Chapter 13
From Whaling to Whale Watching: Cetacean Presence and Species Diversity in the Galapagos Marine Reserve

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Introduction

When sperm whales became scarce in the Atlantic Ocean in the eighteenth century, whalers ventured for new whaling grounds in the Pacific, and in 1792 Captain James Colnett from the British whaling fleet described Galapagos as teeming with whales. Sperm whales (*Physeter macrocephalus*) in their Galapagos breeding grounds were no longer safe (Hickman 1985). After 1812, more than 700 whalers from the US alone and others from Norway, Britain, and Peru removed approximately 5,000 animals from the islands (Hope and Whitehead 1991) and dramatically reduced local populations of Galapagos fur seals (*Arctocephalus galapagoensis*) and tortoises (*Chelonidis elephantopus*) as well.

In the twentieth century, the world began to see the Galapagos as a priceless treasure for wildlife, and since 1930, it began to put in force a series of decrees leading to the creation of the Galapagos National Park in 1959 and the Galapagos Marine Reserve (GMR) in 1986. Today, all commercially hunted whales are either threatened or close to extinction and are officially protected under the International Convention for the Trade of Endangered Species (CITES), the International Union

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for the Conservation of Nature (IUCN), the International Whaling Commission (IWC), and Ecuadorian legislations, such as the Whale Sanctuary created in 1990 and covering not only waters around Galapagos but extending to the entire 200 nautical mile exclusive economic zone (Merlen 1992; Hoyt 2005).

In recent years, the waters around the Galapagos have been identified as one of the focal areas for marine mammals in the eastern tropical Pacific (Ferguson et al. 2003) and are considered one of the global hot spots for marine mammal diversity (MacLeod and Mitchell 2006; Pyenson 2011; Kaschner et al. 2011), with at least 23 species of cetaceans recorded inside the GMR (Day 1994; Palacios and Salazar 2002).

In the past two decades, whale watching has become increasingly popular in Latin America, increasing at an average rate of 11.3% from 1995 to 2008 (Hoyt and Iñíguez 2008), with Galapagos emerging as one of the hot spots for wildlife tourism. However, new concerns have arisen regarding the effects of climate change on the distribution of cetaceans (see Whitehead et al. 2008; MacLeod 2009; Simmonds and Isaac 2007; Kaschner et al. 2011), as warming ocean temperatures are predicted to lead to reduced species diversity in tropical and subtropical environments (Whitehead et al. 2008; Gambaiani et al. 2009). Galapagos is situated within the area of direct influence of the El Niño Southern Oscillation (ENSO) phenomenon and with every El Niño event the marine environment suffers drastic changes caused by excessive heating of surface waters, nutrient stress, and food shortages that lead to the reduction of higher trophic level predator populations such as pinnipeds (Trillmich and Limberger 1985), penguins (Boersma 1998; Vargas et al. 2006), and flightless cormorants (Valle and Coulter 1989). In contrast to these resident predators, cetaceans can move and avoid food shortages, but there is little information about cetacean migrations in and out the GMR (Palacios et al. 2010). Wade and Gerrodette (1993) report a considerable interannual variability of species abundance and presence during their line transects surveys in the eastern tropical Pacific (ETP) from 1986 to 1990. In this context, cetacean presence in the Galapagos can help to understand the current situation of whales and dolphins under changing oceanographic conditions. Thus, long-term data sets are important to assess changes in species composition and possible species loss in the GMR.

Using wildlife tourism in the Galapagos as a research platform, we discuss the situation of cetaceans in the GMR over an 18-year period covering El Niño, La Niña, and neutral conditions, using long-term data sets of occasional sightings reported by trained tour guides as well as from dedicated research cruises. We also provide a description of the general patterns of occurrence for cetacean species and discuss some of the most common species in detail.

Study Area

The Galapagos Archipelago, with 13 large islands, is situated 100 km west of continental South America, where it extends from 3° north to 4° south latitude and 87–94° west longitude. Our study area was restricted to regular tourist navigation routes in the center and south of the GMR.

The GMR is characterized by changing oceanographic conditions due its proximity to the equatorial front in the north of the archipelago (Palacios 2004). It is influenced by two major ocean currents—the South Equatorial and the Equatorial Undercurrent or Cromwell Current (Fiedler and Talley 2006). From the north, the Panama Bight brings warm surface waters with average sea surface temperatures (SST) of 27°C (Palacios 2004) and causes a warm, less productive season from December to May. From June to November, the Humboldt or Peru Current from the south is more prevalent with strong winds and cold, productive waters with average SST of 22°C. The Cromwell Current from the west flows at approximately 100 m depth and collides with the Galapagos Islands in the west off of Fernandina and Isabela islands, producing strong upwelling plumes that extend to the south and north–central portion of the archipelago (Palacios and Salazar 2002). Galapagos is situated in the center of the "ENSO Region 3,4" (Sweet et al. 2007), where El Niño events cause drastic declines in productivity, especially from December to February until La Niña events respond with negative anomalies in SST and high productivity (see Guilyardi et al. 2009).

Methods

Data Collection and Surveys

Species presence in the GMR was established using published records and direct observations from 1993 to 2010 by trained tour guides from Lindblad Expeditions on the MS *Endeavor* and MS *Islander* (Fig. 13.1). For each sighting, information was recorded including date, time, position, and area of the sighting as well as species, number of animals observed, and general behavior. A total of 1,407 sightings were analyzed for presence, dominance, and occurrence for species with at least 20 sightings in total.

Species presence was analyzed as absence/presence records for each year from 1993 to 2010. The number of species sighted each year was compared during El Niño, La Niña, and neutral conditions using ENSO patterns provided by the US National Oceanic and Atmospheric Administration. Common species were selected when they were sighted at least 20 times throughout the study period. Seasonal preference of the most common species was evaluated using T-tests with 95% confidence intervals during warm seasons (December to May) and cold seasons (June to November), adapted from Palacios (2003) to facilitate evaluation of baleen whale presence during Northern Hemisphere and Southern Hemisphere summer months.

Photo ID Studies on Orca

To determine orca movements in the GMR, orcas were photographically identified using natural marks on the dorsal fin (Hammond et al. 1990; Würsig and

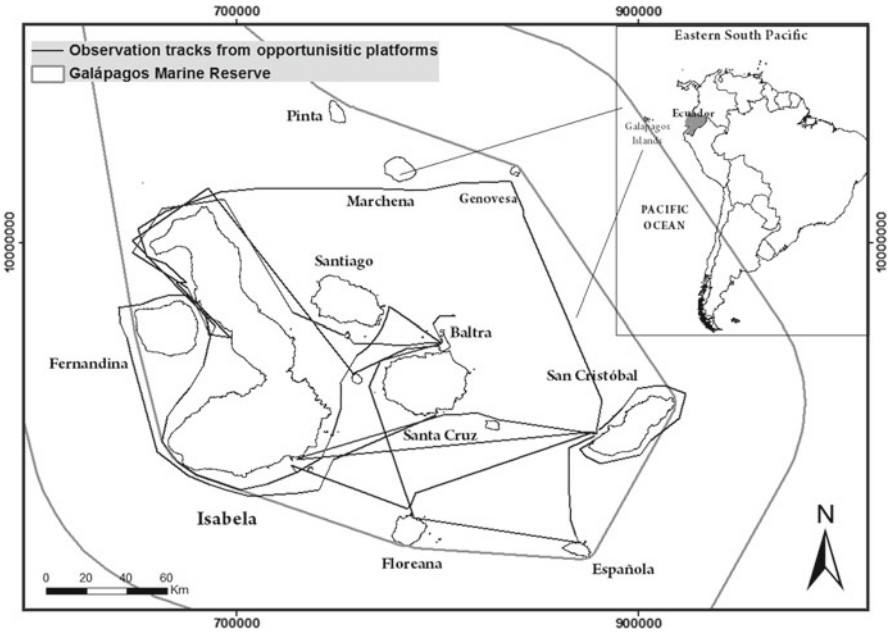

Fig. 13.1 Location of the Galapagos Archipelago and the Galapagos Marine Reserve with the research area according to observation tracks from opportunistic platforms

Jefferson 1990). Only good quality photographs were used for comparison and pods were determined by the identification of different group members sighted at the same time and location.

Results and Discussion

Cetacean Species Diversity in the Galapagos Marine Reserve

A total of 26 cetacean species in six families are reported in the database we compiled for the GMR (Table 13.1). In the present study, 23 species were recorded as occasional sightings during tourist and research cruises. Overall, 11 species are considered rare and were only seen one or two times, while 12 species are considered common, with more than 20 sighting recorded over the study period. The most common species, such as bottlenose dolphins (*Tursiops truncatus*), Bryde's whales (*Balaenoptera edeni*), common dolphins (*Delphinus delphis*), orcas (*Orcinus orca*) and humpback whales (*Megaptera novaeangliae*) make up 70% of the recorded sightings. Among the baleen whales, Bryde's whales are frequently seen, whereas minke whales (*Balaenoptera acutorostrata*), blue whales (*B. musculus*), and fin

Table 13.1 Cetaceans reported for the Galapagos Marine Reserve

	Species name	Type of observation	Source
Balaenopteridae			
Minke whale	*Balaenoptera acutorostrata*	Live sighting	GSC/CDR/GNP
Sei whale	*Balaenoptera borealis*	Live sighting	GSC/CDR/GNP
Bryde's whale	*Balaenoptera edeni*	Live sighting	GSC/CDR/GNP
Blue whale	*Balaenoptera musculus*	Live sighting	GSC/CDR/GNP
Fin whale	*Balaenoptera physalus*	Live sighting	GSC/CDR/GNP
Humpback whale	*Megaptera novaeangliae*	Live sighting	GSC/CDR/GNP
Delphinidae			
Common dolphin	*Delphinus delphis*	Live sighting	GSC/CDR/GNP
Pigmy killer whale	*Feresa attenuata*	Live sighting	CDR/GNP
Short-finned pilot whale	*Globicephala marcorhynchus*	Live sighting	GSC/CDR/GNP
Risso's dolphin	*Grampus griseus*	Live sighting	GSC/CDR/GNP
Fraser dolphin	*Lagenodelphis hosei*	Live sighting	CDR/GNP
Killer whale	*Orcinus orca*	Live sighting	GSC/CDR/GNP
Melon-headed dolphin	*Peponocephala electra*	Live sighting	(Merlen 1995; Smith (1999); Palacios and Salazar 2002)
False killer whale	*Pseudorca crassidens*	Live sighting	(Merlen 1995; Palacios et al. 2004)
Pantropical spotted dolphin	*Stenella attenuata*	Live sighting	(Palacios and Salazar 2002; Palacios 2003)
Striped dolphin	*Stenella coeruleoalba*	Live sighting	(Palacios 2003; Palacios 1999)
Spinner dolphin	*Stenella longirostris*	Live sighting	GSC
Rough toothed dolphin	*Steno bredanensis*	Live sighting	(Merlen 1995; Palacios and Salazar 2002; Palacios et al. 2004)
Bottlenose dolphin	*Tursiops truncatus*	Live sighting	(Palacios 1999)
Kogiidae			
Pigmy sperm whale	*Kogia sima*	Live sighting	GSC/CDR/GNP
Physeteridae			
Sperm whale	*Physeter macrocephalus*	Live sighting	GSC/CDR/GNP
Ziphiidae			
Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*	Stranding record	(Palacios et al. 2004)
Pygmy-beaked whale	*Mesoplodon peruvianus*	Live sighting	Daniel Palacios/ocean alliance, unpublished
Cuvier's beaked whale	*Ziphius cavirostris*	Live sighting	GSC/CDR/GNP
Longman beaked whale	*Indopacetus pacificus*	Live sighting	(Pitman et al. 1999; Palacios and Salazar 2002)
Blainville's beaked whale	*Mesoplodon densirostris*	Live sighting	(Pitman et al. 1999; Palacios and Salazar 2002)

GSC Galapagos Science Center, *CDR* Charles Darwin Research Station, *GNP* Galapagos National Park Service

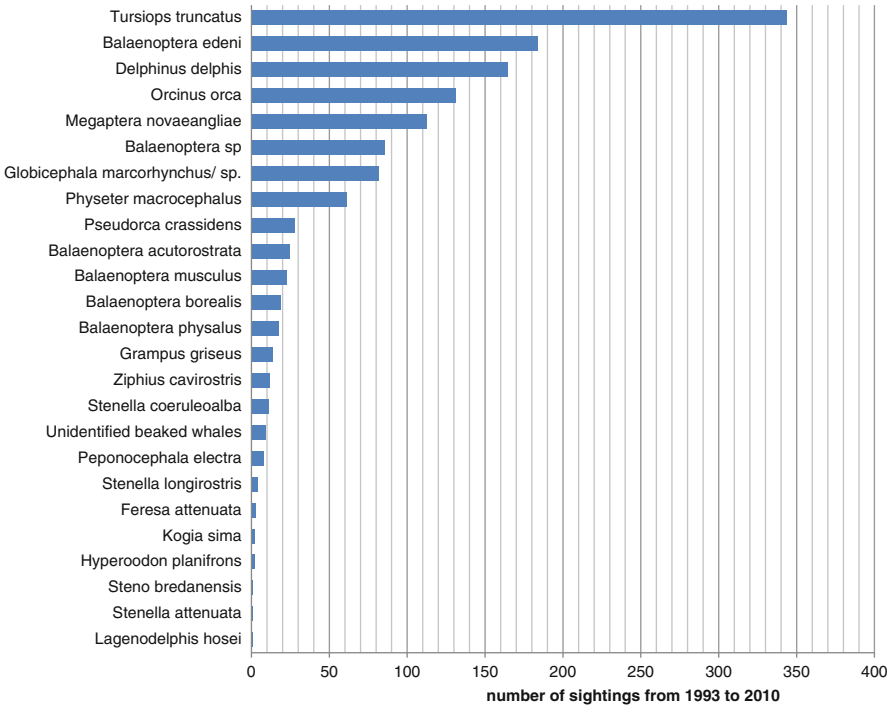

Fig. 13.2 Cumulative sighting records for cetacean species in the Galapagos Marine Reserve from observations collected by tour naturalist guides from 1993 to 2010

whales (*B. physalus*) are considered to be rare in the GMR (Fig. 13.2). While Palacios and Salazar (2002) rank common dolphins as the second most common species, in this study, Bryde's whales were seen far more frequently. This is due, however, to our focus on waters near the islands, within the regular tourist routes, while Palacios and Salazar (2002) and Palacios (2003) based their results on dedicated cetacean surveys that included more pelagic areas of the GMR.

Overall, species numbers fluctuate over the years with a decreasing amount of species being reported during strong El Niño years, such as 1997/1998 and 2010. Despite cold, productive conditions provided by a strong La Niña event in 1999, most species were not sighted until 2001. During the cooler conditions from 2001 to 2008, species numbers peaked from 2001 to 2003, but decreased with the onset of the moderate 2004 El Niño event. Sightings increased again during the cooler La Niña conditions during 2007 and 2008, but diminished to a total of six species during the stronger El Niño event in 2010 (Fig. 13.3).

Most of the species observed were already registered as common in previous surveys, conducted from 1985 to 1995 (Palacios 1999; Palacios and Salazar 2002), but Risso's dolphins (*Grampus griseus*), described as common, are now only very occasionally sighted, whereas dolphins of the genus *Stenella*, Frasers dolphins (*Lagenodelphis hosei*), remain very rare and generally absent during El Niño years, although during offshore research cruises in the eastern tropical Pacific from 1986

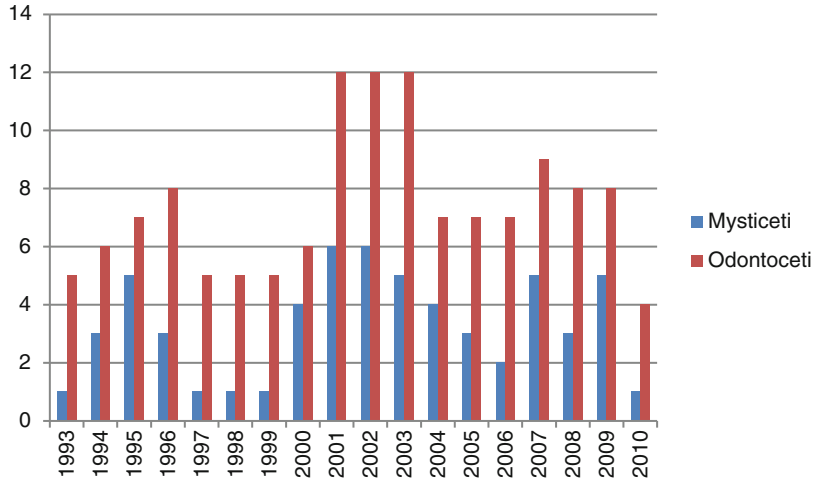

Fig. 13.3 Presence and absence analysis of mysticete and odontocete species in the Galapagos Marine Reserve from 1993 to 2010 using the total number of species sighted each year. ENSO years with moderate El Niño; strong El Niño; moderate La Niña, strong La Niña years (adapted from http://www.cpc.ncep.noaa.gov)

to 1990 spinner, common, and striped dolphins were most common (Wade and Gerrodette 1993). The lack of sightings of Risso's dolphins may be a concern, since they share the same habitat with the frequently seen bottlenose dolphins (Palacios 2003), but the first recorded sightings in our study appeared in 2002—they are only seen during cooler periods and La Niña conditions, though more dedicated surveys are needed to confirm the current distribution of this species. Nonetheless, most species seem to move off the GMR during El Niño years, which confirms recent findings on shifting geographic ranges to remain in a certain niche (Lambert et al. 2011; Kaschner et al. 2011; Whitehead et al. 2008).

All species were observed throughout the year, but only humpback and blue whales showed a significant preference toward the colder, second semester from June to November. This would coincide with the migration of Southeast Pacific whales. According to observations by Merlen (1995) and Smith (1999), most odontocetes, except for the common dolphin, false killer whale and sperm whale, and all other baleen whales, are more frequently seen during cooler seasons, although no significant seasonality could be observed in this study (Table 13.3).

Distribution

Most of the baleen and toothed whales were sighted west off Isabela Island in the Bolivar Channel between Isabela and Fernandina islands (Figs. 13.4 and 13.5). Baleen whales seem to have a clear preference for the cooler and more productive waters of the south and west of the GMR. Most of the blue whales were seen

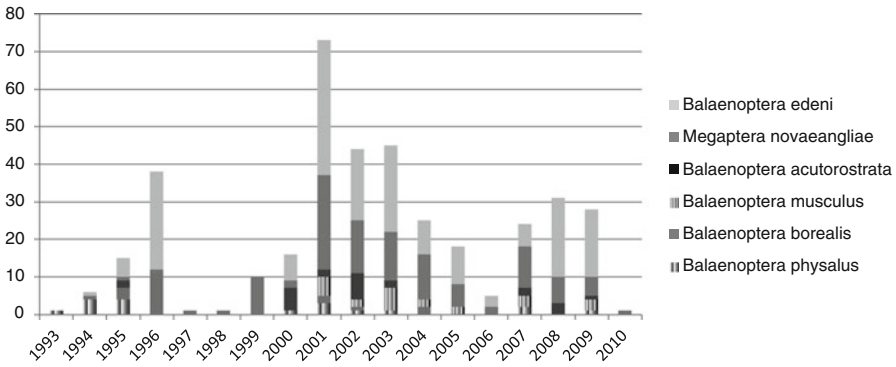

Fig. 13.4 Sighting frequency of baleen whales per total baleen whale sightings from 1993 to 2010

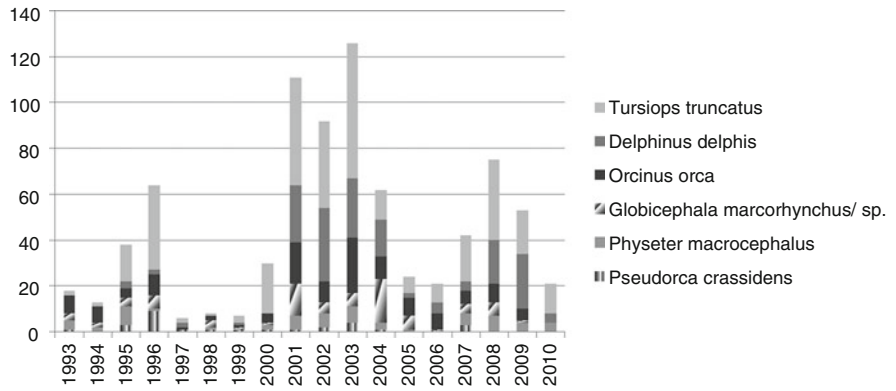

Fig. 13.5 Sighting frequencies of the most common odontocetes per total odontocete sightings from 1993 to 2010

in the south and west of Floreana and Isabela islands. Humpback and Bryde's whales are also frequently sighted in the warmer and less productive central archipelago and east to San Cristobal Island, while minke whales venture into the more tropical, productive area of the south of Genovesa (Fig. 13.6). Odontocetes are present throughout the GMR, even north to Darwin and Wolf islands. Sightings in the more productive southwest, however, are more frequent. Orcas move between all the islands with numerous sightings in the Bolivar Channel, within Santiago, Baltra and San Cristobal islands, and north of Floreana Island (Figs. 13.7 and 13.9). Sperm whales seem to prefer the deep waters of the south and west of Isabela Island, but some sperm whales were seen in shallower waters south of Marchena Island (Fig. 13.7).

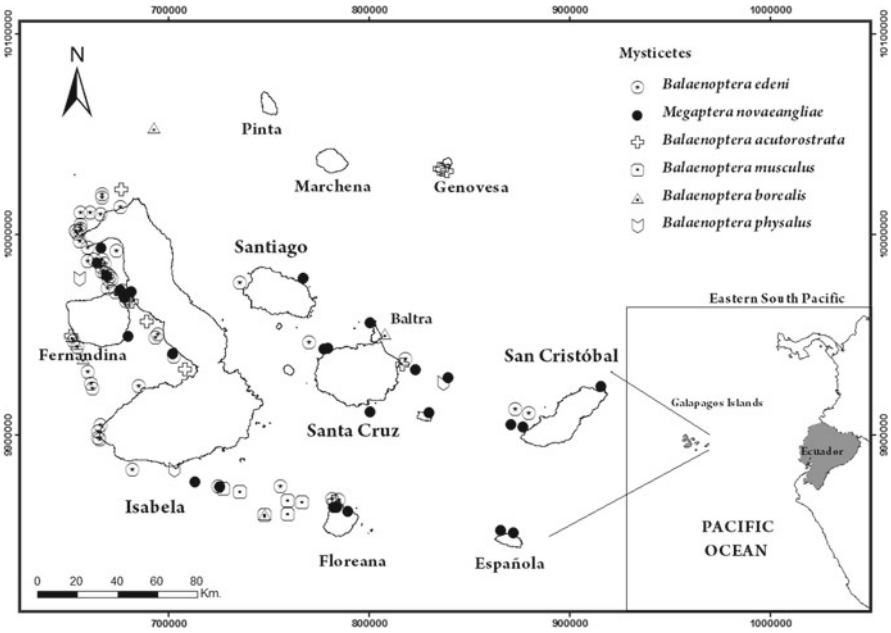

Fig. 13.6 Cumulative sighting distribution of baleen whales in the Galapagos Marine Reserve from 1993 to 2010

Case Studies

Bottlenose Dolphins (*Tursiops truncatus*)

According to the numerous sightings throughout the years, bottlenose dolphins seem to be resident in the GMR. Overall, sightings increased during cooler years, which coincide with the fact that bottlenose dolphins prefer coastal upwelling systems (Palacios 2003), where most of the observations during cruises are made, which may explain the huge proportion of dolphin sightings. Bottlenose dolphins are curious animals and they frequently "bow ride" with cruise boats, which also increases sighting probability.

Common Dolphins (*Delphinus delphis*)

Common dolphins were reported from 1995 to the onset of the 1997 El Niño; disappeared during 1998 and 2000; and returned from 2001 to the end of the study period, including 2010, but were relatively rare from 2004 to 2007. Though they are one of the most common species in the GMR, according to Smith (1999) and Palacios and Salazar (2002), sightings associated with this study became less frequent, especially during warmer

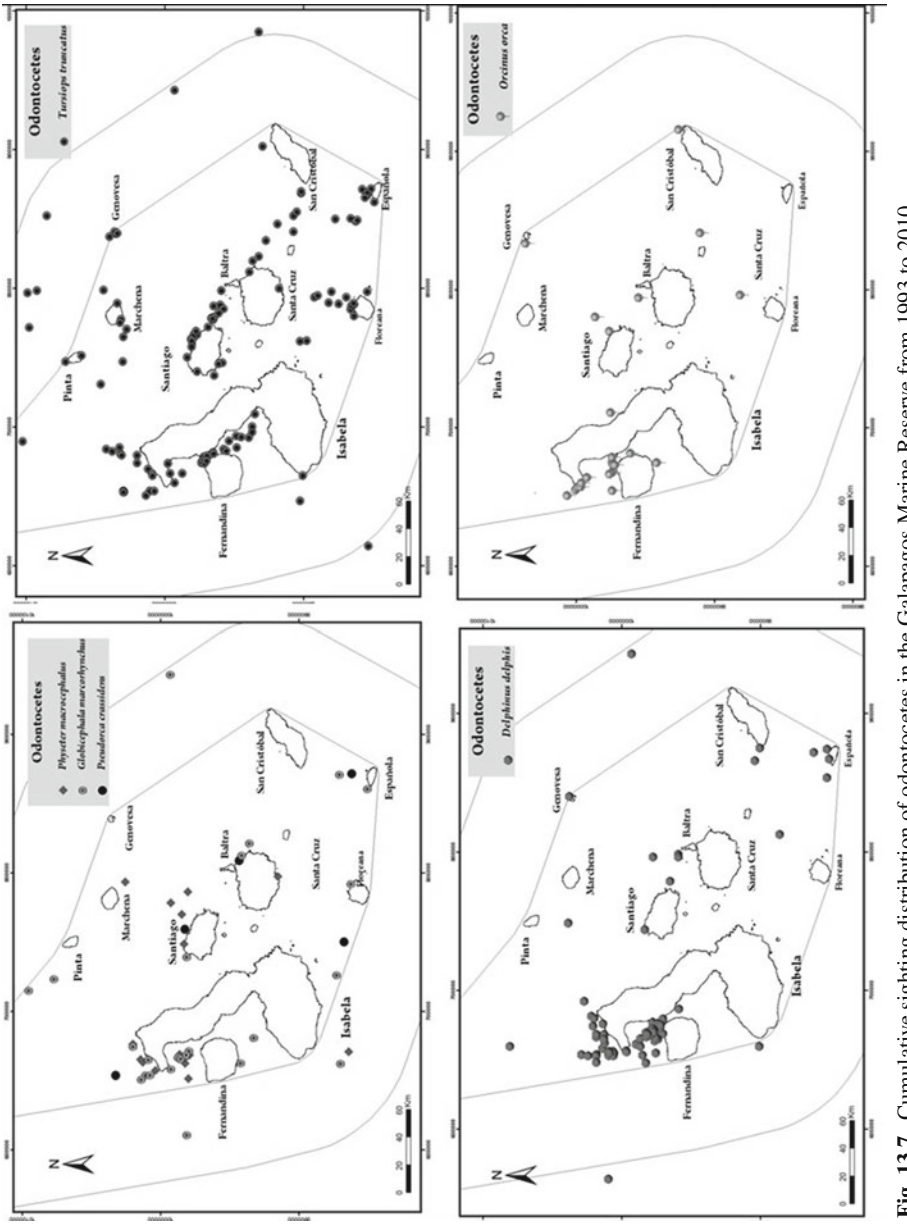

Fig. 13.7 Cumulative sighting distribution of odontocetes in the Galapagos Marine Reserve from 1993 to 2010

years, as no common dolphins were seen during El Niño years; possibly supporting their emigration to other geographic ranges as suggested by Lambert et al. (2011) for common dolphins off the coast of California, USA (Table 13.2 and Fig. 13.5).

Orcas (*Orcinus orca*)

Orcas were present during all years and all seasons of the study with a slightly higher number of recorded sightings during the cold season (Tables 13.2, 13.3 and Fig. 13.5). Most of the orcas were seen in the Bolivar Channel, but occasionally they appeared at Punta Vicente Roca, Fernandina Island, North Seymour Island, San Cristobal Island at Punta Pitt and León Dormido, and Floreana Island at Punta Cormoran (See Fig. 13.7d).

A total of 17 orcas were photographically identified (Fig. 13.8), with a total of 27 sightings and seven resighted animals (see Table 13.4). The relatively high number of resightings suggests a small orca population for Galapagos of less than the estimated orca abundance of 156 animals (Alava 2009), with recorded sighting. The 17 orcas identified for Galapagos can be grouped into four different pods, with an average pod size of 3.2 animals/pod (Table 13.4), consistent with Merlen (1999) who defined an average pod size of 3.1 animals, using sighting recorded from 1948 to 1997. The largest pod, "Pod No. 2" is formed by seven animals, while the other groups observed were of two, four, and five animals, respectively. Four orcas appeared to be solitary animals. The relatively small pod size of Galapagos orcas is characteristic and comparable to transient orcas off the coast of British Columbia, Canada, who feed on marine mammals among other prey (Baird and Dill 1996). Orca attacks on sea lions, dolphins, and whales have been observed in Galapagos (e.g., Brennan and Rodríguez 1994; Merlen 1999), and on humpback whales off the coast of Manabi and Esmeraldas on mainland Ecuador (Denkinger personal observation). Three of the animals were resighted within several years with the longest resighting interval of 6 years from 2005 to 2011, which suggests the presence of a small resident orca population in the GMR.

Sperm Whales (*Physeter macrocephalus*)

Even though Galapagos became a famous hot spot for whaling in the eighteenth century, sperm whales today only account for about 6% of all the sightings (Fig. 13.1). Though the absence of sperm whale sightings in 1997 and 1999 through 2006 seems to be independent of El Niño/La Niña events, as well as the neutral years, the number of sightings fluctuated throughout the years, but never exceeded eight sightings per year (Table 13.2 and Fig. 13.5). Sperm whales in the Galapagos have been decreasing at a rate of 20% per year in recent years, as the low calving rates are unsustainable even though feeding success seems to be comparable to

Table 13.2 Cetacean species presence/absence in the Galapagos Marine Reserve from 1993 to 2010

Species/years	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Balaenopteridae																		
B. acutorostrata	0	0	1	0	0	0	0	1	1	1	1	0	0	0	1	1	1	0
B. borealis	0	0	1	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0
B. edeni	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	0
B. musculus	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0	1	0
B. physalus	1	1	1	0	0	0	0	1	1	1	1	0	0	0	1	0	1	0
Megaptera novaeangliae	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delphinidae																		
Delphinus delphis	0	0	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1
Feresa attenuata	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
G. marcorhynchus	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0
Grampus griseus	0	1	1	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0
Lagenodelphis hosei	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Orcinus orca	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Peponocephala electra	0	0	0	0	0	0	0	0	1	1	1	0	1	1	0	0	0	0
Pseudorca crassidens	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0
Stenella attenuata	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Stenella coeruleoalba	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	1	0
Stenella longirostris	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Steno bredanensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Tursiops truncatus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Physeteridae																		
P. macrocephalus	1	1	1	1	0	1	0	1	1	1	1	1	1	0	1	1	1	1
Kogiidae																		
Kogia sima	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Ziphiidae																		
Ziphius cavirostris	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	0
Indopacetus pacificus	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Table 13.3 Seasonality according to the cumulative number of sightings during warm and cold season of the 12 most common species observed in the Galapagos Marine Reserve

Species	Warm season	Cold season	*P* value[a]
Tursiops truncatus	172	194	>0.05
Orcinus orca	61	70	>0.05
Delphinus delphis	92	73	>0.05
Globicephala macrorhynchus	36	46	>0.05
Pseudorca crassidens	16	12	>0.05
Physeter macrocephalus	33	28	>0.05
Balaenoptera acutorostrata	10	16	>0.05
Balaenoptera borealis	8	11	>0.05
Balaenoptera edeni	89	92	>0.05
Balaenoptera musculus	3	20	0.029
Balaenoptera physalus	6	12	>0.05
Megaptera novaeangliae	18	93	0.013

[a]*T*-test significance with 95% CI

Fig. 13.8 Identified Orcas in the Galapagos Marine Reserve through April 2012

other more successful populations (Whitehead et al. 1997). A sighting of a group with 50 sperm whales off Isabela Island in February 2008 (Jonathan Aguas, personal communication) is encouraging; however, most of the sightings reported here consisted of single animals or small groups with less than 10 animals.

Table 13.4 Sighting records of photo identified orcas and pods in the Galapagos Marine Reserve

ID number	Pod number and composition (as of April 2012)	Sex	Sightings and range
Oo003	1 (2 Adult males)	Male	October 2007–North Seymour
Oo004	1 (2 Adult males)	Male	October 2007–North Seymour
Oo005	No ID	Male	September 2008–Punta Pitt (Cristobal Island)
Oo006	2 (2 Adult males, 1 juvenile male, 4 adult females)	Female	May 2005–Bolivar Channel; December 2011–Punta Cormoran (Floreana); February 2012–Bolivar Channel and Kicker Rock (San Cristobal); March 2012–Bolivar Channel
Oo007	2 (2 Adult males, 1 juvenile male, 4 adult females)	Female	May 2011–Bolivar Channel; December 2011–Punta Cormoran (Floreana)
Oo008	No ID	No ID	December 2011–Punta Cormoran (Floreana)
Oo009	3 (5 Animals, 1 adult male, 2 females, 1 juvenile, 1 calf)	Calf	September 2008–Punta Pitt (San Cristobal)
Oo010	2 (2 Adult males, 1 juvenile male, 4 adult females)	Juvenile Male	February 2012–Kicker Rock (San Cristobal), March 2012–Bolivar Channel; April 2012–Bolivar Channel
Oo011	Single	Male	2005–Fernandina; May 2011–Punta Vicente Roca; September 2011–Bolivar Channel
Oo012	2 (2 Adult males, 1 juvenile male, 4 adult females)	Male	February 2012–Bolivar Channel, March 2012–Bolivar Channel
Oo013	2 (2 Adult males, 1 juvenile male, 4 adult females)	Female	February 2012–Bolivar Channel
Oo014	2 (2 Adult males, 1 juvenile male, 4 adult females)	Female	February 2012–Bolivar Channel and Kicker Rock (San Cristobal);
Oo015	2 (2 Adult males, 1 juvenile male, 4 adult females)	Juvenile Male	February 2012–Bolivar Channel; March 2012–Bolivar Channel
Oo016	2 (2 Adult males, 1 juvenile male, 4 adult females)	Juvenile	March 2012–Bolivar Channel
Oo017	2 (7 Animals)	Juvenile	March 2012–Bolivar Channel
Oo018	4 (1 Female, 3 juveniles)	Female	September 2010–Punta Vicente Roca
Oo019	Single		July 2011–Punta Vicente Roca

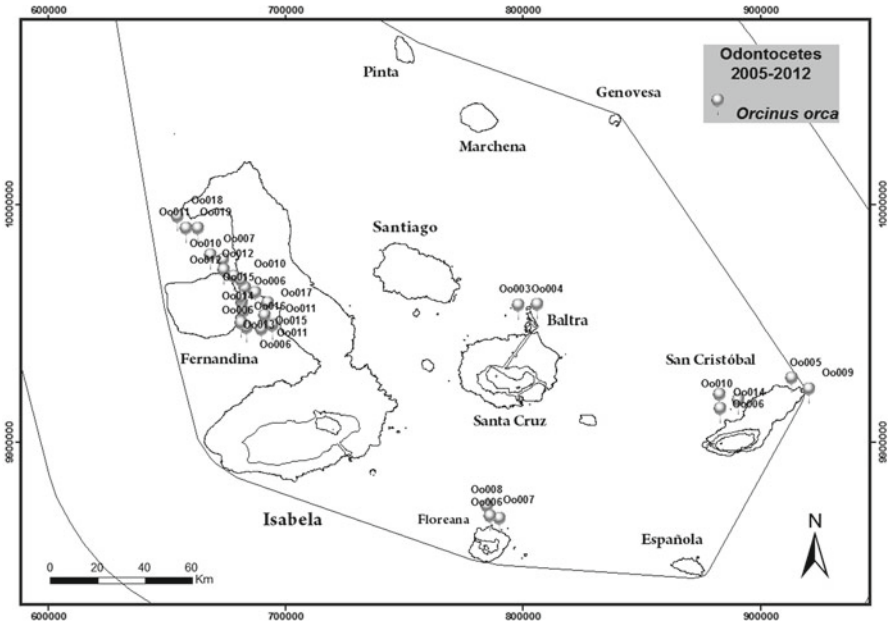

Fig. 13.9 Distribution of identified orca sightings in the Galapagos Marine Reserve from 2005 to April 2012

Bryde's Whales (*Balaenoptera edeni*)

Bryde's whales seem to have disappeared during the 1997/1998 El Niño event and were not seen until 2000. From 2000 to 2009 they were present during all years, but disappeared again in 2010 during the last strong El Niño event (Table 13.2, Fig. 13.4). This species seems to avoid waters of low productivity, as it is more common during the cold season (Table 13.4). Bryde's whales feed in Galapagos waters, where they mostly occur in the very productive upwelling areas in the western portions of the archipelago (Palacios and Salazar 2002; Palacios 2003; Alava 2009). Bryde's whales, however, are also frequently seen north and west of San Cristobal Island throughout the year, where even mother-calf pairs were observed (Denkinger, personal observation).

Humpback Whales (*Megaptera novaeangliae*)

Interestingly, humpback whales, even though less frequently sighted than Bryde's whales, were seen every year since 1994, including El Niño years and are now a common species for the GMR (Table 13.2 and Fig. 13.4). Just as blue whales, humpback whales show a clear preference for the cold season that coincides with the Southern Hemisphere winter migration of the Southeast Pacific population, to

which the humpback whales at the Ecuadorian breeding grounds also belong (Alava and Felix 2006; Félix et al. 2011). While the abundance of humpback whales off the coast of Ecuador peaks in July and August (Alava et al. 2011), most of the sightings in the GMR are at the end of the breeding season in September/October, and humpback whales are seen year round. Humpback whales were seen feeding off Santa Fe Island and south of Isabela Island in February (Denkinger, personal observation), suggesting that the GMR may support a regularly migrating segment of the population, but more photo ID studies are necessary to support this hypothesis. Galapagos has been considered a breeding area for humpback whales (Félix et al. 2011), but the fact that most whales are observed late in the breeding season, most sightings are of single animals or mother-calf pairs, and the lack of competitive male groups could also suggest that Galapagos is used as a stepping stone for whales migrating to the Panamanian/Colombian breeding grounds. This contention is supported by Félix et al. (2011), who found genetic homogeneity of one biopsied female in the Galapagos with haplotypes from Colombian humpback whales.

Blue Whales (*Balaenoptera musculus*)

Blue whales are an endangered species with a current population of possibly less than 1% of the natural population, because of whaling, including catches in Galapagos (Branch et al. 2007). In the GMR, they were considered to be rare (Palacios 1999), but, since 2001, the number of blue whale sightings has increased and they have been consistently present, with the exception of 2006 and 2010 (Table 13.2 and Fig. 13.4). Galapagos blue whales have a significant preference for the colder season from June to November that coincides with migrations of the Southern Chile population to low-latitude waters (Branch et al. 2007). Blue whale sightings from whaling vessels off the coast Peru from 1976 to 1983 peaked during the southern summer from January to March (Reilly and Thayer 1990), which is the opposite of our observations. Three sightings, however, were made during the warmer season with one sighting in February of a group of three feeding blue whales at Caleta Iguana, along southern Isabela Island (Denkinger, personal observation). This may indicate that some animals remain in the Galapagos Islands throughout the year or that there is a possible exchange of Northern Hemisphere blue whales wintering near the Costa Rica Dome.

Conclusions

Cetacean presence in the GMR clearly decreases during El Niño years and increases during cooler La Niña years. Overall, there were fewer species reported during the last 10 years, which could signal a shift in species composition in the GMR. But as the sighting data were opportunistically collected, and only reflect the tourist routes, animal sightings data are not directly comparable with studies based on systematic surveys that include larger areas of the GMR.

Common species such as Bryde's, humpback, and blue whales are sighted throughout the year, with only humpback whales and blue whales showing a clear preference for the cooler, second semester of the year. This indicates that some baleen whales may be resident to the GMR.

All odontocetes are present throughout the year, especially in the more productive waters west of Isabela Island, with bottlenose dolphins being the most common species in the GMR. Orcas are frequently sighted in the Bolivar Channel, but so far four pods have been identified in the region located west and south-central of the GMR. Of the 17 photographically identified orcas, eight were resighted several times and at different locations, which suggests a small resident orca population and an overall small number of orcas in the GMR. Overall, occasional sighting reports are an important tool to detect long-term changes in the composition of the cetacean community.

Although there is great interest in whale watching, this tourism activity has not yet fully developed in Galapagos. The results of this study provide information about the species and the areas where tourists visiting the GMR might expect to see cetaceans more regularly. It is clear that Galapagos supports a unique and diverse cetacean fauna that can be reliably observed along the established routes for tourism vessels, and this information could be the basis for the establishment of a targeted whale watching industry. These operations, nonetheless, should take into account the conservation status and particular responses of the different species to natural environmental fluctuations like ENSO in order to implement an organized and responsible activity.

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