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# Incorporating whale-watch photographs into a 47-year aerial photo-identification catalog for a better assessment of the population dynamics of southern right whales off Argentina

Florencia O. Vilches<sup>1</sup>, Victoria J. Rowntree<sup>1,2,3</sup>, Mariano Sironi<sup>1,4</sup> and Camila Muñoz Moreda<sup>1</sup>

<sup>1</sup> Instituto de Conservación de Ballenas, Argentina

<sup>2</sup> Ocean Alliance, USA

<sup>3</sup> Department of Biology, University of Utah, USA

<sup>4</sup> Diversidad Biológica IV, Universidad Nacional de Córdoba, Argentina

## ABSTRACT

A photographic catalog of 3,200 individually identified southern right whales has been built up on their calving ground at Península Valdés, Argentina, through annual aerial surveys since 1971. This long-term database is a unique resource for biological research, conservation and education, which sensitively records the population's dynamics. However, the database still represents a relatively small sample of whale life histories occurring in Valdés. A way to increase this sample size is to incorporate photographs taken during whale-watch tours in Puerto Pirámides, the hub of Argentina's whale-watch industry. Unlike aerial survey photographs, boat-based photographs are taken almost daily during the seven months of the year when the whales are present. Recently, the operators contributed 460,000 photographs of whales taken between 2003 and 2016. Initial findings added 105 new individuals to the catalog (86 adults, 19 calves) and increased the number of sightings of 45 previously known individuals, some of which had not been seen for 16 years. New information about ages and mother-calf relationships was also found, as well as extended data about calving frequencies of known females. Further and continued analysis of the whale-watch photographs will greatly enrich our understanding of the biology, dynamics and ecology of this population. The resulting expanded database will help to improve conservation strategies and boost citizen science and community work in Valdés.

**Keywords:** Southern right whale, photo-identification, whale watching, Península Valdés calving ground, citizen science.

## INTRODUCTION

The southern right whale population that calves off Península Valdés, Argentina (42° 30' S, 64° 10' W), has been studied continuously for longer than any other species of large whale in the world (Payne 1986). A photographic catalogue of 3,200 individually identified whales has been built up through annual aerial surveys since 1971. Valuable scientific data have been obtained using this non-invasive research methodology. Among other things, we now know that females reproduce on average once every three years; their mean age at first parturition is 9 years; females have repeatedly had fewer calves than expected following El Niño years when sea surface temperatures were higher than normal; the annual rate of population increase has varied through time; and the whales have changed their distribution along the shorelines of the peninsula (Best et al. 2001, Cooke et al. 2001, 2003, 2015, Rowntree et al. 2001, Leaper et al. 2006). The long-term database has become a sensitive indicator of the population's health and dynamics. However it has been restricted by having only one annual aerial survey and still represents a relatively small sample of whale life histories occurring in Península Valdés, which limits its ability as an indicator.

As the population grows, we are miss many whales that are underwater when we fly over them, or that arrive at Península Valdés after or leave the area before the annual survey in September. In addition, aerial photographs seldom document the details in the callosity patterns on the small heads of calves, preventing the identification of whales in their year of birth. Incorporating photographs taken during whale-watch tours will increase our sample size, including whales of known age.

One of the oldest and largest whale-watching industries in the Southern Hemisphere was developed in Puerto Pirámides, the only town in Península Valdés, where more than 94,000 whalewatchers went on tours in 2013 (Secretaría de Turismo y Áreas Protegidas 2015). Since the invention of digital cameras, the six companies that conduct whale-watch tours have accumulated a wealth of professional close-up photographs of the whales they see (more than 10,000 annually) that they offer to tourists as promotional and educational material. Unlike aerial survey photographs, boat-based photographs are taken almost daily during the seven months of the year when the whales are present at Península Valdés.

Our goal is to integrate photographs taken throughout the whale season by professional whale-watch photographers on tourist boats into our aerial survey catalog and database to increase sighting histories and fill data gaps to make a better assessment of the health and population dynamics of the southern right whales that calve at Península Valdés.

## **MATERIALS AND METHODS**

The southern right whales at Península Valdés are surveyed annually during the time of peak whale abundance (September) by flying along the 500km perimeter of the peninsula and photographing the callosity pattern on the head of each whale encountered. Survey observers record each whale's location, behavior and whether it is accompanied by a calf. Photographs are processed in the lab comparing photo-identifiable whales to those in the catalog using a computer-assisted identification program created by Lex Hiby and Phil Lovell (Hiby and Lovell 2001). The program is designed to identify right whales from aerial photographs, which show both sides of a whale's head from a dorsal view (showing its full callosity pattern). Survey techniques and analysis procedures are described in Payne (1986), Payne and Dorsey (1983), Payne et al. (1983, 1990) and Rowntree et al. (2001).

The boat-based photographs were taken opportunistically by eight photographers almost daily during whale-watch tours over the seven-month period of the whale season (June-December), between 2003 and 2016. The tours operate within a 25-km segment of the peninsula's coast and follow the guidelines of the "Patagonian Technique for Whale Watching" (Sironi et al. 2009). Copies of 460,000 boat-based photographs were provided by the whale-watch collaborators and stored in external hard drives. An agreement with respect to ownership and use of right whale photographs was signed with each of the photographers.

Big Fish is a computer-assisted program created by Rebecca Pirzl to identify individual right whales in either boat-based or aerial photographs and was developed by the Australian Government (Pirzl et al. 2006). It is ideal for use on boat-based photographs because it identifies right whales by scoring the presence and absence of callosity features and thus allows the combination of information provided by multiple lateral photographs that show only partial views of the callosity pattern. The first step in our use of Big Fish was to enter the sighting histories of the 3,200 individuals photographed over 45 years of aerial surveys. The next step was to code the callosity pattern of each of the whales in the Península Valdés catalog. A year later, the first set of boat-based photographs (taken between 2003 and 2007) was entered into the BigFish system and compared to those in the Península Valdés aerial survey catalog.

## RESULTS AND DISCUSSION

Among the 1,180 boat-based photographs analyzed, that were taken between July and November of 2003-2007, 151 identifiable whales were found, of which 105 have been incorporated into the catalog and database as new individuals and 46 were previously known whales. The new individuals added to the catalog included 86 adults and 19 calves. The sightings of known individuals included 17 whales that had also been identified in the aerial survey photographs of that year (group A) and 29 whales that had not been identified in the aerial survey of that year (group B), some of which had not been seen for as long as 16 years (Table 1).

Table 1. Number (and percentage) of known whales by age class in each group. Group A: known whales identified from aerial surveys and from whale-watch boats on the same year. Group B: known whales identified from whale-watch boats but not from aerial surveys on the same year.

	Group A	Group B	Total #	Total %
# individuals	17 (37%)	29 (63%)	46	100
# adults with calf	8 (44%)	10 (56%)	18	39
# calves identified	2 (33%)	4 (67%)	6	13

In group A, eight adults were accompanied by calves, but none of the newborns were identifiable from the aerial photographs. The close-up photographs taken from boats allowed us to see the details in the callosity patterns on the small heads of two of these previously unidentified calves and add each of them as new known-age individuals. Whales from group B might have been underwater in the moment the survey plane flew over them or have arrived and left Península Valdés before or after our September aerial survey. Of the 29 whales of group B, 10 were accompanied by a calf, of which 4 could be identified and added to the catalog as new known-age individuals (Table 1). It is worth noting that among the 10 known females in group B, two had a shorter or longer than average calving interval. Females in the Península Valdés population typically calve once every three years (Cooke et al. 2001, IWC 2012), but intervals of two, four and five years are less frequent and are interpreted as of calving failures (Marón et al. 2015).

Whales in group B (known whales identified from whale-watch boats but not from aerial surveys on the same year) represent 63% of the previously known whales detected with the current preliminary analysis (Table 1). This stresses the relevance of the new scientific information that is generated by whale-watch photographers with their daily work at sea. Filling gaps in the sighting history of known females by incorporating whale-watch photographs into our catalog and database has allowed us to document reproductive histories more precisely and will improve our understanding of the calving frequencies and reproductive success of this population.

Two significant matches among the whales in group B illustrate another valuable contribution from incorporating whale-watch photographs into the Península Valdés right whale database. These two known individuals were each seen only once during aerial surveys in 2006 and 2008, when they were photographed as juveniles in socializing groups. Both sighting histories were enriched after analyzing boat-based photographs that showed them as calves next to their mothers, one in 2004 and the other in 2005. This finding provided new information not only on the year of birth of these whales, but also linked these known-age calves to their mothers: one of them was already in the catalog and the other was added to the catalog as a new individual.

So far the initial analyses of the whale-watch photographs have provided novel, valuable, complementary information, such as the addition of new individuals to the catalog and new

sightings of known individuals; the determination of the age of known individuals and their mother-calf relationships; an extension of the information on calving intervals of known females; and the identification of whales over a broader time period, thus informing residency times. Further and sustained analyses of the whale-watch photographs will enrich these types of findings and provide other kinds of information as well. We expect to increase our understanding of residency times on the calving ground of different age and sex classes; obtain information on social bonds by documenting whales that are repeatedly seen together throughout the calving season; and monitor health condition by analyzing skin lesions and scars. Ultimately, incorporating whale-watch photographs to the Península Valdés right whale database will greatly increase our understanding of the biology and ecology of this population and, thus, make population models even more sensitive to changes in the conservation status of Península Valdés whales and their habitat.

This study demonstrates how cooperations between researchers and professional photographers on board whale-watch boats can provide invaluable information to our knowledge of right whales, their health and population dynamics, and in particular, highlights the value of whale-watch boats as excellent platforms of opportunity for whale research.

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