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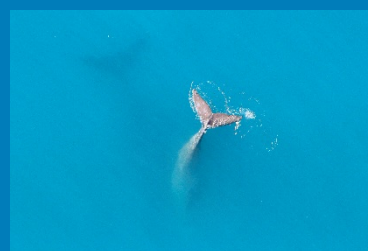
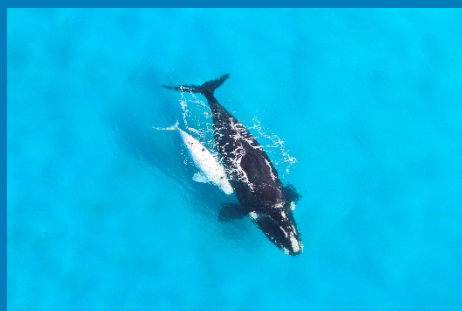
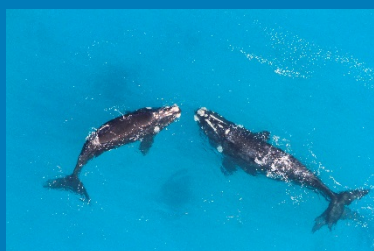
Project A7 - Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2018-2021

Project Leader: D. Jones and K. Travouillon, WA Museum

Final Report on activities for 2018

30th March 2019

Milestone 7 – Research Plan v4 (2018)



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EXECUTIVE SUMMARY

To continue an annual series of aerial surveys since 1993 off the southern Australian coast between Cape Leeuwin WA and Ceduna SA, a survey was undertaken over five days from 18-23 August, 2018. A total of 1095 southern right whales were sighted, including 381 calves; these include double counts given that each flying leg is covered twice, 'outward' and 'inward'. An additional 17 humpback whales (including three calves) were recorded during the survey. A comparison of the maximum counts for each survey leg with previous years, resulted in 2018 having a total of 789 whales and 279 cow/calf pairs which were both lower than in 2017 although 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 for 2018 is 3191 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 6005 photographic images obtained, 329 have been selected for computer - assisted 'matching' with those (some 9000 images of over 2000 individuals) already available in the catalogue. All photo-identification and sightings data have been included and archived in existing databases.

1. INTRODUCTION

Now endangered under the Australian EPBC Act, unsustainable whaling during the 19th and 20th centuries reduced southern right whales 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 number; 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 assessments 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

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). 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 1000ft, with photographs of the individual markings of the whales being taken at 500ft. When whales are sighted a GPS sighting 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. Flights are only undertaken on 'good' days, when wind speeds are less than 15 knots, during August/September when whale numbers are likely to be at close to the maximum given the known calving period. 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 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 a) population trend and b) 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 six days from the 18th to 23rd August 2018 during 39.1 flying hours. During the survey 1095 southern right whales were sighted, including 381 calves of the year, and an additional 17 humpback whales consisting of three calves (Table 1). During the survey there were two legs (leg 7 and 8; both inward) that were unable to be completed due to bad weather of strong 20-30 knot winds (Table 1). The combined maximum counts for each leg (‘outward’ or ‘inward’) for the 2018 data result in a total of 789 southern right whales, including 231 ‘unaccompanied’ adults and 279 cow/calf pairs (Table 2).

The 2018 sightings data of a total 789 whales and 279 cow/calf pairs (using the comparable maximum counts) were both less than the numbers sighted in 2017 of 847 total whales and 303 cow/calf pairs. Nevertheless, these whale counts were still higher than any of the other previous years since 1993 (Table 2) indicating an increasing number of whales. Similar to 2017, the counts of ‘unaccompanied’ whales in 2018 of 231 was again lower than in previous years (2009 (29), 2010 (251), 2012 (275), 2015 (268)), although there appears to be considerable inter-annual variation in the counts of ‘unaccompanied’ whales thereby making it difficult to detect consistent changes in abundance.

4.2 Trend analysis

An exponential regression analysis of the count data for ‘*all animals*’ between 1993 and 2018 (excluding 1996/97) provides an exponential rate of increase over the period of 0.0541 (95% CI 0.0398, 0.0684) which is equivalent to an annual increase of 5.56% (95% CI 4.06, 7.08) (Table 3, Figure 3). The estimated exponential rate of increase based on counts of cow/calf pairs alone was 0.0605 (0.0402, 0.0808) or an annual increase of 6.24% (4.10, 8.42) (Table 3, Figure 4).

Generally, there has been little change to the trend in population increase with the inclusion of the counts from the 2018 survey compared to those estimated from the 1993 – 2017 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, it is still considered that the data conforms to an exponential increase based on inspection of the fitted exponential regression residuals.

4.3 Population size

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 middle year (2017) of the three-year period (2016-18), of 3191 whales. The current population size is the largest estimate for the population since 1993 and is consistent with the higher numbers of cow/calf pairs seen in the last two years. The significantly lower number of cow/calf pairs sighted in 2015 compared to other years reduced the population size estimates over the period 2014 – 2016, although now does not influence the estimate.

4.4 Photography

From 6005 images obtained on the 2018 flight, 329 have been selected for computer-assisted 'matching' with those (some 9000 images of approx. 2200 individual whales) already available in the 'WA' catalogue.

4.5 Current distribution

Sightings of southern right whales during the 2018 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. In particular, both cow/calf pairs and unaccompanied animals were found in higher numbers in and near Doubtful Island Bay and Point Ann (east of Bremer Bay), further east around Israelite Bay (east of Esperance) and at the Head of the Bight in SA (Figure 2). 'Unaccompanied' animals, mostly adults but with no associated calves, had sightings that were more spread along the southern coast than in the previous 2017 survey, particularly around the Head of the Bight.

4.6 Databasing and data archiving

Sightings for the 2018 survey will be added to the sightings database, which at present totals 3860 sheets of which 3273 relates to the period 1993-2018.

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 at 3191 whales, which is the largest estimate for the population since 1993 and consistent with the higher numbers of cow/calf pairs seen in the last two years of surveys. 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.

6. ACKNOWLEDGEMENTS

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

The flying was undertaken under relevant permits from the Western Australian Department of Parks and Wildlife (permit no. 08-002690-1), the South Australia Department for Environment and Water (permit no. MR00060-3-R) 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, 2018.

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	18/08/2018	1. Albany-Esperance*	140	79	0	219	8	3	0	11	05/10	2.4
	19-08	2. Esperance-Caiguna*	181	106	0	287	0	0	0	0	10/15	3.2
	20-08	3. Caiguna-Nullarbor (excl Head of Bight)*	49	7	0	56	0	0	0	0	10	5
	20-08	4. Nullarbor-Ceduna (incl Head of Bight)	134	91	0	225	0	0	0	0	05	2.5
Total Outward		1-4. Albany-Ceduna	504	283	0	787	8	3	0	11		18.6
Inward legs from Ceduna	21-08	5. Ceduna-Nullarbor (incl Head of Bight)*	140	87	0	227	0	0	0	0	10	3.2
	21-08	6. Nullarbor-Caiguna (excl Head of Bight)	39	4	0	43	1	0	0	1	05/10	4.3
	22-08	7. Caiguna-Esperance	0	0	0	0	0	0	0	0	20	3
	22-08	8. Esperance-Albany	0	0	0	0	0	0	0	0	25	3
	23-08	9. Albany –Augusta	26	6	0	32	5	0	0	5	06	2.8
Total Inward		5-9. Ceduna-Augusta	205	97	0	302	6	0	0	6		16.3
Additional legs	23-08	10. Augusta-Perth (Jandakot)	5	1	0	6	0	0	0	0	06	2
	23-08	11. Jandakot-Albany	0	0	0	0	0	0	0	0		2.1
Total 2018	5 days	8 legs	714	381	0	1095	14	3	0	17	05/10	39

¹ as indicated by 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

Table 3. Best fit regressions for the maximum counts of whales in each leg for 1993-2018 (excluding 1996 and 1997) for the Right whale aerial survey C. Leeuwin WA-Ceduna SA.

Period Class	1993 - 2018		1993 - 2017	
	All animals	Cow/calf pairs	All animals	Cow/calf pairs
Exponential increase	0.0541	0.0605	0.0547	0.0603
SE	0.0069	0.0098	0.0075	0.0106
95% CI (Lower – Upper)	0.039 – 0.068	0.040 – 0.081	0.039 – 0.070	0.038 – 0.082
p	0.00000008	0.000003	0.0000003	0.000013
R ²	0.737	0.63	0.719	0.605
Percentage annual increase	5.56	6.24	5.62	6.22
SE	0.69	0.98	0.75	1.07
95% CI (Lower – Upper)	4.06 – 7.08	4.10 – 8.42	4.00 – 7.28	3.89 – 8.59

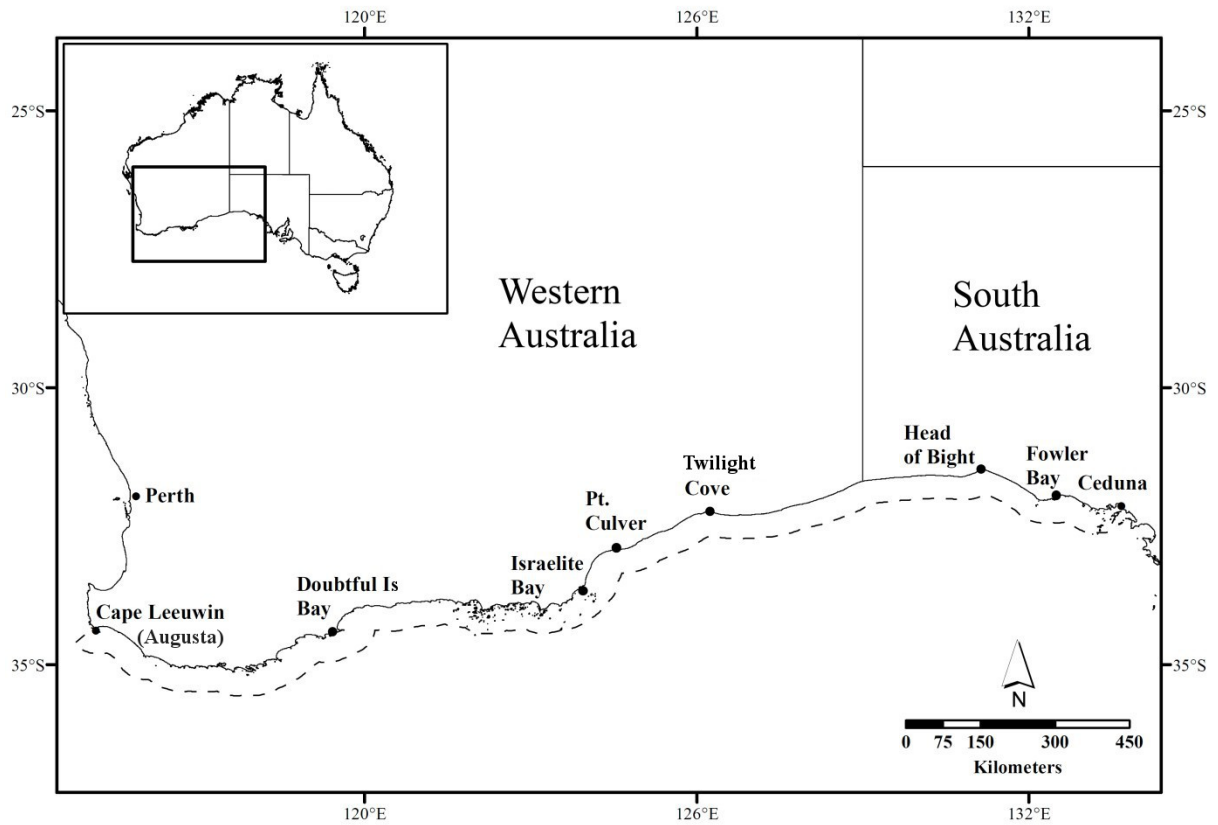


Figure 1 Right whale aerial survey off the coast of south-western Australia in 2018. Dashed line represents approximate survey area

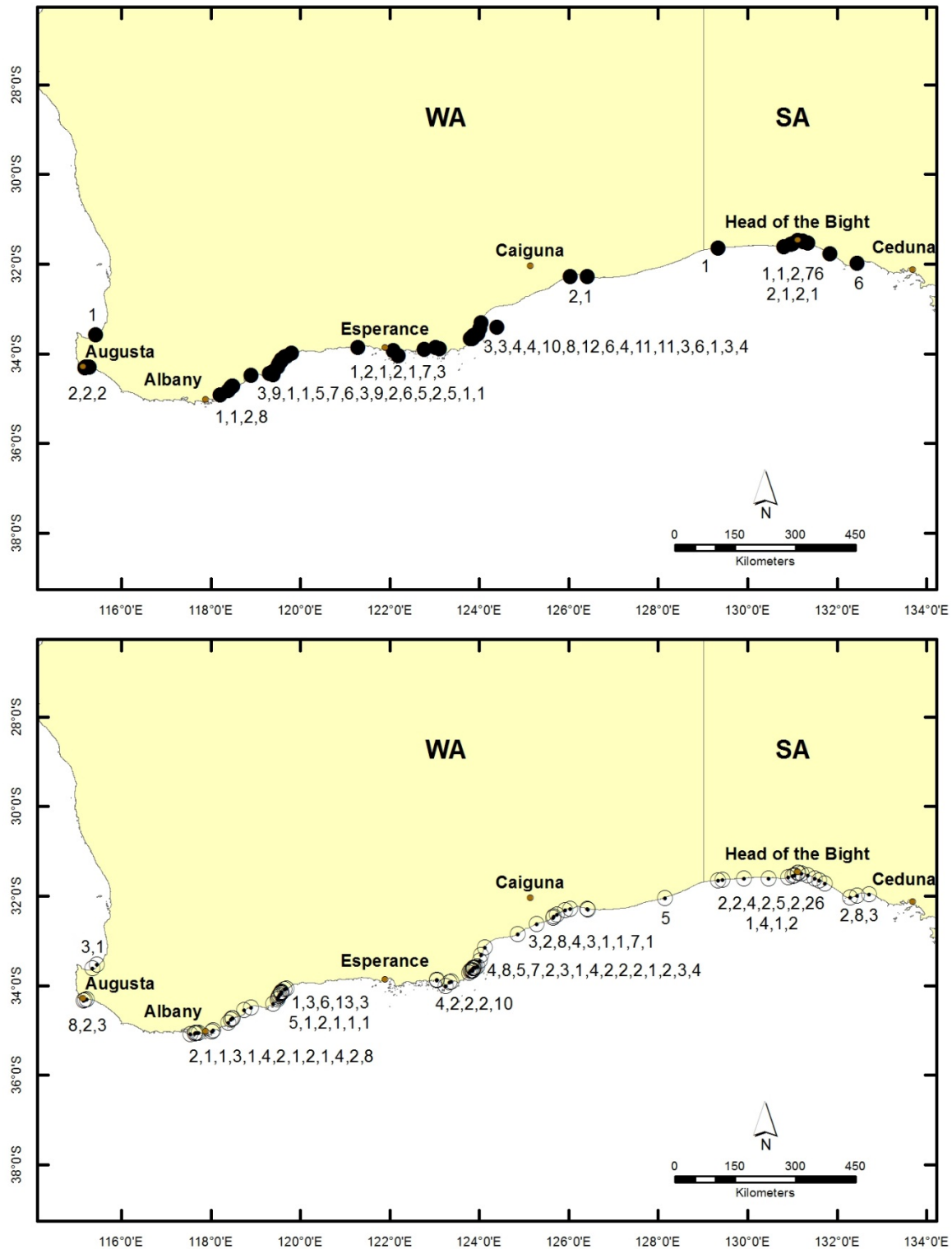


Figure 2 Aerial survey of WA-SA in Aug 2018. Approximate positions of right whale sightings on the flight and their associated group sizes.

- a) Cow-calf pairs (●)
- b) Unaccompanied animals (○)

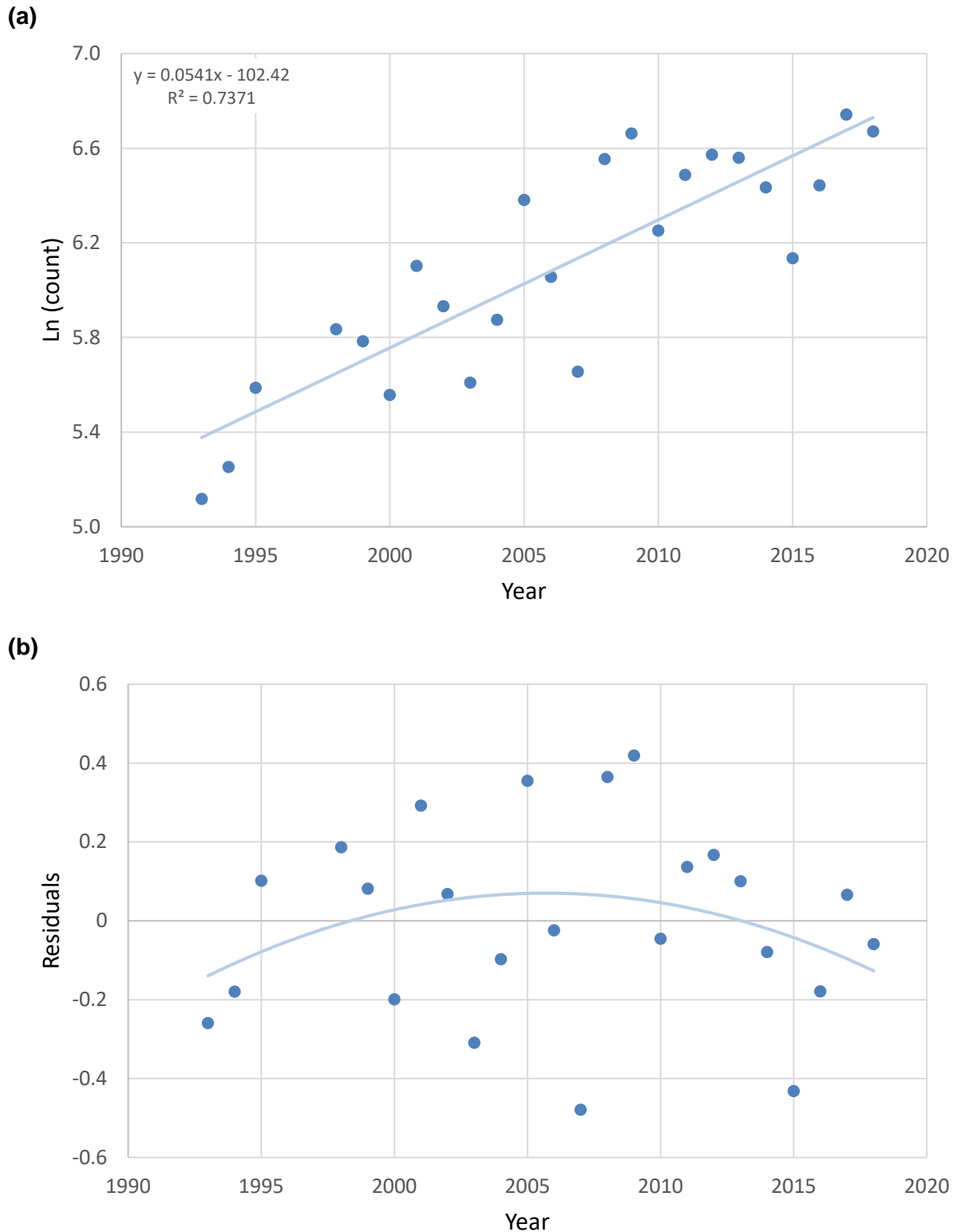


Figure 3. Plots of the fitted (a) linear regression and (b) residuals for the maximum counts of whales in each leg for 1993-2018 (excluding 1996 and 1997) for *All animals*.

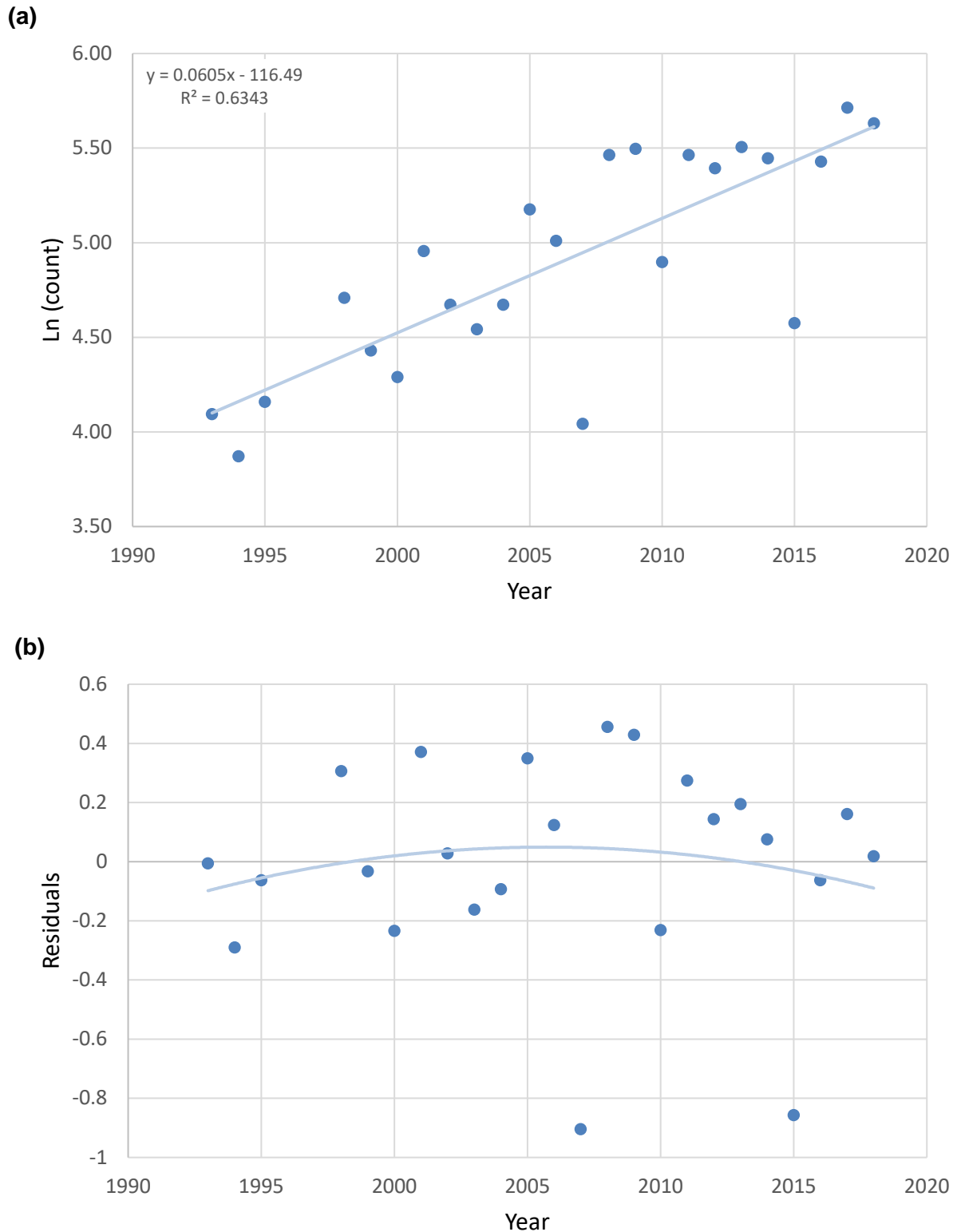


Figure 4. Plots of the fitted (a) linear regression and (b) residuals for the maximum counts of whales in each leg for 1993-2018 (excluding 1996 and 1997) for *Cow/calf pairs*.



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