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ABSTRACT

Southern right whales (*Eubalaena australis*) have experienced high mortality rates at Península Valdés, Argentina in recent years (Rowntree *et al.*, 2013). In 2003, the Southern Right Whale Health Monitoring Program was established by a consortium of NGOs to monitor the health status of this population by post-mortem examinations. Previous reports to the IWC included information on the mortalities through 2015. Here we update information for the 2016-2017 seasons. A total of 774 dead whales were recorded on the Península Valdés calving ground (Chubut Province) since 2003. The number of dead whales was 15 in 2016 and 28 in 2017. As in previous years, most of the dead whales were newborn calves (93% of strandings in 2016 and 96% in 2017; 94.5% for both years combined). More dead whales were recorded in Golfo Nuevo (87% in 2016 and 72% in 2017) than in Golfo San José (13% in 2016 and 28% in 2017). Most whales died in July - August (8 individuals, 56%) in 2016, and in September - October (19 individuals, 68%) in 2017. One juvenile whale stranded alive in Caleta de Los Loros, Río Negro Province on 24 June, 2016 and died seven days later. The remaining whales were dead when reported or found, and post-mortem examinations were performed when and to the extent that carcass condition allowed. Biotoxins, infectious diseases, malnutrition, the physiological and behavioral effects of Kelp Gull (*Larus dominicanus*) attacks on newborn calves and density-dependent processes have been proposed as hypotheses to explain the high calf mortalities in this calving ground (IWC 2011, 2015). Results on biotoxins (Wilson *et al.*, 2015), Kelp Gull lesions (Marón *et al.*, 2015a) and histological findings suggestive of infectious and non-infectious processes (McAloose *et al.*, 2016) were published by Southern Right Whale Health Monitoring Program researchers and collaborators and reported to the IWC Scientific Committee. New lines of research are being developed at present to test the hypothesis that stress from injuries in southern right whales (predominantly due to Kelp Gull attacks) negatively affects their physiological homeostasis and could be a contributing factor to calf deaths in this population.

INTRODUCTION AND BACKGROUND OF SOUTHERN RIGHT WHALE MORTALITIES AT PENÍNSULA VALDÉS

Southern right whale population dynamics have been studied continuously through annual aerial photoidentification surveys at Península Valdés since 1971 (Payne, 1986; Rowntree *et al.*, 2001; Cooke, 2012; Cooke *et al.* 2015). During the first 30 years of the study, deaths appeared to increase at a rate similar to the increase in number of whales using the calving ground (Marón *et al.*, 2015b), but an unexpectedly large number of whales (47) died in 2005 (Uhart *et al.*, 2008), and high mortality events continued annually with an average of 75 whales dying each year from 2007 through 2011 (Rowntree *et al.*, 2013) and a peak of 116 deaths in 2012 (Sironi *et al.*, 2014). These are considered the most extreme mortality events ever observed for the species. In view of these deaths, it seems that this whale population and its ecosystem may be less healthy and robust than previously thought.

The Southern Right Whale Health Monitoring Program (SRWHMP, the “Program”) at Península Valdés is run by a consortium of the NGOs Instituto de Conservación de Ballenas (ICB), Ocean Alliance (OA), Wildlife Conservation Society (WCS), Fundación Patagonia Natural (FPN), the University of California, Davis and University of Utah, in collaboration with research centers and governmental agencies in Argentina and abroad. It was launched in 2003 with support from the US National Marine Fisheries Service and the US Marine Mammal Commission, and operates with funding from foundations, private donors and the NGOs and universities that lead the Program.

The aim of the Program is to evaluate the health status and learn about the biology of the southern right whale population by conducting post-mortem examinations of the animals that strand on the beaches of Península Valdés and surrounding area. Also, it aims at discovering the causes of deaths and their conservation implications for the species. Here we report data on strandings for the 2016-2017 seasons (June through December). Previous reports to the IWC included information through 2015 (Uhart et al., 2008, 2009; Rowntree et al., 2011; Sironi et al., 2012, 2014, 2016). Also, two workshops on the southern right whale die-offs at Península Valdés were convened by the IWC in cooperation with Argentina's national government and the Province of Chubut in 2010 and 2014 (IWC 2011, 2015).

MATERIALS AND METHODS

Stranded whales are located by occasional land surveys and systematic aerial surveys conducted by the Program's researchers, and by reports from a local Stranding Network with nearly 70 members. The Network includes park rangers, fishermen, whale watch captains and company owners, divers, tour operators, nature guides, sailors, airplane pilots, artisanal fishermen, researchers, NGOs, and local authorities such as the Argentine Navy and the Argentine Coastguard. The Stranding Network has been essential to the success of the Program.

To supplement reports from the Stranding Network, the Program's field team regularly surveys the coastline of Península Valdés by plane along its 500-km perimeter. When dead whales are found or reported, the Program's field team of veterinarians and biologists travels to the site and follows a necropsy protocol that includes recording the location, an external examination, photographing and measuring the body, tagging the carcass and, depending on carcass condition, a partial or complete necropsy to collect samples of external and internal organs and tissues. Samples are analyzed by laboratories in Argentina and the USA. All results are reported annually to provincial and national government authorities.

RESULTS

At least 774 southern right whales died in Península Valdés since 2003 (Di Martino et al., 2017). While the annual effort to find dead whales has remained the same, the number of deaths has shown strong variations between years (Fig. 1). For instance:

- the mortality in 2007 (83 deaths) was 4.6 times higher than in the previous year (18 deaths in 2006)
- the mortality in 2012 (116 deaths) equaled the total number of whale deaths in the two previous years combined (53 and 61 deaths in 2010 and 2011, respectively)
- the mortality in 2014 (23 deaths) was nearly one third of the mortality in the previous year (67 deaths in 2013)
- finally, in 2016 (15 deaths) the mortality was the lowest since 2004 but then almost doubled in 2017 (28 deaths).

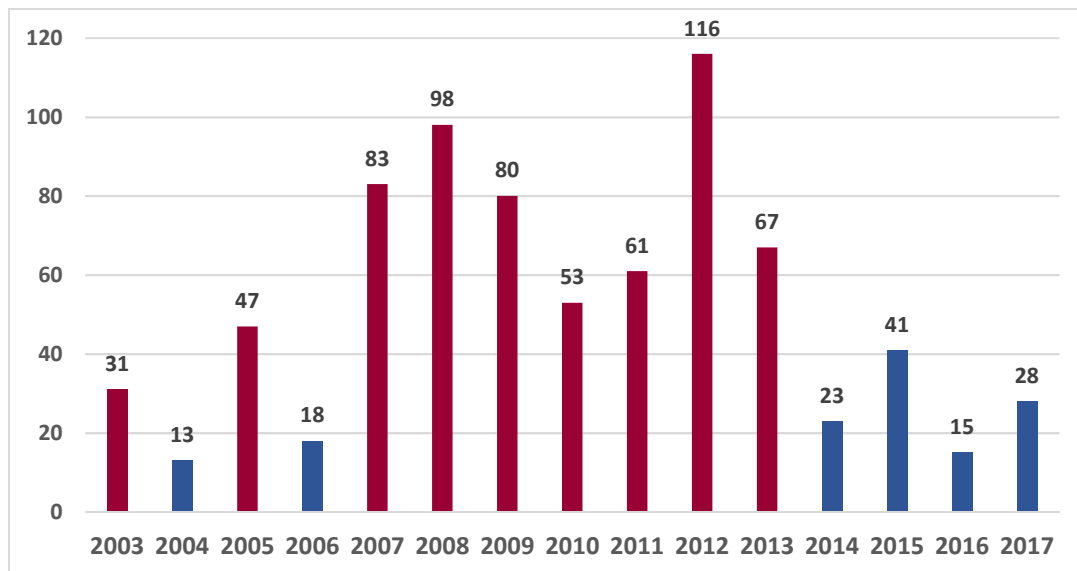


Figure 1. Annual number of dead southern right whales recorded at Península Valdés since 2003. Blue: low-mortality years; red: high-mortality years (see criteria in Marón *et al.*, 2015b).

Summary for 2016:

Fifteen strandings were recorded in 2016 at Península Valdés. Of these, 13 were recorded in Golfo Nuevo (87%) and two in Golfo San José (13%) (Fig. 2). For comparison, during a photoidentification aerial survey of living whales on 26 - 28 September 2016, 260 (68%) whales were in Golfo Nuevo and 124 (32%) were in Golfo San José (Sironi and Rowntree, 2016).

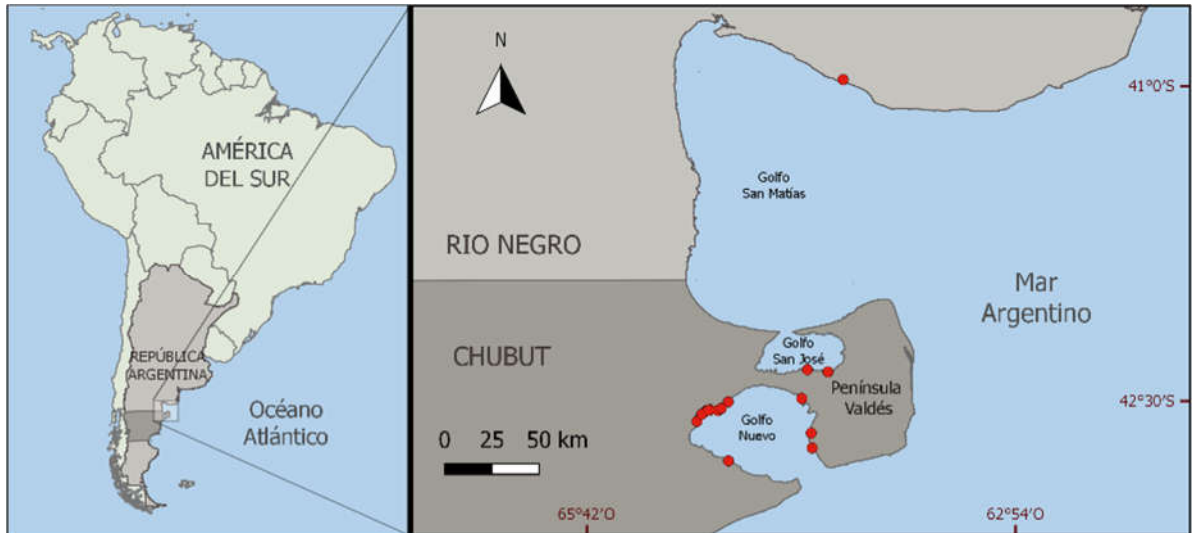


Figure 2. Location of dead whales (red dots) along the shores of Península Valdés and the live stranding in Río Negro Province, to the north, in 2016.

All but one of the whales that died in 2016 were calves (14 or 93%), with only 1 dead adult (7%) (Table 1). The sex ratio was 8 females: 6 males and one whale whose sex could not be determined. Most whales died in July (4 animals or 25%) and August (5 or 31%) totaling 56% of the strandings in those two months. The Stranding Network reported 10 (67%) strandings, while 5 strandings (33%) were found during 5 systematic aerial surveys. All stranded whales at Península Valdés were dead when reported or found.

The prevalence of gull-inflicted lesions on dead whales was recorded on every whale that stranded with its back visible and skin present. Of 10 whales examined, 7 (70%) did not have ante-mortem gull lesions and the remaining 3 (30%) had lesions. The remaining 5 whales could not be assessed for gull lesions due to stranding position, advanced state of decomposition or because the skin was not present. Of the whales without lesions, 86% (6) were less than 5 m in length, and all (7) were less than 6 m long.

One juvenile female whale stranded alive in Caleta de Los Loros, Río Negro Province, to the north of Península Valdés. This whale was first reported on 24 June, 2016 and died seven days later. Very low tide conditions and a remote and inaccessible location prevented it from being rescued. Our team was invited to participate in the necropsy. Rake-type marks were observed on the whale's right tail fluke and on its back, which resemble those seen on cetaceans after orca attacks (Figure 3). It was in good body condition with no evidence of malnutrition. Total length of this animal was 11.55 m.



Figure 3. Rake marks on the whale that stranded alive in Caleta de Los Loros, Río Negro Province, on June 24, 2016.

Summary for 2017:

Twenty-eight whales died along the shores of Península Valdés in 2017, almost doubling the number of strandings (15) in 2016. Twenty deaths were recorded in Golfo Nuevo (72%) and eight in Golfo San José (28%) (Fig. 4). For comparison, during a photoidentification aerial survey of living whales on 9 and 10 September 2017, 592 (75%) whales were in Golfo Nuevo and 196 (25%) were in Golfo San José (Sironi and Rowntree, 2017).

With the exception of one adult (4%), nearly all whales that died in 2017 were calves (27 or 96%) (Table 1). The sex ratio of animals whose sex could be determined was 14 females: 8 males with 6 animals of unknown sex. Most whales died in September (12 animals or 43%) and October (7 animals or 25%) totaling 68% of the strandings in those two months. The Stranding Network reported 16 (57%) dead whales, while 12 strandings (43%) were found during 5 systematic aerial surveys. All whales were dead when reported or found.

Of 15 whales examined for gull-inflicted lesions, 5 (33%) had ante-mortem gull lesions and 10 (67%) did not have lesions. The remaining 13 whales could not be assessed for gull lesions due to stranding position, advanced state of decomposition or because the skin was not present. Of the whales without lesions, 20% (2) were less than 5 m in length, and 90% (9) were less than 6 m long.

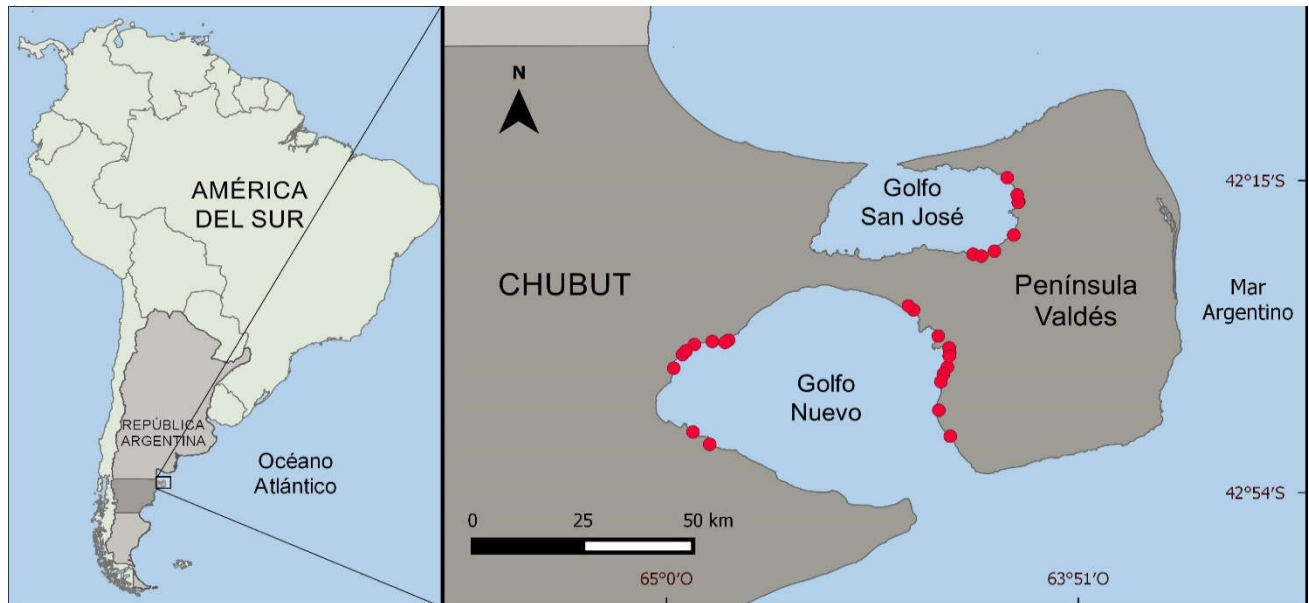


Figure 4. Location of dead whales (red dots) along the shores of Península Valdés in 2017.

Table 1. Age class distribution of strandings recorded at Península Valdés in 2016 and 2017.

Age class	2016	2017	Total (both years)	% of Total (both years)
Calves	14	27	41	95
Juveniles	0	0	0	0
Adults	1	1	2	5
Total	15	28	43	100

DISCUSSION

The annual number of southern right whale strandings at Península Valdés continues to show significant variations between years. However, since 2014 there has been a continuum of low mortality years (when the estimated population growth rate is considered in calculations, Marón et al., 2015b). Twenty-three whales (including 20 calves) died in 2014, representing a marked decrease relative to the period 2007-2013 (see Fig. 1). The 2014 mortality toll was comparable to the number recorded a decade earlier (13 strandings in 2004). The number of deaths in 2015 (41) almost doubled the number of strandings in the previous year, yet still fits the population growth model for a low mortality year (Marón et al., 2015b). Finally, in 2016 (15 deaths) the mortality was the lowest since 2004 but then almost doubled in 2017 (28 deaths).

In 2012 a record 113 calves died in Península Valdés, i.e., 113 adult females lost their calves a few days or weeks after they gave birth. Adult females that experience perinatal calf losses may recover quickly and conceive a second calf in one year rather than two; thus the frequencies of two-year calving intervals (vs. the normal three-year intervals) are expected to increase when perinatal (late-term fetus and neonatal calf) mortality increases (Marón et al., 2015b; Seger et al., 2015). Consequently, it is likely that many adult females that lost their calves in 2012 returned to Península Valdés to give birth in 2014 and possibly were in better body condition to successfully raise their calves, hence reducing the annual calf mortality that season. Similarly, many whales that lost their calves in 2015 may have returned to the calving ground in 2017. Furthermore, 757 live whales were counted in 2014 and 788 in 2017 during the annual aerial photoidentification surveys conducted by Instituto de Conservación de Ballenas and Ocean Alliance (Sironi and Rowntree 2016, 2017). These were the highest numbers ever counted since the surveys began in 1971, supporting the hypothesis that unusually large numbers of pregnant females (that possibly were in better body condition) migrated to Península Valdés in 2014 and 2017 to give birth after losing their previous calves.

Most live whales in this calving ground are found in Golfo Nuevo, the southern gulf of Península Valdés and fewer in Golfo San José, the northern gulf (Rowntree et al., 2001). The percentage of whales that died in Golfo Nuevo in 2016 (87% of all dead whales) was higher than the percentage of live whales counted during aerial photoidentification surveys in September (68%) (Sironi and Rowntree, 2016), while in 2017 the percentages were very similar (72% dead and 75% live) (Sironi and Rowntree, 2017). It appears that in some years the percentage of dead whales in Golfo Nuevo is significantly higher than that of live whales counted from aerial surveys during the peak of the concentration in September, e.g., 86% of the whales that died in 2012 were found in Golfo Nuevo, where only 64% of live whales were counted (Sironi et al., 2014). This suggests that ecological, environmental or physiological conditions potentially leading to mortality affect a higher proportion of calves in Golfo Nuevo than in Golfo San José.

Kelp Gulls eat the skin and blubber of living southern right whales at Península Valdés, creating large wounds on the whales' back (Rowntree et al., 1998; Sironi et al., 2009; Thomas, 1988). Nearly 99% of living mother-calf pairs and 56% of dead calves examined had lesions in the 2000's (Marón et al., 2015a). The number of gull-inflicted lesions and the area affected increase with calf age during their time at Península Valdés (Marón et al., 2015a). It is therefore likely that the calves that died in 2016 and 2017 and had no lesions would have acquired them as the calving seasons progressed. As reported by Marón et al. (2015a), using length as a proxy for age, 47% of dead calves without gull lesions were less than 5 m long, and 94% were less than 6 m in length. Conversely, 75% of calves with lesions on their backs were larger than 6 m (between 6 and 7.5 m).

The continuing high mortality of right whales at Península Valdés prompted the IWC Scientific Committee to convene two workshops of specialists in Puerto Madryn, Argentina in 2010 and 2014, co-organized by the IWC, the US Marine Mammal Commission, Argentina's national delegation to the IWC and the government of Chubut Province at the Centro Nacional Patagónico (CENPAT-CONICET). Three leading hypotheses to explain the high mortalities were proposed in the first workshop: decreased availability of food, exposure to biotoxins, and infectious disease, or a combination of these factors. Two other hypotheses were added during the second workshop: the role of Kelp Gull attacks on whale

health and density-dependent processes (Crespo et al., 2015; IWC, 2011, 2015; Thomas et al., 2013). Based on the workshops' recommendations, the Program focused its efforts on collecting samples and information that would help to further investigate these hypotheses. Results on the role of algal biotoxins (Wilson et al., 2015), Kelp Gull lesions (Marón et al., 2015a) and histologic findings suggestive of infectious and non-infectious processes (McAloose et al., 2016) were reported to the IWC.

Presently, the Program's researchers (Marón et al.) are studying the nutritional condition of the Península Valdés southern right whales by analyzing the fatty acid profiles and lipid content of their blubber to identify indicators of nutritional stress. Preliminary results suggest that nutritional condition does not significantly differ among living and dead calves, and that dead calves do not show signs of malnutrition. Also, Fernández Ajó et al. have started testing the hypothesis that stress from injuries in southern right whales (predominantly due to Kelp Gull attacks) negatively affects their physiological homeostasis. Specifically, the prediction is that increased severity and extent of wounds will correlate significantly and positively with increased concentrations of glucocorticoids (GCs) in baleen, and that baleen GCs will be highest in calves with many wounds, lower in calves with fewer wounds, and least in calves that died due to acute trauma (e.g. shipstrike). This research seeks to further develop the baleen hormone technique developed by Hunt et al. (2017) to assess the effects of stress on health and mortality of right whale calves in Península Valdés. Preliminary results from these two studies will be presented at the IWC Scientific Committee Meeting in separate papers.

Since 2003, thousands of biological samples from southern right whales at Península Valdés have been collected by the Program and analyzed by collaborating scientists in laboratories in Argentina and the USA. Research efforts to unravel the causes of these unexplained deaths continue, and collaborations are welcome. Consistent and sustained high calf mortality rates could affect/slow the Península Valdés southern right whale population's recovery (Rowntree et al., 2013; Marón et al., 2015b).

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