

SC/68C/SH/14

Sub-committees/working group name: SH

Mortalities of southern right whales (*Eubalaena australis*) and related anthropogenic factors in South African waters, 1999 – 2019

Els Vermeulen, Elise Jouve, Peter Best, Jeremy Cliff, Matt Dicken, Deon Kotze, Steven McCue, Mike Meÿer, Mduduzi Seakamela, Greg Thompson, Chris Wilkinson



Papers submitted to the IWC are produced to advance discussions within that meeting; they may be preliminary or exploratory.

It is important that if you wish to cite this paper outside the context of an IWC meeting, you notify the author at least six weeks before it is cited to ensure that it has not been superseded or found to contain errors.

Mortalities of southern right whales (*Eubalaena australis*) and related anthropogenic factors in South African waters, 1999 – 2019

Els Vermeulen¹, Elise Jouve¹, Peter Best^{1*}, Jeremy Cliff^{2,3}, Matt Dicken^{2,4}, Deon Kotze⁵, Steven McCue⁵, Mike Meyer^{5,6}, Mduduzi Seakamela⁵, Greg Thompson², Chris Wilkinson^{1,6}

1. Mammal Research Institute Whale Unit, Department of Zoology and Entomology, University of Pretoria (*posthumous)
2. KwaZulu-Natal Sharks Board, Umhlanga, South Africa
3. School of Life Sciences, University of KwaZulu-Natal, Durban, KZN, South Africa
4. Department of Development Studies, School of Economics, Development and Tourism, Nelson Mandela University, PO Box 77000, Port Elizabeth 6031, South Africa
5. Department of Forestry, Fisheries and the Environment, Oceans and Coasts Branch, Department of Environment, Forestry and Fisheries, 2 East Pier Road, Waterfront, Cape Town, South Africa
6. South African Disentanglement Network, 15 Pinedene Road, Hout Bay, 7806 South Africa

ABSTRACT

In view of observed changes in the southern right whale (*Eubalaena australis*; SRW) population since 2009 and the increased anthropogenic activities in South Africa's coastal waters, an update on SRW mortalities and related anthropogenic factors is warranted. Building on the published information of Best et al. 2001a, data were collated on all SRW mortalities as well as non-fatal ship-strikes and entanglements along the South African coast between 1999 and 2019.

A total of 97 SRW mortalities were recorded along the South African coast between 1999 and 2019, of which the majority were classified as calves of the year. Most strandings occurred on the Western Cape coast between the months of July to November, coinciding with the seasonal presence of the species in South African waters. Eleven of these mortalities could be attributed to ship-strikes whereas 3 mortalities related to entanglements.

In total, 14 ship-strikes and 86 entanglements with SRWs, which did not result in a direct mortality or for which the outcome remained unknown, were recorded in South Africa between 1999 and 2019. Ship-strikes occurred mainly around the area of Cape Town harbour. Entanglements occurred mainly in rock-lobster gear and bather-protection nets in the Western Cape and KwaZulu-Natal provinces respectively, although the latter ceased to occur since 2015 likely due to the replaced of nets by drumlines.

In general, the incidence of SRW mortalities and entanglements decreased post-2009, coinciding with the decreased presence of SRWs along the South African coast. Data suggest that entanglements and ship-strikes do not pose a major conservation threat to the South African SRW population. However, the actual impact of such events may be underestimated as many may go undetected. In view of the population growth rate and the increased anthropogenic activities in coastal South Africa related to "Operation Phakisa", continued monitoring of these incidences is crucial to ensure accurate knowledge-based management decisions in the future.

INTRODUCTION

Each year during the austral winter months, southern right whales (*Eubalaena australis*; SRWs) migrate from their offshore summer feeding grounds at high latitudes towards the coastal waters of Southern Africa where they mate, calve and nurse their young (Best 1990b). In this area, they mainly frequent the southern Cape coast, and, to some extent, South Africa's west coast (Best 1990b, Barendse and Best 2014). This population is believed to be the largest breeding stock of the global population, comprising some 6,100 individuals (Brandão et al. 2018), and has been intensely monitored through annual aerial surveys since 1969. From 1979 onwards, these annual aerial surveys have incorporated photo-identification (Best 1981, 2010; Best 1990a; Best, Brandão, and Butterworth 2001).

Despite the observed population increase post-whaling (Best, Brandão, and Butterworth 2001), recent results show abrupt changes in the population since 2009. These include (a) a 50% to 80% decrease in sightings along the South African coast of unaccompanied adults, (b) a drastic fluctuation in the number of cow-calf pairs since 2015, (b) an increase in calving intervals from 3-year intervals to 4- and 5-year intervals (Vermeulen et al. 2019) and (c) a continued decline in the population increase rate from 7.1% per annum in 2001 (Best et al. 2001b), to 6.5% per annum in 2017 (Brandão et al. 2018). Together, these changes suggest that a fundamental demographic shift in the population may be in progress, caused by a decreased reproductive success rather than an increased mortality (Brandão et al. 2018).

In 2014, the South African Government initiated "Operation Phakisa" to unlock the economic potential of South Africa's Oceans. Although justified, such an initiative has the potential to add to current anthropogenic impacts in the marine environment, particularly when marine systems are already experiencing climate change linked pressures. Although a parallel Marine Spatial Planning (MSP) initiative was initiated to mitigate possible conflicts, the recovery of previously impacted SRWs in coastal South Africa alongside expanding oceans economies, may lead to an increase in human-whale conflict. This may include an increase in ship-strikes and entanglements. Continuous monitoring of human impact on the SRW population in South Africa thus remains critical for meaningful contributions to policy development and mitigations.

In light of the above, this report aims to provide an update on the work of Best et al. (2001a) and Meijer et al. (2011) on SRW mortalities along the South African coast, as well as incidences of ship-strikes and entanglements with the species in the country.

MATERIALS AND METHODS

Data presented herein were collected in areas between Lambert's Bay to Mossel Bay by the Mammal Research Institute Whale Unit (MRIWU) and between Strandfontein (west coast) and the Groot Brak River (south coast) by the Department of Forestry, Fisheries and the Environment (DFFE). However, through the development of technology, the area of data collection increased in more recent years to cover the entire South African coast where mortalities were reported (either through direct reports or social media channels). Every attempt was made to attend each stranding to confirm species ID (photographs taken), and collect, at minimum Level A data (Geraci and Lounsbury 2005). Due to by-law limitations, large whales such as the SRWs are hardly ever necropsied on site; teams therefore assess carcasses for possible external signs of cause of death (large scars, evidence of entanglement, ship-strike etc). When the stranding was in an area too distant to attend, or team members were unavailable, the stranding was termed "unattended stranding-MRIWU" or "incidental record-DFFE". This led to the collection of 550 cetacean strandings

recorded between 1999 and 2019 along the entire South African coast, from which strandings of SRWs were extracted.

Between 1998 and 2005, incidental records of whale entanglements from around the country were kept by DFFE. In 2006, the report keeping was formalised with the establishment of the South African Whale Disentanglement Network (SAWDN). This organisation was formed in order to manage entangled whales using specialized equipment. It is comprised of trained volunteers from the National Sea Rescue Institute (NSRI), KwaZulu-Natal Sharks Board (KZNSB), DFFE, Centre for Sustainable Oceans (Cape Peninsula University of Technology), Cape Nature, Mammal Research Institute-University of Pretoria, South African National Parks, South African Police Service, Cape Nature, Bayworld, the Dolphin Action and Protection Group, various Boat Based Whale Watching and Shark Cage Diving Operators, and the Rock Lobster and Octopus Fishing Industry. Country wide recognition improved with the gradual expansion of 21 trained disentanglement stations (including two KZNSB stations) along the South African coastline. Reports of entangled whales usually come in via the public to the NSRI or DFFE. When possible, a vessel responds with trained SAWDN volunteers on board. When with the entangled whales, all effort is made to disentangle the animal in the safest way possible. Data is collected on location, date, species, gender (when possible) and age class based on size. Sizes of whales were estimated against the length of the responding vessel when up close. However, not all reported whales are sighted again by responding vessels. If the case, information was collated from reporting individuals where possible, including the analysis of photographs when applicable.

Since 1981, the KwaZulu-Natal (KZN) Sharks Board has kept reliable records of all marine life entangled in the bather-protection nets deployed along the KZN coast to provide protection against shark attacks. All bather-protection nets are set at or near the surface in water 10–14m deep, parallel to the shore and 300–500m offshore. Most nets used in KZN are 213.5m long by 6.3m deep and constructed from black flat braid polyethylene with a breaking strain of 160kg. Nets used at Durban are 304.8m long by 7.6m deep and constructed from yellow braid. Anchorage is provided by four or six 35 kg stockless naval-type or Danforth sand anchors. The stretched mesh size of all nets is 51cm and the hang-in coefficient (excess webbing/total stretched webbing \times 100) is 40% (Dudley 1995, 1997). During the study period, there were changes in numbers and length of net installations deployed along the KZN coast, with a 49% reduction in the total length of netting since the 1990s, from 45km to 13km. The bather-protection nets are serviced approximately 20 times per month by KZNSB personnel.

Between SAWDN and KZNSB, a total of 1,274 baleen whale entanglements were recorded between 1999 – 2019, the vast majority in the province of KZN (n=1,076). From these, data on SRWs were extracted.

Data on ship-strikes with cetaceans in South African waters have been collected under DFFE and SAWDN since 1983, and currently includes 79 records. From these, data on SRWs were extracted.

Since 1979, annual photographic SRW aerial surveys have been conducted by MRIWU. Details on the survey techniques is given in (Best 1990b). Photographs of all individuals sighted between 1999 and 2019 were assessed for the presence of scars related to entanglement and/or ship-strikes following Best et al. (2001a).

All data used in this study included at least confirmed information on date, location and species involved (SRW). When possible, information was also collected on size, age class and gender. Age class was primarily determined based on the findings of Best & Ruther (1992) and following Best et al. (2001a); individuals <6m were classified as new-born, between 6m-8.9m as calves, individuals between 9-11.9m as juveniles or sexually immature animals, and those \geq 12m as adults or sexually mature animals. When accurate measurement were not possible, age class was estimated based on a visual assessment of rostrum vs body length, and colour of whale lice on the head; adults have heads forming approximately 30% of the

body length (Best 2007), whereas the proportion in juveniles is smaller, and calves are small in size and often exhibit large patches of the reddish-orange *Cyamus erraticus* on the head (Rowntree 1996).

In the case of entanglements or ship-strikes, the type of gear or vessel involved, respectively, was also reported where possible, as well as the degree of injury to the whale (fatal, severe, minor). Human effort in disentanglements have only been formally recorded since 2006 since the formation of the SAWDN, providing only absolute numbers for the period 2006-2019.

RESULTS

Recorded Mortalities

A total of 97 SRW mortalities were recorded along the South African coast between 1999 and 2019 (see Table 1).

Size compositions and gender

Accurate measurements were taken for 68 individuals. Based on these measurements, 25% were classified as adults, 23.5% as juveniles, 13.2% as calves and 38.2% as new-born, measuring <6m. (figure 1; Table 1).

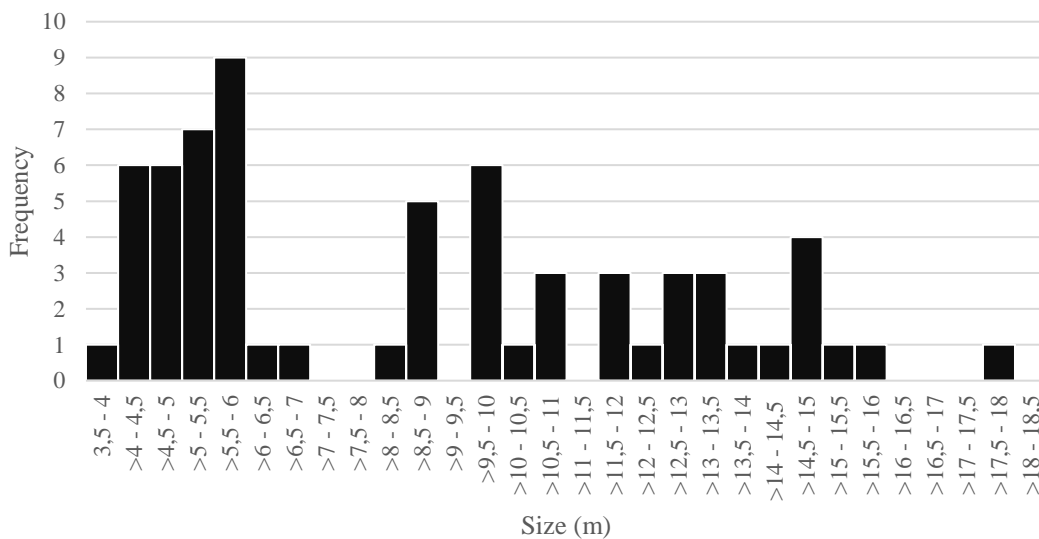


Figure 1: Size distribution of stranded southern right whales in South African waters between 1999 and 2019, for which accurate measurements were available (n=68).

The age class of a further 18 individuals was recorded based on a visual assessment, and included 9 adults, 1 juvenile, 7 calves and 1 new-born.

Gender was recorded for 53 individuals based on the visual inspection of the whale's genital area, and included 28 confirmed females, 2 likely females, 22 confirmed males and 1 likely male.

Table 1: Known mortalities of southern right whales in South African waters, 1999-2019.

Field Nr	Year	Month	Day	Gender	Lat	Long	Location if precise lat/long unknown (in this case, lat/long was approximated)	Age class	Size (m)	Comment
99/05	1999	9	16	M	-34.40	19.29		Newborn	4.84	Unknown - found dead
99/07	1999	12	3	M	-32.95	17.88		Adult	12.0	Unknown - found dead
UA	1999	9	14	Unknown	-34.48	20.51	De Hoop	Newborn	4.95	Unknown - found dead
UA	1999	10	30	Unknown	-33.31	18.14	7.9 km N Yzerfontein	unknown	Unknown	Unknown - found dead
00/09	2000	7	24	M	-34.46	20.83		Newborn	5.91	Unknown - stranded alive
00/10	2000	7	29	M	-32.31	18.33		Newborn	4.42	Unknown - found dead
H_ANS00997	2000	7	31	Unknown	-29.93	31.02		Unknown	Unknown	Entanglement
00/11	2000	9	6	F	-33.90	18.39		Juvenile	9.85	Ship-strike
00/12	2000	9	18	M	-32.66	18.25		Newborn	4.43	Unknown - found dead
00/14	2000	10	12	M	-34.30	18.46		Adult	15.70	Unknown - found dead
00/15	2000	10	12	F	-34.53	20.42		Newborn	4.55	Unknown - found dead
01/04	2001	6	28	M	-34.17	18.34		Adult	12.80	Unknown - found dead
01/06	2001	8	22	F	-32.67	18.25		Newborn	5.44	Unknown - found dead
01/09	2001	9	10	F?	-34.40	20.84		Newborn	5.43	Unknown - found dead
UA	2001	9	26	M	-31.81	18.23	Doringbaai	Adult	Unknown	Unknown - found dead
01/11	2001	10	19	M	-34.71	20.11		Calf	6.00	Unknown - found dead

01/12	2001	10	29	F	-32.83	18.0408		Adult	14.37	Unknown - found dead
01/18	2001	10	12	Unknown	-34.80	20.06		Unknown	Unknown	Unknown - found dead
02/07	2002	7	9	F	-34.23	18.84		Newborn	4.70	Unknown - found dead
02/09	2002	7	10	F	-34.50	20.46		Newborn	5.20	Unknown - found dead
02/12	2002	8	15	M	-34.23	18.47		Juvenile	9.00	Unknown - found dead
02/13	2002	8	15	F?	-34.07	22.18		Calf	6.00	Unknown - found dead
SFRI 2002/8	2002	7or 8	0	M?	-31.81	18.23	Doringbaai	Adult	18.00	Unknown - found dead
02/15	2002	9	7	F	-34.81	20.02		Adult	12.90	Unknown - found dead
02/16	2002	9	12	M	-32.72	17.94		Adult	15.00	Unknown - found dead
Poss same as 02/16	2002	9	18	Unknown			Unknown	Unknown	Unknown	Unknown - found dead
02/17	2002	9	24	Unknown	-34.77	20.04		Calf	6.29	Unknown - found dead
02/20	2002	10	20	Unknown	-34.76	19.68		Calf	6.00	Unknown - found dead
02/19	2002	10	16	Unknown	-34.39	20.85		Juvenile	9.75	Unknown - found dead
03/17	2003	6	27	Unknown	-34.41	19.17		Adult	Unknown	Unknown - found dead
UA	2003	9	2	F	-34.06	22.21		Unknown	Unknown	Unknown - found dead
UA	2003	9	25	F	-34.18	22.14		Unknown	Unknown	Unknown - found dead
UA	2003	8		Unknown	-34.48	20.51	De Hoop	Calf	6.00	Unknown - found dead
UA	2003	9	26	F	-34.10	18.59	False Bay	Juvenile	10.00	Likely ship-strike
04/05	2004	8	24	Unknown	-34.37	20.88		Newborn	5.50	Unknown - found dead
04/06	2004	9	17	F	-33.43	18.26		Adult	14.60	Ship-strike
04/08	2004	10		Unknown	-33.12	17.97		Juvenile	11.58	Unknown - found dead

04/03	2004	7	14	Unknown	-34.48	20.51	De Hoop	Newborn	4.50	Unknown - stranded alive
05/13	2005	7	25	F	-34.46	20.56		Newborn	5.70	Unknown - found dead
SFRI 2005/9	2005	8	8	Unknown	-34.42	19.30		Unknown	Unknown	Unknown - found dead
05/15	2005	9	13	F	-34.07	18.61		Juvenile	10.78	Unknown - stranded alive
05/16	2005	9	21	F	-34.65	19.46		Adult	14.60	Ship-strike
2005/07	2005	9	25	Unknown	-33.72	18.43		Juvenile	10.80	Entanglement
UA0603	2005	9		F	-34.77	19.87	Brandfontein	Adult	15.20	Unknown - found dead
06/06	2006	4	5	F	-33.80	18.37		Juvenile	10.00	Ship-strike
06/13	2006	7	21	F	-34.14	18.31		Adult	14.65	Unknown - found dead
UA0607	2006	7	27	F	-33.79	18.36		Unknown	Unknown	Unknown - found dead
06/15	2006	7	30	Unknown	-34.39	20.83		Newborn	5.00	Unknown - found dead
06/17	2006	7	30	Unknown	-34.37	20.88		Newborn	5.50	Unknown - found dead
06/17	2006	8	14	M	-34.61	20.31		Calf	7.00	Unknown - found dead
06/22	2006	8	28	M	-34.40	20.80		Unknown	Unknown	Unknown - found dead
06/20	2006	9	7	Unknown	-32.60	18.29		Newborn	5.05	Unknown - found dead
06/21	2006	10	10	Unknown	-34.46	20.56		Adult	Unknown	Unknown - found dead
SFRI 2006/18	2006	10	26	Unknown	-34.49	20.48		Adult	~15	Unknown - found dead
UA0612	2006	10		Unknown	-34.48	20.51	De Hoop	Adult	Unknown	Unknown - found dead
UA0613	2006	10		Unknown	-34.48	20.51	De Hoop	Adult	Unknown	Unknown - found dead
UA0614	2006	10		Unknown	-34.48	20.51	De Hoop	Calf	Unknown	Unknown - found dead
UA0615	2006	10		Unknown	-34.48	20.51	De Hoop	Calf	Unknown	Unknown - found dead

UA0616	2006	10		Unknown	-34.48	20.51	De Hoop	Calf	Unknown	Unknown - found dead
07/06	2007	6	10	Unknown	-32.02	18.29		Adult	12.50	Ship-strike
SFRI 2007/7	2007	7	12	F	-34.42	20.85		Newborn	4.5	Unknown - stranded alive
07/07	2007	7	4	Unknown	-32.65	18.26		Adult	13.7	Unknown - found dead
07/08	2007	7	20	M	-34.36	20.91		Newborn	5.98	Unknown - found dead
07/09	2007	8	22	M	-32.72	18.18		Newborn	4.33	Unknown - found dead
07/10	2007	8	26	M	-32.78	17.89		Newborn	3.94	Unknown - stranded alive
07/11	2007	9	1	Unknown	-34.40	21.20		Adult	Unknown	Unknown - found dead
SFRI 2008/5	2008	3	23	F	-32.93	18.35		Juvenile	~10	Unknown - found dead
08/07	2008	10	23	Unknown	-34.66	19.48	Pearly beach	Unknown	Unknown	Unknown
UA	2008	8	13 or 14	Unknown	-34.74	20.08	15km west of Die Mond	Newborn	5.60	Unknown
SFRI 2009/21	2009	10	7	M	-34.40	20.84		Newborn	5.0	Unknown - stranded alive
SFRI 2009/28	2009	11	9	Unknown	-34.60	19.32		Calf	8.60	Unknown - found dead
SFRI 2010/36	2010	11	23	Unknown	-34.51	18.64		Juvenile	10.3	Unknown
SFRI 2011/08	2011	3	18	Unknown	-33.81	18.37		Juvenile	9.0	Unknown - found dead
SFRI 2011/09	2011	3	25	F	-33.78	18.35		Adult	~15	Unknown - found dead
SFRI 2011/24	2011	8	17	F	-34.12	18.45		Calf	8.28	Unknown - stranded alive
SFRI 2011/26	2011	8	27	M	-34.37	21.46		Newborn	4.00	Unknown - stranded alive
SFRI 2011/27	2011	8	29	F	-34.61	19.31		Juvenile	11.9	Unknown - found dead
PEM N4549	2011	7	12	Unknown	-33.81	25.67		Juvenile	10.60	Unknown - found dead

SFRI 2012/05	2012	2	29	M	-34.39	21.43		Adult	13.48	Unknown - found dead
SFRI 2012/19	2012	8	13	Unknown	-33.88	18.49		Newborn	5.2	Unknown - found dead
SFRI 2012/21	2012	10	7	F	-34.10	18.49		Adult	13.4	Ship-strike
SFRI 2012/22	2012	10	9	F	-34.52	19.37		Calf	6.55	Unknown - stranded alive
CET 2013/11	2013	6	28	F	-34.68	20.23		Adult	13.3	Unknown - found dead
CET 2013/27	2013	11	17	Unknown	-32.48	18.33		Unknown	Unknown	Unknown - no information provided
CET 2014/12	2014	5	10	M	-33.85	18.49		Juvenile	10.0	Entanglement 15/03/2014 – stranding on 10/05/2014
CET 2016/11	2016	4	3	F	-33.74	18.44		Adult	12.57	Ship-strike
CET 2016/05	2016	2	1 or 17	M	-33.81	18.38		Juvenile	10.0	Ship-strike
CET 2016/06	2016	2	14	F	-33.93	18.38		Juvenile	8.90	Ship-strike
WU-UA 18/09	2018	6	26	Unknown	-34.14	18.32		Adult	Unknown	Unknown - found dead
WU-UA18/10	2018	7	1	Unknown	-34.72	20.11		Calf	Unknown	Unknown - found dead
WU-UA18/11	2018	7	12	Unknown	-34.20	24.83		Newborn	Unknown	Unknown - found dead
WU-UA18/17	2018	9	18	Unknown	-34.50	19.37		Calf	Unknown	Unknown - found dead
WU-AT 18/01	2018	11	7	Unknown	-34.417	19.247		Newborn	5.85	Unknown - found dead
PEM N5749	2018	8	11	Unknown	-33.98	25.26		Newborn	4.22	Unknown - found dead
PEM N5752	2018	8	30	Unknown	-33.7	25.9		Calf	Unknown	Unknown - found dead
WU-UA19/05	2019	3	18	M	-33.94	18.38		Juvenile	9.10	Ship-strike
WU-AT 19/04	2019	9	30	Unknown	-34.66	19.49		Calf	Unknown	Unknown - stranded alive

Temporal trends

The annual number of recorded SRW strandings decreased notably since 2008, with no recorded strandings in 2015 and 2017. Data are shown in figure 2 in combination with data published in Best et al. (2001) and reported in Best et al. (2011)), to accumulate a time-frame 1963 - 2019

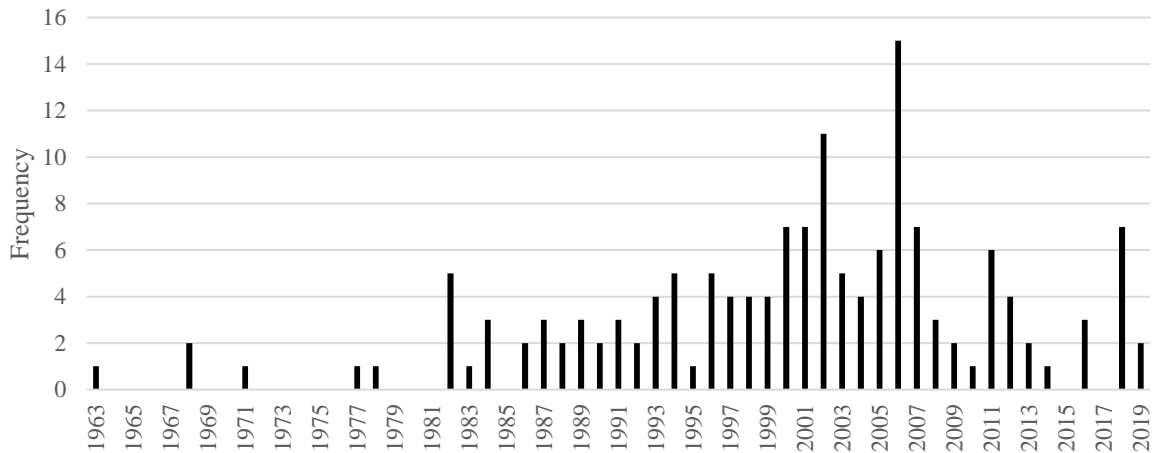


Figure 2: Frequency of southern right whale strandings per year, between 1963 and 2019, incl. data published in Best et al. (2001) for the period 1963-1998.

The vast majority of mortalities (85.5%) occurred between the months July to December, coinciding with the seasonal presence of the species in South African coastal waters. Only 14 mortalities were recorded outside this time period. All new-born and calf strandings were recorded between July and November, with 97.5% of these mortalities occurring by 8th October (Figure 3).

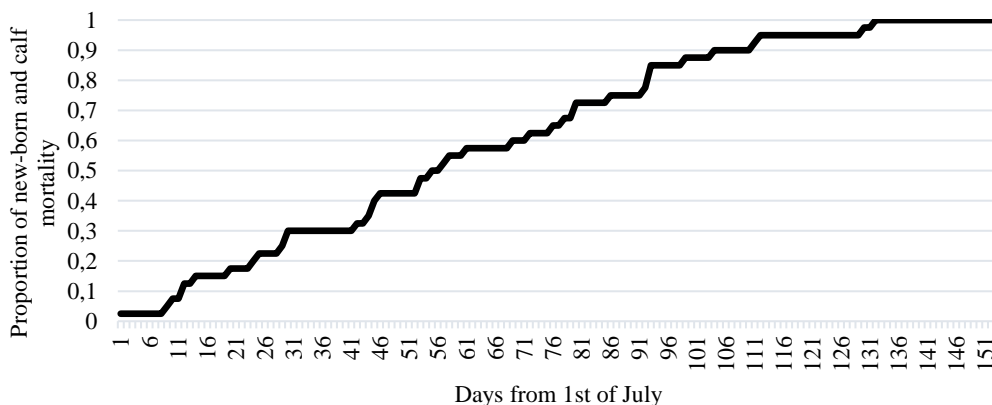


Figure 3: Cumulative distribution of mortalities of southern right whale new-born and calves in South African waters, against time of year (1999 – 2019).

Locality

Most strandings occurred on the Western Cape coastline. Four occurred in the Eastern Cape and only one on the KwaZulu-Natal coastline (figure 4).

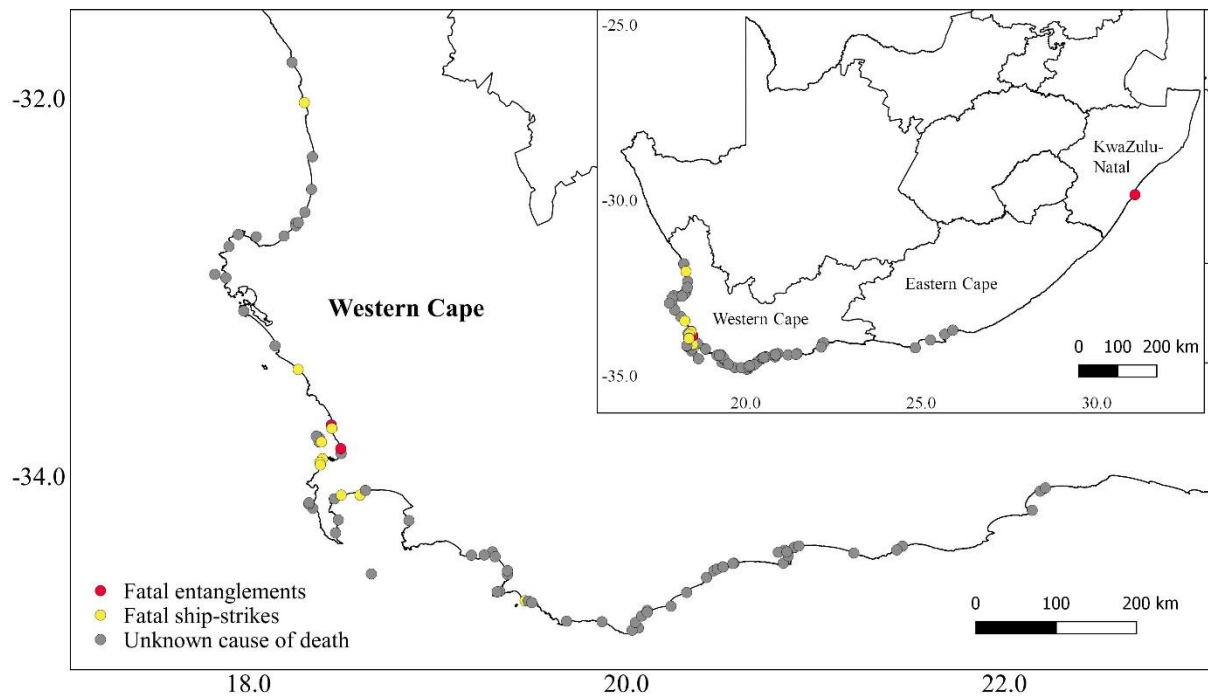


Figure 4: Location of recorded mortalities of southern right whales off South Africa between 1999 and 2019, plus detailed map of the Western Cape.

Causes of death

Only 14.4% of all the SRW mortalities recorded between 1999 and 2019 could be attributed to anthropogenic factors, and included either ship-strikes or entanglements.

Ship-strikes: In total, 11 SRWs were recorded to have been fatally hit by a vessel between 1999 and 2019, representing 11% of all SRW mortalities in this time period (Figure 5; Table 1 and 2). These included 4 adults and 7 juveniles, as well as 2 males, 8 females and 1 individuals of undetermined gender. The type of vessels involved could rarely be determined, but included at least one ski-boat and one trawler vessel. Most ship-strikes occurred around the area of Cape Town Harbour (see figure 4).

Entanglements: Only 3 SRW mortalities were attributed to entanglement in ropes and/or nets (figure 6; Table 1 and 3). One individual (age class and gender undetermined) was entangled in a bather-protection net in July 2000 on the KZN coastline, one juvenile (gender undetermined) in (presumed) rock lobster gear in September 2005 on the Western Cape coastline, and one male juvenile entangled in octopus gear in March 2014 (Western Cape).

Ship-strikes and entanglements that did not result in a recorded mortality

Ship-strikes: Fourteen ship-strikes with SRWs, which did not result in a direct mortality (n=7), or for which the outcome remained unknown (n=7), were recorded between 1999 and 2019 (figure 5; Table 2). These records came from 3 SRWs observed with fresh propeller scars as well as 11 reports from the vessels

involved. Based on a visual assessment, these included at least 3 adults and 3 juveniles. Most (n=10) non-fatal ship-strikes occurred between July and December. Vessels involved included three ski-boats, one ferry, one water taxi, one commercial rock lobster vessel, and two yachts whereas the other vessels remained unidentified. All these non-fatal collisions occurred in the Western Cape coastline, near the Cape Town harbour or off the Cape Peninsula (Figure 7).

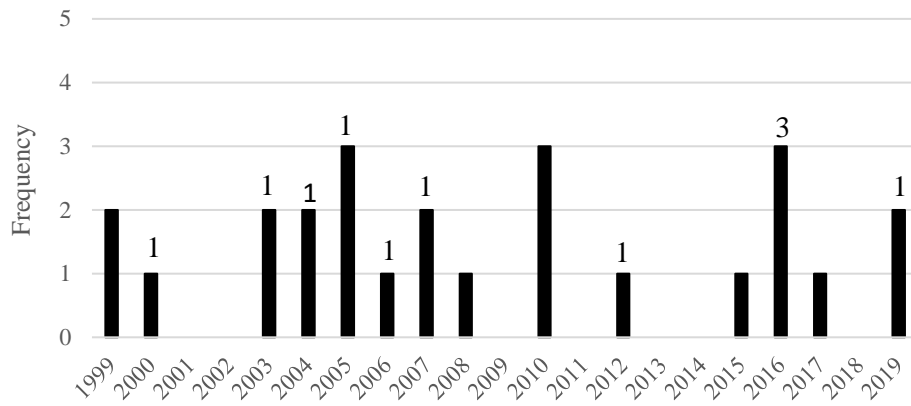


Figure 5: Frequency of ship-strikes (fatal + non-fatal) of southern right whales off South Africa from 1999 to 2019. The number of fatal collisions per year was annotated above the bars.

Table 2: Reported ship-strikes (fatal and non-fatal) with southern right whales in South African waters between 1999 and 2019.

Year	Month	Day	Gender	Latitude	Longitude	Area	Location	Age Class	Size (m)	Result	Relevant Stranding nr	Vessel type	Comment
1999	9		Unknown	-34.05	18.35	Western Cape	Hout Bay	Unknown	Unknown	Unknown		ski-boat	Went over whale, skeg damaged
1999	12	3	Unknown	-29.81	17.07	Western Cape	Jakkalsbaai	Adult	12.60	Unknown		Unidentified Vessel	
2000	9	6	F	-33.91	18.39	Western Cape	Rocklands, Sea Point	Juvenile	9.85	Deadly	00/11	Unidentified Vessel	Had five transverse propellor cuts; 1.33, 1.14 m, 1.42 m and 1.79 m apart.
2003			Unknown			Unknown	Unknown	Juvenile	Unknown	Serious but not deadly		Unidentified Vessel	Struck by propellor of large ship
2003	9	26	F	-34.10	18.59	Western Cape	False Bay	Juvenile	10,00	Deadly	UA	Unidentified Vessel	Floating dead, fresh, supposed ship-strike
2004	7		Unknown	-34.58	19.334	Western Cape	Gansbaai	Unknown	Unknown	Unknown		ski-boat	People thrown overboard
2004	9	17	F	-33.43	18.26	Western Cape	Grotto Bay	Adult	14.60	Deadly	04/06	Unidentified Vessel	Both flippers partly severed, rostrum broken, baleen plates missing, prolapsed uterus. Historically had been satellite tagged.
2005	2	1	Unknown	-33.89	18.46	Western Cape	Table Bay	Unknown	Unknown	Unknown		Yacht Shosholza	Vessel has damaged keel, two yachtsmen injured.
2005	2	22	Unknown	-33.89	18.43	Western Cape	Bell Buoy at CT Harbour	Unknown	Unknown	Minor		Robben Island Ferry <i>Makana</i> at ~12h00	Divers could not find damage to vessel.
2005	9	21	F	-34.65	19.46	Western Cape	Romans Bay	Adult	13.18	Deadly	05/16	Unidentified vessel	Found dead, floating, then stranded at Romans Bay. Towed offshore and anchored at Dyer Island for shark research.
2006	4	5	F	-33.80	18.37	Western Cape	Robben Island	Juvenile	10.00	Deadly	06/06	Unknown Vessel	Drifted north and washed up on the east coast of Robben Island beach. Five transverse prop cuts on the belly. Possible damage to left side of the head.
2007	6	10	Unknown	-32.02	18.29	Western Cape	9km South of Lamberts Bay	Adult	12.50	Deadly	07/06	Unknown Vessel	Found decomposed.
2007	12		F	-34.54	19.36	Western Cape	Hermanus Plaats	Adult	Unknown	Minor		Unknown vessel	Cow/calf seen during aerial survey
2008	8	6	Unknown	-34.20	18.36	Western Cape	Scarborough	Unknown	Unknown	Unknown		Commercial Rock lobster vessel	struck whale not seen

2010	7	18	Unknown	-33.88	18.421	Western Cape	Off Cape Town Harbour	Juvenile	Unknown	Unknown		Yacht - Intrepid SA3588	Whale breached onto yacht, broke mast, railing and coach house. Whale swam off. Damage to whale Unknown.
2010	9	9	Unknown	-34.19	18.43	Western Cape	Within Simonstown port limits	Juvenile	9.00	Minor		Water Taxi - semi-rigid duck "Mellow Yellow"	Craft had 4 passengers onboard and whale popped up - skipper was travelling slowly.
2010	9	21	Unknown	-31.75	18.22	Western Cape	Strandfontein	Unknown	Unknown	Serious but not deadly		large vessel	Seen by BBWW operator
2012	10	7	F	-34.10	18.49	Western Cape	Capricorn Beach - Muizenberg	Adult	13.40	Deadly	SFRI 12/21	Ski-boat	Stranding
2015	8	19	Unknown	-34.19	18.43	Western Cape	Simons Town	Unknown	Unknown	Serious but not deadly		Unid Large vessel	
2016	2	13 or 17	M	-33.81	18.38	Western Cape	0.5 nm east of Murrays Bay, Robben island	Juvenile	10.00	Deadly	CET 2016/05	Unknown vessel	Floating dead at sea -did not strand. Possibly 2nd ship-strike? Reference 2016_5 stranding file
2016	2	14	F	-33.93	18.38	Western Cape	Bantry Bay	Juvenile	8.90	Deadly	No Nr	Unid Large vessel	Stranding
2016	3	3	F	-33.91	18.37	Western Cape	Offshore Sea Point, Cape Town	Juvenile	12.59	Deadly	CET 2016/11	I&J Stern Trawler Avro Warrior_701 ton	Stranded dead at Holbaai Melkbos DEA Ref no 2016/11
2017	9	21	Unknown	-34.12	18.48	Western Cape	Offshore Muizenberg Beach	Adult	14.00	Minor		Unid Large Vessel	Seen by D. Hurwitz BBWW at 15h00. Estimated strike may have occurred 9 months ago? On ventral area roughly between genital area and flippers.
2019	5	29	Unknown	-32.04	18.18	Western Cape	6.5nm NW Lamberts Bay	Unknown	Unknown	Unknown		5.3m catamaran fishing skiboat (~11h00)	Five fishermen onboard, cracked left hull (600mm). Fishermen thrown around boat.
2019	3	16	M	-33.94	18.38	Western Cape	Stranded Maidens Cove	Juvenile	9.10	Deadly	WU-UA19/05	Unid Large vessel	First cut had taken off most of the rostrum of the upper jaw (including half of the left flipper) - five equal cuts into the dorsal/left lateral area. Cuts through the blubber and deep into the muscle. 3 rd cut appeared to have gone into the organs at the thoracic cavity. The 4 th cut had gone deep into the muscle.

Entanglements: Between 1999 and 2019, 86 SRW entanglements were recorded which did not result in a mortality (Table 3; Figure 6). Based on visual inspection of the size, these included at least 13 adults, 18 juveniles and 4 calves, while the age class of the remaining 51 whales remained undetermined. In nearly all cases, the gender of the individuals involved remained undetermined (although non-analysed skin samples are available), with only 6 confirmed females. Of all 86 entangled whales, at least 27 were partly or fully disentangled by human intervention, while 10 managed to free themselves from the gear. For 34 individuals, there was no intervention possible and their outcome remained unknown.

Most non-fatal entanglements (70%) occurred between July and October. In general, the annual frequency of SRW entanglements decreased after 2009 (figure 6).

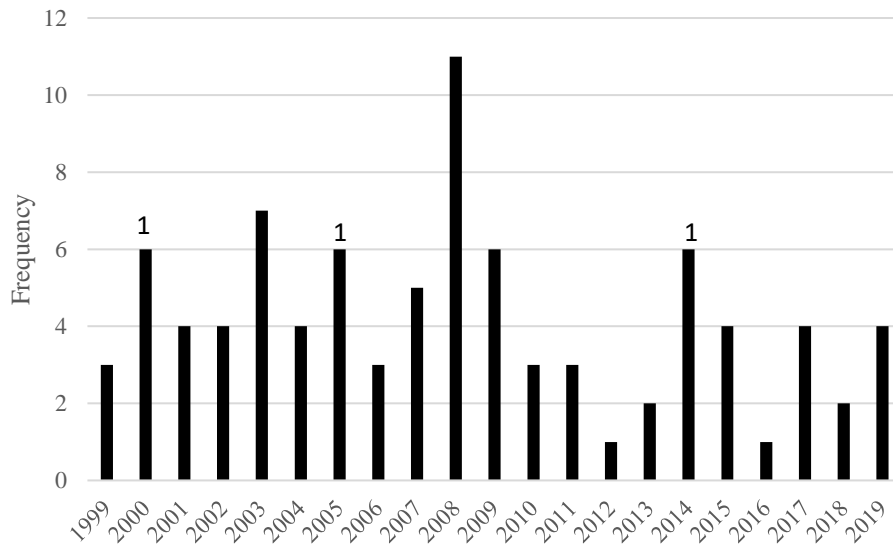


Figure 6: Frequency of entanglements (fatal + non-fatal) of southern right whales off South Africa from 1999 to 2019. The annual number of entanglements resulting in a mortality was annotated above the bar.

The majority of non-fatal SRW entanglements involved rock lobster gear (49.5%; n=34; Table 3) and bather-protection nets (29%; n=25). Unidentified ropes (8.1%; n=7), gear for octopus fishing (5.8%; n=5), likely longline (3.4%; n=3), likely rocklobster gear (3.4%; n=3), unidentified nets (3.4%; n=3), tuna longlines (2.3%; n=2), shark drumlines (2.3%; n=2) and ropes and buoys (1.2%; n=1), and unknown gear (1.2%; n=1), were less involved.

Entanglements involving rock lobster (*Jasus lalandii*) gear occurred annually since 1999, mainly between July and February. Entanglements with bather-protection nets occurred mainly between July and October, however there has been no entanglements in bather-protection nets registered since 2015. Entanglements in other type of gear occurred sporadically throughout the year. Entanglements in Octopus gear only appeared since 2009 when experimental fishing became more prolific, while other gears such as unidentified nets and longlines Tuna have no longer been registered in entanglements since 2006 and 2008 respectively.

Most non-fatal entanglements occurred in the Western Cape province, especially around Cape Town (wwhere disentanglement teams are largely based), while the vast majority of entanglements in bather-protection nets occurred on the KwaZulu-Natal coastline. Nonetheless, three and one entanglement observed on Western Cape and Eastern Cape coastline respectively included bather-protection nets, presumably animals entangled in the KwaZulu-Natal coastline but which broke lose with a piece of the gear still attached (Figure 7).

Table 3: Southern right whale entanglements (fatal and non-fatal) in South African waters between 1999 and 2019

Year	Month	Day	Gender	Latitude	Longitude	Area	Location	Age Class	Size (m)	Result	Gear Involved	Comment
1999	5	27	Unknown	-34.21	18.64	Western Cape	Off St James, False Bay	Unknown	Unknown	No intervention	Rock lobster gear	Grey rope and buoy round tail stock
1999	6	27	Unknown	-34.15	18.33	Western Cape	5 mi S Slangkop	Unknown	Unknown	No intervention	Rock lobster gear	Crayfish trappings implicated
1999	10	10	Unknown	-34.21	18.64	Western Cape	Off Glencairn, False Bay	Unknown	Unknown	No intervention	Rock lobster gear	Trailing buoy
2000	7	31	Unknown	-29.93	31.02	KZN	Ansteys Beach	Unknown	Unknown	Died	Bather-protection net KZNSB	
2000	8	12	Unknown	-34.56	19.34	Western Cape	Walker Bay	Unknown	Unknown	Disentangled	Rock lobster gear	Rope and Orange buoy and current buoys round tail. Seen again on 16th August when it was disentangled.
2000	8	22	Unknown	-34.05	23.37	Western Cape	Plettenberg Bay	Juvenile	10.00	No intervention	Rock lobster gear	3 rope strands through mouth and over top jaw and head, has a knot, 1 buoy. Dubbed "Princess"
2000	8	24	Unknown	-29.54	31.23	KZN	Ballito Bay	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2000	10	13	Unknown	-34.50	20.48	Western Cape	De Hoop	Adult + calf	Unknown	No intervention	Net	MRI Aerial survey - Net? Round tail - cow with calf
2000	10	3	Unknown	-29.54	31.23	KZN	Ballito Bay	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2001	9	15	Female	-33.03	18.01	Western Cape	Saldanha Bay	Unknown	Unknown	Partly disentangled	Net	St Joseph's net round left flipper, tail, anchored. 10mm diameter yellow rope and net 2mm nylon mesh net
2001	10	4	Unknown	-34.54	19.37	Western Cape	Walker Bay	Unknown	Unknown	No intervention	Likely Rock lobster gear	Rope "lasso" round tail stock - loose
2001	10	18	Unknown	-34.04	18.36	Western Cape	Hout Bay	Calf	Unknown	Disentangled	Rope	Rope entanglement of calf
2001	10	23	Unknown	-34.67	19.50	Western Cape	Pearly Beach	Unknown	Unknown	No intervention	Rock lobster gear	Rope + 2 buoys round tail
2002	8	30	Unknown	-30.86	30.38	KZN	Margate	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2002	10	9	Unknown	-34.07	22.22	Western Cape	Mosselbay	Unknown	Unknown	No intervention	Bather-protection net KZNSB	Net + 4-5 yellow buoys round tail
2002	10	29	Unknown	-33.46	18.10	Western Cape	2 km from Dassen Island	Unknown	Unknown	Freed itself	Rope	Anchor rope in mouth?
2002	12	16	Unknown	-32.98	17.85	Western Cape	Jacobs Bay	Unknown	Unknown	No intervention	Bather-protection net KZNSB	Net + yellow floats round peduncle. Resighting from 9 th of October 2002
2003	7	30	Unknown	-30.82	30.41	KZN	St Michaels	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	Resighting on 16 th of December 2003
2003	8	22	Unknown	-29.93	31.02	KZN	Ansteys Beach	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2003	8	3	F	-30.66	30.52	KZN	Banana Beach	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	

2003	9	12	Unknown	-34.21	18.64	Western Cape	Kalk Bay - Simonstown, False Bay	Unknown	Unknown	No intervention	Rock lobster gear	Rope 6 times round tail stock + buoy
2003	9	23	Unknown	-29.73	31.09	KZN	Umhalanga Rocks	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2003	10	15	F	-31.04	30.23	KZN	Port Edward	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2003	10	5	Unknown	-30.29	30.76	KZN	Scottburgh	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2004	7	14	Unknown	-33.82	18.48	Western Cape	Off Blaauwbergstrand	Unknown	Unknown	No intervention	Rock lobster gear	2 buoys round tail
2004	7	19	Unknown	-34.23	18.84	Western Cape	Gordons Bay - Kogelbaai	Unknown	Unknown	No intervention	Rock lobster gear	RL Rope and buoy on side
2004	8	18	Unknown	-33.91	25.63	Eastern Cape	Algoa Bay	Juvenile	Unknown	No intervention	Bather-protection net KZNSB	Net overhead and mouth. Picture shows SRW with large mesh bather-protection net overhead. Mesh caught in callosities. Juvenile whale.
2004	9	14	Unknown	-34.24	18.41	Western Cape	False Bay, nr Cape Point	Juvenile	Unknown	Disentangled	Rock lobster gear	Ropes and buoys round tail. Wrapped at least 15 times around CP and tail.
2005	1	20	Unknown	-33.42	18.09	Western Cape	Dassen Island	Unknown	Unknown	No intervention	Rock lobster gear	2 x rock lobster trap ropes round tail + buoys, broke free of traps, only rope and buoys attached to tail
2005	2	23	Unknown	-33.93	18.38	Western Cape	Clifton/Bantry Bay	Unknown	Unknown	No intervention	Rock lobster gear	RL gear. 6-9 loops yellow rope round head/body, pink buoy on back with cork floats
2005	7	14	Unknown	-34.39	18.83	Western Cape	Off Cape Hangklip	Unknown	Unknown	No intervention	Rock lobster gear	Entangled in ropes
2005	9	15	Unknown	-34.19	18.62	Western Cape	False Bay, near Rocky Bank	Adult	13.70	Disentangled	Rock lobster gear	Rope, buoys and current buoys + crayfish traps (7 traps removed) - entanglement. Indentations in tail stock but damage minimal.
2005	9	25	Unknown	-33.72	18.42	Western Cape	Melkbosstrand	Juvenile	10.80	Died	Rock lobster gear	Yellow RL rope embedded round flipper insertion. Large white shark bite 70 cm.
2005	10	3	Unknown	-34.27	18.57	Western Cape	False Bay	Unknown	Unknown	No intervention	Rock lobster gear	12 mm rope and RL buoys on tail
2006	1	30	Unknown	-33.41	18.09	Western Cape	SW of Dassen Island	Juvenile	Unknown	Partly disentangled	Rock lobster gear	Juvenile female rope around body, head and tail, one? Trap
2006	7	11	Unknown	-32.95	17.59	Western Cape	St Helena Bay (7.3 m)	Juvenile	8.00	Partly disentangled	Net	Entangled in mullet gill net - partial grey morph (mullet net)
2006	8	22	Unknown	-34.21	23.35	Western Cape	Plettenberg Bay off Keurboom river mouth	Unknown	Unknown	No intervention	Rope	At least 5-6 rope turns on bonnet and through baleen - brindle animal
2007	7	31	Unknown	-34.23	23.19	Western Cape	Plettenberg Bay	Unknown	Unknown	No intervention	Rock lobster gear	Green rope + yellow float around tail stock and flukes. Twice around L. fluke + 2m trialling. Rock Lobster current buoy
2007	7	16	Unknown	-30.10	30.87	KZN	Winkelspruit	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2007	8	15	Unknown	-34.00	22.57	Western Cape	Wilderness	Unknown	Unknown	No intervention	Likely longline	Yellow rope around head, unconfirmed report, shore sighting

2007	8	15	Unknown	-34.05	23.37	Western Cape	Plett, Robberg (just south)	Unknown	Unknown	No intervention	Likely longline	Rope around body close to DF. Rope is thick.
2007	10	9	Unknown	-34.11	18.49	Western Cape	Pringle Bay / Muizenberg (depth 9,75m)	Juvenile	10.00	Disentangled	Rock lobster gear	2 x Red buoys + 6 x floats and 110mx17mm + 50mx10mm yellow rope - Rock lobster trap
2008	1	5	Female	-34.34	18.81	Western Cape	Pringle Bay, False Bay	Adult + calf	Unknown	No intervention	Rock lobster gear	11h10 reported, cow + calf, Cow trapped in recreational Rock lobster ring net rope around head, animal sped off.
2008	2	20	Unknown	-33.43	18.10	Western Cape	Dassen Island (depth 10 m)	Juvenile	10.00	Disentangled	Rock lobster gear	Red buoy, yellow float, red cork and yellow rope from rock lobster trap - 10m
2008	4	3	Unknown	-34.10	18.33	Western Cape	Chapmans Peak/Kommetjie	Juvenile	10.00	Partly disentangled	Rock lobster gear	Complete R/lobster trap with yellow 12mm rope + red buoy, + yellow 12mm rope + red buoy from 2nd trap.
2008	6	5	Unknown	-34.06	22.32	Western Cape	Glentana + Plettenberg Bay	Unknown	Unknown	No intervention	Rope	Yellow + Green polypropylene "mooring rope" around head and tail stalk.
2008	8	8	Unknown	-34.09	22.97	Western Cape	Struisbay/Pearly Beach/Buffels Bay	Juvenile	8.00	No intervention	Rock lobster gear	Possibly three wraps around peduncle Green + yellow ropes, pink buoy + white float
2008	8	16	Unknown	-34.79	20.07	Western Cape	Struisbaai	Unknown	Unknown	No intervention	Longline Tuna	Longline - LHS Fluke = 1 wrap, RHS fluke = 2 wraps and peduncle = 1 wrap
2008	8	23	Unknown	-34.21	22.04	Western Cape	Dana Bay (Mossel Bay) (depth 8-10 m)	Juvenile	9.00	Partly disentangled	Longline Tuna	8-10m brindle. Tuna longline through mouth, over body both sides, trailing float
2008	8	6	Unknown	-30.91	30.34	KZN	Southbroom	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2008	9	5	Unknown	-34.21	18.66	Western Cape	False Bay	Unknown	Unknown	Freed itself	Unknown	fresh Entanglement scars on tail stalk - no entanglement present
2008	9	26	Unknown	-29.27	31.45	KZN	Zinkwazi	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2008	12	5	Unknown	-34.44	19.24	Western Cape	Hermanus	Unknown	Unknown	Disentangled	Rock lobster gear	Rock lobster ring net. 12mm blue/white ski-rope and Yellow + red floats
2009	1	21	Unknown	-33.91	18.38	Western Cape	Sea Point -	Unknown	Unknown	No intervention	Rope + rope and buoy	Thick Yellow rope around head to flukes + large Orange buoy trailing behind flukes
2009	8	15	Unknown	-34.69	19.50	Western Cape	Pearly Beach	Juvenile	8.00	No intervention	Rock lobster gear	Yellow rope + 2x white floats, whale estimated at 8m. Rope through mouth, down length and wrapped around caudal peduncle, some damage
2009	9	19	Unknown	-34.16	24.87	Eastern Cape	Keurbooms river Mouth	Adult	Unknown	Freed itself	Rope	Yellow nylon rope around body + tail
2009	9	20	Unknown	-34.16	18.44	Western Cape	Glencairn	Unknown	Unknown	Freed itself	Octopus gear	Octopus trap + flagged buoy
2009	9	17	Unknown	-30.05	30.91	KZN	Amanzimtoti	Calf	6.00	Disentangled	Bather-protection net KZNSB	Bather-protection nets badly entangled with panel over its back and large amount netting on tail
2009	10	5	Unknown	-30.06	30.89	KZN	Amanzimtoti	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	Net #2 whale released safely
2010	7	13	Unknown	-34.19	22.16	Western Cape	Glentana, Mossel Bay	Unknown	Unknown	No intervention	Rope	Red Anchor rope

2010	8	14	Unknown	-34.37	18.81	Western Cape	Hangklip	Juvenile	9.00	Disentangled	Rock lobster gear	RL yellow rope - Two wraps around each fluke + Red buoy + 11m rope behind
2010	8	16	Unknown	-34.44	19.23	Western Cape	Hermanus	Unknown	Unknown	No intervention	Rock lobster gear	RL gear - two buoys (one white + one red) + 11m rope trailing behind
2011	1	7	Unknown	-33.44	18.10	Western Cape	Dassen Island	Adult	12.00	Disentangled	Rock lobster gear	RL trap Yellow 12mm rope (length 81.5m) Orange Buoy and white cork
2011	5	22	Unknown	-30.13	30.86	KZN	Karridene	Juvenile	9.00	Disentangled	Bather-protection net KZNSB	Bather-protection nets Top rope (14mm 7 Keg floats) - 5-6 wraps caudal peduncle
2011	10	3	F	-30.07	30.90	KZN	Amanzimtoti	Adult	Unknown	Freed itself	Bather-protection net KZNSB	Believed bather-protection net around caudal peduncle of cow which had a calf. Broke free
2012	9	16	Unknown	-34.06	22.24	Western Cape	1nm offshore Tergniet MB	Adult + Calf	Unknown	Disentangled	Bather-protection net KZNSB	Cow had Bather-protection net (89.6kg) around peduncle & included header (yellow surface buoys) and bottom (round bar weights)
2013	1	16	Unknown	-33.90	18.45	Western Cape	Bell buoy Table Bay Harbour	Adult	15.00	Partly disentangled	Rock lobster gear	Entangled in 12 mm RL rope & buoy, around peduncle & flukes
2013	8	12	F	-30.92	30.34	KZN	Southbroom	Adult	Unknown	Partly disentangled	Bather-protection net KZNSB	Bather-protection net around Peduncle / Grapnel and two keggings buoys on 30m rope
2014	3	15	M	-34.14	18.46	Western Cape	150m off St James tidal pool FB	Juvenile	10.00	Died	Octopus gear	Five wraps around caudal peduncle and a lateral loop overhead, includes three octopus traps. Believed it was free but not the case. Stranded 10/05/2014
2014	4	9	Unknown	-32.71	18.07	Western Cape	Sandy Point Harbour	Unknown	Unknown	No intervention	Likely longline	Had a large white buoy (with black numbers) trailing behind flukes
2014	6	4	Unknown	-29.52	31.24	KZN	Thompsons Bay	Adult	10.00	Disentangled	Bather-protection net KZNSB	Bather-protection net, Initially covering only the head but later fully covered in net except tail
2014	7	29	Unknown	-29.68	31.13	KZN	Umdloti	Calf	8.00	Disentangled	Bather-protection net KZNSB	Bather-protection net released by lifeguards had rope and net around the tail
2014	7	21	Unknown	-29.68	31.12	KZN	Umdloti	Unknown	Unknown	Lost or released	Shark drumline	
2014	9	30	Unknown	-34.16	24.85	Eastern Cape	St Francis Bay	Unknow	Unknown	No intervention	Rock lobster gear	Boy marked "Regal"
2015	1	29	Unknown	-33.44	18.09	Western Cape	5.7 nm south of Dassen Island	Juvenile	8.00	No intervention	Rock lobster gear	Reported to be ensnared on bottom. It had three wraps of 18 mm rope around the body (posterior to the flippers) and had three wraps on the caudal peduncle with a tight rope joining the two areas, restricting the body to the shape of a bow. The trap had 120 m or rope and it was unable to move.
2015	7	29	Unknown	-30.87	30.38	KZN	Margate	Adult	13.00	Disentangled	Shark Drumline	Drumline around tail stock and flukes.
2015	9	21	Unknown	-29.01	32.52	KZN	Thompson Bay	Calf	7.00	Disentangled	Bather-protection net KZNSB	Bather-protection net - net panel destroyed with head and bottom ropes were twisted together running over the animal around the left flipper then back over the head
2015	9	21	Unknown	-29.52	31.23	KZN	Thompson Bay	Unknown	Unknown	Lost or released	Bather-protection net KZNSB	
2016	3	2	Unknown	-33.90	18.40	Western Cape	300m off Rocklands Beach CT	Juvenile	9.00	Partly disentangled	Rock lobster gear	4 RL ropes on back @ LHS entering cluster with current buoy and 3 ropes leaving on LHS

2017	6	20	Unknown	-34.21	18.47	Western Cape	~150m off Rocklands Bay, False B	Unknown	Unknown	Freed itself	Octopus gear	Seen by observer to be thrashing with yellow octopus rope crossing body
2017	8	20	Unknown	-34.35	19.02	Western Cape	Between Palmiet and Kleinmond	Adult	12.00	Disentangled	Unknown	The whale was dragging 20m of rope behind it with a small buoy attached. Three rope wraps were around caudal peduncle
2017	8	22	Unknown	-34.15	18.44	Western Cape	Sunny Cove (False Bay)	Juvenile	10.50	Disentangled	Octopus gear	Octopus trap, had 8 ropes on the flukes (including grey sinking rope and yellow floating rope, as well as concrete tyre and chain around caudal peduncle and fluke
2017	9	9	Unknown	-34.26	18.48	Western Cape	Millers Point (False Bay)	Unknown	Unknown	Freed itself	Octopus gear	Temporarily entangled -seen to be thrashing - Octopus Trap
2018	5	30	Unknown	-34.19	22.16	Western Cape	Santos beach Mossel Bay	Juvenile	Unknown	Freed itself	Rope	Swimming safety rope. Photograph indicated whale temporarily caught on callosity's
2018	8	20	Unknown	-34.42	19.25	Western Cape	300m off Gearing's Point	Unknown	Unknown	No intervention	Likely rock lobster gear	Rope wrapped at least three times around Caudal Peduncle-no rope or buoy seen trailing behind
2019	2	21	Unknown	-33.91	18.39	Western Cape	Originally 2.3nm off Sea Point	Juvenile	10.00	Disentangled	Rock lobster gear	Had 6 wraps around caudal peduncle and 3 wraps around left fluke. Has a red float with white cross on tail and attached 93m rope (14mm).
2019	4	16	Unknown	-34.10	18.35	Western Cape	~1nm offshore Noordhoek	Unknown	Unknown	No intervention	Rock lobster gear	SRW in group of 6 whales feeding, Yellow buoy attached to flukes and whale was dragging it down.
2019	5	23	Unknown	-34.37	18.81	Western Cape	18.09nm offshore Hangklip	Unknown	Unknown	Freed itself	Rock lobster gear	Rope and buoy around caudal peduncle. Freed itself - rope broke
2019	6	30	Unknown	-34.16	18.44	Western Cape	Clovelly Corner (False Bay)	Adult + Calf	Unknown	Freed itself	Octopus Gear	ALDFG - Whale was seen to be struggling to get to surface. Ad cow had rope and a grey box on back

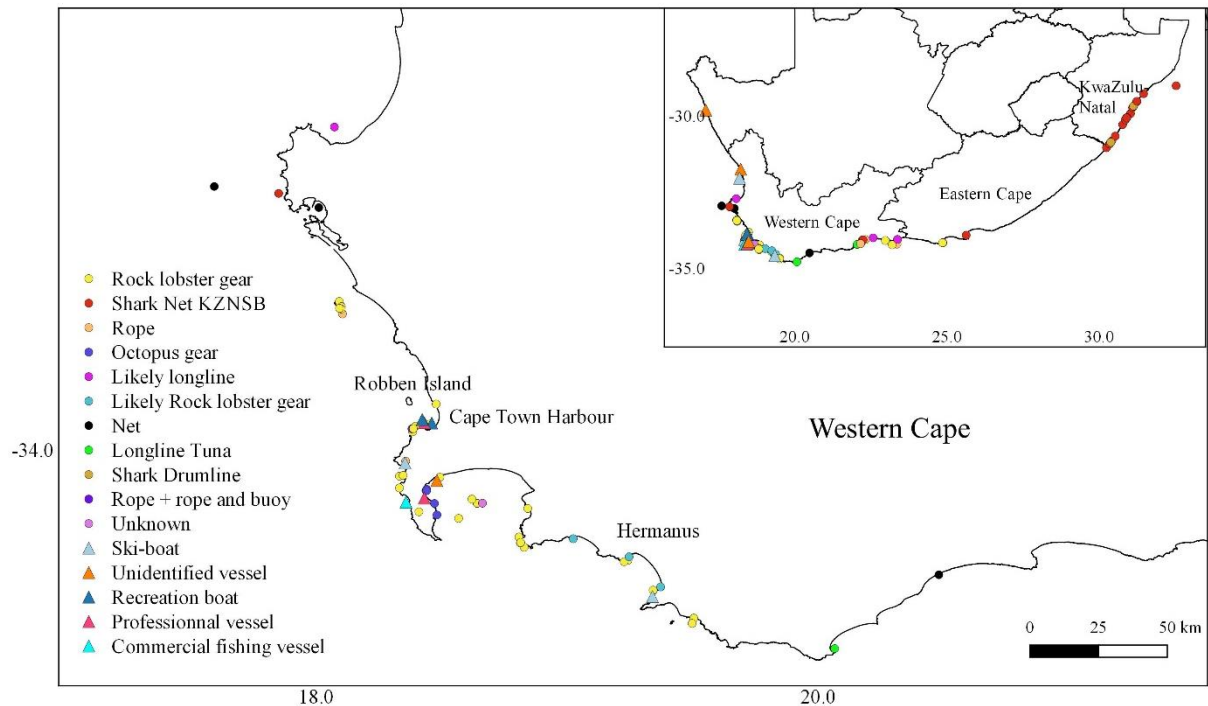


Figure 7: Location of anthropogenic incidents that did not result in registered mortalities of southern right whales off South Africa between 1999 and 2019, including a more detailed map of the area around Cape Town.

Incidence of scarring

In total, 15 identified animals were photographed post-1998 with scarring on the peduncle, likely caused by ropes and/or entanglement. In one case a rope/net was still visible around the whale's peduncle (in 2000). Most of these whales presented such scars upon first identification, with only 3 previously identified individuals presenting such scarring for the first time in a photographic recapture. At least four animals in the photographic catalogue, all identified post-1998, present scars that could be attributed to propellers (set of parallel lines at regular intervals), and are thus most likely the result of a ship-strike.

DISCUSSION

Southern right whale mortalities

Recorded mortalities of SRWs along the South African coast generally increased over time associated with the positive population growth rate (Best et al. 2001a, 2011). However, this general trend seems to reverse after 2007, when the incidence of recorded mortalities decreased. As technology and the development of a stranding and disentangle network around the South African coast advanced in the most recent years, consequently such a decrease is not believed to be related to a decline in the reporting of SRW mortalities. In fact, due to the temporal coincidence, this decline is believed to be related to the drastic decrease in SRW prevalence along the South African coast since 2009 (Findlay et al. 2017a, Vermeulen et al. 2020). Data from 40 years of SRW aerial surveys indicate that sightings of unaccompanied adults (i.e. males as well as non-calving females) along the South African coast have decreased dramatically from about 250-430 on the 2006-2008 surveys to about 12-34 on the 2017-2019 surveys (Vermeulen et al. 2020). Additionally, since 2015, the number of cow-calf pairs along the South African coast has fluctuated enormously, with the lowest sighting density over the last 30 years in 2016 (55 cow-calf pairs) while an all-time record of > 400 cow-calf pairs was observed in 2018 (Vermeulen et al., 2020). Preliminary data suggest these changes are related to a

shift in foraging strategy (e.g. van den Berg et al. 2021) and related reduction in body condition (Tavar et al. 2021), and not the result of an increased adult mortality (as already suggested by Brandão et al. 2018). The data presented in this study supports this latter hypothesis.

The majority of SRWs stranded between 1999 and 2019 were calves of the year (53%). This is in line with the findings of Best et al. (2001a) and Best et al. (2011). In the past decade alone (2011-2019), this proportion increased to 64.7%; likely related to the drastic decrease in the number of unaccompanied adults and consequent increase in the proportion of calves (from an average of 32% between 1991 and 2010 to 44% between 2011 – 2019 on the annual photographic aerial surveys; MRIWU, unpublished data).

It is not surprising that the majority of strandings coincided with the seasonal presence of the species in the South African breeding ground, and accordingly, occurred in their main concentration area (southern Cape coast; Best 1990). Notably, outside of this main breeding area, strandings were more prevalent along the South African west coast rather than south-east coast, in line with the reported use of this non-nursery area (Mate et al. 2011, Barendse and Best 2014, Shabangu et al. 2020).

Anthropogenic impacts

The vast majority of ship-strikes and entanglements recorded between 1999 and 2019 occurred in the area between Cape Town Harbour (west coast) and Cape Agulhas. Although the area use of SRWs in the southern Cape is well studied (e.g. Best 1990; Elwen and Best 2004), the use of the South African west coast as a breeding and/or feeding ground remains poorly understood (Best 2006). Nonetheless, a few dozen right whales use the intensely used South African west coast as a foraging ground during austral summer months (e.g. Mate et al. 2011), leaving the whales vulnerable to anthropogenic impacts. A better understanding of this area use would therefore be beneficial in any attempt to mitigate human-whale conflicts in this area. Considering >10% of known SRW mortality in South Africa is related to deadly collisions with vessels (mainly females) and the area use by other baleen whale species including dense aggregations of humpback whales (Findlay et al. 2017b), a reduction of vessel speed for incoming and departing ship traffic within 15nm from Cape Town harbour, as well as the use of lookout observers on board vessels for spotting whales is strongly recommended.

Nearly 70% of all entanglement cases with SRWs involved rock lobster gear or bather-protection nets, occurring in the Western Cape and KwaZulu-Natal provinces respectively. In general, catches of West coast rock lobster started in November near Dassen Island and progress southwards towards the area of the Cape Peninsula up to October (Meÿer et al. 2011). However, recent reductions in the West coast rock lobster biomass have resulted in permit changes with fishing starting in Port Nolloth in October (ring nets) and catches moving south for traps from November to July. For South coast rock lobster, fishing begins in October and ends on the 30th September of the following year. This leads to a temporal and spatial overlap with SRWs, resulting in entanglements in rock lobster gear peaking on the west coast from November to April (coinciding with increased SRW presence in the area; Barendse and Best 2014), and on the southwest and south coast from July to October (coinciding with breeding season; Best 1994). Therefore, time and area restrictions in hot spots of SRWs could reduce entanglement incidents significantly (Meÿer et al. 2011). Bather-protection nets caused 26 entanglements with SRWs in the period 1999-2019, of which one had a fatal outcome. However, since 2015, no such entanglements have been recorded, possibly related with the extensive replacement of bather-protection nets with drumlines in various areas (Cliff and Dudley 2011). Furthermore, since 2019 the KZNSB has removed nets at specific beaches, as whale activity has increased in the vicinity of the installations between June and November, to reduce the risk of whale entanglement.

Although the cause of death of stranded whales is often difficult to determine, especially without a full necropsy, very little mortality seems directly attributed to obvious anthropogenic impacts like entanglements

and ship-strikes (0.2% of the South African population, estimated at 6,116 individuals; Brandão et al. 2018). This is supported by the continued low prevalence of related severe scarring in the extensive and long-term photo-identification catalogue (Best et al. 2011; Best et al. 2001), although it is recognized that this may be underestimated as the photographic focus during the surveys lies on the head of the whales for identification purposes. Furthermore, the rate of entanglement decreased post-2009, coinciding with the decreased presence of unaccompanied adult SRWs along the South African coast (Findlay et al. 2017; Vermeulen et al. 2020). Therefore, in general, ship-strikes and entanglements do not seem to be a major conservation threat to the South African SRW population. However, many ships strikes and entanglements may go undetected and/or unreported, or the fate of the whale involved often remains undetermined. Therefore, the actual number of mortalities related to such events is likely underestimated. Furthermore, the positive population growth rate and the recent government initiative to “unlock the economic potential of South Africa’s Oceans (Operation Phakisa)” may lead to an increased incidence of anthropogenic related mortalities. Continued monitoring of these incidences is therefore crucial to ensure accurate knowledge-based management decisions in the future, especially in view of the reduced body condition of female SRWs along our coast compared to two decades ago (Thavar et al. 2021). Additionally, improved necropsies and data collection are advised to improve data quality.

ACKNOWLEDGEMENTS

The authors like to acknowledge all involved in data collection of southern right whale mortalities and anthropogenic impacts, including (but not limited to) Dolphin Action Protection Group, South African Police Service, National Sea Rescue Institute, Department of Environment Forestry and Fisheries, trained members of SAWDN, South African Stranding Network, various municipalities, marine mammal scientific community of South Africa, Bayworld, Dyer Island Conservation Trust, Lower Breede River Conservancy, South African Shark Conservancy, Southern Wildlife Environmental Society, Cape Nature, SANPARKS, NSRI, boat-based and Shark Cage Diving operators, Rock Lobster and Octopus Fishing Industry and private citizens.

We would also like to acknowledge all the trained members of SAWDN for their efforts to disentangle whales and collection of information on whale entanglements; without the support of the NSRI this would not have been possible.

REFERENCES

- Barendse J, Best PB (2014) Shore-based observations of seasonality, movements, and group behavior of southern right whales in a nonnursery area on the South African west coast. *Marine Mammal Science* 30: 1358–1382. <https://doi.org/10.1111/mms.12116>
- van den Berg GL, Vermeulen E, Valenzuela LO, Bérubé M, Ganswindt A, Gröcke DR, Hall G, Hulva P, Neveceralova P, Palsbøll PJ, Carroll EL (2021) Decadal shift in foraging strategy of a migratory southern ocean predator. *Global Change Biology*: 1052–1067. <https://doi.org/10.1111/gcb.15465>
- Best P, Peddemors V, Cockcroft V, Rice N (2001a) Mortalities of right whales and related anthropogenic factors in South African waters, 1963-1998. *Journal of Cetacean Research and Management*: 171–176. Available from: <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Mortalities+of+right+whales+and+related+anthropogenic+factors+in+South+African+waters,+1963-1998#0>.
- Best PB (1981) The status of right whales off South Africa (1969-1979). Sea Fisheries Institute, Cape Town.
- Best PB (1990a) Natural markings and their use in determining calving intervals in right whales off South

- Africa. *South African Journal of Zoology* 25: 114–123. <https://doi.org/10.1080/02541858.1990.11448199>
- Best PB (1990b) Trends in the inshore right whale population off South Africa, 1969–1987. *Marine Mammal Science* 6: 93–108. <https://doi.org/10.1111/j.1748-7692.1990.tb00232.x>
- Best PB (1994) Seasonality of reproduction and the length of gestation in southern right whales *Eubalaena australis*. *Journal of Zoology* 232: 175–189. <https://doi.org/10.1111/j.1469-7998.1994.tb01567.x>
- Best PB (2006) The presence of right whales in summer on the west coast of South Africa: The evidence from historical records. *African Journal of Marine Science* 28: 159–166. <https://doi.org/10.2989/18142320609504140>
- Best PB (2007) Whales and dolphins of the southern African subregion. Cambridge University Press, 338 pp.
- Best PB (2011) Review of aerial photo-identification surveys for right whales off south africa (1979-2010). Iwc report SC/S11/RW15: 1–20.
- Best PB, Ruther H (1992) Aerial photogrammetry of southern right whales , *Eubalaena australis*. *Journal of Zoology (London)*: 595–614.
- Best PB, Brandão A, Butterworth DS (2001b) Demographic parameters of southern right whales off South Africa. *Journal of Cetacean Research and Management (Special Issue)*: 161–169.
- Best PB, Meÿer MA, Kotze D, Hofmeyr G, Thornton M (2011) Mortalities of right whales in South African waters and associated factors (excluding entanglements), 1999-2010. Report to the International Whaling Commission SC/S11/RW14.
- Brandão A, Vermeulen E, Ross-gillespie A, Findlay K, Butterworth DS (2018) Updated application of a photo-identification based assessment model to southern right whales in South African waters , focussing on inferences to be drawn from a series of appreciably lower counts of calving females over 2015 to 2017. IWC Scientific Committee Report SC/67B/SH2.
- Cliff G, Dudley SFJ (2011) Reducing the environmental impact of shark-control programs : a case study from KwaZulu-Natal , South Africa. *Marine and Freshwater Research* 62: 700–709. <https://doi.org/10.1071/MF10182>
- Elwen S, Best P (2004) Female southern right whales *Eubalaena australis*: Are there reproductive benefits associated with their coastal distribution off South Africa? *Marine Ecology Progress Series* 269: 289–295. <https://doi.org/10.3354/meps269289>
- Findlay K, Thornton M, Wilkinson C, Vermeulen E, Hoerbst S (2016) Report on the 2016 Mammal Research Institute Whale Unit Southern Right Whale Survey , Nature ' s Valley To Lambert ' s.
- Findlay KP, Seakamela SM, Meÿer MA, Kirkman SP, Barendse J, Cade DE, Hurwitz D, Kennedy AS, Kotze PGH, McCue SA, Thornton M, Vargas-Fonseca OA, Wilke CG (2017) Humpback whale “super-groups” - A novel low-latitude feeding behaviour of Southern Hemisphere humpback whales (*Megaptera novaeangliae*) in the Benguela Upwelling System. *PLoS ONE* 12: 1–18. <https://doi.org/10.1371/journal.pone.0172002>
- Geraci, J. R., & Lounsbury, V. J. (2005). *Marine mammals ashore: a field guide for strandings*. National Aquarium in Baltimore.
- Mate B, Best P, Lagerquist BA, Winsor MH (2011) Coastal, offshore, and migratory movements of South African right whales revealed by satellite telemetry. *Marine Mammal Science* 27: 455–476. <https://doi.org/10.1111/j.1748-7692.2010.00412.x>
- Meÿer MA, Best PB, Anderson-Reade MD, Cliff G, Dudley SFJ, Kirkman SP (2011) Trends and interventions in large whale entanglement along the South African coast. *African Journal of Marine Science* 33: 429–439. <https://doi.org/10.2989/1814232X.2011.619064>
- Rowntree VJ (1996) Feeding, distribution, and reproductive behavior of cyamids (Crustacea: amphipoda) living on humpback and right whales. *Canadian Journal of Zoology* 74: 103–109. <https://doi.org/10.1139/z96-014>

Shabangu FW, Andrew RK, Findlay K (2020) Acoustic occurrence, diel-vocalizing pattern, and detection ranges of southern right whale gunshot sounds off South Africa's west coast. *Marine Mammal Science*: 1–18. <https://doi.org/10.1111/mms.12760>

Thavar, T., Christiansen, F., Ganswindt, A., Sironi, M., Uhart, M., Bejder, L., Vermeulen, E. (2021) Southern right whale (*Eubalaena australis*) body condition and glucocorticoid levels at the South Africa breeding ground. Report presented to the 68c meeting of the Scientific Committee of the International Whaling Commission.

Vermeulen E, Wilkinson C, Thornton M (2019) Report of the 2018 South African Southern Right.

Vermeulen E, Wilkinson C, Van Den Berg G (2020) Report of the southern right whale aerial surveys – 2019. Unpublished paper SC/68B/SH/02 presented to the IWC Scientific Committee, Cambridge.