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Status of blue whales off Isla de Chiloe, Chile, during 2007 field season

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ABSTRACT

Since 2004, a collaborative research program of the Alfaguara Project on blue whales off Isla de Chiloe, Chile, has produced important new information on present day conservation status of this population. This paper presents preliminary findings from 2007 and compares such data with that reported in previous years. Land-based monitoring in 2007 resulted in 36 days of observations with 262.85 h of land-based effort. The maximum number of individuals sighted from land ranged from 2 to 44, with an average of 18.14 individuals per day (SD=12.00 ; CI_{95%} =14.08 - 22.20). Preliminary results on fifteen of seventeen photo-identification surveys conducted in 2007 resulted in the documentation of 123 blue whale groups comprising 156 individuals. The number of whales encountered does not include animals resighted on same day. Individual photo-identification of left and right side respectively, resulted in 80 individual blue whales, including seven between years and sixteen within year recaptures; and 74 individual blue whales, including nine between years and fourteen within year recaptures. The combined photo-identification catalogue (2004-2007) is comprised of 143 individual blue whales (left-side) and 137 (right-side). A photo-identification recapture from different areas provides evidence that the blue whale feeding ground off southern Chile is extensive and dynamic. A recapture analysis of 2005 and 2006 whales shows an overall return rate of 10.8% (left side) and 11.4% (right side) highlighting the northwestern Isla de Chiloe as an important long-term feeding area for this population. Of the 80 individuals recorded this season, 56.8% (n=42) were recorded to be “skinny”, including 5.4% (n=4) with ribs clearly visible. The 2007 proportions of skinny whales are the highest documented to date. It is unknown if these skinny whales represents any potential threat to this population. Therefore, it is essential that long-term photo-identification research continue to monitor this condition.

INTRODUCTION

During the 20th century, blue whales became a principal target of the whaling industry throughout the world, notably following the opening in 1904 of the rich whaling grounds in the Southern Ocean. Knowledge of blue whale populations is limited and few data are available to assess the status of the different populations, particularly in the Southern Hemisphere where blue whale numbers were dramatically reduced by decades of poor management and illegal whaling (Clapham *et al.*, 1999). In Chile, catches of blue whales occurred in waters along the continent and in Antarctic waters. Approximately 2,982 individuals were taken in continental waters off Chile between 1929 and 1971, and at least 27,720 from 1911 to 1929 in the Chilean Antarctic Territory (Aguayo *et al.* 1998).

Although the distribution and historical catches of each subspecies in Chile remains undetermined, new information is increasing our knowledge of blue whales in Chilean waters. A feeding ground was described in southern Chile (Hucke *et al.* 2004, Cabrera *et al.* 2005), and systematic research developed by Centro de Conservación Cetacea (CCC) highlighted the northwestern of Isla de Chiloe as an important feeding area (Galletti Vernazzani *et al.*, 2005; Galletti Vernazzani *et al.*, 2006) and revealed that the sighting rate of blue whales off northwestern Isla de Chiloe is among the highest in the Southern Hemisphere (Branch *et al.*, In press).

Two subspecies of blue whales are currently accepted in the southern hemisphere: the “pygmy” blue whale (*Balaenoptera musculus brevicauda*) in the Subantarctic zone, and the “true” blue whale (*B. m. intermedia*) for the whales that summer in the Antarctic Zone (Rice, 1998). Both true and pygmy blue whales are known from Chilean waters (Aguayo L. 1974). Blue whales off Isla de Chiloe differ from Antarctic or true blue whales (IWC, 2006) and Branch *et al.* (In press) hypothesize that these whales belong to a separate, as yet undescribed subspecies. However the taxonomic status of blue whales that feed off Isla de Chiloe during the austral summer is unresolved.

This paper present preliminary findings from our 2007 field season of the Alfaguara Project on blue whales off Isla de Chiloé.

METHODS

During 2007, research was conducted until 27 April from aerial, marine and coastal platforms. Results from aerial surveys, extending from 35.85° S to 44.06° S and made possible through the support of the Chilean Navy, will be reported at a later date.

Land-Based Monitoring

Using 12x50 binoculars, trained observers conducted land-based observations during daylight hours (08:00 to 20:30), from a platform located 104 m above sea level (41° 58' 12,5" S / 74° 03' 03,5" W) whenever visibility was higher than 5 nm and wind speed less than 20 kt.

For each whale or group of whales sighted, the time, minimum number of whales, angle and estimated distance of the whales from the coast were recorded.

The location and altitude of the coastal sighting platforms varied between years. While there were no significant differences in sighting area coverage, the variability in whale distribution could affect direct, between-year comparisons of data.

Photo-Identification

Blue whales are individually identifiable from the unique pattern of mottling on both sides of the body near the dorsal fin (Sears *et al.*, 1990) and in some cases permanent scars were used to identify or confirm individuals. Photo-identification methodologies employed during the 2007 field season were identical to those used since 2004 (Cabrera *et al.*, 2006). The overall consistency in research design, data collection techniques and data analysis allowed between-year comparisons to be made.

Boat-based photo-identification surveys were conducted on good weather days off northwestern Isla de Chiloé, between 41°45'S and 42°12'S and within 20 nm from the coastline. However, during 2004, one marine survey was conducted around the Corcovado Gulf, and an additional opportunistic photo-identification was taken in December 2006 by a member of the CCC National Marine Mammal Sighting Network in Atacama (29° S).

When a whale or group of whales was sighted, they were approached for photo-identification using standard procedures with two digital, professional cameras and 300 mm and 400 mm stabilized lenses. Both right and left sides, dorsal fins and prevalent scars were photographed and data on group composition, behavior and associated fauna were collected. Location was recorded with a GPS device and sea surface temperature was measured on every survey.

Clear, well-focused photographs of left and right sides and dorsal fins of individual blue whales were compared within year to determine the number of individuals sighted as well as sighting frequency. Individual blue whales from each year then were compared to the CCC's catalogue. A new identification number was assigned to unmatched whales only when photographs were determined to be of suitable quality. Photographs of low quality or whales only partially photographed were not included in the catalogue and were archived independently for future analysis.

Using the photo-identification data for each year, we examined the number of days individual whales were re-sighted; minimum residency time (the number of days between first and last sightings within the same season); re-sighting rate (the proportion of individual whales identified on more than one day within the same season) and return-rate (the proportion of individual whales recaptured on later years). Re-sighting rate, minimum residency time and return-rate were obtained for both, left and right data sets and calculated on records from 2005 to 2007. Data from 2004 included only two marine surveys in different areas and was not used in the analysis.

All whales identified to date are photographically catalogued by individual allowing for an in depth analysis of scars and health condition.

RESULTS

Land-Based Effort and Whale Sightings

Between 02 February and 16 March 2007, 36 days of observations averaging 7.3 h (SD=3.1 h) were conducted.

Whales were observed on all days of land-based sighting effort (262.85 h). The number of groups of whales sighted daily ranged from 2 to 35, totaling 547 groups with an average of 15.19 groups per day (SD=9.56 ; CI_{95%} =11.96 – 18.43). The number of individuals sighted from land ranged from 2 to 44, totaling 653 individuals with an average of 18.14 individuals per day (SD=12.00 ; CI_{95%} =14.08 - 22.20).

Between 2004 and 2007, baleen whales were recorded on 93 days (632.4 hrs) of systematic land-based effort off northwestern of Isla de Chiloe, and 9 days (36.5 hours) of opportunistic sightings in 2006 (Table 1).

Table 1 – Land based effort and groups and individuals of baleen whales per days.

Year ¹	Land-based Sampling Period (mo, d)	Sighting Effort (days / hour)	Groups of balaenopterids per day			Individuals of balaenopterids per day		
			Range	Average (mean ± SD)	95%CI	Range	Average (mean ± SD)	95%CI
2004	02/16 – 03/17	29 / 190.9	*	*	*	2 - 19	9.03 ± 4.70	7.25 – 10.82
2005	01/31 – 03/15	28 / 177.7	0 - 19	8.54 ± 5.21	6.52 – 10.55	0 - 31	13.64 ± 8.10	10.50 – 16.78
2006 ²	02/08 – 03/20	09 / 36.5	7 - 23	14.33 ± 5.87	9.82 - 18.85	8 - 37	20.67 ± 8.87	13.94 – 27.39
2007	02/02 – 03/16	36 / 262.8	2 - 35	15.19 ± 9.56	11.96 - 18.43	2 - 44	18.14 ± 12.00	14.08 – 22.20

¹Location of sighting platform varied from year to year and could affect direct comparison between years.

²Land-based observations in 2006 were made opportunistically.

Unlike previous years, during the 2007 season, baleen whales generally were not observed in close proximity to the coast. Therefore it was not possible to identify species and confirm the presence of blue whales. Whales were observed opportunistically from the coast until the end of our field season on 28 April 2007.

Survey Effort and Photo-Identification

Individual blue whales were identified from photographs of natural markings and permanent scars. Two collections of photographs are maintained separately within the catalogue representing left and right head region, dorsal fins, sides and caudal peduncles. The catalogue, from 2004 through 2007, consists of 143 left-side and 137 right-side individual identifications from 37 boat-based surveys. All individuals were considered non-calves (i.e. adults or subadults).

Fifteen photo-identification surveys totalling 82.9 hrs were conducted between 01 February and 29 April 2007. During these surveys, 123 blue whale groups comprising 156 individuals were identified (Table 2). The number of whales encountered does not include animals resighted on the same day. Individual photo-identification of left and right side respectively resulted on 80 individual blue whales, including seven between years and sixteen within year recaptures; and 74 individual blue whales, including nine between years and fourteen within year recaptures (Table 3).

Two additional marine surveys were conducted on 26 and 27 April, before the end of the season, resulting in 33 groups consisting of 49 blue whales. These data are not included in any of the results presented on this paper as we had insufficient time to analyze it for this meeting.

Ten whales (6%) were not included in the catalogue due to poor quality of photographs or insufficient photographic information.

Table 2 – Photo-ID effort, groups and number of blue whales approached

Year	Sampling Period (mo, d)	Number of surveys	Hours of Observation (hrs)	Groups of blue whales encountered	Number of blue whales encountered
2004	02/25 – 03/15	2 ¹	17:35	2	3
2005	02/01 – 03/15	8	29:13	25	58
2006	02/04 – 04/15	12	67:15	70	112
2007	02/01 – 04/29	15	82:52	123	156
TOTAL		37	196:55	220	329

¹ One marine survey (10,25 hr) in the Corcovado Gulf.

Table 3 – Left and right side photo-ID's and recaptures

Year	New Photo-ID	Recapture within season	Left Side Recapture from previous years	Total Individual Photo-ID Season	New Photo-ID	Recapture within season	Right Side Recapture from previous years	Total Individual Photo-ID Season
2004	4 ¹	0	0	4	2	0	0	2
2005	12	1	0	12	7	1	0	7
2006	54 ²	8	1	55	63	10	0	63
2007	73	16	7	80	65	14	9	74
TOTAL	143	25	8	-	137	25	9	-

¹ Includes opportunistic photo-identifications.

² Includes an opportunistic photo-identification off Atacama.

Recaptures and Residency Times

During 2007, 16 individuals (20.0%) comparing left side photographs and 14 individuals (18.9%) comparing right side photographs were observed on multiple occasions. Analyses of the 2005/2007 data set indicates that in 2007 residency rate was higher than in previous years. For left side photographs, residency rates ranged from 8.3% to 20.0% with an average of 14.3% (SD=5.8%) and right side photographs ranged from 14.3% to 18.9% with an average of 16.4% (SD=2.4%).

The minimum residency time of all re-sighted blue whales since 2005 ranged from 2 to 67 days, with a mean of 17.64 (S.D=19.88) days for left side photographs and of 18.86 (S.D=20.17) days comparing right side photographs.

Of the fourteen whales re-sighted in 2007, three individuals were identified on three occasions over a period of 13, 35 and 67 days. However, the second longest minimum residency time was 59 days for one individual sighted on two occasions.

In 2006, one individual (left side) out of 55 identified (1.8%) was first catalogued in 2005. By contrast, in 2007, 7 individuals (left-side) out of 80 (8.8%) and 9 (right-side) out of 74 (12.2%) have been identified in previous seasons.

All between year sightings are individuals that have been identified on one occasion in each season. A recapture in 2007 from 2004 was of the only blue whale photo-identified during a marine survey conducted in the Corcovado Gulf. A second recapture in 2007 was from a whale previously identified in 2005 off northwestern Isla de Chiloe. All other between year recaptures were from whales identified in 2006 in the study area. A recapture analysis of 2005 and 2006 whales shows an overall return rate of 10.8% (left side) and 11.4% (right side).

Table 4 – Return rate to northwestern Isla de Chiloe of blue whales photo-identified in 2005 and 2006

Year	New Whales Identified	Left Side		New Whales Identified	Right Side	
		Recapture of Individuals	Return rate		Recapture of Individuals	Return Rate
2005	12	1	8.3%	7	1	14.3%
2006	53	6	11.3%	63	7	11.1%
Overall	65	7	10.8%	70	8	11.4%

Group size, Behaviour and Physical Conditions

Based on sightings recorded of marine surveys, in 2007 blue whales were generally observed in groups of 1 or 2 individuals ($n=123$; 1.27 ± 0.46). Blue whales were not sighted in three surveys. Feeding behavior and/or defecation were recorded on ten out of twelve surveys.

Additionally, social behaviors including chasing, partial breaches, high-speed swimming and forceful blows were recorded. Similar social behavior by blue whales has been observed in the Gulf of St. Lawrence (Sears *et al.* 1999) and was first reported in 2006 off northwestern Isla de Chiloe (Galletti Vernazzani *et al.* 2006).

Thin or “skinny whales” were observed and photographically documented. The proportion of skinny whales to all whales photo-identified during 2007 is the highest number documented to date (Table 5).

‘Skinny’ blue whales were observed during eleven out of twelve marine surveys. Analyses of photographs resulted in the establishment of three categories of skinny whales based on respective degree of depression of the lateral flank and visible vertebrae and ribs that may be related to the degree of thinness. The diagnostic features identified consisted of 1) depressed or concaved flanks; 2) dorsal processes of the individual vertebrae were clearly visible projecting along the back anterior to the dorsal fin with depressed tissue between the individual processes; and 3) the outline of the ribs could be seen through the blubber (Galletti Vernazzani *et al.*, 2006).

Table 5 – Summary of skinny whales recorded from 2005 to 2007

	Number of skinny whales recorded category 1	Percentage of skinny whales recorded category 1	Number of skinny whales recorded category 2	Percentage of skinny Whales recorded category 2	Number of skinny whales recorded category 3	Percentage of skinny whales recorded category 3
Year			Left Side			
2005	3	25%	2	16.7%	0	0%
2006	13	23.5%	7	12.7%	1	1.8%
2007	43	53.8%	18	22.5%	3	3.8%
Year			Right Side			
2005	2	28.6%	1	14.3%	0	0%
2006	18	28.6%	6	9.5%	1	1.6%
2007	42	56.8%	19	25.7%	4	5.4%

Skinny blue whales only were observed in 2005 during the first marine survey on 10 February (Galletti Vernazzani *et al.*, 2005). In 2007, skinny blue whales were recorded between the first marine survey conducted on 08 February and the last marine survey conducted on 27 April. It is important to note that in 2007 season, two individuals that were first in category 3, were later recaptured within season after 11 and 35 days and were found to be in category 1.

It is also important to note that many of whales assigned to category 2 could be category 3 as the ribs become evident only when the animal is at a certain position on the water surface, and thus are not always photographed.

In addition, skin lesions found on blue whales off Isla de Chiloe were analysed and reported in SC/59/SH21.

International Collaboration

The 2004/2005 CCC photo-ID catalogue was provided to Cascadia Research for comparison with the East Pacific blue whale catalogue (A. Douglas, Cascadia Research, per. comm.). No matches were found between the 14 photo-IDs from 2004/2005 CCC catalog and the subset of 55 identifications Cascadia had for the Eastern Tropical Pacific (which includes photos from Costa Rica, Galapagos and Peru primarily collected by Southwest Fisheries Science Center, Cascadia Research and Whale Conservation Institute).

DISCUSSION

Distribution and Site Fidelity

Blue whale feeding aggregations are dynamic and whales may move between and within feeding grounds from day to day searching for dense patches of krill. Fiedler *et al.* (1998) reported that the dynamics of prey aggregations may

be a very important factor affecting whale distribution. The recapture between years of individual blue whales photographed in different feeding areas, provides evidence that blue whales off northwestern Isla de Chiloe also uses the Corcovado Gulf (Alfaguara Project photograph in 2004), supporting the idea that blue whale feeding ground is large and dynamic.

However, the site fidelity of blue whales expressed as significant annual return rate for the species in the Southern Hemisphere and high number of individuals photo-identified off northwestern Isla de Chiloe, clearly highlights that this region in an important long-term feeding area for this population.

Skinny Whales

Balance *et al.* (2001) and Anderson (2005) reported skinny blue whales from the Maldives similar to those observed off Isla de Chiloe. However, Anderson (2005) suggested that during the period blue whales occur off the Maldives, they may not be feeding as much as other times of the year. This does not explain why only some of the blue whales were skinny. There are at least three possible explanations for the skinny blue whales: (1) natural or human produced changes in prey availability or habitat quality, (2) some physiological changes in the whales, or (3) disease. We believe the most likely cause of this condition is nutritional stress due to the lack of prey resources but the underlying reason(s) for this remain unknown. The number and proportion of skinny blue whales observed in 2007 is the highest reported to date. It is unknown if these skinny whales represents any potential threat to this population. Therefore, it is essential that long-term photo-ID research continue to monitor this condition.

CONCLUSIONS

Research conducted over the last 4 years confirms the importance of northwestern Isla de Chiloe as a long-term feeding area for blue whales and therefore important for the conservation of these whales in Chilean waters. Results to date strengthen the importance of the long-term collaborative research and monitoring program off the northwestern coast of Isla de Chiloe. Of particularly concern is the high number of skinny blue whales observed during the feeding season and possible conservation implications to this population. It is recommended that long-term photo-identification research continue to monitor blue whale population and health conditions.

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