SC/69A/SH/10

Sub-committees/working group name: SH

Report of the southern right whale aerial surveys

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Report of the southern right whale aerial surveys

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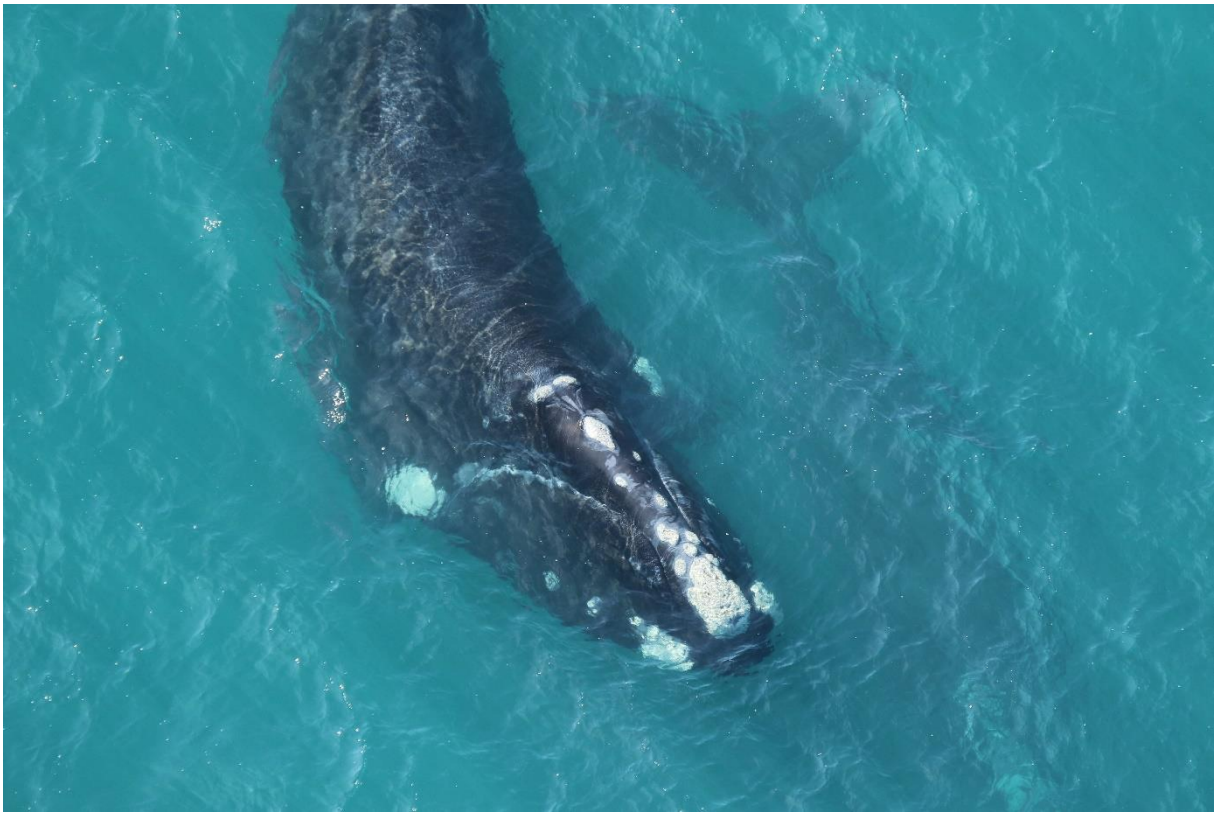

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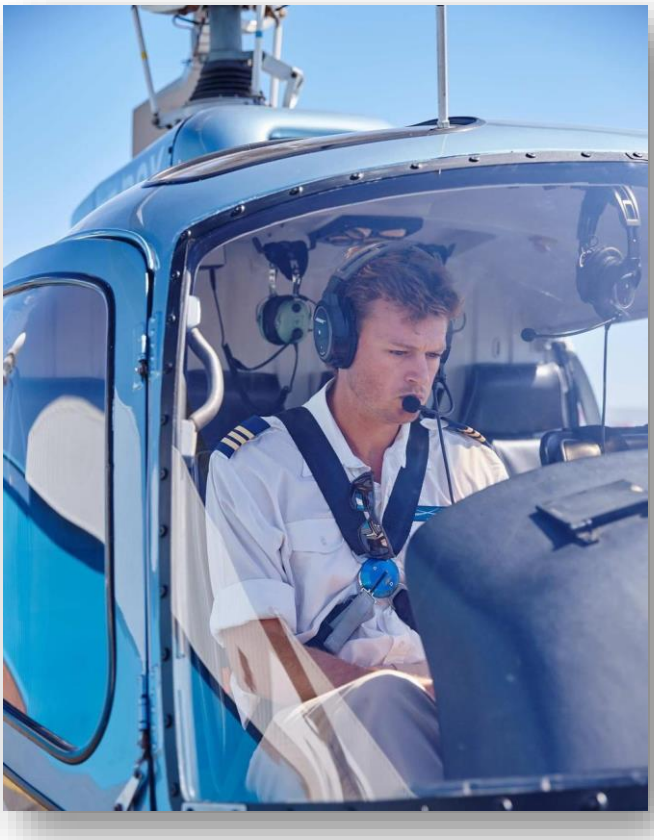

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Content

Abstract

The post-whaling recovery of the South African southern right whale (*Eubalaena australis*) population has been monitored since 1969 through annual aerial surveys, which include a photo-identification component since 1979. This uninterrupted 43-year survey series has revealed a steady population increase since the protection of the species from commercial whaling. Nonetheless, recent results have indicated substantial changes including a marked decline in the prevalence of unaccompanied adults since 2010, an increase in the reproductive cycle from the normal 3-year cycle to 4- and 5- year cycle since 2010, and an enormous fluctuation in the number of cow-calf pairs along the South African shore since 2015.

The 2022 annual photo-identification aerial survey, covering the area between Nature's Valley to Muizenberg, was flown between 1 and 5 October 2022 in a westward direction, with the aim to count all southern right whales and photograph all nursing females as well as individuals with a brindle or grey blaze colouration. A total of 21 hours and 41 minutes were flown in an Airbus AS350 BA helicopter, chartered by Silvercross Helicopters, to complete the survey. Of these, 17 hours and 27 minutes were flown as search effort, and 2 hours 18 minutes were flown in transit to and from the survey start and endpoints. In total, 304 cow-calf pairs of southern right whales (608 animals) and 50 unaccompanied adults were observed, leading to a total of 658 southern right whales. Albeit a small increase compared to the 2021 survey, these numbers of cow-calf pairs and unaccompanied adults, numbers remain low compared to numbers observed prior to 2009.

In total, 302 adult females and 27 unaccompanied adults were photo-identified during the survey. Subsequent data analysis indicated the presence of 25 duplicates in the dataset, and 1 individual with a lack of good-quality photographs, leading to the identification of 303 unique individual southern right whales, including 277 cows. Of these, 145 could be matched to previously known females giving results on 144 new inter-calving intervals. The observed calving intervals indicated most cows calving in 2022 had a 4-year (19%), and either a 3- or 5-year (13% each) calving interval.

Like in the past 2 surveys, photo-identification analyses showed the low frequency of re-identifications of the older females known in the catalogue. The vast majority (70%) of females (re-)identified in 2022, had been added to the catalogue post-2011, and only 33 cows photographed in 2022 were known to the catalogue since prior to the year 2000. Whether or not this is a result of a non-random component of the population being captured on the October survey, remains to be determined.

Before the annual helicopter survey, one aerial count survey was conducted, with the sole purpose of counting cow-calf pairs. This survey was flown in an eastward direction on 2 August 2022 using an autogyro. Results of this survey indicated the presence of 248 cow-calf pairs and 40 unaccompanied adults in the coastal area between Hermanus New Harbour and Witsand (covering the main nursery grounds).

The fluctuations in the coastal prevalence and increased calving intervals observed in the South African southern right whale population reiterate the extreme value of this long-term dataset.

Introduction

Since 1969, the South African population of southern right whales has been monitored through annual aerial surveys to assess their population increase following the international protection from commercial whaling. From 1979 onwards, these annual aerial surveys have incorporated photo-identification (Best, 1981; Best, 1990; Best et al., 2001; Best 2011), a method by which individual whales are identified through overhead photographs of the callosity pattern on the head and/or skin pigmentation patterns found on the back (brindle colouration, grey blaze and white patches) (Payne et al. 1983). During the surveys, the focus is given to all nursing females and associated calves (cow-calf pairs), as well as individuals with a brindle, white blaze or partial grey colouration. This currently 43-year-long database of individual sighting histories serves as a basis for vital demographic parameters of the population to be modelled and estimated (Best et al., 2001; Best et al., 2005).

In the past decade, results of this long-term database show abrupt changes in the population including: (a) an abrupt decrease in sightings along the South African coast of unaccompanied adults (i.e. adult whales without a calf incl. males and females) since 2009, (b) extreme fluctuations in the number of cow-calf pairs since 2015 (Findlay et al., 2017), (c) an increase in calving intervals from 3-year calving intervals to 4- and 5-year intervals (Vermeulen et al., 2018; Brandão et al., 2018), (c) an apparent shift in peak presence of cow-calf pairs in the South African breeding ground from early October to late August/early September (Vermeulen et al., 2018), and (d) a slight decrease in the population increase rate from 7.1% per annum in 2001 (Best et al., 2001), to 6.8% in 2011, 6.6% in 2012 and to 6.5% per annum (Brandão et al., 2023). Together, these data warrant further in-depth analyses and indicate that the continuation of the long-term monitoring of southern right whales within the calving grounds of the southern Cape is more vital than ever before.

This report provides the results of the 2022 southern right whale aerial surveys.

Methods and Procedures

Annual photo-identification aerial survey

The annual helicopter-based photo-identification survey of southern right whales is conducted along the southern Cape coast of South Africa from Nature's Valley to Muizenberg (for locations see Figure 3) at the end of September - early October, a time when it is believed most calves are present along the coast (i.e. most calves have been born and have not yet left on their annual migration south). Operating procedures have been largely standardised over this 40+ -year survey-series (although technological advances have been incorporated where necessary). The survey is flown coastwise and westwards at an altitude of 330 m and a ground speed of 80-100 kts under adequate sighting and photographic conditions. The survey is generally conducted between 08h00 to 16h00 each day as glare compromises photography earlier and later in the day. The survey continues the following day from the point reached at the end of the previous day. In the past years, the surveys have been flown with an Airbus AS350 BA helicopter (see figure 1) some 800 m offshore, with two observers searching from the starboard forward and rear seat, while a second observer searches offshore from the rear port seat (with assistance from the pilot on the port forward seat). Should glare interfere with sighting conditions, then the flight path would shift temporarily over the shore, with the pilot and rear observer searching seawards to increase sightability (see Figure 1). A support vehicle accompanies the aerial survey, allowing for daily provisioning of the survey team, transport of equipment and luggage, and, most importantly, rotation of observers during each day's survey if needed.

Figure 1. Picture of the Airbus AS350 BA helicopter in Cape Town International Airport (picture courtesy of Silvercross Helicopters).

All observed cetacean groups are recorded, including group size and composition, as well as time and position. If photography of southern right whales is required, the helicopter descends to an altitude of 150 m. The callosity patterns and pigmentation features of all cow and calf pairs and animals with a distinct colouration pattern are photographed by the rear observer using a Canon 7DII EOS camera with a 100-400 mm lens. Once photography is complete the aircraft returns to an altitude of 330 m and resumes searching or moves directly to the next sighted group at an altitude of 150 m.

Aerial count survey

To examine the general increase of cow-calf pairs along the southern Cape coast during whale season (June to December), an additional aerial survey was carried out between Hermanus New Harbour and Witsand (for locations see Figure 3) using a light-weight autogyro (or gyrocopter; Figure 2). Due to the configuration of an autogyro, the sole purpose of this survey was to count southern right whale females associated with calves as accurately as possible.

Figure 2. Image of the autogyro used for the count survey

As in previous years, the coastline between Hermanus New Harbour and Witsand was surveyed to cover two of the main nursery grounds of the southern Cape coast, i.e. De Hoop Nature Reserve and Walker Bay (Elwen and Best, 2004).

The survey is flown in an eastward direction between 08h00 and 14h00 at an altitude of approximately 300 m, a speed of approximately 60 kts and 500 m offshore. During the survey, the pilot would mainly search ahead and coastwise, while the observer in the back would search offshore. Intercom communication between the pilot and the observer allows for the observer to make notes of the cow-calf pairs counted both inshore and offshore. When whales were too far offshore to determine group composition, they would be approached after which the aircraft would return to approximately 500 m offshore. If the presence of a calf could not be determined with certainty, the observed whale would be recorded as unaccompanied, and the survey would continue. Each survey would take no longer than approximately 3 hours in a continuous flight, limiting the likelihood of duplicates within the count.

Photo-identification analysis

Photographs of the 2022 annual photo-identification aerial surveys were processed as follows: Firstly, the best images of each encounter were selected and those for same-day duplicates amalgamated. Secondly, photographs were visually inspected to eliminate within-year duplicates for the photo-identification matching process. Finally, matching of individuals was conducted using the Hiby-Lovell automated computer-based image recognition (Hiby and Lovell, 2001) and associated database system,

which utilises digitised extracts of the callosity patterns (automatically adjusted for tilt and inclination) to make inter-individual comparisons. Once all the matching was complete, capture-recapture histories and associated calving intervals were extracted from the dataset.

Results

Annual photo-identification aerial survey

The 2022 annual photo-identification aerials survey was flown along the coast between the 1 and 5 October 2022 in a westward direction between Nature's Valley and Muizenberg. The helicopter and survey team were positioned at Witsand on the 29th of September 2022. The region between Nature's Valley and Infanta Point was surveyed on 1 October. Infanta Point to Skipskop was surveyed on 2 October, Skipskop to De Kelders on 4 October and the remaining coast from De Kelders to Muizenberg on 5 October, with an emergency stop in Kleinmond due to technical problems with the helicopter.

A total of 21 hours and 41 minutes of flight operations were required to complete the survey, of which 17 hours and 27 minutes were flown as search effort, and 2 hours 18 minutes were flown in transit to and from the survey start and endpoints. Table 1 shows the general progress of the survey. Figure 3 shows the flight path including the distribution of the different sightings. Figures 4, 5 and 6 provide additional detail to the sightings.

Table 1: Flight schedule of the 2022 annual southern right whale aerial survey flown between Nature's Valley and Muizenberg.

Flight	Date	Flight Start	Flight End	Total Time	Survey start	Survey end	Search Time	Transit Time	CC SRW	Un Ad SRW
1	29/09/2022	Cape Town International Airport	Witsand	01:10	Transit			01:10		
2	01/10/2022	Witsand	George	00:46	Transit			00:46		
3	01/10/2022	George	George	01:27	Natures Valley	George coast	00:47	00:40	0	3
4	01/10/2022	George	Witsand	02:55	George coast	Witsand	02:49	00:06	25	13
5	01/10/2022	Witsand	Witsand	01:25	Witsand	Infanta Point	01:18	00:07	28	8
6	02/10/2022	Witsand	De Hoop	02:50	Infanta Point	Skipskop	02:42	00:08	70	8
7	04/10/2022	De Hoop	Pearly Beach	02:53	Skipskop	Brandfontein	02:34	00:19	52	4
8	04/10/2022	Pearly Beach	Grootbos	02:55	Brandfontein	Pearly Beach	02:34	00:21	58	7
9	04/10/2022	Grootbos	Grootbos	01:31	Pearly Beach	De Kelders	01:19	00:12	25	0
10	05/10/2022	Grootbos	Hermanus	02:20	De Kelders	Hermanus Harbour	02:11	00:09	41	6
11	05/10/2022	Hermanus	Kleinmond (emergency landing)	00:35	Hermanus Harbour	Kleinmond	00:29	00:06	4	1
12	05/10/2022	Kleinmond	Cape Town International Airport	00:54	Kleinmond	Muizenberg	00:44	00:10	1	0
Total				**21:41**			**17:27**	**2:18**	**304**	**50**

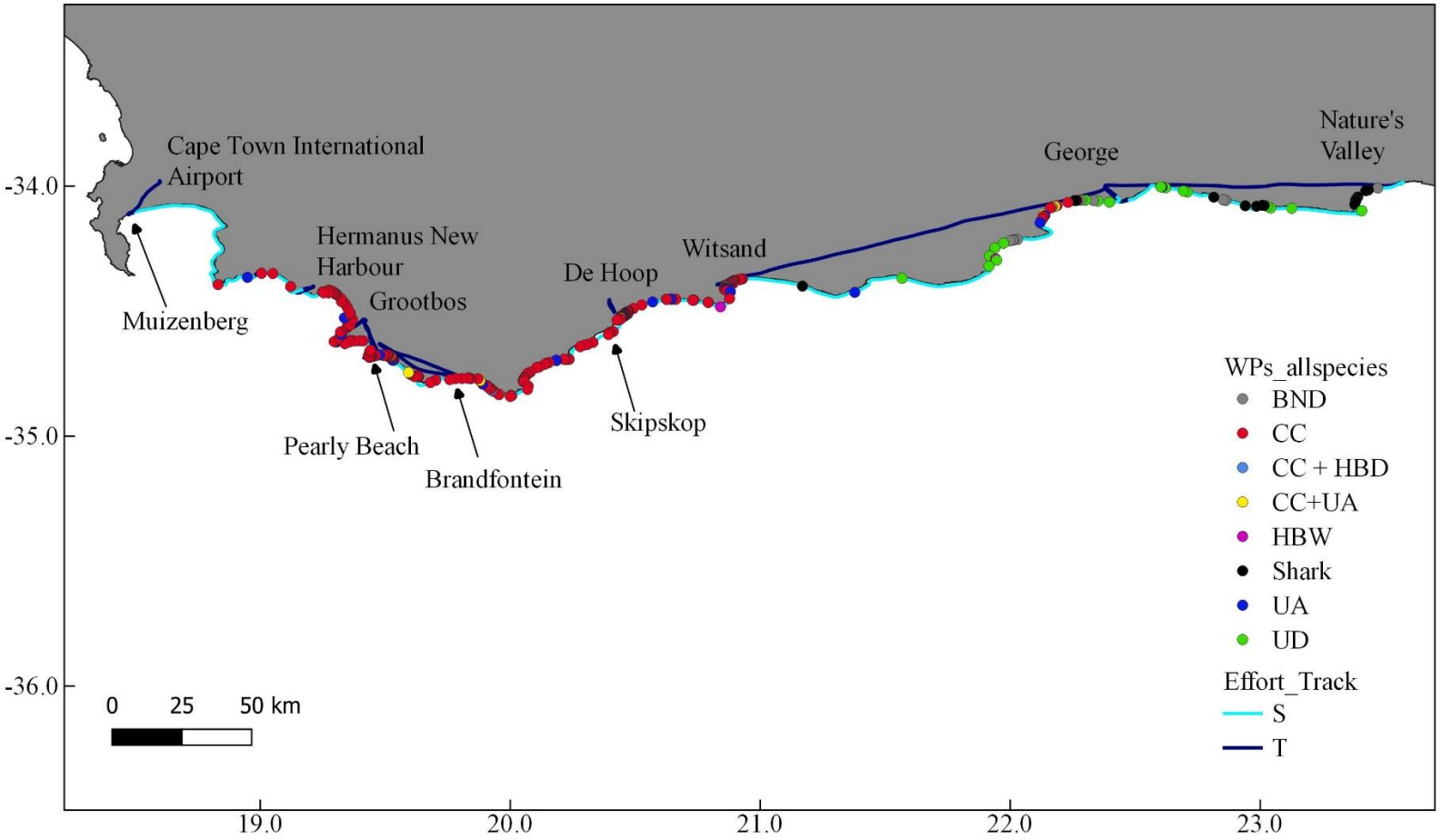

Figure 3. Flight path with search effort (light blue line) and transit (dark blue line), as well as encounters of bottlenose dolphins (BND), southern right whale cow and calves (CC), groups including southern right whale cows, calves and humpback dolphins (CC + HBD), groups including southern right whale cows, calves and unaccompanied adults (CC + UA), humpback whales (HBW), large sharks (Shark), southern right whale unaccompanied adults (UA) and unidentified dolphins (UD) during the 2022 South African southern right whale survey between Nature's Valley and Muizenberg.

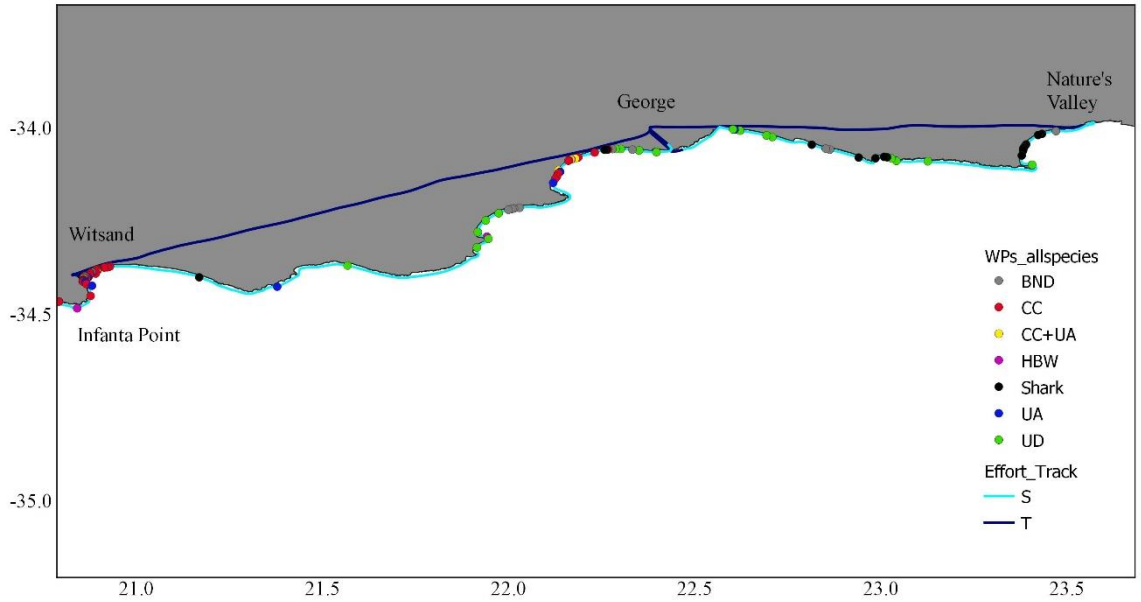

Figure 4. Flight path with search effort (light blue line) and transit (dark blue line), as well as encounters of bottlenose dolphins (BND), southern right whale cow and calves (CC), groups including southern right whale cows, calves and unaccompanied adults (CC + UA), humpback whales (HBW), large sharks (shark), unaccompanied southern right whales (UA) and unidentified dolphins (UD) during the 2022 South African southern right whale survey between Nature's Valley and Infanta Point.

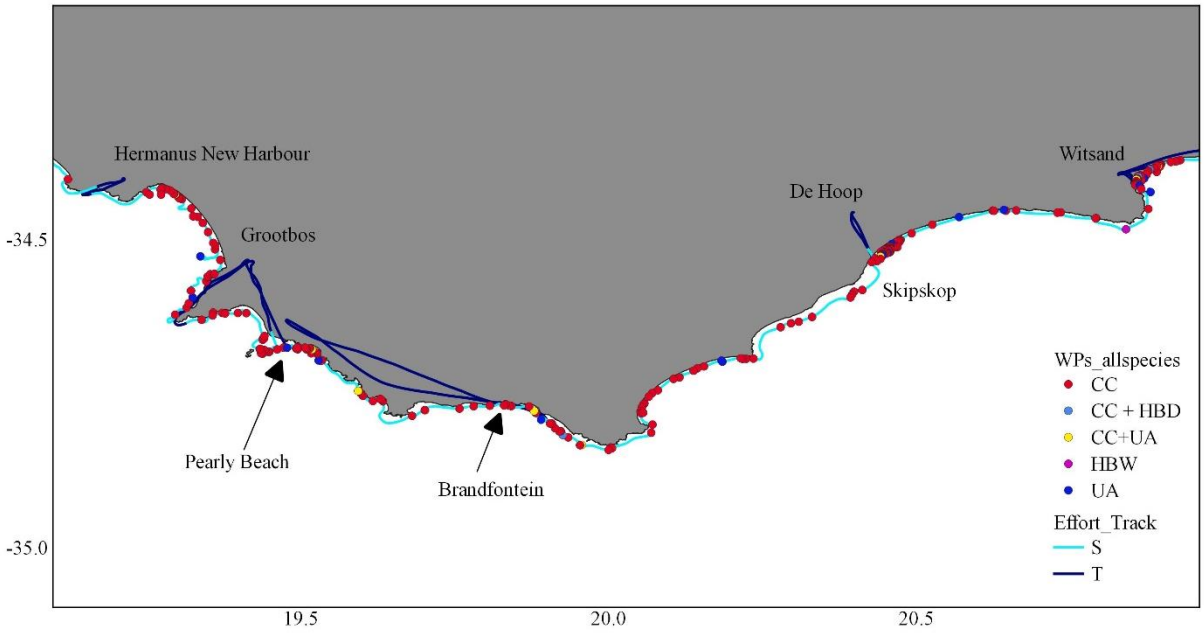

Figure 5. Flight path with search effort (light blue line) and transit (dark blue line), as well as encounters of southern right whale cow and calves (CC), groups including southern right whale cows, calves and humpback dolphins (CC + HBD), groups including southern right whale cows, calves and unaccompanied adults (CC + UA), humpback whales (HBW) and unaccompanied southern right whales (UA), during the 2022 South African southern right whale survey between Witsand and Hermanus New Harbour.

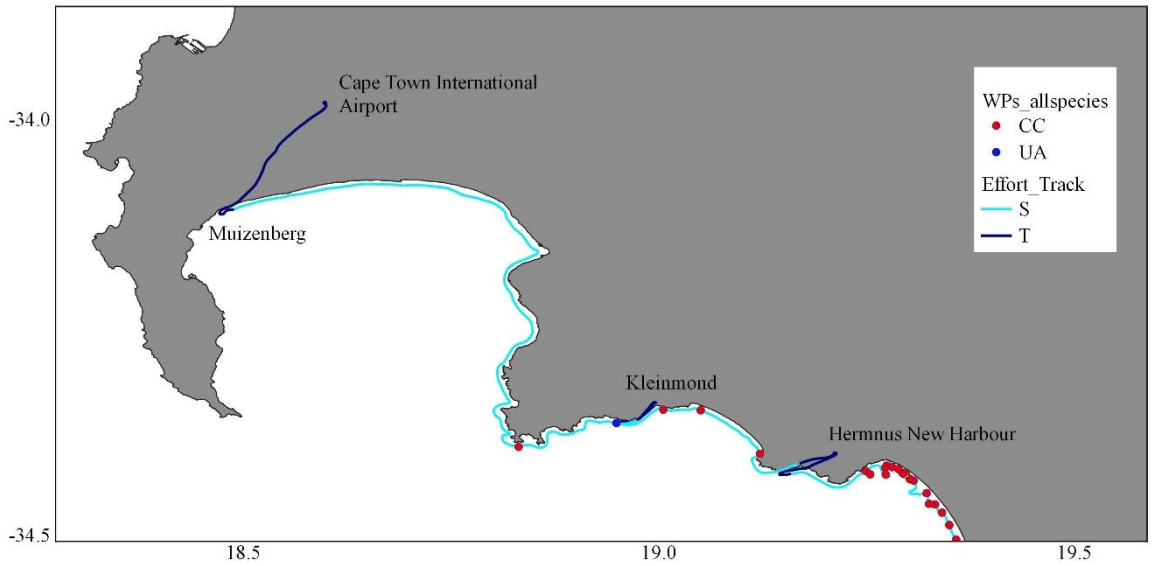

Figure 6. Flight path with search effort (light blue line) and transit (dark blue line), as well as encounters of southern right whale cow and calves (CC), and unaccompanied adults (UA), during the 2022 South African southern right whale survey between Hermanus New Harbour and Muizenberg.

Table 2 shows the cetacean groups encountered in adequate sighting conditions across the entire survey region (Nature's Valley to Muizenberg). In total 304 cow and calf pairs of southern right whales (608 animals) in 252 groups, as well as 33 groups equalling 50 unaccompanied adult southern right whales, were encountered during the survey. Over 8,500 photographs of southern right whales were taken during the survey including between-group spacer images. Furthermore, 1 cow-calf pair of humpback whales (*Megaptera novaeangliae) was* encountered, as well as 3 groups of humpback dolphins (*Sousa plumbea*), 9 groups of some 645 bottlenose dolphins (probably *Tursiops aduncus*) and 18 groups totalling some 1000 unidentified dolphins were encountered (Figure 3, 4, 5, 6 and Table 2).

Table 2. Numbers of groups and individual cetaceans encountered during the 2021 South African southern right whale survey between Nature's Valley and Muizenberg.

	Southern right whales	**Southern right whales**	**Humpback whales**	**Humpback dolphins**	**Bottlenose dolphins**	**Unidentified dolphins**
	Cow-calf pairs	**Unacc. Adults**				
Groups	252	33	1	3	9	18
Individuals	304	50	2	4	645	1,000

Field counts of cow-calf pairs and unaccompanied adult southern right whales encountered on the 2022 annual aerial survey are shown in figure 7 in relation to the field counts since 1979.

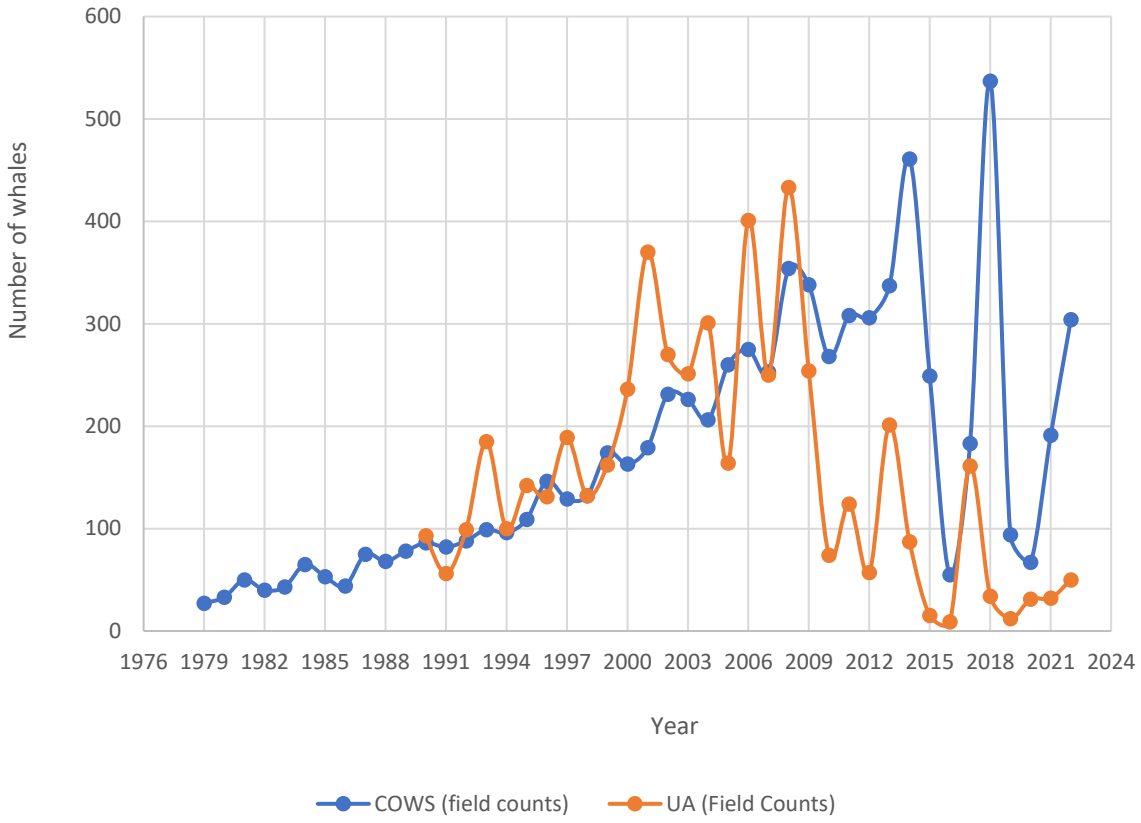

Figure 7. Numbers of southern right whale cow and calf pairs and unaccompanied adults counted on the South African southern right whale survey each year since 1979.

Aerial count survey

Due to financial limitations, one aerial count survey was conducted between the Hermanus New Harbour and Witsand in addition to the annual photo-identification aerial survey, for the sole purpose to count cow-calf pairs. This survey was flown on 2 August 2022, during which 248 cow-calf pairs and 40 unaccompanied adults were counted. As can be seen in Figure 8, the largest concentration of cow-calf pairs was observed in the De Hoop Nature Reserve.

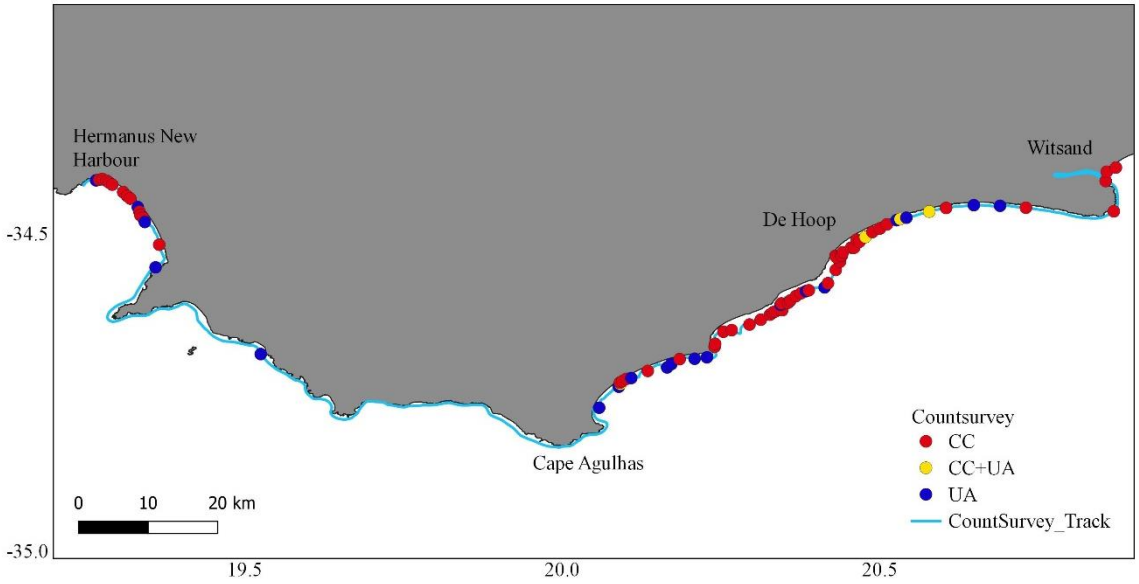

Figure 8. Map indicating the encounters of southern right whale cow-calf pairs along the stretch of coastline between Hermanus New Harbour and Witsand on 2 August 2022, as well as encounters of unaccompanied adult southern right whales (UA), southern right whale cow-calf pairs (CC) and groups including unaccompanied adults and cow-calf pairs (CC+UA).

Photo-identification analysis

In total, 302 cow-calf pairs and 27 unaccompanied adults (329 individuals) were photo-identified during the survey. Subsequent data analysis indicated the presence of 25 duplicates in the dataset, and 1 individual with a lack of good-quality photographs, leading to the identification of 303 unique individual southern right whales, including 277 cows (Figure 9). Of these, 145 could be matched to previously known females whereas the others were assigned as newly identified cows (Table 4).

Table 4. The number of southern right whale cow-calf pairs counted, the number of unique females identified (i.e. duplicates excluded) and the number of identified females matched with previously known individuals, during the 2022 annual aerial survey

	2022
Number of females with calves counted	304
Number of unique females with calves identified	277
Number of females with calves matched to previously known females	145

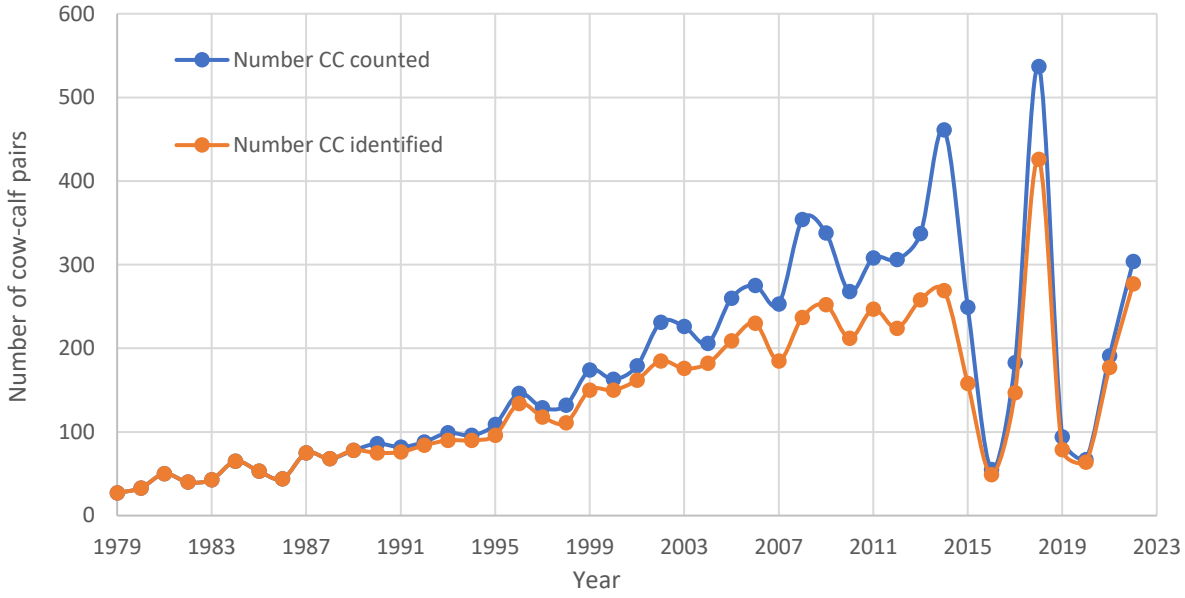

Figure 9. The number of females with calves counted and identified during the annual aerial surveys since 1979. The difference between both graphs indicates the number of within-year duplicates (individuals photographed more than once during an aerial survey).

Photo-identification matching gave results on 144 new inter-calving intervals (i.e., 1 reidentified female was previously identified as an unaccompanied adult). Most females calving in 2022 had a 4-year (19%), or either a 3- or 5-year (13% each) calving interval (Figure 10). Nonetheless, as can be seen in figure 10, the total proportion of females with a 3-, 4- and 5-year calving interval continues to be very low, indicating there is a greater number of females with even longer calving intervals (see Figure 11).

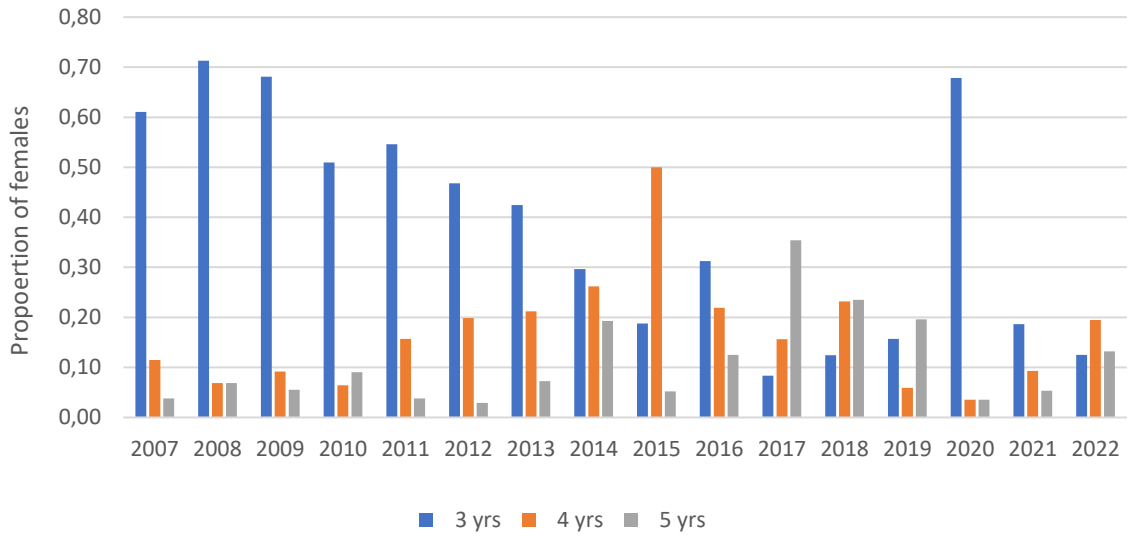

Figure 10. The frequency of 3-, 4- and 5-year calving intervals in female southern right whales identified on the annual aerial surveys since 2007.

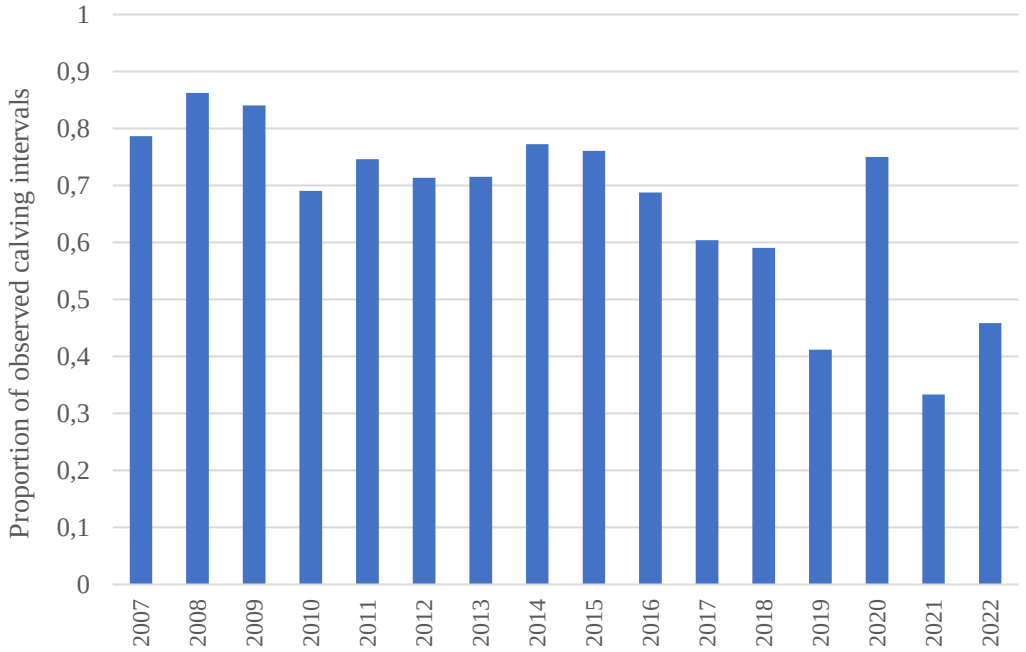

Figure 11. The proportion of 2-, 3-, 4- and 5-year calving intervals combined, between 2007 and 2022.

Like in the past 2 surveys, photo-identification analyses showed the low frequency of re-identifications of the older females known in the catalogue. In fact, the vast majority (70%) of females (re-)identified in 2022, had been added to the catalogue post-2011, and only 33 cows photographed in 2022 were known to the catalogue since prior to the year 2000.

Discussion

Albeit a small increase compared to the 2021 survey, these numbers of cow-calf pairs and unaccompanied adults, numbers remain low compared to numbers observed before 2009 (Figure 7) and are still believed to reflect altered migration patterns and calving success in the population as a trade-off to maintain limited energy reserves to ensure survival and maximize reproductive investment (Trathan et al., 2006; Murphy et al., 2007; Braithewait et al., 2015). Such a hypothesis is further supported by the drastic decrease in body condition of South African southern right whales observed over the past two decades (Vermeulen et al., 2023), as well as altered foraging (van den Berg et al. 2021). Preliminary research into the foraging ecology of the species has revealed large-distance migrations to foraging grounds previously unknown to be used by the South African population (Vermeulen et al., in review; ForInfo XX). Considering the vast oceanic range of southern right whale feeding grounds, all these findings combined may point toward large-scale ecosystem changes in the Southern Ocean. This is perhaps not surprising, given the unprecedented impacts of recent climate change on Southern Ocean physical features, which in turn have driven regional changes on all levels of Antarctic marine food webs (see Rogers et al., 2020). The change in the feeding strategy of South Africa's population of southern right whales could represent an attempt to cope with an environmental

shift in (some of) their foraging grounds. However, considering their decreased body condition and increase in calving intervals, this change does not seem to be successful.

The continuation of the survey series and an assessment of the resulting demographic parameters remains of crucial importance to monitor and investigate the observed changes in the South African southern right whale population, and its effects on population dynamics. This will entail not only a continuation of the annual photo-identification aerial surveys but also the continuation of the additional count surveys to monitor the timing of peak calving along the South African coast and additional photo-identification effort before the annual aerial survey, especially around the main concentration areas of cow-calf pairs (especially De Hoop Nature Reserve), to re-assess, among other things, birthing season, residency time of cow-calf pairs and the portion of the female population captured on the annual photo-identification survey. A continued in-depth assessment of the foraging ecology, migration, reproductive success, and body condition of this population is furthermore crucial, to gaining a better understanding of the observed changes in the population.

Additionally, considering unaccompanied adult southern right whales form the backbone of the South African Whale-Watching industry (legislation around this industry prohibits the approach of cow-calf pairs at a distance < 300m), the continued low presence of these whales along the South African coast has serious consequences for cow-calf pairs. Without more specific data and in the precautionary approach, it is strongly recommended that the South African permitting authority and the South African Boat-based Whale-watching Association engage with researchers to properly manage the activities with this valuable natural resource, especially considering the likely low energetic reserves of the nursing cows.

Acknowledgements

The annual aerial photo-identification survey was conducted under charter from Silvercross Helicopters and the auspices of TotalEnergies, for which we are very grateful. The De Hoop Collection is deeply thanked for providing accommodation during the survey. We are grateful to the Overberg Test Range Air Traffic Control for the weather reports and for accommodating us in their airspace amid their own operations. Numerous people are thanked for kindly providing weather and sighting condition information along the coast. The aerial count surveys were conducted under the charter of Jean Tresfon, whom we wish to thank for his continuous support.

All surveys were carried out under a permit from the Department of Forestry, Fisheries and the Environment to approach whales and under specific Marine Protected Area permits from the relevant conservation authorities.

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