D R A F T

POP2017-03: Salvin's albatross Bounty Islands population project

Ground component

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Executive summary

The Department of Conservation commissioned NIWA to complete ground-based surveys of Salvin's albatrosses (*Thalassarche salvini*) that breed on the Bounty Islands. This fieldwork involved deploying transmitting Global Positioning System (GPS) tracking devices and geolocation data loggers (Global Location Sensing (GLS) tags) on breeding birds on Proclamation Island, Bounty Islands; banding and recapturing birds in a study area; completing counts of breeding and non-breeding birds along transects at various time of the day; and deploying automated time-lapse cameras that covered part of the study area.

In the first year of the project, 14 transmitting GPS tags were deployed on breeding Salvin's albatrosses, all but one of which produced locations for periods of approximately 100 days following deployment. In the second year of the project a further four transmitting GPS tags and 12 PTT tags were deployed on breeding Salvin's albatrosses, which also operated successfully, on average, for approximately 100 days. Additionally, in the first year of the project, 54 GLS tags were deployed on breeding Salvin's albatrosses, of which 33 were successfully retrieved in the second year of the project. The location data acquired from these different tags revealed that Salvin's albatross at the Bounty Islands exploited waters to the east of mainland New Zealand, with 'hotspots' located towards the east coast of the northern part of South Island and the southern part of North Island, with further 'hotspots' towards the central and western sections of the Chatham Rise, and also Murnoo Bank. There was some relatively limited evidence that waters of the Stewart-Snares shelf were also favoured, together with waters to the southeast of the colony. These results appear to support the idea that Salvin's albatrosses at the Bounty Islands and at the Western Chain in the Snares Islands, the only other New Zealand breeding site for this species, tend to utilise separate areas within the New Zealand region during the breeding season, with birds from the Western Chain exhibiting a more westerly distribution.

Over the course of the project's two field trips, a total of 141 breeding Salvin's albatrosses were banded, all but one with both metal and plastic leg bands, at a potential study site on Proclamation Island. In both years, birds banded in 1985 and 2012 were resighted, and of the 98 birds banded in 2018, 57 were resighted in 2019.

In the first year of the project, ground-truthing counts were completed at the same time as an aerial photographic survey of breeding Salvin's albatross was undertaken. The ground-truthing revealed that a mean of 47% of birds were actively breeding.

Finally, in the first year of the project, six trail cameras were deployed in the study site covering a total of approximately 41 active nests. Each camera was set to take photographs at hourly intervals during daylight hours, and all cameras were retrieved in the second year of the project. All but one camera produced imagery, three for the entire year's deployment and two for part of the year.

1 Introduction

Salvin's albatross (*Thalassarche salvini*) is endemic to New Zealand, with the main breeding population at the Bounty Islands comprising over 95% of the New Zealand population. In 1978 the Bounty Islands population was estimated at approximately 76,000 pairs (Robertson & van Tets 1982) and at approximately 31,000 pairs in 1997 (A. Booth & J. Amey in Taylor 2000). Aerial surveys of the entire Bounty Islands archipelago in 2010, 2013 and 2018 found approximately 32,000, 40,000 and 27,000 breeding pairs (corrected for the proportion of non-breeding birds), respectively (Baker et al. 2014, Baker & Jensz 2019). However, differences in the methodologies used to generate these ground-based and aerial, photographic estimates, and relatively large difference in the correction factor used to adjust aerial survey totals for non-breeding birds, makes interpretation of population trajectory from these data problematic. Nevertheless, counts of breeding pairs of Salvin's albatross at Proclamation Island within the Bounty Islands showed a 14% decline between 1997 and 2004, a decline of 13% between 2004 and 2011 and an overall decline of 30% between 1997 and 2011 (Sagar et al. 2015).

In addition to the Bounty Islands, Salvin's albatross also breed at the Western Chain within the Snares Islands. Direct counts of breeding pairs in 2008, 2009 and in 2014 resulted in total estimates for the Western Chain of approximately 1100-1200 pairs (Sagar et al. 2011, Sagar et al. 2014), suggesting a relatively small but stable population.

The conservation status of Salvin's albatross was upgraded in 2016 to 'Threatened - Nationally Critical' (Robertson et al. 2017) on the basis of its apparent population decline at the Bounty Islands and its potential high risk from commercial fishing impacts.

Salvin's albatross has been recorded as bycatch in New Zealand trawl fisheries in relatively high numbers (e.g. Bell & Bell 2019). Additionally, Richard et al. (2020) estimated that 2,250 Salvin's albatross were killed across all commercial fishing activity between 2014-15 and 2016-17 and identified Salvin's albatross as the second most at-risk New Zealand seabird species from commercial fishing (Richard et al. 2020). One of the key inputs into the spatially-explicit fisheries risk assessment process, which quantifies the risk to seabirds from commercial fishing, is species-specific at-sea distribution information, yet the at-sea distribution of Salvin's albatrosses that breed at the Bounty Islands is described from only a relatively small number of birds (Thompson et al. 2014).

The apparently declining Salvin's albatross population and relatively high fisheries risk indicates the need of both determining the current breeding population size at the Bounty Islands and the at-sea distribution of Salvin's albatrosses to better understand the spatio-temporal overlap with fisheries activities.

The Conservation Services Programme (CSP) of the Department of Conservation (DOC) commissioned NIWA to carry out research on Salvin's albatross at the Bounty Islands, with the following specific elements to be undertaken:

- Global Location Sensing (GLS) tag deployments in year one (2018), with trial Platform Transmitting Terminal/Global Positioning System (PTT/GPS) transmitting device deployment.
- Retrieval of GLS devices and deployment of additional PTT/GPS devices in year two (2019).

- Band and re-sight birds with the potential to establish a study site area on Proclamation Island (which has the easiest access and the most data previously collected on the Bounty Islands).

- Targeted counts to ground-truth aerial survey (year one)

Following discussions with the DOC, an additional work element was included in the work plan, specifically:

- Deployment of time-lapse trail cameras to record activity in the Salvin's albatross study colony

A photographic aerial survey of breeding Salvin's albatross at the Bounty Islands (year one) was made by another research provider contracted to the DOC. Some of the information presented in this report was presented in the report produced at the end of the first year of the project (Sagar et al. 2018).

2 Methods

2.1 Logistics

In the first year of the project, Proclamation Island within the Bounty Islands was visited on 20 to 22 October 2018, inclusive. The field team, comprising Paul Sagar (NIWA), Graham Parker (Parker Conservation), Kalinka Rexer-Huber (Parker Conservation) and Matt Charteris (Waybacks Ltd), travelled to and from the islands on the vessel *Evohe*. In the second year of the project, Proclamation Island was visited on 24 to 29 October 2019, inclusive. Again, transport to and from the islands was provided by *Evohe*, and in the second year the field team comprised Paul Sagar, Graham Parker and Kalinka Rexer-Huber.

2.2 Study area

The study area occupied a broad, geographically distinct ledge at the top of the eastern part of Proclamation Island, centred on 47.74936° S 179.02776° E, and is identified in Figure 2-1. In this area breeding Salvin's albatrosses were most abundant in the relatively open areas between boulders, while erect-crested penguins (*Eudyptes sclateri*) usually nested closer to the boulders (Figure 2-2). Additionally, there were relatively few New Zealand fur seals (*Arctocephalus forsteri*) in this area, and so disturbance to seals and hence nesting albatrosses and penguins was minimised as much as practicable.

Figure 2-1: Eastern end of Proclamation Island, Bounty Islands, viewed from Bucket Cove. The red lines indicate the approximate extent of the Salvin's albatross study colony.

Figure 2-2: View of the Salvin's albatross study colony from above. This photograph was taken on 20 October 2018 from approximately the highest point above the study colony shown in Figure 2-1.

2.3 GLS tags

In year one of the project, a total of 54 GLS tags were deployed on breeding Salvin's albatrosses. Each GLS tag was attached to the bird's metal leg band using a plastic cable tie fitted with a stainless-steel pawl to minimise the effects of saltwater corrosion. Two types of GLS tag were deployed: Migrate Technology (Migrate Technology Ltd., Cambridge, England) C330s (n = 32) and Biotrack (Biotrack Ltd., Wareham, England) MK3006s (n = 22).

GLS tag retrieval took place in in the second year of the project. No additional GLS tags were deployed in the second year of the project.

2.3.1 GLS tag data analyses

GLS data extracted from the Biotrack GLS tags were initially decompressed using the 'Decompressor' software package. Then, for each individual, the light data obtained from all GLS tags were processed using the 'TwGeos', 'GeoLight', and 'BAStag' packages in R (Wotherspoon et al. 2013, Lisovski et al. 2015, Wotherspoon et al. 2016), in which location estimates were derived from the length of time between day and night (twilights) for latitude and the time of local midday to midnight with respect to Greenwich Mean Time for longitude (Hill and Braun 2000, Jaeger et al. 2017). Location correction using sea-surface temperature data was not conducted at this stage, which may account for the relatively large spatial extent and potentially erroneous data points within the processed data set.

The at-sea distribution for individuals was determined between October 2018 through to the following March. For each tag type, monthly fixed kernel home range analyses were performed using the 'adehabitatHR' package in R (Calenge 2006). The smoothing parameter (h) was chosen via least squares cross-validation (Worton 1989, Phillips et al. 2004). Density contours corresponding to the core habitat (50%) and home range (95%) kernel density distributions were determined. In order to produce the most realistic spatial distribution for the GLS tracks, we spatially constrained the GLS data to include all locations found within the 100% kernel density contour generated from GPS tracking locations in year one of the project, plus an additional 150 km buffer.

2.4 GPS and PTT tags

In the first year of the project (October 2018), 14 transmitting GPS devices were deployed on breeding Salvin's albatrosses. Additionally, each of these 14 birds was also fitted with a GLS device, attached to the bird's stainless-steel metal band (see 2.3). The GPS devices were of two types – Wildlife Computers Rainier-S20 solar-powered transmitting GPS tags (Wildlife Computers Inc., Redmond, Washington, USA), and Lotek PinPoint Argos transmitting GPS tags (Lotek, Newmarket, Ontario, Canada).

In the second year of the project (October 2019), 4 Geotrak GT-12GS-GPS solar-powered transmitting GPS tags (Geotrak Inc., Apex, North Carolina, USA) and 12 Telonics TAV-2630 PTT satellite tags (Telonics Inc., Mesa, Arizona, USA) were deployed on breeding Salvin's albatrosses. Note that the Telonics tags were transmitting satellite tags and did not acquire and transmit GPS locations.

Each device was attached to a pre-cut baseplate made of plastic guttering. Briefly, the process of attaching the devices was as follows. First, the base plate was attached with Tesa tape to back feathers over the spine of the bird, in line with the leading edge of the wings. Second, the device was attached to the base plate and feathers with a combination of cable ties with stainless-steel pawl, Tesa tape, and a two-part epoxy glue. Examples of GPS devices deployed on separate birds are shown in Figure 2-3 and Figure 2-4. Because all tags were attached with a combination of tape, glue and cable ties to dorsal feathers, eventually tags would be lost from the birds, either through degradation of the attachment media, or through moulting of the feathers to which the device was attached. No GPS or PTT devices were retrieved. All devices were pre-programmed to maximise the number of locations transmitted each day, while at the same time operating within the constraints of the power required to transmit the locations (solar-powered devices) or to maximise the operating lifespan of the device (non-solar, battery-powered devices). Theoretically, the solar-powered devices should have continued operating and transmitting location data more or less indefinitely, but device loss from the bird (see above) effectively curtailed the operating lifespan of these devices.

Figure 2-3: Salvin's albatross fitted with Wildlife Computers Rainier S-20 solar-powered transmitting GPS tag, October 2018.

Figure 2-4: Salvin's albatross fitted with Lotek PinPoint Argos transmitting GPS tag, October 2018.

2.4.1 GPS and PTT tag data analyses

GPS and PTT data were not subjected to any additional processing or filtering beyond that which had been applied to the data prior to being made available to NIWA. The at-sea distribution for individuals was identified between October (year of deployment) through to the following March using the same fixed kernel home range approach as described for the GLS data (see 2.3.1).

2.5 Banding and resighting of breeding birds

In 2012, 50 breeding adult Salvin's albatrosses were banded on Proclamation Island (Sagar & Charteris 2012) in the well-defined area used during the current visit as a study area (see 2.2 and Figure 2-1), and so this formed the basis of the area where further banding, and resighting of breeding birds was carried out in 2018 and 2019. In both years of the project, breeding birds were banded with uniquely numbered stainless-steel leg bands and were also fitted with a uniquely numbered red plastic band (to aid future resighting without the need to either recapture, or approach very closely, a bird in order to read the metal band number), with one band on each leg. In both years, breeding birds within the study area were checked for metal or plastic leg bands and numbers recorded.

2.6 Ground-truthing

Ground-truthing counts of Salvin's albatrosses were completed on Proclamation Island on 22 October 2018 in order to determine the proportions of birds that were actively breeding (a bird on a nest containing an egg) or that were non-breeding, which in turn was quantified as birds on an empty nest or birds loafing in the colony (and not attached to a nest).

Four transects, each undertaken by a separate individual, were completed on three occasions: at 10:25, 12:15, and 13:30 hours. A total of 12 transects (four observers x three time periods) were completed, with each transect being unique. The observer walked slowly along the transect counting birds on nests with an egg, birds on an empty nest and loafers, all within 1 m either side of the transect line being walked. The length of each transect was determined by the density of nests and the level of disturbance observed – an attempt was made to count at least 30 active nests per transect, but the count was terminated if loafers became disturbed and began to walk ahead of the observer.

2.7 Cameras

Six nest cameras were deployed on Proclamation Island on 21 October 2018. Each was mounted on a small vertical section of rock, out of the way of wildlife traffic, using rock bolts and customised aluminium mounts. The cameras were positioned to take images of about 41 nests that were active at the time. Each camera was set to take photographs at hourly intervals during daylight. The cameras were designed to be weather-tight but for further protection from the elements Tesa tape, overlain with a layer of self-amalgamating tape, sealed the join in the waterproof case. The positions of the cameras are given in Table 2-1. All six cameras, and associated mountings, were retrieved in October 2019.

Table 2-1: Locations of six time-lapse cameras deployed on Proclamation Island, Bounty Islands, 21 October 2018.

Name	Latitude (°S)	Longitude (°E)	Elevation (m)

CAM1A BOUNTY	-47.7494	179.02771	44.853
CAM1B BOUNTY	-47.7496	179.02758	43.809
CAM2A BOUNTY	-47.7494	179.02757	49.325
CAM2B BOUNTY	-47.7494	179.02768	44.192
CAM3A BOUNTY	-47.7494	179.02763	49.711
CAM3B BOUNTY	-47.7497	179.02752	47.128

3 Results

3.1 GLS tags

In October 2019, a total of 33 GLS tags were retrieved (61% of those deployed). All tags yielded data, although two Migrate Technology tags had to be returned to the manufacturer to extract the data.

Kernel density utilisation distributions (UDs) based on the GLS data for October 2018 through to March 2019 are presented in Figure 3-1. Overall, both the 50% and 95% UDs remained relatively consistent in their spatial extents across all months, and occupy areas to the east of New Zealand, with the 95% UD extending as far north as East Cape and as far south as the mid-50°S latitudes.

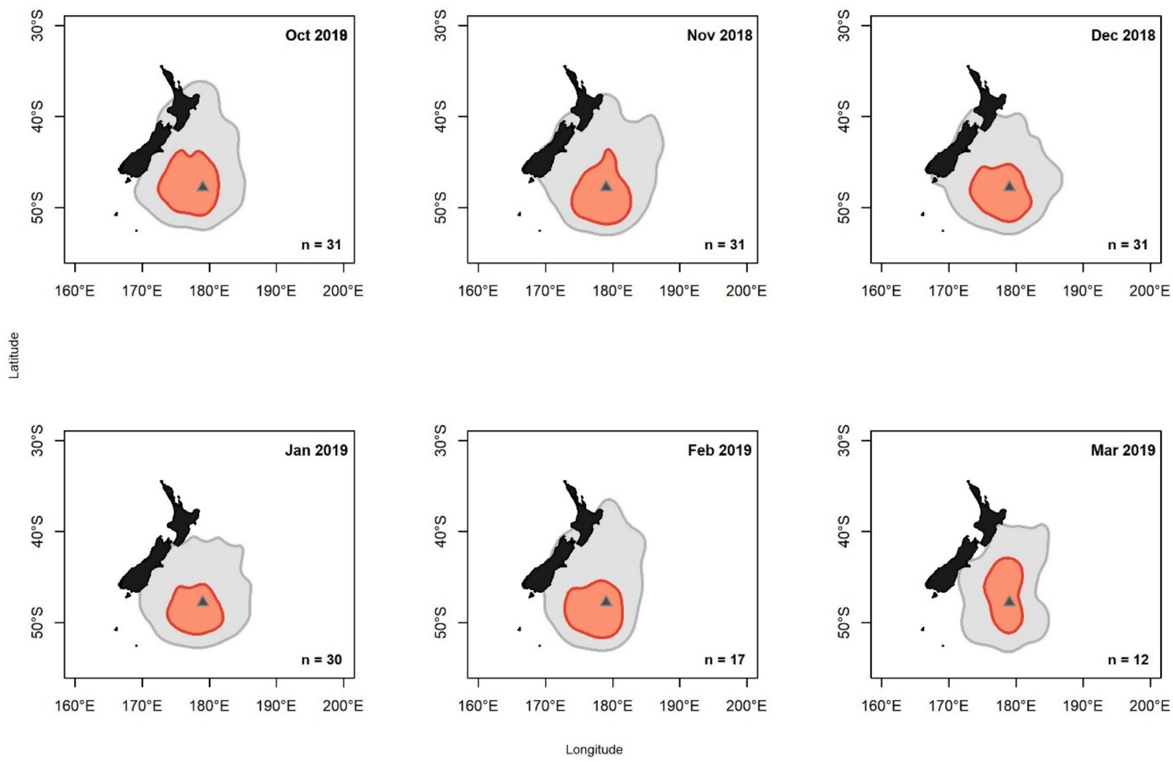

Figure 3-1: Kernel density utilisation distributions (UDs) for Salvin's albatrosses at the Bounty Islands, 2018-2019, based on GLS data. The 50% UD (red) and 95% UD (grey) are shown, and the colony location is represented by the dark grey triangle.

3.2 GPS and PTT tags

For all four tag types deployed, filtered GPS and PTT data sets were supplied from the Department of Conservation. In the case of GPS data, we have assumed that all locations are accurate to a few tens of metres. The PTT data supplied, from the 12 Telonics tags deployed in October 2019, were of Argos class 1, 2 or 3, where locations of class 1 have an estimated error of 500 to 1500 m, locations of class 2 have an estimated error of 250 to 500 m and locations of class 3 have an estimated error of less than 250 m.

One of the Lotek PinPoint tags failed to transmit any useful data following deployment. Although all four tag types were optimised to transmit the maximum number of locations per day, the number of locations received varied by tag type (Table 3-1). The two solar-powered transmitting GPS tags produced the most locations per day: Wildlife Computers Rainier S-20 tags and Geotrak GT-12GS-GPS tags yielded on average 24.7 and 18.3 locations per day, respectively, whereas the two non-solar tags generated fewer daily locations: Lotek PinPoint (GPS) and Telonics TAV-2630 (PTT) tags yielded on average 3.3 and 8.9 locations per day, respectively (Table 3-1). On average, all four tag types were active for approximately 100 days, ranging from a mean of 94.8 days for Geotrak GT-12GS-GPS tags to a mean of 108.3 days for Telonics TAV-2630 PTT tags (Table 3-1).

Table 3-1: Summary statistics for each of the four transmitting tag types deployed in each year of the project. Values are means with one standard deviation.

	Tag Type	Locations per day	Days active
Year 1			
	Wildlife Computers Rainier S-20	24.7 ± 0.7	98.1 ± 52.9
	Lotek PinPoint	3.3 ± 0.4	107.5 ± 29.7
Year 2			
	Geotrak GT-12GS-GPS	18.3 ± 0.6	94.8 ± 37.4
	Telonics TAV-2630 PTT	8.9 ± 0.7	108.3 ± 28.6

Kernel density utilisation distributions (UDs) based on the GPS data for October 2018 through to March 2019 (year one), for the GPS data for October 2019 through to March 2020 (year two) and for the PTT data for October 2019 through to March 2020 (year two) are presented in Figure 3-2, Figure 3-3 and Figure 3-4, respectively. Overall, both the 50% and 95% UDs are generally similar to those identified in Figure 3-1 for GLS data in that they occupy areas to the east of New Zealand. However, the full extent of the kernels is generally less for GPS and PTT data, reflecting the increased accuracy of these locations. The GPS and PTT data indicate that the birds' distributions are relatively more restricted during November, consistent with relatively short foraging trips during the guard stage. There is little evidence in these data to suggest the distributions of Salvin's albatross were markedly different between the two years of the project

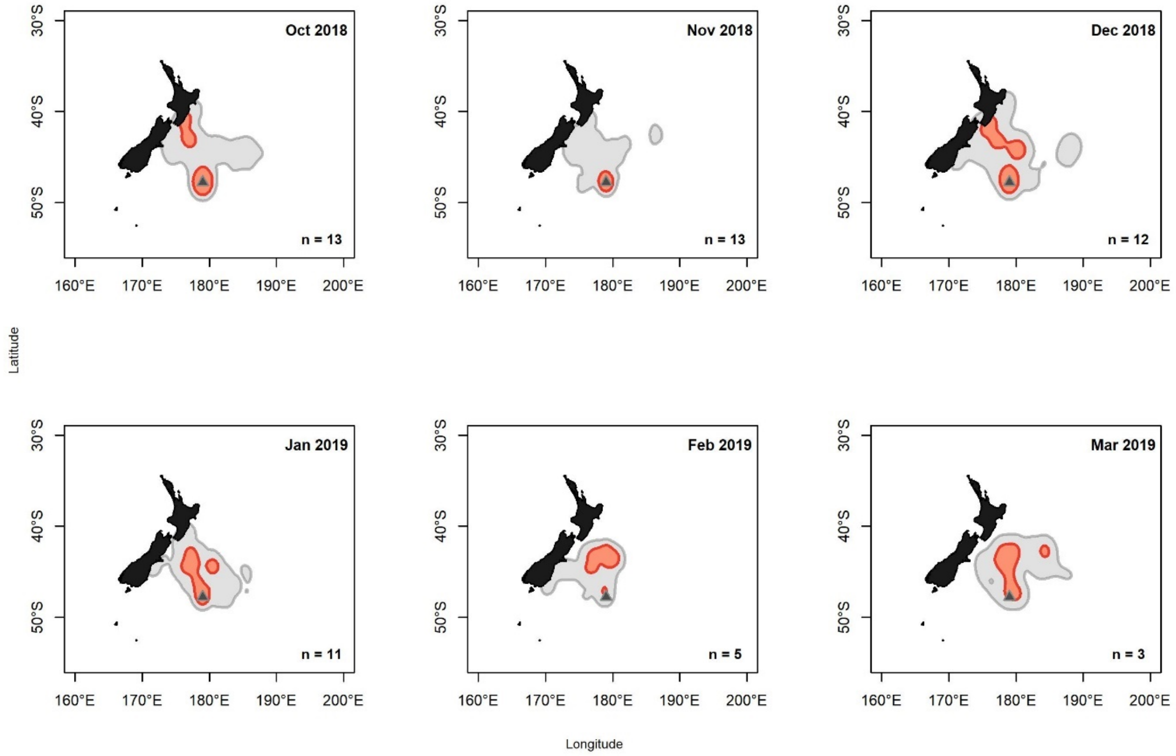

Figure 3-2: Kernel density utilisation distributions (UDs) for Salvin's albatrosses at the Bounty Islands, 2018-2019, based on GPS data. The 50% UD (red) and 95% UD (grey) are shown, and the colony is represented by the dark grey triangle. Number of active devices is indicated at the lower right of each plot.

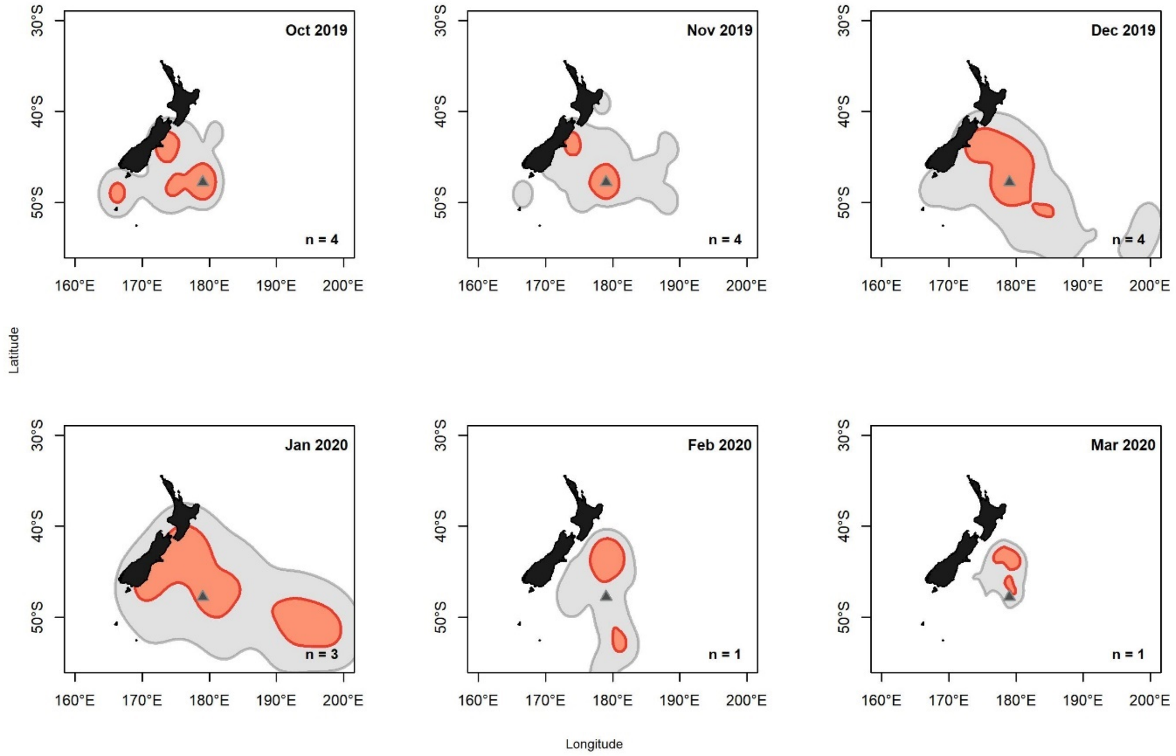

Figure 3-3: Kernel density utilisation distributions (UDs) for Salvin's albatrosses at the Bounty Islands, 2019-2020, based on GPS data. The 50% UD (red) and 95% UD (grey) are shown, and the colony location is represented by the dark grey triangle. Number of active devices is indicated at the lower right of each plot.

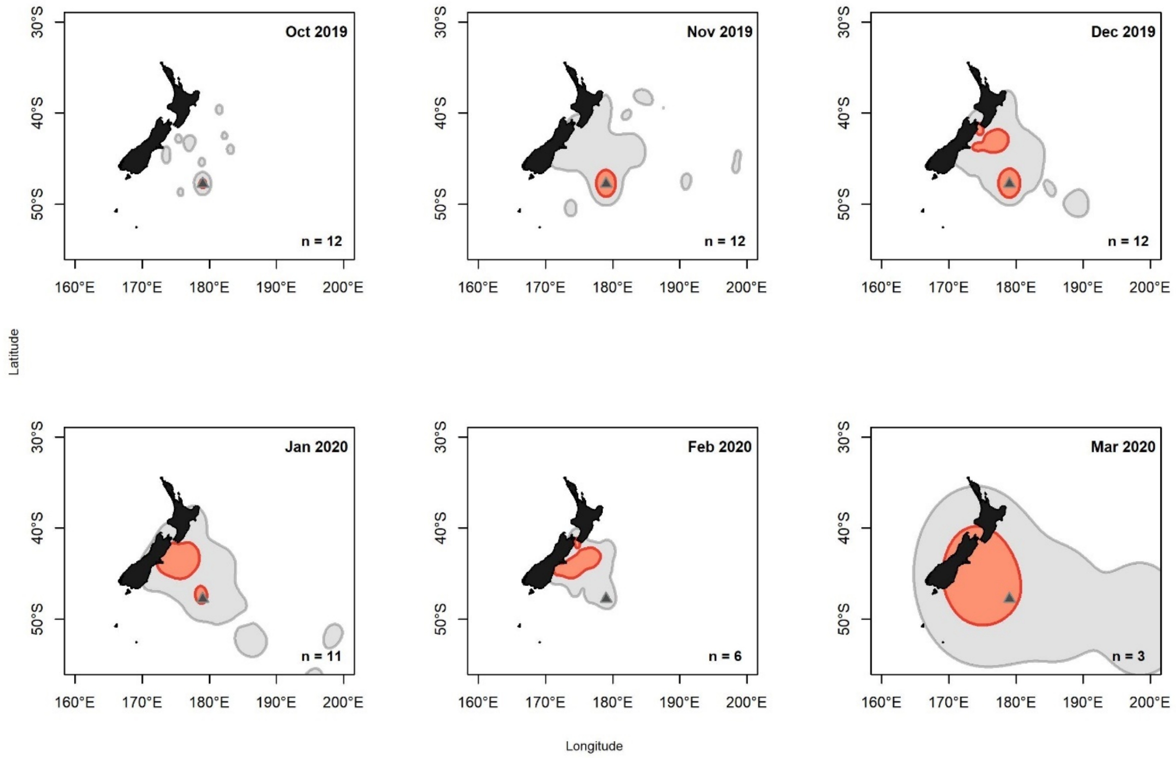

Figure 3-4: Kernel density utilisation distributions (UDs) for Salvin's albatrosses at the Bounty Islands, 2019-2020, based on PTT data. The 50% UD (red) and 95% UD (Grey) are shown, and the colony location is represented by the dark grey triangle. Number of active devices is indicated at the lower right of each plot.

3.3 Banding and resighting of breeding birds

In October 2018, 98 breeding Salvin's albatrosses were banded with stainless-steel leg bands and 97 of these birds were also fitted with a red plastic leg band. Recaptures were made of six birds from a cohort of 590 well-grown Salvin's albatross chicks banded on Proclamation Island in 1985 by C.J.R. Robertson, and eight birds were resighted from birds banded as breeding adults in 2012.

In October 2019, 43 breeding Salvin's albatrosses were banded with metal and plastic bands, bringing the total banded across the two years of the project to 141. A total of 80 birds were recaptured, comprising nine birds banded as chicks in 1985 (making these birds 34 years old), 14 birds banded as breeding adults in 2012 and 57 birds banded the previous year (in October 2018).

All banding data have been submitted to the New Zealand Bird Banding Scheme but have not been considered further here.

3.4 Ground-truthing

Summary data from ground counts made along 12 transects are presented in Table 3-2. These counts indicated that the proportion of breeding birds on Proclamation Island between 10:25 and 13:30

hours ranged from 0.41 to 0.52, with a mean of 0.47. There were no obvious differences in the proportion of nesting birds between the three time periods.

Table 3-2: Ground-truthing counts of Salvin's albatrosses at Proclamation Island. Status of birds encountered along 2 m-wide transects at three time periods, 22 October 2018.

Time	Transect	Nest with egg	Empty nest with bird	Loafers	Total birds	Proportion of birds breeding
10:25	1	42	7	39	88	0.48
	2	50	20	31	101	0.49
	3	47	20	37	104	0.45
	4	26	16	16	58	0.45
12:15	1	43	19	23	85	0.50
	2	33	16	14	63	0.52
	3	32	12	28	72	0.44
	4	30	14	26	70	0.43
13:30	1	38	6	31	75	0.51
	2	32	5	25	62	0.52
	3	36	22	30	88	0.41
	4	30	12	31	73	0.41

3.5 Cameras

Three of the six nest cameras recorded a photographic record of Salvin's albatross phenology information for the full year, while a further two yielded images for part of the nesting period. The sixth camera malfunctioned due to water ingress. No further analyses of the imagery obtained have been made.

4 Discussion

4.1 Distribution of Salvin's albatross during the breeding season

Overall, Salvin's albatrosses at the Bounty Islands tended to remain towards the east of New Zealand's South and North islands during the breeding season. Within this broad distribution, 'hotspots' of core habitat were identified from Banks Peninsula northwards encompassing eastern Cook Strait and the Wairarapa coast. Additional 'hotspots' occurred along the Chatham Rise and Mernoo Bank. Although based on a small number of GPS devices, in 2019-2020 there was some evidence of 'hotspots' on the Stewart-Snares shelf area and to the southeast of the Bounty Islands (Figure 3-3). The distribution identified here is consistent with that reported in an earlier study of

Salvin's albatross, based on results from 13 GLS tags (Thompson et al. 2014). Although hindered by device reliability issues, Thompson et al. (2014) showed that Salvin's albatrosses at the Bounty Islands remained to the east of New Zealand, and during the first half of the breeding season utilised waters to the north and northwest of the islands.

The easterly distribution of Salvin's albatross at the Bounty Islands during the breeding season contrasts with the distribution of Salvin's albatross at the Western Chain within the Snares archipelago. Birds at the Western Chain tended to occupy an area to the west of New Zealand, approximately to the west of the 170°W line of longitude, during the breeding season, although birds utilised the east coast of South Island as far north as Banks Peninsula (see Figure 4-1, previously Figure 3-2 of Thompson et al. 2014)

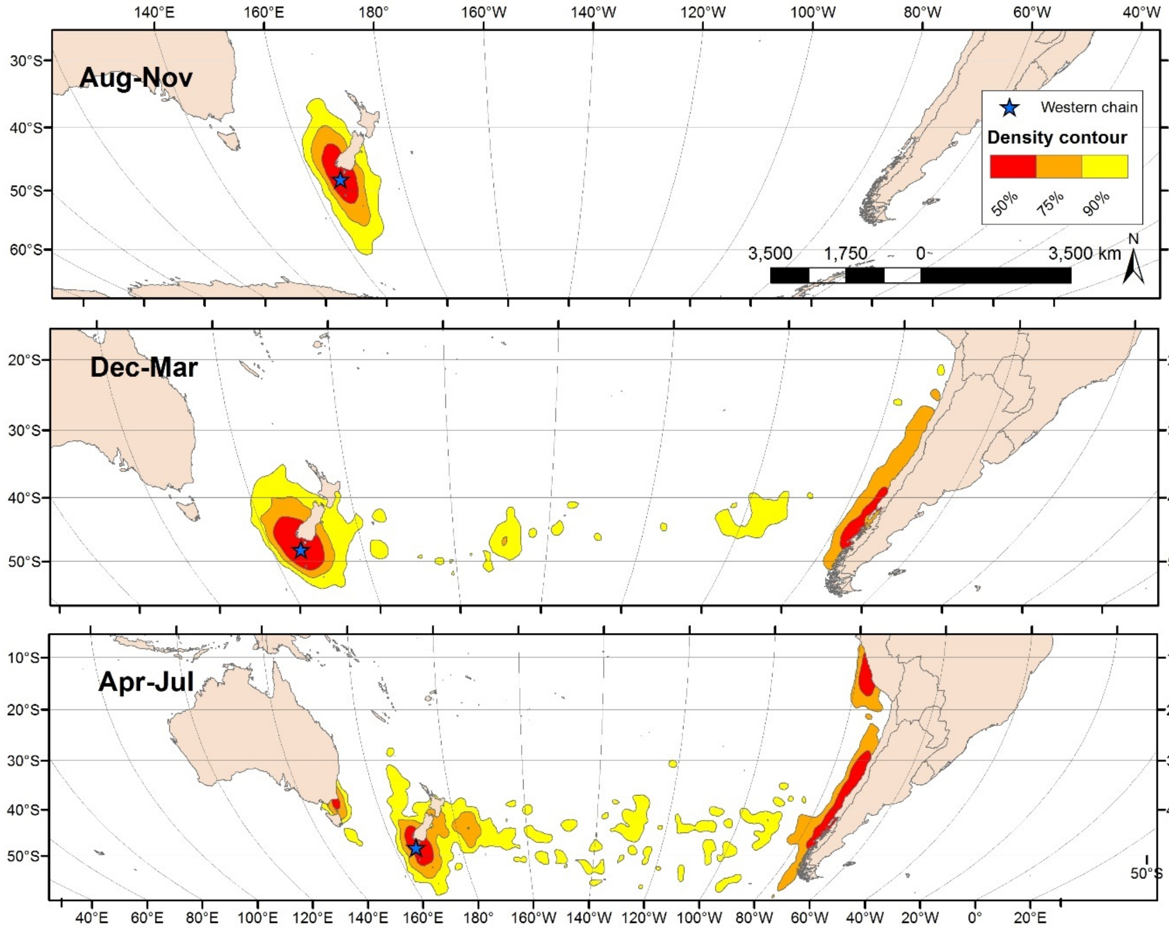

Figure 4-1: Kernel density utilisation distributions (UDs) for Salvin's albatrosses at the Western Chain, Snares Islands, 2008-2009, based on GLS data. The 50% UD (red), 75% UD (orange) and 90% UD (yellow) are shown, and the colony location is represented by the blue star. Number of birds = 24. Thompson et al. 2014.

4.2 Study population

The two visits to the Bounty Islands during this project, and specifically to Proclamation Island, have demonstrated that it would be theoretically possible to establish a Salvin's albatross study population. Of all the islands within the archipelago, landing at Proclamation Island appears to be relatively straight forward with experienced and skilled operators (both boat and land based), and once ashore there are relatively safe areas in which to work on Salvin's albatross that appear to create relatively little disturbance and which are relatively free of fur seals. However, Salvin's albatross arguably represents the most challenging species of albatross to work on within New Zealand in terms of access to breeding sites and the challenges of working at such sites once there. The Bounty Islands and the Western Chain in the Snares Islands provide little shelter to the prevailing weather systems and relatively calm conditions are a prerequisite to simply reach the islands and then land at study areas. Both island groups are extremely exposed, bare rock outcrops that require considerable skill and experience at which to work safely. It is likely, therefore, that advances in technology, and the increased use of data-transmitting and data-gathering devices such as the cameras trialled in this study, will be required in order to maximise the benefits of deploying field teams to work on Salvin's albatross.

4.3 Ground-truthing

The ground-truthing counts in October 2018 revealed that overall the proportion of birds actively breeding at Proclamation Island was 47% (Table 3-2). In contrast, Baker et al. (2014) reported that the proportion of actively breeding Salvin's albatross in October 2013, also at Proclamation Island, was 74%. It should be noted that there were some differences in the methodologies employed to generate these data, but, nevertheless, such a difference in the size of this metric has implications for estimates of Salvin's albatross breeding population at the Bounty Islands when assessed through aerial photography.

5 Acknowledgements

We thank the CSP for supporting this project and the skipper and crew of *Evohe* for safely transporting the field teams to and from the Bounty Islands, and for providing logistical expertise while at the islands. We also thank DOC staff at Murihiku/Invercargill office for providing logistical support before and after the field trips.

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