

# Spatial and temporal dynamics of whalewatching in Península Valdés, Patagonia, Argentina

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## ABSTRACT

Península Valdés (Patagonia, Argentina) is considered one of the best places in the world to watch southern right whales (*Eubalaena australis*) due to the large number of animals as well as to their predictability and proximity to the coast. The present study describes the spatial and temporal dynamics of whalewatching, and the different groups of whales that were the focus of this activity in Península Valdés during six reproductive seasons (from 2005 to 2008 and from 2012 to 2013). The aim was to generate useful tools to improve whalewatching activity in this area. Data were recorded from 1,816 whalewatching trips operated from Puerto Pirámides. Every trip had several stopovers to watch whales, defined as 'sightings'. At the beginning of the season, most sightings occurred near Puerto Pirámides port, while at the end of the season, sightings were farther from the port. During the first half of the whale season, trips tended to be coastal and shorter but the groups of whales sighted were more varied, including solitary animals, mating groups and mothers with their recently born calves. In the second half of the season, trips tended to be further from the coast and longer, but the whales sighted were mainly mother-calf pairs, the last group of whales to leave the area. This difference in the characteristics of the sightings as the whale season progressed could be the basis to generate different recreational experience opportunities. Whalewatching has a major impact on the regional economy and whalewatching regulations, if correctly applied, could improve the quality of a conservation plan, considering that both gulfs of Peninsula Valdés (San José and Nuevo) are the main calving areas for this species in the South Atlantic Ocean.

KEYWORDS: WHALEWATCHING; REGULATIONS; DISTRIBUTION; BREEDING GROUNDS; SHORT-TERM CHANGE; SOUTHERN RIGHT WHALE; SOUTH AMERICA; SOUTHERN HEMISPHERE

## INTRODUCTION

The Patagonian coast, particularly Península Valdés (Chubut, Argentina), is one of the most important places in the world for the reproduction of the southern right whale (*Eubalaena australis*) in the Southwest Atlantic (Bastida and Lichtschein, 1984; Bastida *et al.*, 2007; Payne *et al.*, 1990). This whale has a current annual population growth rate of about 4–6% (Crespo *et al.*, 2014) and a breeding population estimated around 4,000 whales (Cooke, 2013). Southern right whale adults arrive in Península Valdés between April and May each year and increase in number (by reproduction) until September, reaching more than 1,000 individuals (Crespo *et al.*, 2014) in only 4,000km<sup>2</sup>. The whales prefer near-shore areas (between 10 and 100m from the shore; Rivarola *et al.*, 2001) and shallow waters (around 5m depth), especially mothers with calves (Bastida *et al.*, 2007), which stay long periods of time on the surface (Fazio, 2013). The first births take place in mid-June and the last ones at the end of October. Females remain in the area with their calves for two or three months after birth (Best and Rüther, 1992; Cooke *et al.*, 2001).

Due to the large number of whales as well as to their predictability and proximity to the coast, Península Valdés is considered one of the best places in the world to watch right whales (Argüelles and Bertellotti, 2008; Rivarola *et al.*, 2001). Tourist numbers at this site peak at the end of September or early October (Rowntree *et al.*, 2001), coinciding with the peak in whale abundance (Crespo *et al.*, 2014). Although wildlife tourism is a relatively recent phenomenon, it is growing rapidly (Cisneros-Montemayor *et al.*, 2010; Hoyt, 2001; Hoyt and Hvenegaard, 2002;

Orams, 2002) and has become a global business worth over US\$ two billion a year worldwide (Bailey, 2012; Chen, 2011; O'Connor *et al.*, 2009). Like other wildlife tourism destinations, Península Valdés has also experienced a rapid growth: between 1991 and 2004 the number of tourists who took part in a boat-based whalewatching activity increased from 17,446 to 96,436 (Losano and Ruíz Díaz, 2009). However, since 2005 differences in the number of tourists between years have been small, with a total of around 100,000 tourists per year (see Table 1) (Losano, 2008; Secretaría de Turismo y Áreas Protegidas, pers. comm; Secretaría de Turismo y Áreas Protegidas, 2011).

Ecological tourism, including whalewatching and tours to see penguins, sea lions and elephant seals, is the main tourist attraction of Chubut (Campagna *et al.*, 1995; Crespo and Dans, 2012) and is today one of the fastest growing sources of income and employment after oil exploitation and fisheries (Argüelles and Bertellotti, 2008). In 1985, there were only two companies working with three boats, but since the early 1990s, 12 boats have been operating simultaneously (Tagliorette *et al.*, 2008). As in other countries in the world (Heckel *et al.*, 2003), this increasing activity needed adequate local regulation, as recognised initially by the owners and captains of the whalewatching companies. In the 1990s, the government of Chubut Province granted whalewatching licenses to only six companies, allowing no more than two boats per company to be in the water at the same time.

The rapid development of whale tourism has undoubted economic and public-consciousness benefits but has also raised concern about potentially negative effects on the animals. Chubut Province is at the forefront of protecting

Table 1

Evolution of the number of tourists who took part in a whalewatching tour from boats that operated from Puerto Pirámides (Chubut, Argentina); months, number of trips and sightings done in each year studied; duration of each whalewatching trip and sighting. Means are followed by their standard deviation (SD). Time was measured in minutes.

Year	Number of tourists	Months	Number of trips	Number of sightings	Mean time of a trip $\pm$ SD	Median time of a trip (range)	Mean time of a sighting $\pm$ SD	Median time of a sighting (range)
2005	92,514 <sup>a</sup>	Jul. to Dec.	363	1,011	85.77 $\pm$ 22.19	84 (34–228)	15.16 $\pm$ 11.36	12 (1–59)
2006	107,731 <sup>a</sup>	Jun. to Dec.	552	2,304	81.65 $\pm$ 15.96	79 (42–171)	11.17 $\pm$ 8.89	9 (1–71)
2007	113,148 <sup>a</sup>	Jun. to Dec.	552	2,045	73.90 $\pm$ 13.51	72 (41–211)	11.35 $\pm$ 8.50	9 (1–62)
2008	101,743 <sup>a</sup>	Jul. to Nov.	92	343	96.46 $\pm$ 11.35	94 (79–146)	14.07 $\pm$ 15.13	10 (1–185)
2009	107,103 <sup>a</sup>	–	–	–	–	–	–	–
2010	114,628 <sup>a</sup>	–	–	–	–	–	–	–
2011	91,424 <sup>a</sup>	–	–	–	–	–	–	–
2012	100,823 <sup>b</sup>	Aug. to Nov.	138	467	90.24 $\pm$ 17.02	90 (33–159)	14.17 $\pm$ 15.36	10 (1–185)
2013	94,843 <sup>b</sup>	Jun. to Nov.	119	355	91.03 $\pm$ 10.86	89 (61–131)	12.44 $\pm$ 12.80	11 (1–129)
Total	–	–	–	–	82.14 $\pm$ 17.63	81 (33–228)	12.30 $\pm$ 6.52	15 (2–75)

<sup>a</sup>Secretaría de Turismo y Áreas Protegidas, 2011. <sup>b</sup>Secretaría de Turismo y Áreas Protegidas, pers. comm.

its wildlife resources. It has specific legislation and the appropriate enforcement authorities to control the development of the whalewatching activities (Coscarella, 2005). In 2008, the Government Office of Tourism of Chubut Province implemented a new whalewatching Law N° 5714 and Decree 167, which establishes that whalewatching trips must be done in a limited area of around 160km<sup>2</sup>, between Punta Piaggio and Punta Cormoranes (Fig. 1), from the lowest mean tide line to three nautical miles away from the coast, and that boats (only one per company at the same time) can only operate from Puerto Pirámides. The law also approves the ‘Patagonian Technique for Whale Watching’, which includes a code of conduct for whalewatching. The main goal of the ‘Patagonian Technique for Whale Watching’, as for most whalewatching regulations worldwide (Carlson, 2010; Kessler and Harcourt, 2013), is to establish the technical aspects expressly permitted and prohibited for disposal of marine transportation of persons for whalewatching tourism purposes. It is founded on a sustainable basis to adapt the whalewatching manoeuvres of service permittees to conservation guidelines.

The present study describes the spatial and temporal dynamics of whalewatching in Península Valdés and the different groups of whales sighted during this activity along six whale breeding seasons (from 2005 to 2008 and from 2012 to 2013). This data could also be useful to define different recreational experience opportunities in whalewatching in the area.

## MATERIALS AND METHODS

This study was carried out during the whale breeding seasons (June to December) from 2005 to 2008 and from 2012 to 2013 (Table 1). One or two observers recorded data from 1,816 whalewatching boat trips, obtaining more than 1,338 hours of direct observation during 2,486 hours on board. All boats of the six companies that operated in those years set sail from Puerto Pirámides (42°34’S, 64°16’W) (Fig. 1). The different types of boats (around 15 boats in the whalewatching fleet) included inflatable boats, single hull ships and a catamaran, and the number of passengers each could carry ranged from 19 to 70, according to the size of the boat. Large boats usually had more than one outboard engine, while small boats had only one, and these engines ranged from 150 to 300HP each. Trips normally took place between Punta Piaggio (42°32’S, 64°21.5’W) and Punta Alt (42°41’S, 64°15.1’W) (Fig. 1).

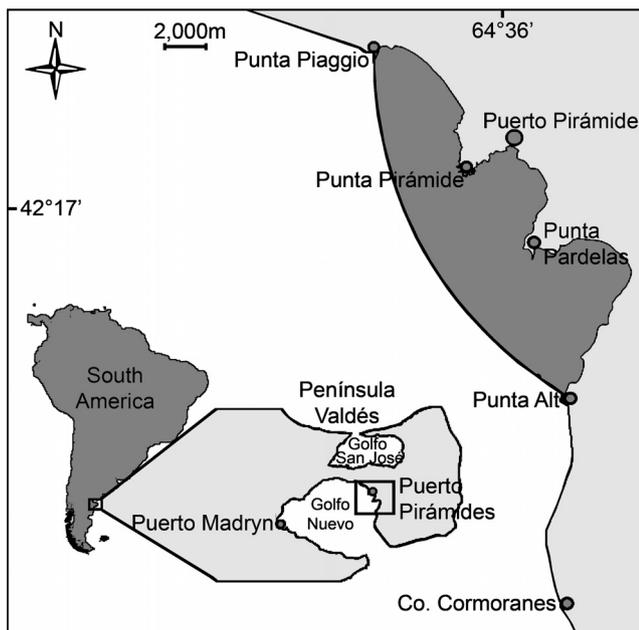


Fig. 1. Main study area (dark grey) in Golfo Nuevo, Península Valdés.

Table 2  
Data recorded in each sighting.

Data recorded	Details
Duration	Starting when the boat was approx. 50m away from the focal whale, and finishing when the boat was more than 50m away from the whale.
Location	GPS used: Garmin eTrex Legend.
Wind intensity	0 = no wind; 1 = low intensity (1–8kn); 2 = mid intensity (9–15kn); 3 = strong wind (16–22kn); 4 = very rough wind (>22kn). Anemometer used: SKYWATCH Xplorer.
Douglas (Dg)	0 (no waves)–4 (large waves)
Number of whales	Maximum value observed: 16, always nearer than 50m from the boat.
Type of focal whale	Mother-calf: one or more pairs of a mother and a calf born in the current season (less than one year old). Mating group: one female and several males performing a peculiar mating behaviour. Other: solitary animals that could be grouped by chance but not in a mating behaviour.

On every trip, the date, type of boat, duration and weather condition were recorded (with southerly winds of more than 20 kn, marine authorities closed the port and prohibited all navigation). During each trip, boats often stopped several times to observe a whale or groups of whales. Each stopover was considered as a ‘sighting’, defined as the observation that took place when the boat stopped or stayed for at least

one minute at a distance of around 50m from one or more whales. The number of trips and sightings in each year are shown in Table 1. On each sighting, several variables, such as duration, location, wind intensity, Douglas scale and number and type of focal whales were recorded (Table 2).

The years studied were gathered together in most analyses because they had similar patterns. All statistical analyses

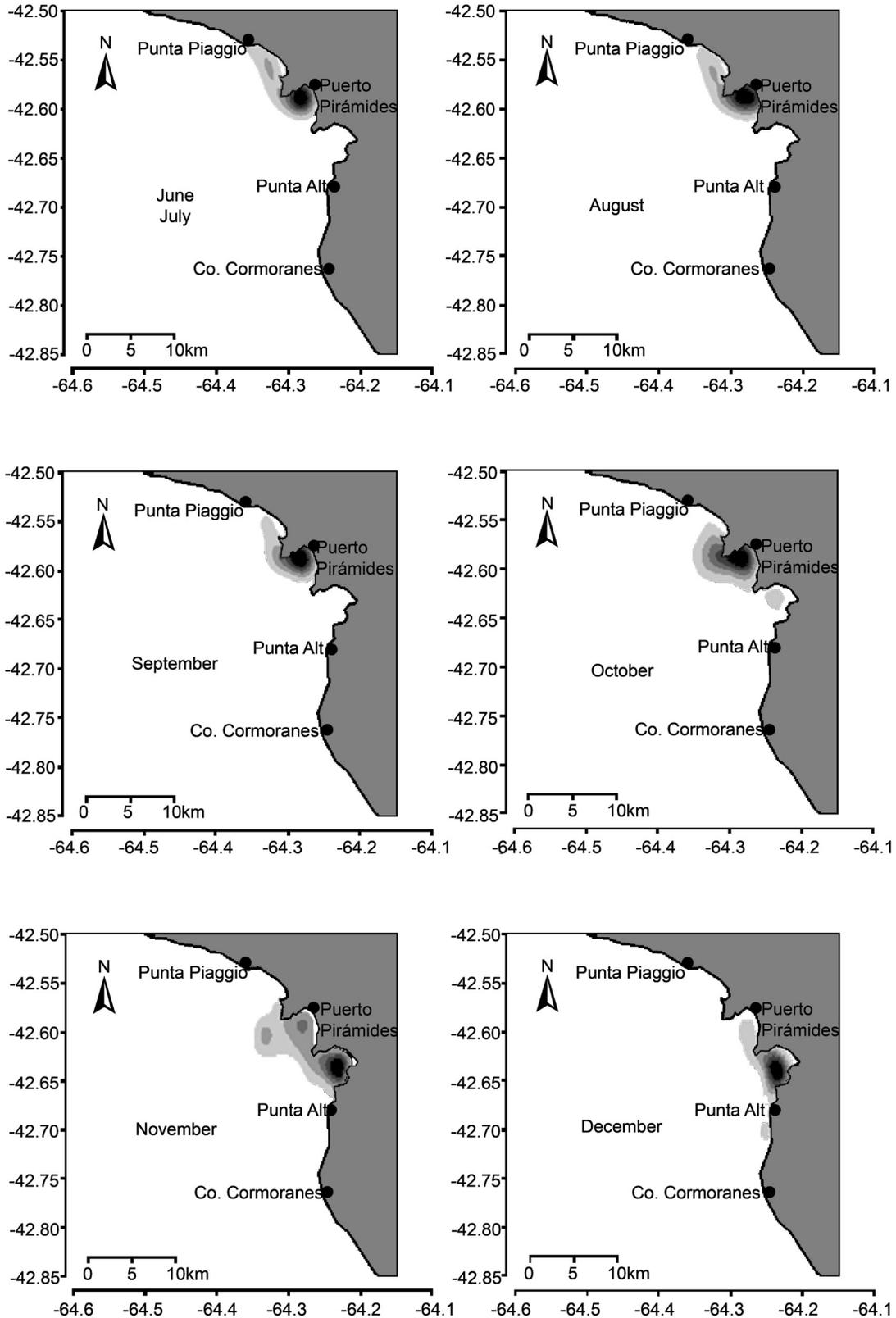


Fig. 2. Sighting density maps (Kernel technique) of whalewatching from Puerto Pirámides during the whale breeding season (2005 to 2008, 2012 and 2013). Darker zones represent higher numbers of sightings. June and July were gathered together because they had very similar density maps.

were performed using SPSS 15.0.1 for *Windows* (data analysis software system, 2006). The variance homogeneity of the data sets was assessed using the Levene test to determine the use of parametric or non-parametric analyses. Spatial distribution analyses were performed using R 2.13.0 (R Development Core Team, 2011), the word editor Tinn-R (Faria, 2009) and sp libraries rgdal, PBSmapping, maptools, gpplib, maptools, spatstat and fields (Baddeley and Turner, 2005; Bivand *et al.*, 2008; Furrer *et al.*, 2010; Keitt *et al.*, 2010; Lewin-Koh *et al.*, 2011; Pebesma and Bivand, 2005; Peng *et al.*, 2010; Schnute *et al.*, 2010) developed by R.

## RESULTS

As the season progressed, sightings were carried out in different areas (Fig. 2). In the first half of the season (June to September), the median distances of sightings to Puerto Pirámides were shorter (Kruskal-Wallis: = 1382.15,  $p < 0.001$ , all T3-Dunnnett:  $p < 0.001$ ; Fig. 3), with 61.7% of the sightings ( $n = 3,247$ ) at less than 1,000m from the coast.

Data from all the years studied together, except 2005 (due to insufficient data), showed that 60.2% of the sightings were of mother-calf pairs, 11.4% of mating groups and 28.4% of others. There were significant differences in the percentages of each category of whale sighted as the season progressed

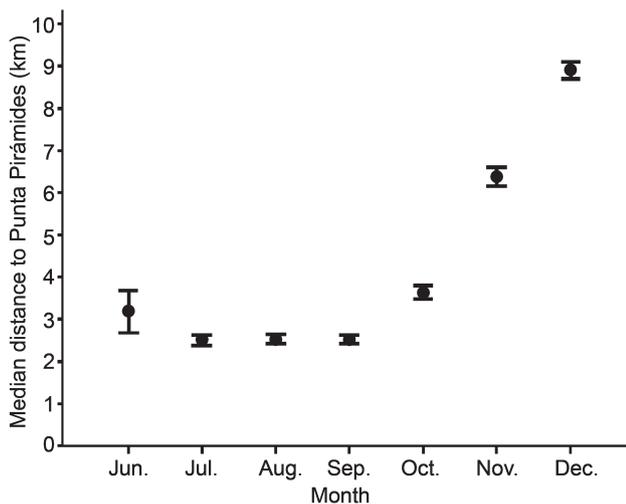


Fig. 3. Median distances of sightings to Punta Pirámides during the whale breeding season (June to December) of the six years studied. Error bars: 95% CI.

( $G_{6,0.95} = 1633.4$ ,  $p < 0.001$ ). In earlier months (June to August), it was more frequent to watch a mating group or other type of group in a sighting, while in later months (September to December), mother-calf pairs were the most frequent group to watch (Fig. 4). In earlier months, mother-calf pairs were sighted only at less than 2,000m from the coast, while in later months, mother-calf pairs were spread throughout the total range of distances to the coast; mating groups and others had different or even opposite distribution patterns (Fig. 5). These spatial distributions for each group were neither homogeneous in earlier months ( $G_{3,0.95} = 103.0$ ,  $p < 0.001$ ) nor in later months ( $G_{3,0.95} = 142.3$ ,  $p < 0.001$ ).

The weather conditions affected whalewatching activity. Most trips were made with northerly winds (39.3%), followed by westerly (29.7%) and southerly winds (20%). When the sea conditions were bad (higher Douglas,  $D_g$  values), trips tended to be shorter (ANOVA:  $F_6 = 5.08$ ,  $p < 0.001$ ; only  $D_g = 2.5$  and 3 were significantly different from  $D_g = 1$  and 2, Tukey-test:  $p < 0.05$ ; Fig. 6), but sightings tended to be longer (Kruskal-Wallis:  $X^2_8 = 33.14$ ,  $p < 0.001$ ; only  $D_g = 0.5$  was significantly different from  $D_g = 3.5$ , T3-Dunnnett:  $p < 0.05$ ; Fig. 7).

The median time of a trip was significantly different between years (Kruskal-Wallis:  $\chi^2_5 = 370.92$ ,  $p < 0.001$ ; T3-Dunnnett: years 2006 and 2007  $p < 0.01$  with all other years), decreasing from 2005 to 2007, and increasing in 2008 and

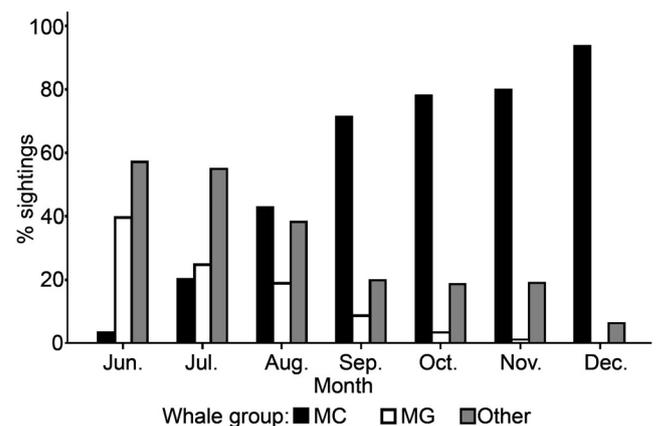


Fig. 4. Percentage of sightings with different types of whale groups during the whale season in the years 2006 to 2008, 2012 and 2013. MC: Mother-Calf pair; MG: Mating Group.

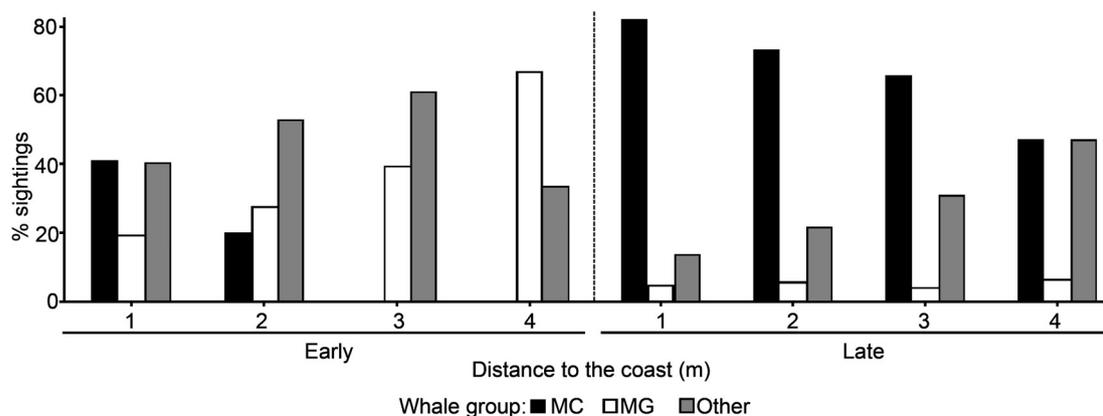


Fig. 5. Percentage of sightings with different types of whale groups according to the distances to the coast in the years 2006 to 2008, 2012 and 2013. Early: from June to August; Late: from September to December. MC: Mother-Calf pair; MG: Mating Group.

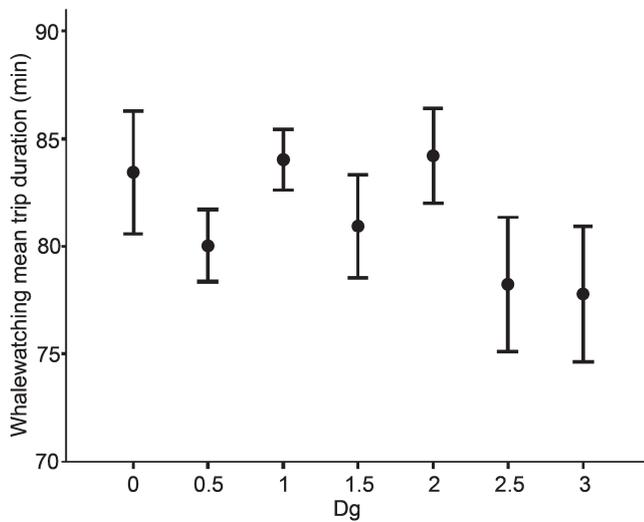


Fig. 6. Whalewatching trip mean duration as a function of Douglas scale (Dg) for the years 2005 to 2008, 2012 and 2013. Error bars: 95% CI.

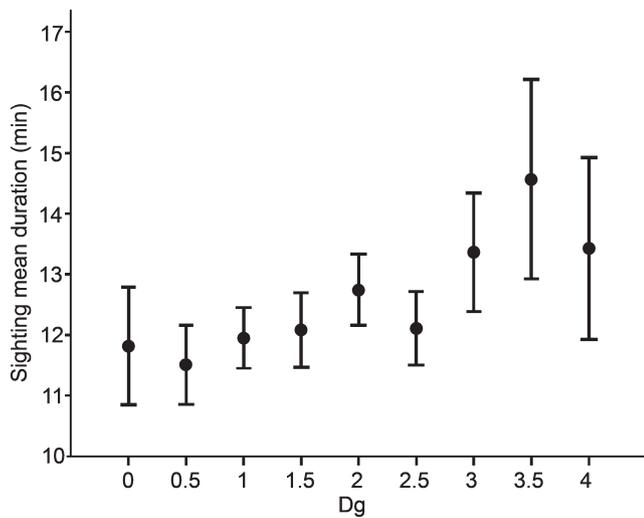


Fig. 7. Sighting mean duration as a function of Douglas scale (Dg) for the years 2005 to 2008, 2012 and 2013. Error bars: 95% CI.

subsequent years (Table 1). Similarly, the median time of a sighting was significantly different between years (Kruskal-Wallis: 155.81,  $p < 0.001$ ; T3-Dunnett: years 2006 and 2007  $p < 0.01$  with all other years, except between each other), with higher durations in 2005, 2008 and succeeding years (Table 1). On the other hand, higher trip durations were recorded towards the end of the season (Kruskal-Wallis: = 40.95,  $p < 0.001$ ; T3-Dunnett: years 2012 and 2013  $p < 0.05$  with all other months; Fig. 8).

**DISCUSSION**

Whalewatching boats concentrate their activities according to whale aggregation areas. Since southern right whales prefer coastal waters, most sightings took place at less than 1,000m from the coast. Most sighting locations varied across the whale breeding season due to whale movements. During the first half of the season (June to September) most sightings were recorded near Puerto Pirámides port – where large numbers of whales are concentrated – which is a benefit for the companies, which look to optimise their fuel costs. In October, many whales moved into deeper waters,

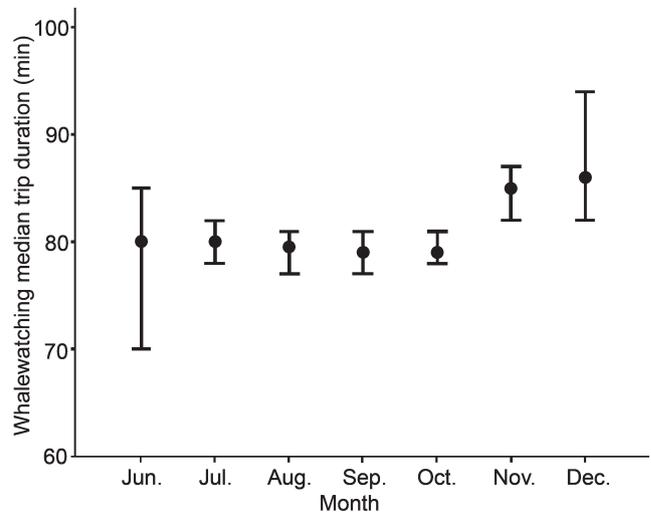


Fig. 8. Median duration of whale watching trips per month (all years gathered together). Error bars: 95% CI.

where they perform long dives apparently to feed. Consequently, whalewatching trips at this time took place farther from Puerto Pirámides port and also farther from the coast. Whales have been seen performing feeding behaviours several times (Argüelles, Fazio and Bertellotti, unpublished data), and Hoffmeyer *et al.* (2010) and Vighi *et al.* (2014) demonstrated that the zooplankton patches of Golfo Nuevo in the Southern Hemisphere’s spring (September to December) could be dense enough to make feeding worthwhile on this nursery ground. Finally, at the end of the season (November and December), most whales were found farther south and away from Puerto Pirámides, moving outside Golfo Nuevo to southern feeding grounds (Vighi *et al.*, 2014). Despite the micro-scale pattern of whale movements, whalewatching companies always attempted to navigate as close to the port as possible, not only because of economic saving, but also because bad weather conditions occasionally forced them to do so.

In the earlier months of the whale season (June to August), most of the sightings were of mating groups or others. In addition, many mothers were still pregnant and it was common to watch them resting alone on the surface. Although births tended to start in July, the new regulation applied from 2008 onwards permitted watching of mother-calf pairs from only 1 September so as not to disturb recently born calves. At mid-season and at the end of the season, sightings were mostly of mother-calf pairs, which is also the last group of whales to leave the area. These results coincided with those reported in 1993 by Rowntree *et al.* (2001). Mother-calf pairs were the most abundant whale group (around 60%) sighted during the season, in agreement with reports by Rivarola *et al.* (2001) and Argüelles (2008), not only because they stayed in the area longer, but also because companies want to show them to tourists at least once per trip. In earlier months, mothers prefer coastal waters because their calves are still very small, whereas in later months, calves are large enough to stay on the surface while mothers remain offshore or swim with them, maybe teaching them to feed. Mother-calf pairs occupy coastal areas at the beginning of the season, whilst mating groups seem to prefer offshore areas, as reported by Crespo *et al.* (2014). Solitary or grouped animals (‘others’) were distributed along the total

range of distances to the coast with no special pattern, except at the end of the season when they shared areas farther from the coast with mother-calf pairs. In general terms, in the first half of the whale season, trips tended to be coastal and shorter (but never less than 90min) but the groups of whales sighted were more varied. In contrast, during the second half of the season trips tended to be further from the coast and longer, but the groups of whales sighted were mainly mothers with their calves. This difference in the characteristics of the sightings throughout the whale season (early or late) could be the basis to generate different recreational experience opportunities, promoting two types of whalewatching boat trips; ‘friendly’ or ‘adventure’ (see Fig. 5). A friendly trip would take less time, occur near the coast and have more amenities for tourists. On the other hand, an adventure trip would offer not only whalewatching, but also a more exciting and adventurous navigation.

Whalewatching from Puerto Pirámides was frequently restricted by weather conditions. Most days on which the port was closed, it was due to strong southerly or south-westerly winds because of the high waves they caused. This is the reason why most trips were conducted in northerly winds, followed by westerly winds (the most common wind direction in Patagonia) and least frequently in southerly winds (easterly winds are scarce in the region). On days that the sea was very rough, but not rough enough to close the port, trips tended to be shorter and sightings tended to be longer since these sea conditions did not allow captains to find many whales. They stayed longer with each whale. Another interesting detail is that from 2005 until the present, the increase in the number of whalewatching tourists in Puerto Pirámides per year was not as large as the increase that had occurred since its origins, which could indicate that the activity in that town may have reached its carrying capacity. From 2005 to 2007, the number of tourists increased slightly per year, and trips were shortened to maximise passenger numbers per day. Nevertheless, in 2008, probably due to the international economic crisis, there was around a 10% decrease in the number of whalewatchers (101,743) relative to 2007, which reduced the number of trips per day, and trips were also longer. This effect could also be a result of compliance with the current legislation that came into force in 2008. One of the regulations of the ‘Patagonian Technique for Whale Watching’ states that trips should be at least 90 minutes in length (shorter only in poor weather conditions), to guarantee a high quality tourism service. Longer trips were accompanied by longer sighting-times, which means that the boats stayed longer with the same whales. As expected, at the end of the season, when whales are farther from the port, trips lasted longer. Furthermore, as the 2011 season progressed, the number of tourists decreased markedly, possibly due to the Puyehue volcano eruption that interrupted flights to Patagonia, severely affecting the incoming revenues to the area.

Whalewatching boats follow right whale distribution in a large area of Golfo Nuevo, which makes whalewatching an excellent scientific platform; it also has a strong educational potential and protects right whales against other harmful commercial activities (Chen, 2011; Rivarola *et al.*, 2001). In addition, the spatial and temporal dynamics of the sightings could be a good indicator of the different activities of whales

in the area, for example mentioned feeding behaviour. The community involved in whalewatching can help with solving problems with the animals they live and work with. For example, the people of Puerto Pirámides brought about action against the kelp gulls that peck skin and blubber from the backs of southern right whales, causing them serious injuries, a problem that only occurs in Península Valdés and that affects mainly calves (Fazio *et al.*, 2015; 2012).

Governmental guidelines or codes of conduct related to the behaviour of whalewatching operators have greater acceptance when whalewatching operators and tourism organisations are consulted extensively during the drafting of the guidelines. There is top-down remit for the production of new guidelines, but there is bottom-up involvement in their construction (Garrod and Fennell, 2004; Macedo *et al.*, 2013). This is the case for the law on whalewatching implemented in 2008, which was the result of several years of joint work between all those involved in whalewatching, such as agencies of Chubut Province, whalewatching operators, researchers, NGOs, the IWC, and IFAW. Some of this joint work is reflected in the Whale Watching Sustainable Tourism Workshop carried out in Puerto Pirámides in 2004 and the International Workshop on Management and Non-Lethal Use of Cetacean conducted in Puerto Pirámides in 2005.

Most whalewatching regulations issued by Chubut are similar to others that affect this activity in other countries (Kessler and Harcourt, 2013; Secretaría de Turismo y Áreas Protegidas, 2011). Some of these rules, if correctly applied, could improve the quality of a conservation plan, considering that both gulfs of Península Valdés (San José and Nuevo) are the main calving areas for this species in the Southwest Atlantic Ocean. Currently a Conservation Management Plan (CMP) for the Southwest Atlantic Southern Right Whale involving Argentina, Brazil, Chile, Peru and Uruguay is being prepared. One of the main objectives of the CMP is to protect the habitat of the southern right whale and minimise human threats in order to maximise its population recovery.

While the potential negative effects that tourism growth could cause in southern right whalewatching are of great concern, the regulation that currently exists and the management plan that is under development are vital for the conservation of this species in Patagonia and are excellent examples for other countries.

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