Marine Biodiversity Hub

National Environmental Science Programme

Monitoring population Dynamics of 'Western' Right Whales off Southern Australia 2018–2021
Final Report on activities for 2019

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Project A7 - Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2018-2021

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Important Disclaimer

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EXECUTIVE SUMMARY

Annual aerial surveys of southern right whales have been conducted off the southern Australian coast, between Cape Leeuwin (W.A.) and Ceduna (S.A.), since 1993 to monitor the recovery of this species following commercial whaling. We conducted an aerial survey of southern right whales in August 2019 (18^{th} – 24^{th}) to continue these annual series of surveys and inform the long-term trend data. In total, 1111 southern right whales were sighted, including 425 calves, which consist of double counts given that each flying leg is covered twice as 'outward' and 'inward'. An additional 13 humpback whales were observed during the survey. A comparison of the maximum count for each survey leg with previous years resulted in 2019 having a total of 577 whales and 221 cow/calf pairs. This is the lowest whale count for the past four years (since 2015), although overall there is still higher than any of the other previous years since 1993. The maximum counts for cow/calf pairs are used to obtain a population size estimate, which is currently estimated at 3164 whales. This population estimate is for the 'western' Australian subpopulation, which is considered to represent the majority of the 'Australian' population. The population trend analysis indicates a continued increase in whale numbers by approximately 6% per year (based on counts of cow/calf pairs), with no apparent slowdown in the population growth rate. From 6149 photographic images obtained, 299 have been selected for computer -assisted 'matching' with those already available in the national ARWPIC catalogue. All photo-identification and sightings data have been included and archived in existing databases.

1. INTRODUCTION

Now classified as endangered under the Australian '*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)', unsustainable whaling during the 19th and 20th centuries reduced southern right whales (*Eubalaena australis*) almost to extinction (to a few hundred animals) throughout the southern hemisphere, including off Australia. Since the mid-1970s, and following the cessation of whaling on the species, there have been signs of recovery for part of the population that migrates to the southern Australian coast each year. Specifically, this has been evident for waters off Western Australia (WA) and western South Australia (SA) which is referred to as the 'western subpopulation'. Since 1976, aerial surveys have been undertaken annually along the south-western coast of Australia to determine numbers and population trend, life history information, and obtain individual identification photographs of whales aggregating close inshore during calving and nursing. Initially, these surveys were undertaken along the WA south coast from Cape Leeuwin east to Twilight Cove and then were extended from 1993 into SA waters to Ceduna, given evidence of intra- and inter-season coastal movement. Collection of these data is a 'high priority' in the Australian EPBC Act Recovery Plan (Conservation Management Plan) to assess the current status of this Threatened Species and assess the effectiveness of Federal and State management approaches that aim to facilitate this species' recovery and range expansion.

In the south-east of the southern Australian coast there has been little sign of recovery in numbers; a working hypothesis assumes separation between two subpopulations – 'western' and 'eastern'. Given the relative paucity of animals that visit the remainder of the southern Australian coast, the 'western' subpopulation is considered to represent the majority of the 'Australian' population. A comprehensive understanding of the population abundance and degree of spatial connectivity of southern right whales in Australian waters is currently lacking. This limits assessment of the species recovery and understanding of the nature and degree of difference between the south-eastern and south-western Australian populations. To address this, the NESP funded project '*Project A13 - Estimation of population abundance and mixing of southern right whales in the Australian and New Zealand regions*' will provide an abundance estimate of the total Australian population of southern right whales for the first time. It will also investigate the connectedness of whales that utilise breeding areas on the eastern, southern and western coasts of Australia. Results from these aerial surveys of the 'western' subpopulation (*Project A7*) will be directly incorporated into the broader, national *Project A13*. The count data from these aerial surveys provide estimates of population size and trend for the 'western' population and the associated photo-identification data provides information on connectivity between the 'western' and 'eastern' population and life history information (e.g. calving intervals).

2. AIMS

In order to provide information that assists an assessment of the conservation status of Australia's south-west population of endangered southern right whales, the project has the following aims:

a) Continue annual aerial surveys to collect count and photo-identification data for the south-west population of Australia's southern right whales from the southern coast between Cape Leeuwin (WA) and Ceduna (SA)
b) Determine estimates of population trend since 1993 and current population size
c) Maintain and incorporate individual photo-identification data into the existing Australian Right Whale Photo-identification Catalogue (ARWPIC), assess life history parameters, and facilitate the identification of demographic relationships between the south-west and south-east populations
d) Maintain the sightings database of the 'western' population of southern right whales.

3. METHOD

Aerial surveys of southern right whales are undertaken following established protocols, using a high wing, single engine aircraft (Cessna 172) crewed by a pilot/observer and photographer/observer along the coast between Cape Leeuwin (Western Australia) and Ceduna (South Australia). The survey is undertaken during August/September when whale numbers are likely to be at close to the maximum given the known calving period and flights are only conducted on 'good' days, when wind speeds are less than 15 knots. Most animals, particularly cows accompanied by their calves of the year, are easily observed in the relatively clear waters on the south coast and no corrections are made for the detection probability of a sighting (g(0)), which is assumed to be 1. Each flight surveys an area within *ca* one nautical mile of the coast, assuming all animals are close to the coast, at a survey altitude of 1000 ft, with photographs of the individual markings of the whales taken at 500 ft (Fig. 1). When whales are sighted, a GPS position is recorded, a direct count of the number of whales is made and individuals are circled for photography, with an emphasis on cows with calves. For individual identification, clear aerial photographic images of the head callosity pattern and/or other identifying characteristics are required.

Each annual survey involves multiple 'legs' along the coast that can occur on the same day or spread across several days, depending on the weather. Each 'leg' is generally covered twice, once 'outwards' from C. Leeuwin to Ceduna and once 'inwards' on the return flights. The maximum count on either the 'outward' or 'inward' flight on each 'leg' are then used to obtain estimates of both population trend and current population size, which is consistent and comparable to previous years since 1993.

A population trend analysis is undertaken using an exponential regression (i.e. a linear regression of the natural log of the count on year) of the maximum count data for 'all animals' and 'cow/calf' pairs (Table 2) from aerial surveys flown between C. Leeuwin (WA) and Ceduna (SA) since 1993. It excludes data for two years (1996 and 1997), due to potential bias in the data as a result of possible undercounting of whales during those years. The total population size estimate is currently obtained using a simple model adopted at the 2011 International Right Whale Workshop (IWC, 2013) based on the numbers of cow/calf pairs (i.e. mature females) sighted, multiplied by a single applied conversion factor. The conversion factor is based largely on evidence from increasing populations off Argentina and South Africa, whereby the cow/calf count over three years (to allow for a 3-year calving interval) is multiplied by a factor of 3.94. Given the multiplication factor is based on a 3-year average of counts, it can be influenced by consecutive low/high counts.

Photographs from the flights are added to the 'WA' catalogue for computer-assisted 'matching' with those already identified. A computer-assisted comparison system (Hiby & Lovell 2001) is used to 'match' individual photographs obtained on the flights with those already available in the 'WA catalogue'. From late 2003 it replaced manual methods used previously. The system compares digitised extracts of overhead ('topside') photographs of

individual head callosity patterns. ‘Matched’ individuals are then included in the ‘WA catalogue’, comprising animals from Western Australia and South Australia, as well as from some other eastern states, the southern Indian Ocean and the Antarctic. It is contained in an ‘Individual Whale’ database. Sightings information is added to the existing sightings database which relates detailed sightings information to individuals already identified photographically.

4. RESULTS

4.1 Aerial survey

An aerial survey of the 'western' population of Australian southern right whales was undertaken between C. Leeuwin (WA) and Ceduna (SA) over seven days in total from the 18th to 24th August 2019 during 39.3 flying hours. During the survey, 1111 southern right whales were sighted, consisting of 425 calves of the year. An additional 13 adult humpback whales (Table 1) were sighted and various species of sharks. Of the seven days, six were survey days whereas one day flying was unable to be undertaken due to strong 20-30 knot winds. The maximum counts for each leg (maximum of the 'outward' or 'inward' leg) for the 2019 data result in a total of 577 southern right whales, consisting of 135 'unaccompanied' adults and 221 cow/calf pairs (Table 2).

4.2 Current distribution

Sightings of southern right whales during the 2019 aerial survey were consistent with the distribution of whales in previous years, with higher numbers of sightings of particular classes of animals at various locations along the coast (Fig. 2). The distribution of cow/calf pairs and unaccompanied animals appeared to closely correlate each other this year, with sightings of both groups in similar places along the coast. Specifically, there were higher numbers of both groups in four main areas; Albany east to Doubtful Island Bay, Israelite Bay to Point Culver, Twilight Cove and at the Head of the Bight in South Australia (Fig. 1 & 2).

4.3 Photography

From 6149 images obtained on the 2019 flight, 299 have been selected for computer-assisted 'matching' with those already available in the ARWPIC catalogue.

4.4 Population Size

The number of whales sighted in 2019 was less than the numbers sighted in the past four years (since 2015) for both the total numbers of whales (N=577) and cow/calf pairs (N=221), based on the comparable maximum counts (Table 2). It is evident there is significant annual variation in the numbers of whales sighted (Fig. 3a). For unaccompanied animals, this variation demonstrates a 2 to 4 year cycle in growth and for cow/calf pairs it is 3 to 5 year cycles (Fig. 3b). Considerable annual variation in whale numbers and cycles in population growth makes it difficult to detect consistent and reliable changes in abundance from one year to the next, and inhibits our ability to identify immediate threats to the population.

Current population size is estimated using a simple model adopted at the International Right Whale Workshop held in Buenos Aires, Argentina, in September 2011 (IWC, 2013), based largely on evidence from increasing populations off Argentina and South Africa. This model

uses the cow/calf count over three years (to allow for the 3-year periodicity in calving), which is multiplied by a factor of 3.94. For the 'western' Australian subpopulation, this results in a current population size (i.e. for the three-year rolling average period, 2017 to 2019) of 3164 whales. The current population size is comparable to the 2018 estimate of 3191 whales and are the largest estimates for the population since 1993, although reflects a decrease in cow/calf whale sightings compared to 2018, which undergoes annual variation. The number of cow/calf pairs is the lowest count for the past five years.

4.5 Trend analysis

An exponential regression analysis of the count data for '*all animals*' between 1993 and 2019 (excluding 1996/97) provides an exponential rate of increase over the period of 0.0505 (95% CI 0.037, 0.064), which is equivalent to an annual increase of 5.18% (95% CI 3.73, 6.65) (Table 3, Figure 4). The estimated exponential rate of increase based on counts of cow/calf pairs alone was 0.0582 (0.039, 0.077) or an annual increase of 5.99% (95% CI 4.01, 8.02) (Table 3, Figure 5).

Generally, there has been little change to the trend in population increase with the inclusion of the counts from the 2019 survey compared to those estimated from the 1993 – 2018 data (Table 3). There does not appear to be any slowdown in the growth rate of the population at present, despite potential weak evidence from the 2015 survey data (Bannister et al 2015), which seems to be an anomalous year. Consequently, the data still appears to conform to an exponential increase based on inspection of the fitted exponential regression residuals. Despite annual variation in whale counts, there is still a positive trend in population size of approximately 6%.

4.6 Databasing and data archiving

Sightings for the 2019 survey have been added to the marine mammal sightings database maintained by the Australian Antarctic Division.

Previous count data, sightings and individual whale sheets have been submitted to the Australasian Right Whale Photo-identification Catalogue (ARWPIC) hosted by the Australian Marine Mammal Centre and Australian Antarctic Data Centre at the Australian Antarctic Division (archived at the Australian Antarctic Division Archives), Hobart. Those from 2018 have been forwarded to that archive.

The data will be incorporated into a larger national assessment of the current conservation status of Australian right whales and their recovery relative to their pre-whaling abundance as part of the NESP '*Project A13 - Estimation of population abundance and mixing of southern right whales in the Australian and New Zealand regions*'. This project will undertake a population abundance and trend analysis, mark-recapture analysis of life-history parameters, population connectivity and individual movements.

5. CONCLUSIONS

The current population size of the 'western' Australian subpopulation is estimated to be at 3164 whales, which is comparable to the 2018 rolling average estimate of 3191 whales. Estimates from 2018 and 2019 are the largest for the population since 1993 and consistent with an increasing trend in population, despite significant annual variation in whale counts. The population trend analysis indicates a continued increase in whale numbers by approximately 6% per year (based on counts of cow/calf pairs), with no apparent slowdown in the population growth rate despite weak evidence from the 2015 survey data, which seems to be an anomalous year. Considerable annual variation in whale numbers and cycles in population growth makes it difficult to detect consistent and reliable changes in abundance from one year to the next and inhibits our ability to confidently identify immediate threats to the population. This supports the continuation of surveys conducted on an annual basis, such that a longer sampling frequency (e.g. surveys every 3 years) is likely to produce unreliable long-term trend data.

6. ACKNOWLEDGEMENTS

We greatly acknowledge John Bannister's dedication and long-term commitment to this project. Jenny Schmidt (flying for Great Southern Aviation, Albany, WA) piloted the flights with Andrew Halsall (Andrew Halsall Photography) as observer/photographer; we also acknowledge their hard work and dedication.

The flying was undertaken under relevant permits from the Western Australian Department of Parks and Wildlife (licence no. BA27000083), the South Australia Department for Environment and Water (permit no. MR00060-4-V and U26871-1) and ethical approval from Murdoch University (permit no. O3031/18). J.L.B. secured funding for the project.

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Tables and Figures

Table 1. Summary of results from the Right whale aerial survey, C. Leeuwin WA-Ceduna SA, August 2019.

Flight	Date	Leg	Whale sightings								Weather[1]	Flying hrs
			Right whales				Other large whales[2]					
			A[3]	C	Y	T	A	C	Y	T		
Outward legs, From Albany	18-08-19	1. Perth-Albany	19	4	0	23	6	0	0	6	240/07	4.6
	19-08-19	2. Albany-Esperance	112	72	4	188	3	0	0	0	230/08	5.4
	20-08-19	3. Esperance-Caiguna*	139	64	0	203	3	0	0	0	350/10	5.4
	21-08-19	4. Caiguna-Nullarbor (excl. Head of Bight)	23	11	0	34	1	0	0	0	90/05	4.6
		5. Nullarbor-Ceduna* (incl Head of Bight)	78	66	0	144	0	0	0	0	90/08	2.2
Total Outward		**1-5. Albany-Ceduna**	**371**	**217**	**4**	**592**	**13**	**0**	**0**	**13**		**24.3**
Inward legs from Ceduna	22-08-19	6. Ceduna-Nullarbor (incl. Head of Bight)*	69	61	0	130	0	0	0	0	90/05	2.6
		7. Nullarbor-Caiguna* (excl. Head of Bight)	25	15	0	40	0	0	0	0	00/15	4.0
	24-08-19	8. Caiguna-Esperance	102	56	1	159	0	0	0	0	150/10	4.3
		9. Esperance-Albany*	114	76	0	190	0	0	0	0	130/09	4.1
Total Inward		**6-9. Ceduna-Augusta**	**310**	**208**	**1**	**519**	**0**	**0**	**0**	**0**		**15**
Total	**6 days**	**9 legs**	**681**	**425**	**5**	**1111**	**13**	**0**	**0**	**13**		**39.3**

[1] direction of wind/wind speed (knots)
[2] all humpbacks; no other large whales recorded
[3] A = adult, C = calf, Y = 'yearling', T = total
* survey legs with maximum numbers of whales used for mapping and calculating trend (i.e. in Table 2)

Table 2. Total comparable maximum counts of whales for each leg since 1993 for the Right whale aerial survey, C. Leeuwin WA-Ceduna SA.

Year	a. All animals	b. Unaccompanied animals	c. Cow/calf pairs
1993	167	47	60
1994	191	95	48
1995	267	139	64
1996	233	123	55
1997	254	148	53
1998	342	120	111
1999	325	157	84
2000	259	113	73
2001	447	163	142
2002	377	163	107
2003	273	85	94
2004	356	142	107
2005	591	237	177
2006	427	127	150
2007	286	172	57
2008	702	230	236
2009	782	294	244
2010	519	251	134
2011	657	185	236
2012	715	275	220
2013	706	214	246
2014	623	159	232
2015	462	268	97
2016	628	172	228
2017	847	241	303
2018	789	231	279
2019	577	135	221

Table 3. Best fit regressions for the maximum counts of whales in each leg for 1993-2019 (excluding 1996 and 1997) for the Right whale aerial survey C. Leeuwin (WA) to Ceduna (SA).

Period	1993 - 2019		1993 - 2018	
Class	All animals	Cow/calf pairs	All animals	Cow/calf pairs
Exponential increase	0.0505	0.0582	0.0541	0.0605
SE	0.0067	0.0092	0.0069	0.0098
95% CI (Lower – Upper)	0.037 – 0.064	0.039 – 0.077	0.039 – 0.068	0.040 – 0.081
p	0.00000012	0.000002	0.00000008	0.000003
R^2	0.71	0.64	0.74	0.63
Percentage annual increase	5.18	5.99	5.56	6.24
SE	0.67	0.92	0.69	0.98
95% CI (Lower – Upper)	3.73 – 6.65	4.01 – 8.02	4.06 – 7.08	4.10 – 8.42

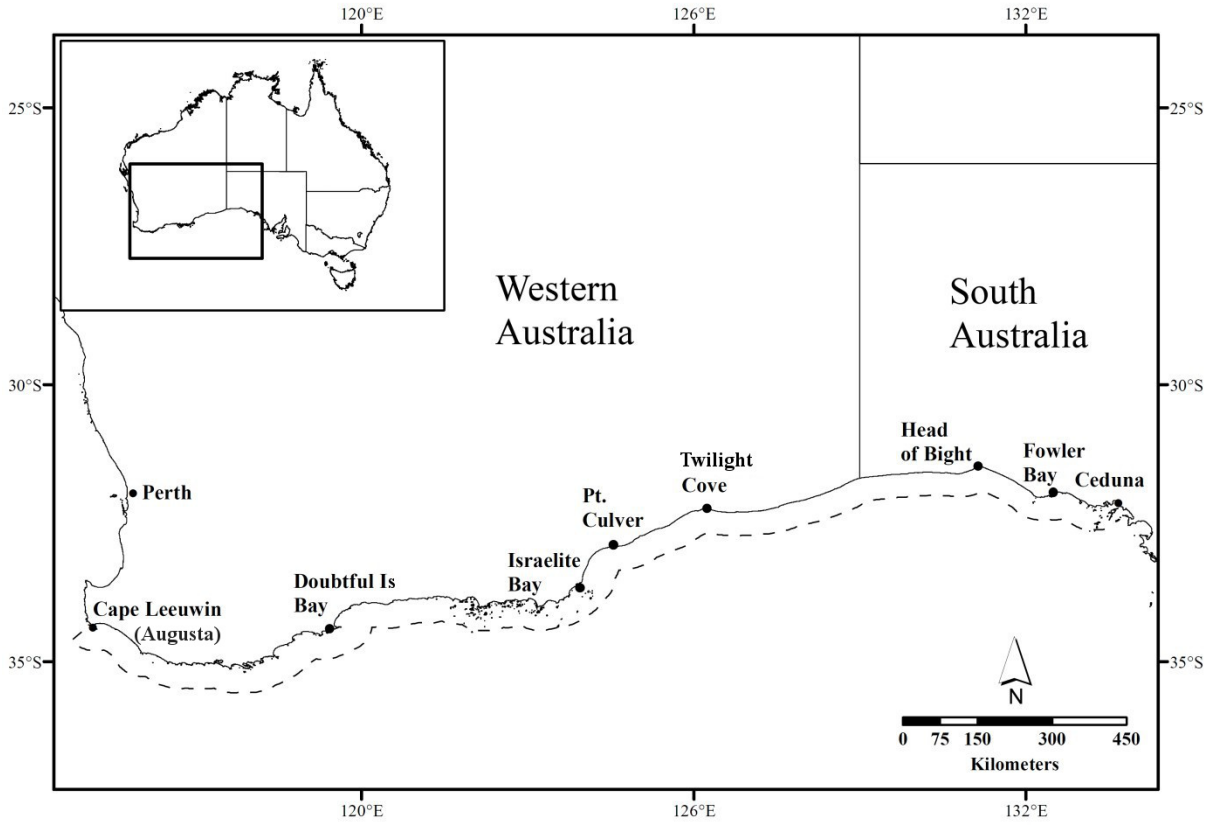

Figure 1 Right whale aerial survey off the coast of South West Australia in 2019. Dashed line represents the approximate survey area

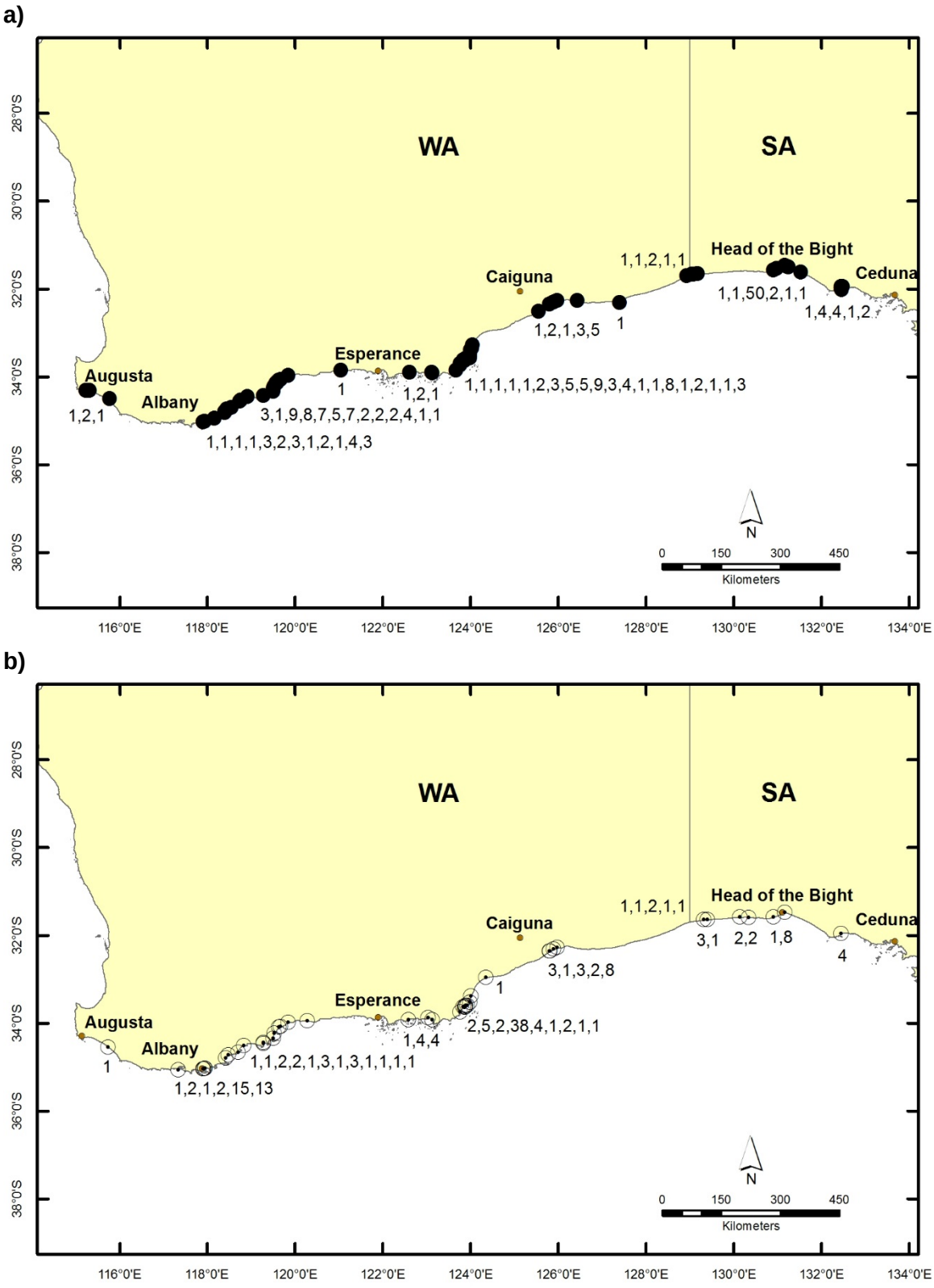

Figure 2 Aerial survey of WA-SA in Aug 2019. Approximate positions of right whale sightings on the flight and their associated group sizes.

a) Cow-calf pairs (●)

b) Unaccompanied animals (⊙)

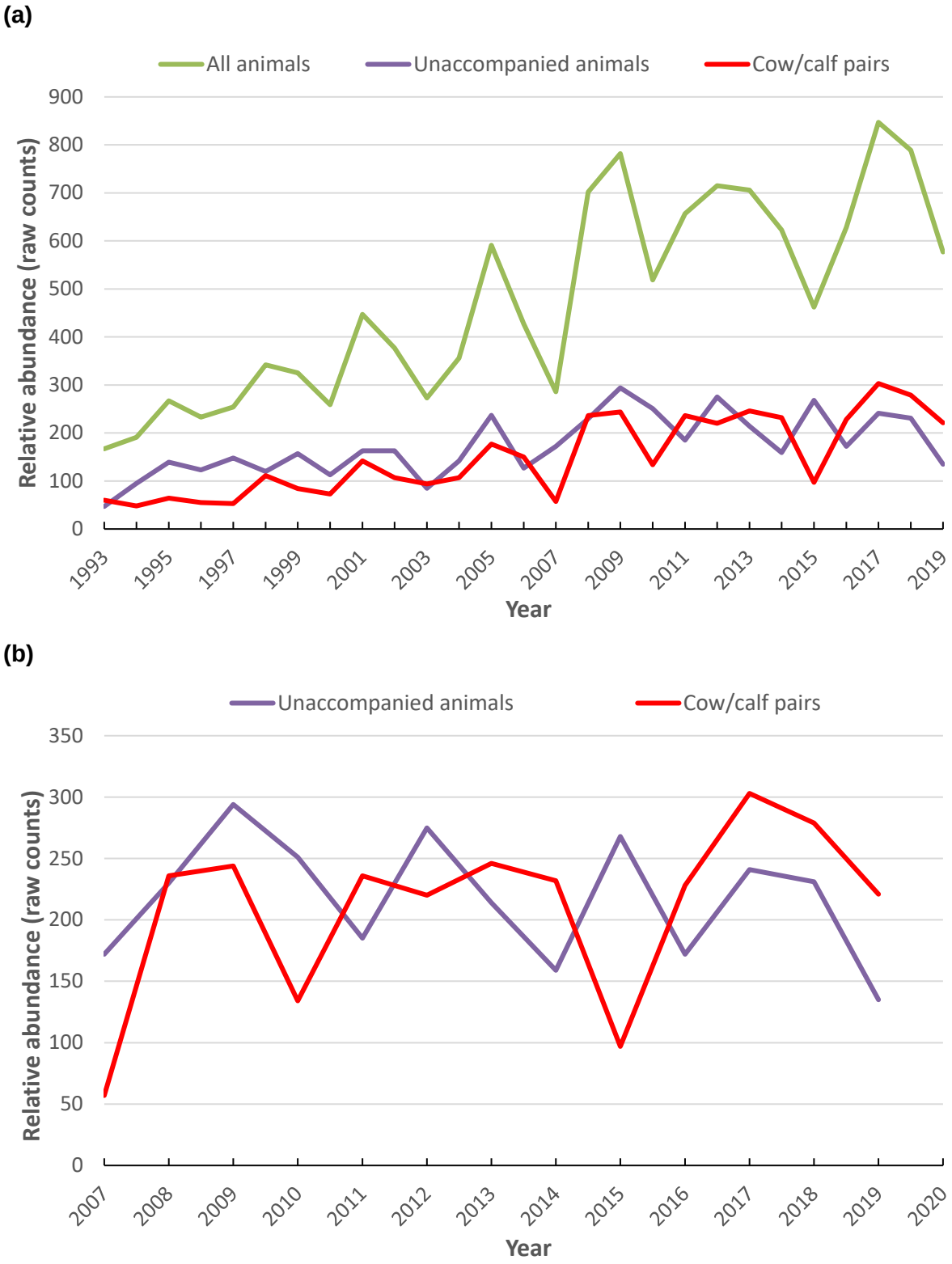

Figure 3. Graph of the relative abundance of the 'western' population of southern right whales for (a) all animals, unaccompanied animals and cow/calf pairs, between 1993 and 2019 and (b) unaccompanied animals and cow/calf pairs between 2007 and 2019.

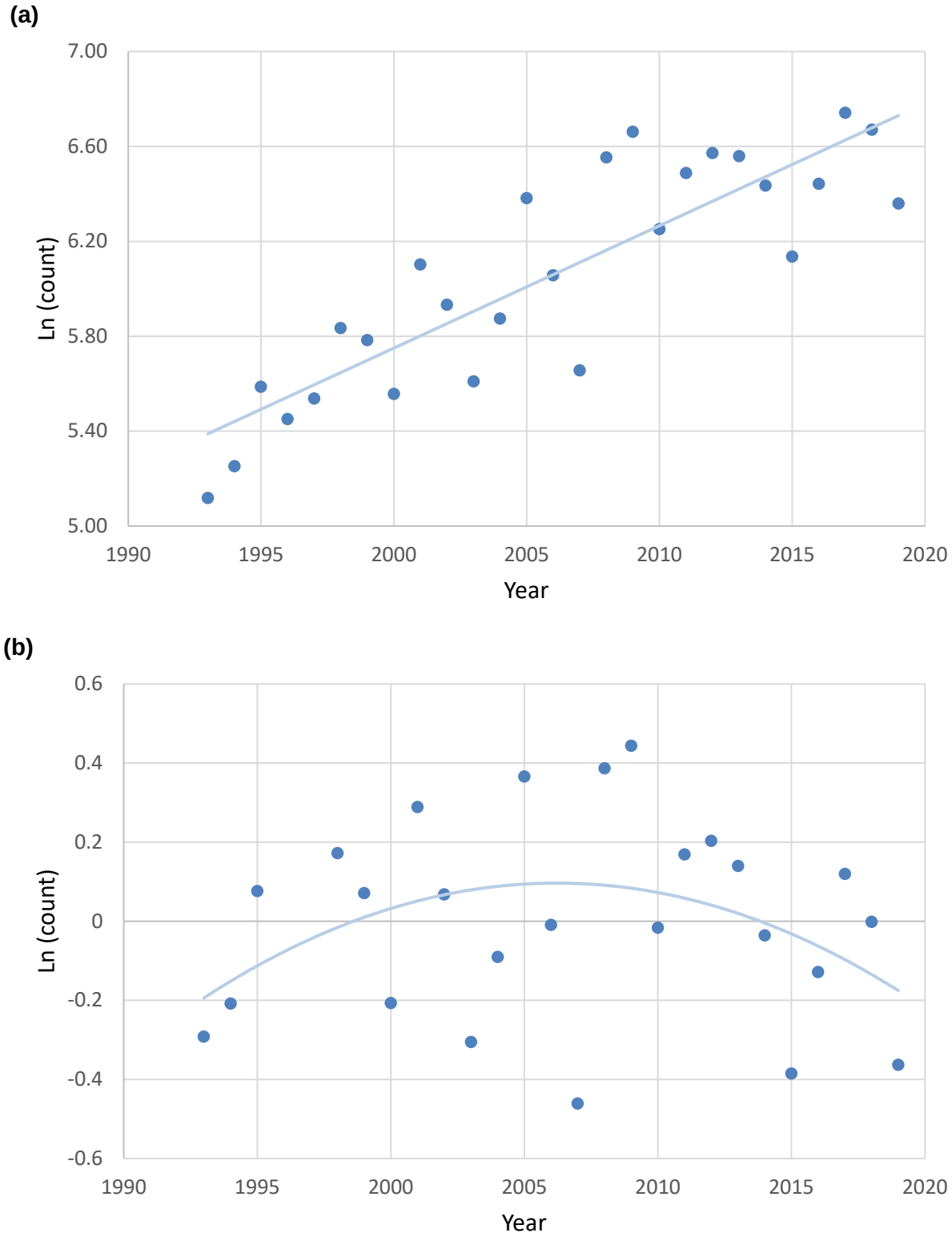

Figure 4. Plots of the fitted (a) linear regression and (b) residuals for the maximum counts of whales in each leg for 1993-2019 (excluding 1996 and 1997) for *All animals*.

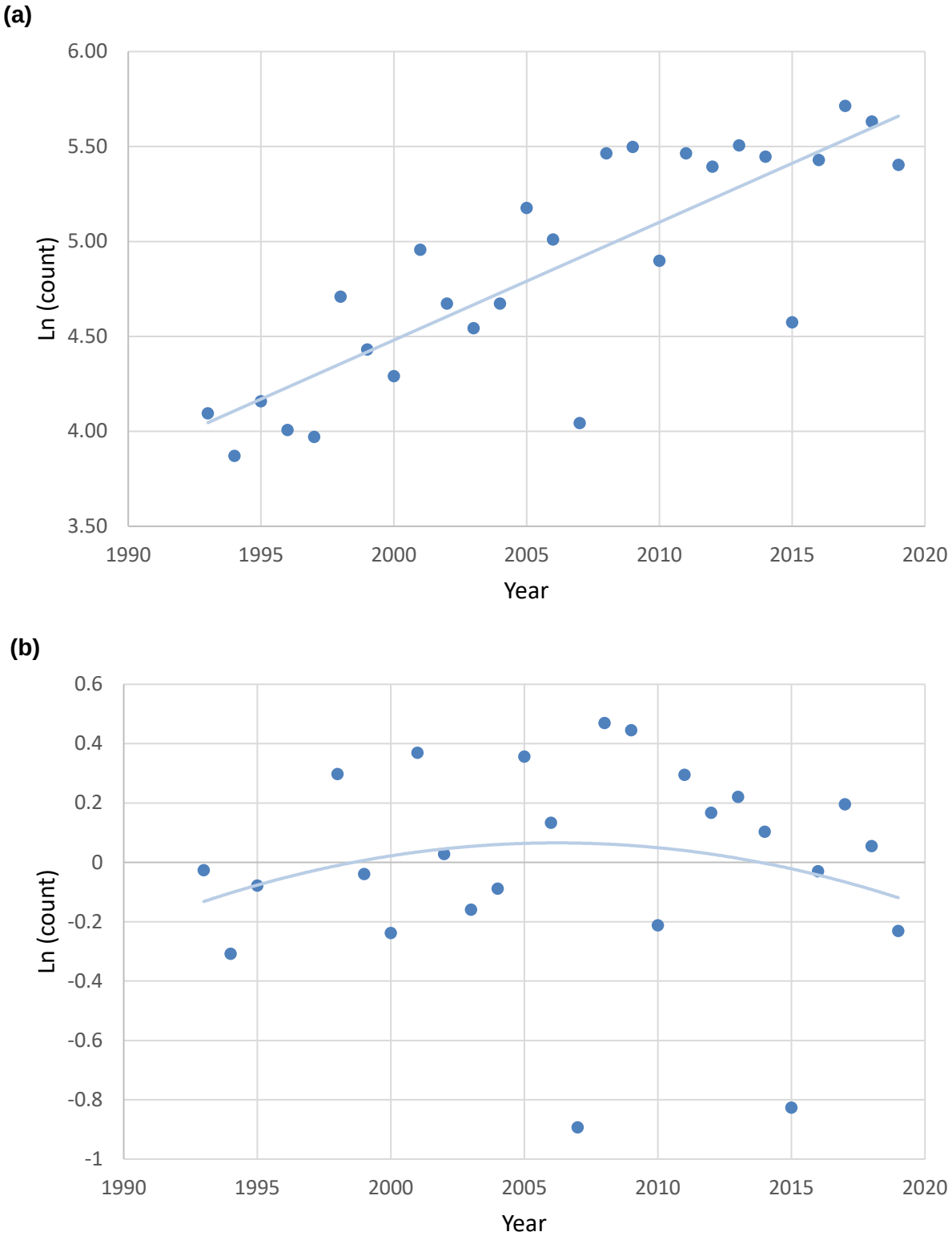

Figure 5. Plots of the fitted (a) linear regression and (b) residuals for the maximum counts of whales in each leg for 1993-2019 (excluding 1996 and 1997) for *Cow/calf pairs*.

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