale (*E. australis*) in Peru until 2021. Adapted from Van Waerebeek et al. (2008).

	Date	Position	Location	Composition	Description	Reference
1	25 November 1987	17°38' S, 71°20' W	Ilo, Moquegua	2 individuals	Before going south, they stayed for about three days	Van Waerebeek et al. (1992)
2	07 September 1996	16°13' S, 73°42' W	Atico, Arequipa	Mother-calf pair	They remained in the same area until 12 November 1996	Van Waerebeek et al. (1992)
3	December 1996	16°26' S, 73°08' W	La Planchada, Arequipa	Mother-calf pair	Possible re-sighting of pair no. 2, due to the proximity of location	Van Waerebeek et al. (1998)
4	26 August 2003	15°08' S, 75°21' W	Bahía San Fernando, Ica	Mother-calf pair	Apparently left the bay at the end of September	Santillán et al. (2004)
5	30 July 2005	12°29' S, 76°48' W	Pucusana, Lima	Mother-calf pair	Moved north and then west	Van Waerebeek et al. (2008)
6	August 2005	04° S, 80°58' W	Punta Sal, Tumbes	2 individuals	Possible sighting, close to humpback whales	Van Waerebeek et al. (2008)
7	06 January 2006	18°17' S, 70°27' W	Los Palos, Tacna	1 individual	Stranding	Pizarro-Neyra (2010)
8	05 April 2007	12°24' S, 77°10' W	San Bartolo, Lima	1 individual	Sighting from a seismic vessel	Van Waerebeek et al. (2008)
9	20 August 2012	12°10' S, 77°02' W	Chorrillos, Lima	Mother-calf pair	Stayed approximately 3h	Orihuela & Cortegana-Arias (2013)

(Ramírez, 1989c, 1990; Ramírez & Urquizo, 1985). Because the decline from 1983 to 1985, the minimum catch size moved from 10.7 to 12.2 m to improve whale protection (Ramírez, 2007a, b).

During whaling, Bryde's whales were sighted mainly in northern Peru, from Chimbote, Ancash to Zorritos, Tumbes (03°38' S, 81°57' W) (Fig. 2A), where mating was observed (Ramírez, 1988a). From 03°30' S to 08° S, Bryde's whales were found at a mean SST of 23°C (range = 18.8 to 25.3°C) (Valdivia et al., 1981b; Ramírez, 1989a, d). Two "forms" of Bryde's whales were proposed; the "northern" and "southern" forms, spatially separated around 7° S in Chiclayo, Lambayeque (Fig. 2A). Later, the descriptions of neritic and oceanic forms presented in other countries were adopted (Valdivia et al., 1981a). The oceanic form was distributed during spring and summer off Paita (Fig. 2A), at temperatures up to 20°C, especially of 22 to 25°C (range = 18.8 to 25.3°C), and 200 nm or more from the coast, although they enter up to 8 nm with the oceanic water's movement toward the east (Valdivia et al., 1981b; Ramírez, 1992, 2007a). The neritic form was found in fall and winter at a mean SST of 20.6°C (range = 18.2 to 23.3°C) off Chimbote (Ramírez & Urquizo, 1985; Ramírez, 1992).

According to catch data, Bryde's whales were considered abundant and present in Peru almost all-year round (Valdivia et al., 1984; Arias-Schreiber, 1996), but no current information supports this notion. Occasional sightings have been reported during IMARPE cruises from 10° S to 04° S (*i.e.* Bello et al., 1998; Sánchez & Arias-Schreiber, 1998; Márquez & Arias-Schreiber, 2001). In 2012 and 2013, two individuals were reported off Piura; and in 2016, 16 individuals were present during 12 sightings (Fig. 2B) (Castro et al., 2017; Pacheco et al., 2019). Sightings of singles were the most frequent, although two mother-calf pairs were observed milling (Castro et al., 2017). Also, two stranded individuals were reported in 2015 off Lambayeque (Fig. 2B) (Bachmann, 2018). These reports are evidence that they would be becoming more frequent in northern Peru (Castro et al., 2017). Increased research effort will provide new reports and updated information on Bryde's whales abundance and distribution.

Fin whale (*B. physalus*)

Early reports placed this species under the scientific name *Physalus fasciatus*, and it was reported to occur around Lobos de Tierra Island, Piura (Fig. 2A) (Tschudi, 1844a; Reyes, 2009). Fin

whales swam faster than whaling ships, making their capture difficult (Gunther, 1936; Clarke, 1962; Majluf & Reyes, 1989). From 1925 to 1927, 605 individuals were captured in Peru (Fig. 9A), suggesting an important abundance (Harmer, 1928). After that, whaling was sporadic with low annual catches, suggesting a population decline (Ramírez & Urquizo, 1985; Ramírez, 1988b).

Approximately 1,985 fin whales were captured from 1925 to 1985. The maximum catch occurred between 1965 and 1967 because whaling was directed to this species and other baleen whales due to the lack of sperm whales (Valdivia et al., 1981a). Most of the individuals captured were shorter than the established minimum capture length of 16.8 m. There was no commitment to comply with this regulation due to the need to supply whaling operators' oil and meal offered to the market (Ramírez, 1988b). Between 1968 and 1977, fin whales were hunted in occasional encounters that searched for other whale species (Ramírez, 1988b). Finally, in 1976, fin whales were protected by the IWC, although two individuals were captured in Peru in 1977 (Valdivia et al., 1983; Majluf & Reyes, 1989; Reyes, 2009).

Fin whales were sighted and captured mainly off Paita (Fig. 2A) (Ramírez, 1988b), where they fed on euphausiids (Reyes, 1992; Arias-Schreiber, 1996). This species was seen in early winter, from August to November (Harmer, 1928; Van Waerebeek & Engblom, 2007). However, other authors reported that the species could stay year-round, being more frequent in summer and spring, from September to April, at a mean SST of 21.7°C (Ramírez & Urquizo, 1985; Ramírez, 1988b; Reyes, 1992). Similarly, Kostritsky (1952) indicated that fin whale presence corresponded to warm seasons. But after 1977, sightings did not exceed ten individuals per year (Fig. 9B) (Ramírez & Urquizo, 1985), and there are no reports from 1982 until the end of whaling.

In March and May 1998, nine fin whales were recorded during two sightings on an IMARPE cruise at SST between 18 and 21°C, but no specific locations were provided (Sánchez et al., 1998). On 03 March 2007, a group of 11 fin whales was sighted off Callao (12°09' S, 77°23' W) (Fig. 2B) (Van Waerebeek & Engblom, 2007). It was questioned whether these individuals corresponded to a new subspecies (*B. physalus quoyi*) from the Southern Hemisphere because morphological characteristics, such as nasal bone configuration and size, did not match the description of *B. physalus*. To date, this aspect has not been reviewed because of

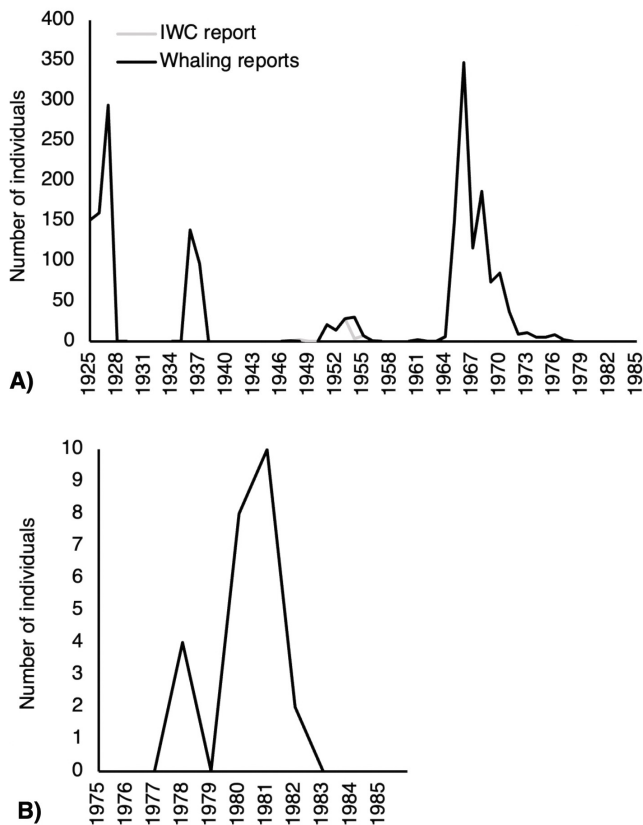


Figure 9. Temporal variation in fin whale (*B. physalus*) (A) catches and (B) sightings reported in Peru from 1925 to 1985. Elaborated from the IWC report and whaling expedition information provided by the whaling companies and research cruises (see Table 1).

the lack of sightings for a detailed analysis. The global distribution analysis of fin whales from 1986 to 2012 by Hamilton et al. (2009) and Edwards et al. (2015) points to their absence in Peru. However, on 15 May 2017, a sighting on the northern coast suggested that they would also be close to Ecuador, and possibly returning to Peru (Fig. 2B) (Pacheco et al., 2019).

Southern right whale (*E. australis*)

Townsend (1935) recorded Southern right whales in Peru for the first time when Peruvian whalers captured an individual in 1957/1958 season. It was considered that the species could be seen in south Peru, close to the border with Chile, where at least 8,634 whales were hunted between 1785 to 1913 (Kostritsky, 1952; Grimwood, 1968; Aguayo-Lobo et al., 2008). Also, Maury's (1851) whale chart showed whaling areas of this species off Lima and Piura (central and northern Peru, respectively). But without specific reports and catch data, the species was not considered to be present in Peruvian waters (Van Waerebeek et al., 2008, 2009).

On 25 November 1987, two individuals were reported in Ilo, Moquegua (17°38' S, 71°20' W). Subsequently, eight other sightings were recorded until 2012 (Table 4), which gradually shifted northward to Punta Sal, Tumbes (04° S, 80°58' W) (Fig. 2B) (Van Waerebeek et al., 2008). Although this suggests an expansion of the distribution range, which could be confirmed in the future (Van Waerebeek et al., 2008), the low number of records precludes this assertion (Van Waerebeek et al., 2009).

The whaling effect is noticeable in the Chile-Peru Southern right whale subpopulation, considered "Critically Endangered" on the

IUCN Red List. The IWC created the Conservation Management Plan for the Southern right whale in 2012, which united the Chilean and Peruvian governments to improve conservation strategies and ensure the species' long-term survival (Vernazzani et al., 2016). However, as of 2018, there were fewer than 50 mature individuals in both countries (Cooke, 2018c). Additionally, the lack of knowledge on aspects of their local distribution and migration, in breeding or feeding areas, does not allow more precise subpopulation trends and size.

Antarctic minke whale (*B. bonaerensis*)

There was no evidence of Antarctic minke whales in Peru until 27 September 1991, when a juvenile male was recorded entangled near the Pucusana artisanal fishing port, Lima (12°30' S) (Fig. 2B). Subsequently, a juvenile female was recorded on 30 October 1991, near the same port (Arias-Schreiber, 1996). The last report was of an entangled juvenile observed on 01 June 2002 in Morin port, La Libertad (08°24' S, 78°54' W) (Fig. 2B) (García-Godos et al., 2013). Since minke whales were not targeted during whaling, no further information on this species is available, either in terms of distribution or abundance. Also, no current reports are available; thus, the status of this species in Peru remains unknown (Van Waerebeek & Reyes, 1994).

Conclusions and outlook

Scientific data collected during whaling produced important information about the distribution and/or abundance of baleen and sperm whales in Peru. Most studies have focused on the sperm whales during the whaling era because they were the main target species. After the moratorium, reports on almost all whale species regarding their spatial distribution and abundance (e.g. Arias-Schreiber, 1996; Reyes, 1992, 2009) were limited by scarce and outdated information. The occasional reports of Bryde's, fin, and blue whales on the northern Peruvian coast after whaling suggests that the research coverage is insufficient. Similarly, the lack and seasonality of the surveys could underestimate the presence and frequency with which large whales could inhabit the Peruvian sea.

This review shows that overexploitation led to drastic changes in the abundance of baleen and sperm whales off Peru. The scarcity of reports for certain species could not only imply that populations have not yet recovered, but also that the effort in evaluating the population recovery of the species is limited. Currently, whale-watching on humpback whales on the north coast has increased and updated the information available on this species, supporting the estimation of the abundance of the SE Pacific stock. It is expected that the continuity of these activities will allow the extension of studies to other species, such as the Bryde's whale, which has occasionally been observed during the humpback whale breeding season. Also, abundance estimation models should be conducted from the data collected in research cruises by IMARPE.

After whaling, studies and even reports of large whales have been extremely scarce, so the description of their distribution has not shown significant changes. New studies must evaluate the distribution in relation to changes in physico-chemical parameters and the presence of climate events such as El Niño-

Southern Oscillation. Every reporting opportunity should be taken to evaluate whales' movements, so it would be appropriate to support community education projects that help locals report species along the Peruvian coast. Stranding reports could be considered an indirect proxy for the location of these cetaceans, and necropsies can provide information on their interaction with other species, fishing activity, or the possible presence of pathologies.

Finally, although large whales were considered abundant in the Peruvian sea, it remains complex to adequately define the "initial" local status of each species. The description of whales' historical distribution and abundance allow us to reasonably assume that due to whaling and current threats, not all populations have fully recovered locally. Moreover, even though commercial whaling carried out in Peru, by foreign nations and its own, contributed to the decrease of the large whale populations, it allowed the collection of information that is still valid today. However, it is still necessary to implement at least seasonal visual surveys on the Peruvian coast to understand the current trends of large whales and to complement and/or update existing information.

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References

- Acevedo, J., Aguayo-Lobo, A., Allen, J., Botero-Acosta, N., Capella, J., Castro, C., Dalla Rosa, L., Denking, J., Félix, F., Flórez-González, L., Garita, F., Guzmán, H. M., Haase, B., Kaufman, G., Llano, M., Olavarría, C., Pacheco, S. A., Plana, J., Rasmussen, K., Scheidat, M., Secchi, E.R., & Stevick, P. T. (2017a). Migratory preferences of humpback whales between feeding and breeding grounds in the eastern South Pacific. *Marine Mammal Science*, 33(4), 1035-1052. <https://doi.org/10.1111/mms.12423>
- Acevedo, J., Aguayo-Lobo, A., González, A., Haro, D., Olave, C., Quezada, F., Martínez, F., Garthe, S., & Cáceres, B. (2017b). Occurrence of sei whales (*Balaenoptera borealis*) in the Magellan Strait from 2004-2015, Chile. *Aquatic Mammals*, 43(1), 63-72. <https://doi.org/10.1578/AM.43.1.2017.63>
- Acevedo, J., Haro, D., Dalla, L., Aguayo-Lobo, A., Hucke-Gaete, R., Secchi, E., Plana, J., & Pastene, L. A. (2013). Evidence of spatial structuring of eastern South Pacific humpback whale feeding grounds. *Endangered Species Research*, 22(1), 33-38. <https://doi.org/10.3354/esr00536>
- Aguayo-Lobo, A., Acevedo, J., Brito, J. L., Olavarría, C., Moraga, R., & 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-Schreiber, M. (1996). Informe sobre el estado de conocimiento y conservación de los mamíferos marinos en el Perú. *Informe Progresivo Instituto del Mar del Perú*, 38, 3-30. <https://hdl.handle.net/20.500.12958/1193>
- Arriaga, L. (1981). Actividad ballenera en el Pacífico Sur-oriental. In FAO Advisory Committee on Marine Resources Research, G. Clark (Ed.), *Mammals in the Seas: General papers and large cetaceans* (pp. 311-319). FAO Fisheries Series. Rome, Italy.
- Bachmann, V. M. (2018). *Analysis of sea turtle and marine mammal strandings along the northern coast of Peru between 2003 and 2016: Patterns and underlying causes*. [Master's thesis, Universidad Andrés Bello]. <https://hdl.handle.net/20.500.12958/3424>
- Bachmann, V. M., Goya, E., Ramírez, P., De la Cruz, J., Torres, D., Castañeda, J., Torres, E., Macalupu, J., Polar, M., Vera, M., Humaní, S., Quiñones, J., Campos, S., Vásquez, C., & Ulloa, D. (2018). Twenty years of large whales strandings over the Peruvian coast (1997-2017). In SOLAMAC (Ed.), *Abstracts, XII Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur & 12vo Congreso de la Sociedad de Mamíferos marinos de América del Sur* (p. 24).
- Baker, C. S., & Clapham, P. J. (2004). Modelling the past and future of whales and whaling. *Trends in Ecology and Evolution*, 19(7), 365-371. <https://doi.org/10.1016/j.tree.2004.05.005>
- Ballón, M., Bertrand, A., Lebourges-Dhausy, A., Gutiérrez, M., Ayón, P., Grados, D., & Gerlotto, F. (2011). Is there enough zooplankton to feed forage fish populations off Peru? An acoustic (positive) answer. *Progress in Oceanography*, 91(4), 360-381. <https://doi.org/10.1016/j.pocean.2011.03.001>
- Bello, R., Arias-Schreiber, M., & Sánchez, R. (1998). Distribución y abundancia relativa de cetáceos durante el crucero BIC Humboldt 9709-10, de Matarani a Paita. *Informe Instituto del Mar del Perú*, 130, 78-85. <https://hdl.handle.net/20.500.12958/1469>
- Bini, G. (1951). Osservazioni su alcuni mammiferi sulle coste del Chile e del Peru. *Bollettine di Pesca, Piscicoltura e Idrobiologia* (Roma), 27(6), 5-19.
- Branch, T.A., Matsuoka, K., & Miyashita, T. (2004). Evidence for increases in Antarctic blue whales based on Bayesian modelling. *Marine Mammal Science*, 20(4), 726-754. <https://doi.org/10.1111/j.1748-7692.2004.tb01190.x>
- Branch, T. A., Stafford, K. M., Palacios, D. M., Allison, C., Bannister, J. L., Burton, C. L., Cabrera, E., Carlson, C. A., Vernazzani, B. G., Gill, P. C., Hucke-Gaete, R., Jenner, K. C. S., Jenner, M. N., Matsuoka, K., Mikhalev, Y. A., Miyashita, T., Morrice, M. G., Nishiwaki, S., Sturrock, V. J., Tormosov, D., Anderson, R. C., Baker, A. N., Best, P. B., Bprsa, P., Brownell Jr, R. L., Childerhouse, S., Findlay, K. P., Gerrodette, T., Ilangakoon, A. D., Joergensen, M., Kahn, B., Ljungblad, D. K., Maughan, B., McCauley, R. D., McKay, S., Norris, T. F., Oman Whale and Dolphin Research Group, Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K., & Warneke, R. M. (2007). Past and present distribution, densities and movements of blue whales *Balaenoptera musculus* in the Southern Hemisphere and northern Indian Ocean. *Mammal Review*, 37(2), 116-175. <https://doi.org/10.1111/j.1365-2907.2007.00106.x>
- Burgman, M., Ferson, S., & Akçakaya, H. R. (1993). *Risk assessment in conservation biology*. (Springer Science & Business Media, vol. 12). London, UK.
- Castro, C., Rasmussen, K., Pacheco, A. S., Cardenas, D., Carnero-Huaman, R., Echevarría, G., & Gregory, K. (2017). Bryde's whale *Balaenoptera edeni* occurrence and movements in coastal

- areas off Ecuador, Peru and Panama. A preliminary report. Scientific Committee, International Whaling Commission Paper SC/67A/SH15. [Available from <https://iwc.int/en/>].
- Clapham, P. J., & Ivashchenko, Y. V. (2016). Stretching the truth: length data highlight falsification of Japanese sperm whale catch statistics in the Southern Hemisphere. *Royal Society Open Science*, 3(9), 160506. <https://doi.org/10.1098/rsos.160506>
- Clapham, P. J., Young, S., & Brownell Jr, R. L. (2002). Baleen whales: Conservation issues and the status of the most endangered populations. *Mammal Review*, 29(1), 37-62. <https://doi.org/10.1046/j.1365-2907.1999.00035.x>
- Clapham, P. J., Childerhouse, S., Gales, N. J., Rojas-Bracho, L., Tillman, M. F., & Brownell Jr, R. L. (2007). The whaling issue: conservation, confusion, and casuistry. *Marine Policy*, 31(3), 314-319. <https://doi.org/10.1016/j.marpol.2006.09.004>
- Clarke, R. (1962). Whale observation and whale marking off the coast of Chile in 1958 and from Ecuador towards and beyond the Galapagos Islands in 1959. *Norsk Hvalfangsttid-Tidende*, 51(7), 265-287.
- Clarke, R. (1980). Catches of sperm whales and whalebone whales in the Southeast Pacific between 1908 and 1975. *Report of the International Whaling Commission*, 30, 285-288.
- Clarke, R., & Aguayo, A. (1965). Bryde's whale in the south-east Pacific. *Norsk Hvalfangsttid-Tidende*, 51(7), 141-148.
- Clarke, R., & Paliza, O. (2001). The food of sperm whales in the southeast Pacific. *Marine Mammal Science*, 17(2), 427-429. <https://doi.org/10.1111/j.1748-7692.2001.tb01287.x>
- Clarke, R., & Paliza, O. (2008). Resúmenes de las investigaciones balleneras en el Pacífico sureste y otros océanos. *Boletín Instituto del Mar del Perú*, 23(1-2), 1-136. <https://hdl.handle.net/20.500.12958/1065>
- Clarke, R., MacLeod, N., & Paliza, O. (1976). Cephalopod remains from the stomachs of sperm whales caught off Peru and Chile. *Journal of Zoology*, 180(4), 477-493. <https://doi.org/10.1111/j.1469-7998.1976.tb04693.x>
- Clarke, R., Aguayo, A., & Paliza, O. (1980). Pregnancy rates of sperm whales in the southeast Pacific between 1959 and 1962 and a comparison with those from Paita, Peru, between 1975 and 1977. *Report of the International Whaling Commission, Special issue 2*, 151-158.
- Clarke, R., Paliza, O., & Aguayo, A. (1988). Sperm whales of the southeast. Pacific Part IV. Fatness, food and feeding. *Investigation on Cetacea*, 21, 53-195.
- Clarke, R., Paliza, O., & Aguayo, A. (1993). Riesgo para la recuperación de la existencia de cachalotes en el Pacífico Sureste debido al desarrollo de la pesca de la Pota. *Boletín de Lima*, 85, 73-78.
- Clarke, R., Félix, F., Paliza, O., & Brtnik, P. (2002). Why sperm whales have disappeared from Ecuadorean and northern Peruvian seas. Scientific Committee, International Whaling Commission Paper SC/54/E13. [Available from <https://iwc.int/en/>].
- Cobo, B. (1964). *Historia del Nuevo Mundo* (vol. 1). Editorial Madrid. Sevilla, España.
- Coker, R. E. (1908). The fisheries and the guano industry of Peru. *Bulletin of the Bureau of Fisheries*, 28, 345-354.
- Comisión Permanente del Pacífico Sur – CPPS (South Pacific Permanent Commission) (1955). Reglamento de permisos para la explotación de las riquezas del Pacífico Sur. Comisión Permanente del Pacífico Sur. Quito, Ecuador.
- Cooke, J. G. (1983). Estimates of the stock of Bryde's whales fished off the coast of Peru. *Report of the International Whaling Commission*, 33, 453-456.
- Cooke, J. G. (2018a). *Megaptera novaeangliae*. *IUCN Red List of Threatened Species* 2018, e.T13006A50362794. <https://doi.org/10.2305/IUCN.UK.2018-2.RLTS.T13006A50362794.en>
- Cooke, J. G. (2018b). *Balaenoptera musculus* (errata version published in 2019). *IUCN Red List of Threatened Species* 2018, e.T2477A156923585. <https://doi.org/10.2305/IUCN.UK.2018-2.RLTS.T2477A156923585.en>
- Cooke, J. G. (2018c). *Eubalaena australis* (Chile-Peru subpopulation) [Data set]. *IUCN Red List of Threatened Species* 2018, e.T133704A50385137. <https://doi.org/10.2305/IUCN.UK.2018-1.RLTS.T133704A50385137.en>
- Cooke, J. & Clapham, P. J. (2018). *Eubalaena japonica*. *IUCN Red List of Threatened Species* 2018, e.T41711A50380694. <https://doi.org/10.2305/IUCN.UK.2018-1.RLTS.T41711A50380694.en>
- Cooke, J. G. & Reeves, R. (2018). *Balaena mysticetus*. *The IUCN Red List of Threatened Species* 2018, e.T2467A50347659. <https://doi.org/10.2305/IUCN.UK.2018-1.RLTS.T2467A50347659.en>
- de Morais, I. O., Danilewicz, D., Zerbini, A. N., Edmundson, W., Hart, I. B., & Bortolotto, G. A. (2017). From the Southern right whale hunting decline to the humpback whaling expansion: A review of whale catch records in the tropical western South Atlantic Ocean. *Mammal Review*, 47(1), 11-23. <https://doi.org/10.1111/mam.12073>
- DeLury, D. B. (1947). On the estimation of biological populations. *Biometrics*, 3(4), 145-167. <https://doi.org/10.2307/3001390>
- Donovan, G. P. (1984). Blue whales off Peru, December 1982, with special reference to pygmy blue whales. *Report of the International Whaling Commission*, 34, 473-476.
- Edwards, E. F., Hall, C., Moore, T. J., Sheredy, C., & Redfern, J. V. (2015). Global distribution of fin whales *Balaenoptera physalus* in the post-whaling era (1980–2012). *Mammal Review*, 45(4), 197-214. <https://doi.org/10.1111/mam.12048>
- Español-Jiménez, S., Bahamonde, P. A., Chiang, G., & Häussermann, V. (2019). Discovering sounds in Patagonia: Characterizing sei whale (*Balaenoptera borealis*) downsweeps in the south-eastern Pacific Ocean. *Ocean Science*, 15(1), 75-82. <https://doi.org/10.5194/os-15-75-2019>
- Félix, F., Castro, C., & Laake, J. L. (2011). Abundance and survival estimates of the southeastern Pacific humpback whale stock from 1991–2006 photo-identification surveys in Ecuador. *Journal Cetacean Research and Management*, 3, 301-307. <https://doi.org/10.47536/jcrm.vi.303>
- Félix, F., Acevedo, J., Aguayo-Lobo, A., Ávila, I. C., Botero-Acosta, N., Calderón, A., Cáceres, B., Capella, J., Carnero, R., Castro, C., Cheeseman, T., Dalla, L., Dellabianca, N., Denking, J., Friedlaender, A., Guzmán, H., Haase, B., Haro, D., Huckle-Gaete, R., Llano, M., Oviedo, L., Pacheco, A. S., Pacheco, J., Palacios, D., Palacios-Alfaro, J., Pallin, L., Pérez, M. J., Rasmussen, K., Sanchez-Godinez, C., Santillán, L., Secchi, E., Torres, M. A. & Vásquez, E. (2021). Humpback whale breeding stock G: updated population estimate based on photo-id matches between breeding and feeding areas. Scientific Committee, International Whaling Commission Paper SC/68C/ASI/02. [Available from <https://iwc.int/en/>].

- Flores, R. A. (2010). Los balleneros anglonorteamericanos y la apertura comercial del Pacífico sur a fines de la época colonial (1790-1820). *Histórica*, 34(2), 63-98.
- Florez-González, L., Ávila, I. C., Capella, J., Flak, P., Félix, F., Gibbons, J., Guzman, H., Haase, B., Herrera, J. C., Peña, V., Santillán, L., Tobón, C. I., & Van Waerebeek, K. (2007). *Estrategia para la conservación de la ballena jorobada del Pacífico Sudeste. Lineamientos para un plan de acción regional e iniciativas nacionales*. Fundación Yubarta. Cali, Colombia.
- Gambell, R. (1987). Whales in the Antarctic ecosystem. *Environment International*, 13(1), 47-54. [https://doi.org/10.1016/0160-4120\(87\)90043-2](https://doi.org/10.1016/0160-4120(87)90043-2)
- García-Cegarra, A. M., Villagra, D., Gallardo, D., & Pacheco, A. S. (2019). Statistical dependence for detecting whale-watching effects on humpback whales. *Journal of Wildlife Management*, 83(2), 467-477. <https://doi.org/10.1002/jwmg.21602>
- García-Godos, I. (2006). A note on the occurrence of sperm whales (*Physeter macrocephalus*) off Peru, 1995-2002. *Journal of Cetacean Research and Management*, 8(1), 113-119.
- García-Godos, I., & Santillán, L. (2004). Registros de Cachalote *Physeter macrocephalus* en Perú, año 2003. In SOLAMAC (Ed.), Abstracts, XI Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur y 5to Congreso de la Sociedad de Mamíferos Marinos de América del Sur (p. 51).
- García-Godos, I., Van Oordt, F., & León, S. (2008). La ballena jorobada (*Megaptera novaeangliae*) en isla Lobos de Tierra, un área potencial de reproducción al norte de Perú. In SOLAMAC (Ed.), Abstracts, XIII Reunión de Especialistas en Mamíferos Acuáticos de América del Sur y 7mo Congreso de la Sociedad de Mamíferos Marinos de América del Sur (p. 144).
- García-Godos, I., Van Waerebeek, K., Alfaro-Shigueto, J., & Mangel, J. (2013). Entanglements of large cetaceans in Peru: Few records but high risk. *Pacific Science*, 67(4), 523-532. <https://doi.org/10.2984/67.4.3>
- Garrett, T. (1980). Pelagic whaling off the 'Coast of Peru' 1936-1954. Statistical material. *Report of the International Whaling Commission, Special issue 2*, 134-136.
- Grimwood, I. R. (1968). The distribution and status of some Peruvian mammals. *New York Zoological Society Special Publication*, 21, 1-86.
- Guidino, C., Llapapasca, M. A., Silva, S., Alcorta, B., & Pacheco, A. S. (2014). Patterns of spatial and temporal distribution of humpback whales at the southern limit of the Southeast Pacific breeding area. *PLoS ONE*, 9(11), e112627. <https://doi.org/10.1371/journal.pone.0112627>
- Gunther, E. (1936). A report on oceanographical investigations in the Peru coastal current. *Discovery Reports*, 13, 107-276.
- Hamilton, T., Redfern, J. V., Barlow, J., Ballance, L., Gerrodette, T., Holt, R., Forney, K., & Taylor, B. L. (2009). Atlas of cetacean sightings from Southwest Fisheries Science Center cetacean and ecosystem surveys: 1986 – 2005 (NOAA Technical Memorandum NMFS NOAA-TM-NMFS-SWFSC-440). National Oceanic and Atmospheric Administration. [Available from <http://www.nefsc.noaa.gov/nefsc/publications>].
- Harmer, S. (1928). The history of whaling. *Journal of the Proceedings of the Linnean Society*, 140, 51-95.
- Häussermann, V., Gutstein, C. S., Beddington, M., Cassis, D., Olavarria, C., Dale, A. C., Valenzuela-Toro, A. M., Perez-Alvarez, M. J., Sepúlveda, H. H., McConnell, K. M., Horwitz, F. E., & Försterra, G. (2017). Largest baleen whale mass mortality during strong El Niño event is likely related to harmful toxic algal bloom. *PeerJ*, 5, e3123. <https://doi.org/10.7717/peerj.3123>
- Hucke-Gaete, R., Haro, D., Torres-Florez, J. P., Montecinos, Y., Viddi, F., Bedriñana-Romano, L., Nery, M. F., & Ruiz, J. (2013). A historical feeding ground for humpback whales in the eastern South Pacific revisited: The case of northern Patagonia, Chile. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 23(6), 858-867. <https://doi.org/10.1002/aqc.2343>
- International Whaling Commission (IWC) (1982). *The IWC Summary Catch Database IWC-v5.3*. [Available from <https://iwc.int/en/>].
- International Whaling Commission (IWC) (2013). Chairman's Report of the Thirty-third Meeting. *Report of the International Whaling Commission*, 32, 17-42.
- Jackson, J., Carroll, E., Smith, T., Zerbini, A. N., Patenaude, N., & Baker, C. S. (2016). An integrated approach to historical population assessment of the great whales: Case of the New Zealand Southern right whale. *Royal Society Open Science*, 3(3), 150669. <https://doi.org/10.1098/rsos.150669>
- Jonsgård, Å. (1960). On the stocks of sperm whales (*Physeter catodon*) in the Antarctic. *Norsk Hvalfangsttid-Tidende*, 49(7), 289-299.
- Kato, H., Miyashita, T., & Shimada, H. (1995). Segregation of two sub-species of the blue whales in the Southern Hemisphere. *Report of the International Whaling Commission*, 45, 273-283.
- Kostritsky, L. (1952). Las ballenas y su aprovechamiento en el Perú. *Pesca y caza*, 4, 33-48.
- Majluf, P., & Reyes, J. C. (1989). The marine mammals of Peru: A review. In D. Pauly, P. Muck, J. Mendo & I. Tsukayama (Eds.), *The Peruvian Upwelling Ecosystem: Dynamics and Interactions* (pp. 344-363). Lima, Peru.
- Márquez, J., & Arias-Schreiber, M. (2001). Avistamiento de cetáceos en el mar peruano y su relación con algunos parámetros oceanográficos en mayo 2000. *Informe Instituto del Mar del Perú*, 163, 19-24. <https://hdl.handle.net/20.500.12958/1929>
- Maury, M. F. (1851). *Whale chart* [Preliminary sketch]. Published at the National Observatory.
- Mazzoldi, C., Bearzi, G., Brito, C., Carvalho, I., Desiderà, E., Endrizzi, L., Freitas, L., Giacomello, E., Giovos, I., Guidetti, P., Ressurreição, A., Tull, M., & MacDiarmid, A. (2019). From sea monsters to charismatic megafauna: Changes in perception and use of large marine animals. *PLoS ONE*, 14(12), e0226810. <https://doi.org/10.1371/journal.pone.0226810>
- Mejía, J. (1964). Marcación de cachalotes frente a Perú. *Informe del Instituto de Investigación de Recursos Marinos*, 26. <https://hdl.handle.net/20.500.12958/486>
- Mejía, J., & Poma, L. A. (1966). Informe preliminar del crucero de otoño 1966 (Cabo Blanco—Ilo). *Boletín Instituto del Mar del Perú*, 13. <https://hdl.handle.net/20.500.12958/241>
- Meyer-Gutbrod, E. L., & Greene, C. H. (2018). Uncertain recovery of the North Atlantic right whale in a changing ocean. *Global Change Biology*, 24(1), 455-464. <https://doi.org/10.1111/gcb.13929>

- Orihuela, M., & 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. <https://doi.org/10.15381/rpb.v20i2.2685>
- Pacheco, A. S. (2019). *Modelamiento del hábitat de la ballena jorobada (Megaptera novaeangliae) en el norte de Perú: Variabilidad espacio temporal por tipo de grupo*. [Academic Thesis. Universidad Ricardo Palma, Lima, Perú]. <http://repositorio.urp.edu.pe/handle/URP/2429>
- Pacheco, A. S., Llapapasca, M. A., López-Tejada, N., Silva, S., & Alcorta, B. (2021). Modeling breeding habitats of humpback whales *Megaptera novaeangliae* as a function of group composition. *Marine Ecology Progress Series*, 666, 203-215. <https://doi.org/10.3354/meps13686>
- Pacheco, A. S., Silva, S., & Alcorta, B. (2009). Winter distribution and group composition of humpback whales (*Megaptera novaeangliae*) off northern Peru. *Latin American Journal of Aquatic Mammals*, 7(1-2), 33-38. <https://doi.org/10.5597/lajam00131>
- Pacheco, A. S., Silva, S., & Alcorta, B. (2011). Is it possible to go whale watching off the coast of Peru? A case study of humpback whales. *Latin American Journal of Aquatic Research*, 39(1), 189-196. <https://doi.org/10.3856/vol39-issue1-fulltext-20>
- Pacheco, A. S., Silva, S., Alcorta, B., Gubbins, S., Guidino, C., Sanchez-Salazar, F., Petit, A., Llapapasca, M. A., Balducci, N., Larrañaga, E., Zapata, M., Grados, E., Valdivia, C., Pinasco, G., Garcia-Cegarra, A. M., Cáceres, D., Biffi, D., Silva, L., Auger, A., Borda, D., Reyes, A. B., Carnero-Huamán, R., Villagra, D., Duque, E., Pinilla, S., Ransome, N., Suarez, A. P. & Jaramillo-Calle, V. (2019). Cetacean diversity revealed from whale-watching observations in northern Peru. *Aquatic Mammals*, 45(1), 116-122. <https://doi.org/10.1578/AM.45.1.2019.116>
- Pastene, L. A., Acevedo, J., & Branch, T. A. (2020). Morphometric analysis of Chilean blue whales and implications for their taxonomy. *Marine Mammal Science*, 36(1), 116-135. <https://doi.org/10.1111/mms.12625>
- Pizarro-Neyra, J. (2010). Varamiento de cetáceos en Tacna, Perú (2002-2010). *Revista Peruana de Biología*, 17(2), 253-255. <https://doi.org/10.15381/rpb.v17i2.37>
- Pizarro-Neyra, J. (2017). Recent strandings of sperm whale, *Physeter macrocephalus*, in southern Peru. *Latin American Journal of Aquatic Mammals*, 12(1-2), 50-52. <https://doi.org/10.5597/lajam00236>
- Prieto, R., Janiger, D., Silva, M. A., Waring, G. T., & Gonçalves, J. M. (2012). The forgotten whale: A bibliometric analysis and literature review of the North Atlantic sei whale *Balaenoptera borealis*. *Mammal Review*, 42(3), 235-272. <https://doi.org/10.1111/j.1365-2907.2011.00195.x>
- Ramírez, P. (1983). Capturas y observaciones de la ballena azul *Balaenoptera musculus* L. en Paita-Perú, 1961-1966 y 1975-1982. *Revista de la Comisión Permanente del Pacífico Sur*, 13, 97-102.
- Ramírez, P. (1985). Peru progress report on cetacean research: October–December 1983. *Report of the International Whaling Commission*, 35, 176-177.
- Ramírez, P. (1988a). Comportamiento reproductivo del «cachalote» (*Physeter catodon* L.). *Boletín de Lima*, 59, 29-32.
- Ramírez, P. (1988b). Captura de la «ballena de aleta» en Paita, Perú (*Balaenoptera physalus* L.). *Boletín de Lima*, 58, 93-96.
- Ramírez, P. (1988c). La ballena jorobada *Megaptera novaeangliae* en la costa norte del Perú: Periodos 1961-1965 y 1975-1985. *Boletín de Lima*, 56, 91-96.
- Ramírez, P. (1988d). Capturas de ballena sei (*Balaenoptera borealis*) frente a Paita, Perú. In H. Salzwedel & A. Landa (Eds.), *Recursos y Dinámica del Ecosistema de Afloramiento*, 2do Congreso Latinoamericano sobre Ciencias del Mar. Boletín Instituto del Mar del Perú (volumen extraordinario) (pp. 341-343). <https://hdl.handle.net/20.500.12958/1144>
- Ramírez, P. (1989a). Captura de cetáceos mayores desde las estaciones costeras del Perú: 1951-1985. *Boletín de Lima*, 64, 91-95.
- Ramírez, P. (1989b). Capturas de cachalotes en Paita: 1976-1981. *Boletín de Lima*, 63, 81-88.
- Ramírez, P. (1989c). Alimentación de la «ballena Bryde» durante el fenómeno «El Niño». *Boletín de Lima*, 62, 87-90.
- Ramírez, P. (1989d). Captura y observaciones de la «ballena Bryde» en el norte del Perú. *Boletín de Lima*, 65, 91-95.
- Ramírez, P. (1990). Distribución de los cetáceos mayores después del Fenómeno «El Niño» 1982-1983. *Boletín de Lima*, 70, 85-90.
- Ramírez, P. (1992). Tres notas sobre la «ballena Bryde» (*Balaenoptera brydei*): Alimentación, contenido estomacal y distribución. *Boletín de Lima*, 82, 15-28.
- Ramírez, P. (2001). Capturas de cachalote frente a Paita, Perú. Julio 1957 a diciembre 1961 y enero 1968 a junio 1981. *Informe Progresivo Instituto del Mar del Perú*, 147, 3-19. <https://hdl.handle.net/20.500.12958/920>
- Ramírez, P. (2007a). Capturas y observaciones de la ballena Bryde, *Balaenoptera brydei* (Olsen), en el noroeste del mar peruano, 1968-1985. *Informe Instituto del Mar del Perú*, 34(3), 241-250. <https://hdl.handle.net/20.500.12958/1961>
- Ramírez, P. (2007b). Sobre la longitud mínima de caza de la ballena Bryde en el mar peruano. *Informe Instituto del Mar del Perú*, 34(3), 251-254. <https://hdl.handle.net/20.500.12958/1962>
- Ramírez, P., & Franco, F. (1982). Humpback whale, *Megaptera novaeangliae* off the north Peruvian coast 1961-1967 y 1975-1981. *Report of the Meeting of the International Whaling Commission*. London, UK.
- Ramírez, P., & Urquiza, W. (1985). Los cetáceos mayores y el fenómeno El Niño 1982-1983. In W. Arntz, A. Landa & J. Tarazona (Eds.), *El Niño, su impacto en la fauna marina*, 9no Congreso Latinoamericano de Zoología. Boletín Instituto del Mar del Perú (volumen extraordinario) (pp. 201-206). <https://hdl.handle.net/20.500.12958/1211>
- Reeves, R. R. (Ed.) (2003). *Dolphins, whales and porpoises: 2002-2010 Conservation Action Plan for the world's cetaceans*. IUCN/SSC Cetacean Specialist Group. Gland, Switzerland & Cambridge, UK.
- Reyes, J. C. (1992). *Informe nacional sobre la situación de los mamíferos marinos en Perú*. CPPS/PNUMA. Lima, Perú.
- Reyes, J. C. (2009). *Ballenas, delfines y otros cetáceos del Perú. Una fuente de información*. Squema ediciones. Lima, Perú.
- Ruffle, A. M. (2002). Resurrecting the International Whaling Commission: Suggestions to strengthen the conversation effort. *Brooklyn Journal of International Law*, 27, 639.
- Saetersdal, G., Mejía, J., & Ramírez, P. (1963). La caza de cachalote en el Perú. Estadísticas de captura para los años 1947-1961 y un intento de analizar las condiciones de la

- población en el periodo 1954-1961. *Boletín del Instituto de Investigación de Recursos Marinos*, 1(3), 45-84. <https://hdl.handle.net/20.500.12958/73>
- Sánchez, R., & Arias-Schreiber, M. (1998). Cetáceos observados frente a la costa peruana y su relación con la distribución y abundancia de los recursos pelágicos. *Crucero BIC Humboldt 9809-09, de Paita a Callao. Informe Instituto del Mar del Perú*, 141, 55-66. <https://hdl.handle.net/20.500.12958/1549>
- Sánchez, R., Arias-Schreiber, M., & Ontón, K. (1998). Avistamientos de cetáceos en el mar peruano y su relación con los principales recursos pelágicos. *Crucero BIC Humboldt 9803-05 de Tumbes a Tacna. Informe Instituto del Mar del Perú*, 135, 163-179. <https://hdl.handle.net/20.500.12958/1505>
- Santillán, L. (2011). Records of humpback whales (*Megaptera novaeangliae*) in Sechura bay, Peru, in spring 2009-2010. *Journal of Marine Animals and Their Ecology*, 4(1), 29-35.
- Santillán, L., Roca, M., Apaza, M., de Oliveira, L. R., & 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>
- Savelle, J. M., & Kishigami, N. (2013). Anthropological research on whaling: prehistoric, historic and current contexts. *Senri Ethnological Studies*, 84, 1-48. <https://doi.org/10.15021/00002436>
- Schweigge, E. (1964). *El litoral peruano* (2nd ed.). Universidad Nacional Federico Villarreal. Lima, Peru.
- Serrano-Villavicencio, J. E., Bartoletti, T., & Bueno, C. (2020). Mammals collected by Johann Jakob von Tschudi in Peru during 1838-1842 for the Muséum d'Histoire Naturelle de Neuchâtel, Switzerland. *Boletim do Museu Paraense Emílio Goeldi - Ciências Naturais*, 15(3), 905-931. <https://doi.org/10.46357/bcnaturais.v15i3.249>
- Smith, S. C., & Whitehead, H. (2000). The diet of Galapagos sperm whales *Physeter macrocephalus* as indicated by fecal sample analysis. *Marine Mammal Science*, 16(2), 315-325. <https://doi.org/10.1111/j.1748-7692.2000.tb00927.x>
- Taylor, B. L., Baird, R., Barlow, J., Dawson, S. M., Ford, J., Mead, J. G., Notarbartolo di Sciara, G., Wade, P. R., & Pitman, R. L. (2019). *Physeter macrocephalus* (amended version of 2008 assessment). *IUCN Red List of Threatened Species 2019*, e.T41755A160983555. <https://doi.org/10.2305/IUCN.UK.2008.RLTS.T41755A160983555.en>
- Testino, J. P., Petit, A., Pacheco, A. S., Silva, S., Alfaro-Shigueto, J., Sarmiento, D., Quiñones, J., More, A., Motta, E., Fernandez, S., Campbell, E., Carrillo, G., Epstein, M., Llapapasca, M. A., & González-Pestana, A. (2019). Killer whale (*Orcinus orca*) occurrence and interactions with marine mammals off Peru. *Pacific Science*, 73(2), 261. <https://doi.org/10.2984/73.2.7>
- Thomas, P. O., Reeves, R. R., & Brownell, R. L. (2016). Status of the world's baleen whales. *Marine Mammal Science*, 32(2), 682-734. <https://doi.org/10.1111/mms.12281>
- Tønnessen, J., & Johnsen, A. (1982). *The history of modern whaling*. University of California Press. California, USA.
- Townsend, C. H. (1935). The distribution of certain whales as shown by the Logbook records of American whaleships. *Zoologica*, 19, 1-50.
- Tschudi, J. J. (1844a). Mammalium conspectus quae in Republica Peruana reperiuntur et pleraque observata vel collecta sunt in itinerere. *Archiv für Naturgeschichte*, 10, 244-255.
- Tschudi, J. J. (1844b). *Untersuchungen über die fauna peruana: Therologie. Scheitlin und Zollikofer*. St. Gallen, Switzerland.
- Valdivia, J., & Ramírez, P. (1981). Peru progress report on cetacean research: June 1979–May 1980. *Report of the International Whaling Commission*, 31, 211-214.
- Valdivia, J., Franco, F., & Ramírez, P. (1981a). The exploitation of Bryde's whales in the Peruvian sea. *Report of the International Whaling Commission*, 31, 441-448.
- Valdivia, J., Ramírez, P., Tovar, H., & Franco, F. (1981b). Report of a cruise to mark and assess Bryde's whales of the 'Peruvian stock', February 1980. *Report of the International Whaling Commission*, 31, 435-440.
- Valdivia, J., Landa, A., Ramírez, P., & Tovar, H. (1982). Peru progress report on cetacean research: May 1980 to March 1981. *Report of the International Whaling Commission*, 32, 199-203.
- Valdivia, J., Landa, A., Ramírez, P., & Franco, F. (1983). Peru progress report on cetacean research: April 1981 to April 1982. *Report of the International Whaling Commission*, 33, 237-243.
- Valdivia, J., Landa, A., & Ramírez, P. (1984). Peru progress report on cetacean research: 1982-1983. *Report of the International Whaling Commission*, 34, 223-228.
- Van Waerebeek, K., & Engblom, G. (2007). Fin whales off Peru, unseasonal, nondescript and undersized: Further indications for a possible third subspecies of fin whale. Scientific Committee, *International Whaling Commission Paper SC/59/SH22* [Available from <https://iwc.int/en/>].
- Van Waerebeek, K., & Reyes, J.C. (1994). A note on incidental fishery mortality of southern minke whales off Western South America. *Report of the International Whaling Commission, Special issue 15*, 521-523.
- Van Waerebeek, K., Alfaro-Shigueto, J., & Arias-Schreiber, M. (1996). Humpback whales off Peru: New records and a rationale for renewed research. Scientific Committee, *International Whaling Commission Paper SC/48/SH1*. [Available from <https://iwc.int/en/>].
- Van Waerebeek, K., Pastene, L., Alfaro-Shigueto, J., Brito, J., & Mora-Pinto, D. (1997). The status of the blue whale *Balaenoptera musculus* off the west coast of South America. Scientific Committee, *International Whaling Commission Paper SC/49/SH9*. [Available from <https://iwc.int/en/>].
- Van Waerebeek, K., Reyes, J. C., & 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., & Van Bresse, M.-F. (1998). Sighting of a mother-calf pair of Southern right whale *Eubalaena australis* in Peruvian waters. *Estudios Oceanológicos*, 17, 105-107.
- Van Waerebeek, K., Santillán, L., & Suazo, E. (2008). Incidental sightings of Southern right whales off Peru, 1987-2007: Recovery remains uncertain. Scientific Committee, *International Whaling Commission Paper SC/60/BRG33*. [Available from <https://iwc.int/en/>].

- Van Waerebeek, K., Santillán, L., & Suazo, E. (2009). On the native status of the Southern right whale *Eubalaena australis* in Peru. *Boletín del Museo Nacional de Historia Natural*, 52, 75-82.
- Vernazzani, G. B., Arroyo, P., Goya, E., & Palma, A. (2016). Conservation Management Plan for eastern South Pacific Southern right whale population (*Eubalaena australis*). Scientific Committee, *International Whaling Commission Paper SC/66b/BRG23* [Available from <https://iwc.int/en/>].
- Villagra, D., Garcia-Cegarra, A. M., Gallardo, D. I., & Pacheco, A. S. (2021). Energetic effects of whale-watching boats on humpback whales on a breeding ground. *Frontiers in Marine Science*, 7, 1208. <https://doi.org/10.3389/fmars.2020.600508>
- Williams, R., Hedley, S. L., Branch, T. A., Bravington, M. V., Zerbini, A. N., & Findlay, K. P. (2011). Chilean blue whales as a case study to illustrate methods to estimate abundance and evaluate conservation status of rare species. *Conservation Biology*, 25(3), 526-535. <https://doi.org/10.1111/j.1523-1739.2011.01656.x>
- Yochem, P. K. & Leatherwood, S. (1985). Blue whale, *Balaenoptera musculus* (Linnaeus, 1758). In S.H. Ridgway & R. Harrison (Eds.) *Handbook of Marine Mammals: The sirenians and baleen whales* (vol. 3, pp. 193-227). Academic Press. Florida, USA.
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