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Southern Royal Albatross research on Campbell Island/Motu Ihupuku 2023

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SUMMARY

Southern Royal Albatross (*Diomedea epomophora*) are endemic to Aotearoa New Zealand, breeding only on the Auckland Islands (Maukahuka) and Campbell Island (Motu Ihupuku). While Southern Royal Albatross were previously subject to concerted research projects, particularly at its stronghold on Campbell Island, the species has not been monitored consistently over the last 20 years due to logistical challenges. Yet, the most recent rapid survey on Campbell Island in 2020 indicated concerning declines.

As such, in February 2023 a New Zealand navy-supported research trip embarked to Campbell Island. The key aims of the trip were 1) counting of nests of Southern Royal Albatross in the traditional study area to gain insight into population trends, 2) deploying geolocators to gather information on offshore distribution, 3) collecting resight data for future demographic studies, and 4) installing remote cameras at nests to study breeding biology, phenology, and success.

Due to New Zealand's emergency response to cyclone Gabrielle, the research trip lasted one day. However, 29 geolocators were deployed on Southern Royal Albatross and 12 available remote cameras were installed at their nests. More importantly, while no systematic nest count of the traditional study area was possible, rapid nest counts aligned with previous counts, further suggested a concerning decline of the Southern Royal Albatross at its stronghold. This is particularly alarming because even though the species breeds biennially, both cohorts (and hence the overall population) appeared to be declining at a similar rate.

An in-depth and up-to-date study of Southern Royal Albatross at Campbell Island, including a thorough nest count, is urgently needed to further assess the species' population and its trends.

POP2022-11 Campbell Island/Motu Ihupuku Seabird Research & Operation Endurance February 2023

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Summary

This project (POP2022-11) was initially scoped as a desk-based project to identify cost-efficient monitoring methodologies for Campbell Island. However, when Operation Endurance (a collaboration between DOC and the Navy facilitating access to Campbell Island) was announced to take place in February 2023, POP2022-11 was re-scoped to implement actual monitoring, rather than identifying future monitoring avenues.

The February 2023 Operation Endurance trip to Campbell Island built on work from the March 2020 Operation Endurance trip, focusing on southern royal albatross (*Diomedea epomophora*). The main aims were counting of nests of southern royal albatross in the Col study area (and Moubray study area, if time permitted) to gain insight into population trends, deploying 29 GLS devices to gather long-term information on offshore distribution, collecting resight data (bands and PIT tags) for future demographic studies, and installing remote cameras at nests to study breeding biology, phenology, and success. Additional aims included counting of Antipodean albatross (*Diomedea antipodensis*) nests and conducting genomic sampling as well as deploying remote cameras on grey-headed albatross (*Thalassarche chrysostoma*) nests, if time permitted.

The trip to Campbell Island lasted one day, and hence it was only possible to deploy the 29 GLS tags and set up all 12 available remote cameras on southern royal albatross nests. No systematic search and count of the Col study area was possible, and there was insufficient time for Antipodean and grey-headed albatross work. Four banded southern royal albatrosses were resighted in the Col study area. Anecdotal evidence based on the limited nests sighted during this trip aligns with sightings during the 2020 trip and continues to suggest a concerning decline of the southern royal albatross at its stronghold. This is particularly alarming because even though southern royal albatross breed biennially, both cohorts (and hence the overall population) appear to be declining at the same rate because the 2020 survey covered one cohort and the 2023 survey the other.

An in-depth and up-to-date population study of southern royal albatross, including a thorough (preferably island-wide) nest count, is still needed to further assess the status of the southern royal albatross population and its trends.

Introduction

Campbell Island/Motu Ihupuku lies in the South Pacific Ocean approximately 700 km south of New Zealand, and is the southern-most subantarctic island of New Zealand (Moore & Moffat 1990). It covers over 11,000 ha, and has a long history of sealing, whaling, and farming since its discovery in 1810 (Moore et al. 2012). The island was farmed from 1895 to 1931 (Moore & Moffat 1990), with cattle (*Bos taurus*) removed in 1984, feral cats (*Felis catus*) disappearing in the mid-1980s, and sheep (*Ovis aries*) removed from the island by 1992 (Moore et al. 2012). Norway rats (*Rattus norvegicus*) were eradicated by 2001.

Southern royal albatross (*Diomedea epomophora*) are endemic to New Zealand, naturally uncommon, slow to mature (6-12 years), breed biennially, and are long-lived (Moore et al. 2012). Campbell Island is home to over 99% of the southern royal breeding population, with the most recent census (2004-08) estimating 8,300 to 8,700 breeding pairs (Moore et al. 2012). The introduction of mammals, such as cats and rats, the degradation of the island from farming, such as burning of vegetation, grazing, and depletion of nesting habitat, and direct depredation of birds by humans greatly reduced royal albatross numbers (Moore et al. 2012). Between the 1940s and 1990s, breeding, banding, and population studies were set up at Col and Moubray study areas, with regular and thorough studies from 1987 to 1998 providing a clear baseline of data (Moore et al. 2012). Three additional blocks (Faye, Paris, and Honey) were set up in the late 1990s as index count sites to supplement study area counts (Moore et al. 2012).

Over 35,000 royal albatrosses were banded on Campbell Island mostly by meteorological staff between 1941 and 1998, peaking in the 1960s and 1970s (Moore et al. 2012). Banding became restricted to the Col and Moubray study areas after 1987, and eventually birds in the study areas had their old bands replaced with more reliable bands (made with a thicker grade of stainless steel) or with transponders (*Trovan ID100*, passive integrated transponders (PIT)) due to a large number of leg injuries (Moore et al. 2012). This work was completed between 2004 and 2008, and a total of 2,882 banded birds were found (Moore et al. 2012). By the end of the 2008 season, approximately 674 birds retained an appropriate band (Moore et al. 2012). A total of 405 birds had a PIT inserted, of which 314 (43 females, 271 males) had a confirmed reading on a subsequent visit (Moore et al. 2012).

In November 2019, an Operation Endurance trip (a DOC-Navy collaboration) to Campbell Island included seabird population monitoring (Rexer-Huber et al. 2020), with a follow-up trip in March 2020 (Mischler 2020). The March 2020 trip focused primarily on southern royal albatross population numbers, and the count of Col study area resulted in a surprisingly low number of nests (Mischler 2020). The actual nest count in 2020 was 104 nests with an adjusted total (to allow for comparisons with previous counts which were always done in Dec-Jan) of 137 nests compared to a mean of 197 nests between 2004-08 and a mean of 187 nests between 1991-99 (Mischler 2020). Due to covid restrictions, budget constraints, and/or natural disasters, the February 2023 Operation Endurance trip was the first possible opportunity to return to Campbell Island for another count of southern royal albatross nests. As such, this project (POP2022-11) was re-scoped from the initial desk-based identification of cost-efficient monitoring methodologies for Campbell Island (CSP 2022), to the implementation of actual on-ground monitoring. Thus, this report builds on the Mischler (2020) report.

The main objectives following the re-scoping of POP2022-11 were:

1. **Southern royal albatross**:
    a) Population estimate: support the development of a remote sensing methodology for an island-wide population estimate by conducting nest counts in the Col study area (and Moubray study area, if time permits).
    b) At-sea tracking: deploy 29 geolocator tags (GLS) on breeding adults (ideally partners of at least 10 pairs) in the Col study area to gain long-term low-resolution insights into distribution and fisheries risk (15 females, 14 males). Retrieve previously-deployed GLS devices (deployed in 2012/13 and 2014/15) if seen.
    c) Demographics: collect resight data (bands and PIT tags) on known birds in the Col and Moubray study areas to inform demographic parameter estimates.
    d) Breeding success: install six trail cameras at nests with birds with GLSs to use time-lapse photography to study breeding biology, phenology, and success.
    e) Mercury sample collection: collect blood and feathers from 20 adults (equal male and female ratio) for a Pacific-wide mercury pollution study.
2. **Antipodean albatross**:
    a) Genomics samples: collect blood samples from all Antipodean albatross encountered in the Moubray study area (or anywhere on the island) for a species-complex wide genomic study.
    b) Population count: conduct nest counts of all detected Antipodean albatross nests in the Moubray study area.
3. **Grey-headed albatross**:
    a) Breeding success: install six trail cameras at suitable vantage points in the Bull Rock colony to use time-lapse photography to study breeding biology, phenology, and success.
    b) Demographics: collect resight data (bands) from birds in the traditional study areas to inform demographic parameters.

Trip duration and timing

The February 2023 Operation Endurance trip was of short duration, departing from Bluff late on Monday 13 February and returning to Lyttleton on midday Saturday 18 February. The ship arrived and offloaded passengers at Campbell Island in the morning of Wednesday 15 February. The timing for the remainder of the trip on Campbell was as follows:

- 15 February: Offload and quarantine army/navy gear, wait for all remaining gear to be brought ashore (late afternoon), set up base.
- 16 February: Opportunistic nest counts, band and PIT tag resights, GLS and nest camera deployments on southern royal albatross at Col study area; on ship by 1600.

Ship departed early evening on Thursday 16 February for Lyttleton.

Overall Summary of Methods and Results (Objectives 1 - 3)

Since there was only one day (9-10 hours) available to conduct work, most of the objectives were not achieved. Priority shifted to deploying the 29 GLS tags and setting up all 12 cameras on southern royal albatross nests. Considering this, specific methods and results for each objective are outlined below.

Southern royal albatross (Objective 1a)

A team of two people walked to the top of the Col-Lyall boardwalk and into the Col study area. To maintain consistency with previous surveys, site marker and sector boundary coordinates for the Col study area were loaded onto a GPS units (Garmin 64st). Maps and sector boundary descriptions available from the appendix in Moore et al. (2012) were printed and carried in the field for additional clarity. Nests were searched for starting from approximately 200 m away from the boardwalk by walking until a nest was seen. Active nests with a bird and an egg or chick were marked on the GPS. Time did not allow for systematic nest searching of the Col study area. Nests were visited, counted, and checked as they were seen while walking near the ridgeline (Fig. 1). All mapping analyses were done on qGIS.

A total of 49 active nests were visited within the Col study area, 30 with an egg and 19 with a chick (Fig. 1). The track walked was recorded and also shown in Fig. 1. When this track is overlaid with nest locations from March 2020, a total of 42 nests would have been encountered assuming that nests within a 50 m buffer distance from the track were visible and visited. If the buffer distance is increased to 80 m, a total of 55 nests would have been encountered (Fig. 1, Table 1). For an overall comparison, nest locations from 2004-2008 and 2019/20 are shown in Fig. 2. The survey done in 2019/20 was the first time a count had been done since 2008/09, but the difference in timing of the survey compared to previous years required a correction and this is clearly outlined in Mischler (2020). If the track from 2023 is overlaid with nest locations from 2006/07 (the lowest nest count during the 2004-08 survey with 182 nests; Mischler 2020), a total of 78 nests would have been encountered within a 50 m buffer distance and 103 nests within a 80 m buffer distance. If the track is overlaid with nest locations from 2008/09 (the highest nest count during the 2004-08 survey with 214 nests; Mischler 2020), a total of 97 nests would have been encountered within a 50 m buffer distance and 127 nests within a 80 m buffer distance (Table 1). These are much higher than the counts from both 2020 and 2023 and indicate a serious decline in the breeding population of southern royal albatross.

Table 1. Nest counts of southern royal albatross in Col study area on Campbell Island for 2006/07, 2008/09, and 2019/20. The nest count in 2022/23 was opportunistic and not of the entire study area, and the number of nests which would have been encountered in 2006/07, 2008/09, 2019/20 are shown as a comparison within both a 50 m and a 80 m buffer distance from the track walked in 2023.

Season	Nest Count	Nests counted along 2023 track	Nests within 50 m buffer of 2023 track	Nests within 80 m buffer of 2023 track
2022/23 (Feb)	-	47	-	-
2006/07 (Dec-Feb)	182	-	78	103
2008/09 (Dec-Feb)	214	-	97	127
2019/20 (March)	104 (137)^	-	42	55

^corrected nest count if actual nest count is adjusted to fit Dec-Feb survey period (see Mischler (2020) for details)

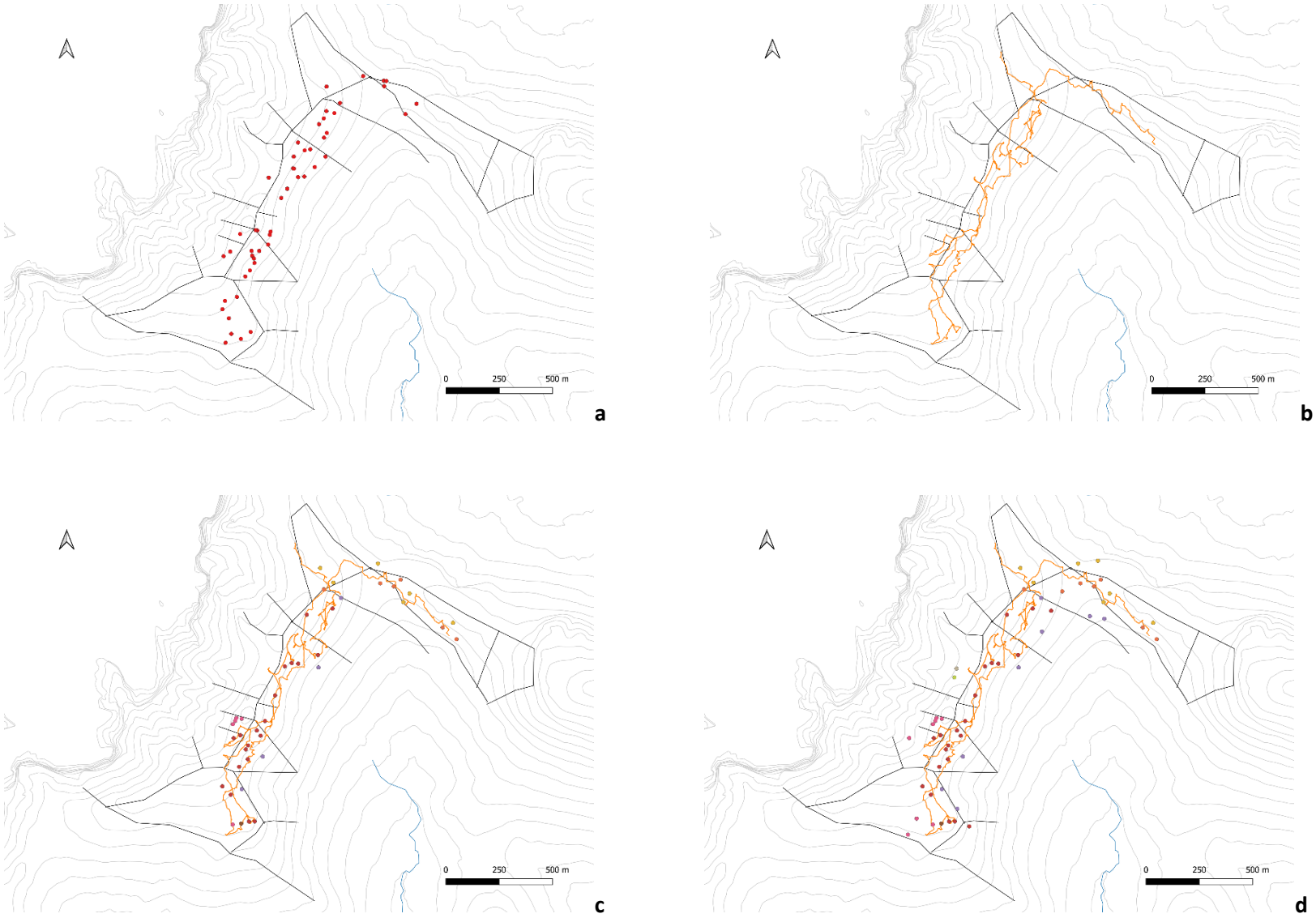


Fig. 1. Map of southern royal albatross Col study area on Campbell Island showing (a) active nests (49 nests) that were counted and visited, and (b) the track that was randomly walked through the study area while looking for nests for geolocator tag deployments. Maps (c) and (d) show the track from February 2023 overlaid with the nest locations from March 2020 where (c) includes nests (42 nests) within a 50 m buffer distance from the track and (d) includes nests (55 nests) within a 80 m buffer distance from the track.

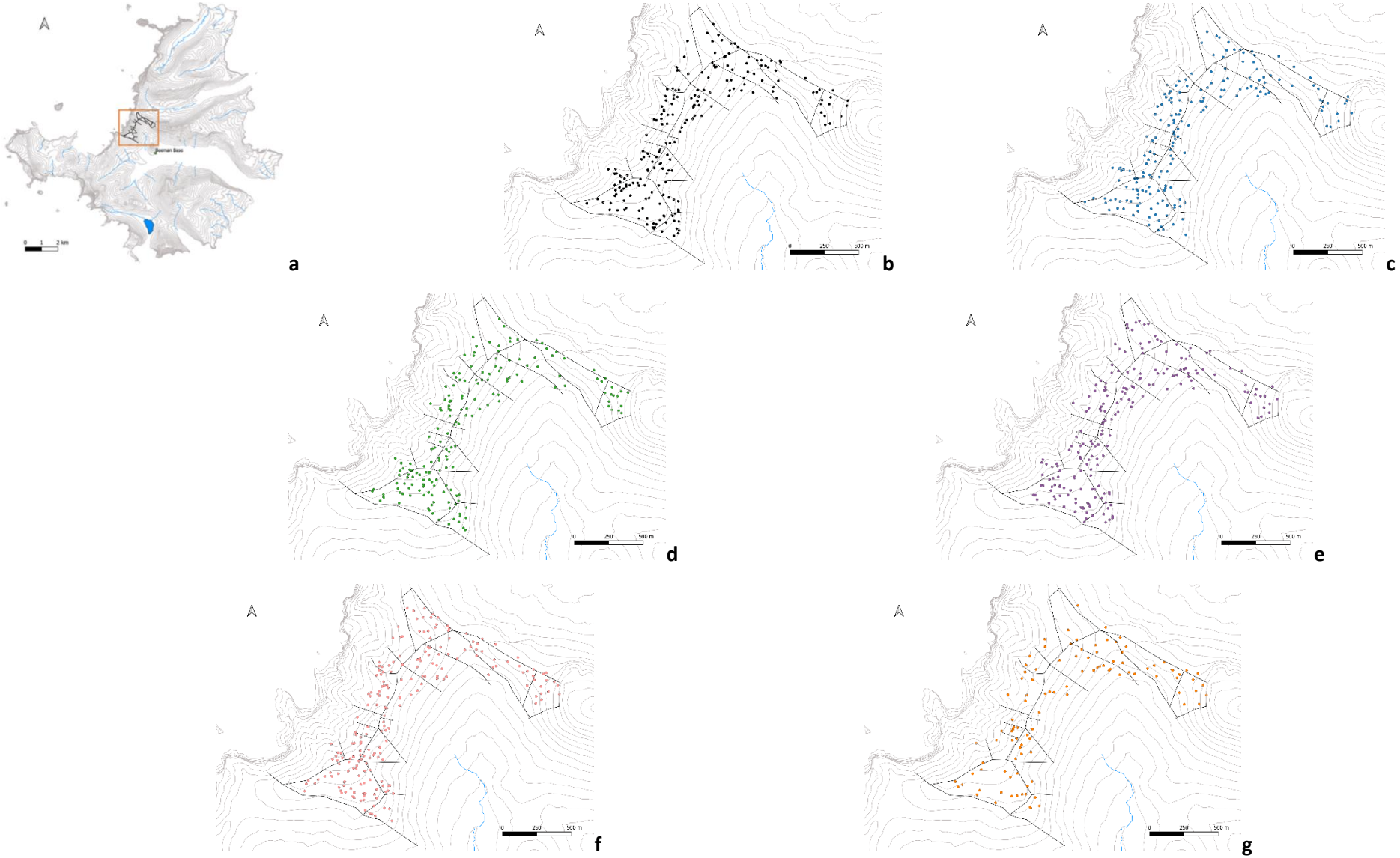
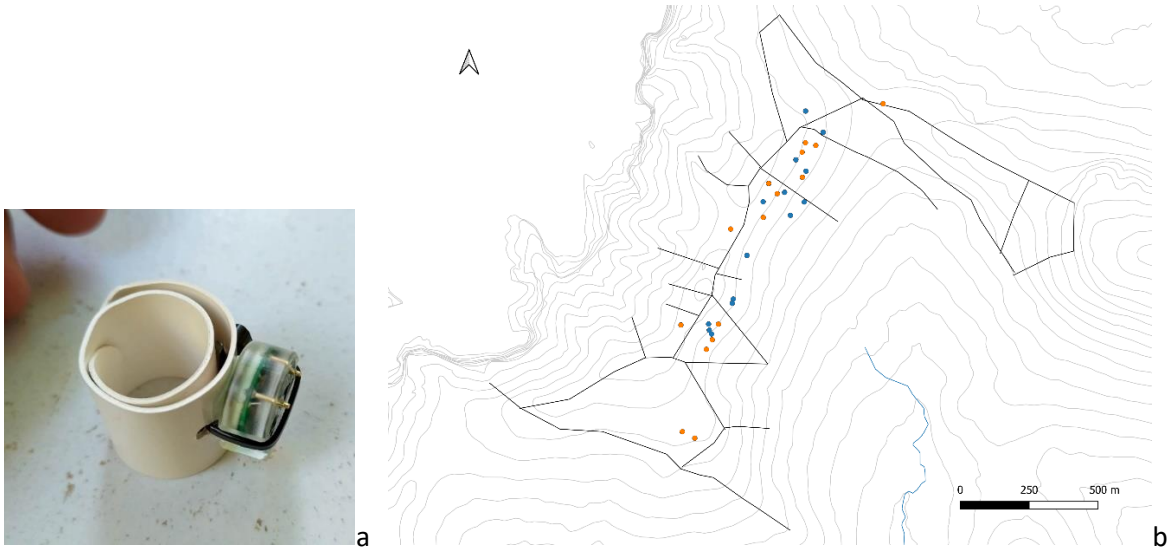


Fig. 2. Map of Campbell Island highlighting the location of the southern royal albatross Col study area (a) within the orange square. Maps b-g show southern royal albatross nest locations within the Col study area (shown as an enlarged version of the orange square seen in (a)) surveyed in December to February between 2004-08 seasons, where 2004/05 (207 nests) is shown in (b), 2005/06 (185 nests) in (c), 2006/07 (182 nests) in (d), 2007/08 (196 nests) in (e), 2008/09 (214 nests) in (f), and the March survey in 2019/20 (104 nests) shown in (g).

Southern royal albatross (Objective 1b)

GLS tags were attached to plastic wraparound bands prior to deployment, with two holes drilled and a cable tie inserted through the band and around the GLS tag (Fig. 3). Wraparound bands for males had a diameter of 22 mm (14 devices), and 19 mm for females (15 devices). GLS tags were deployed without removing the bird off the nest by simply opening the plastic band, wrapping it around the leg, and applying super glue on the outside opening (Fig. 3). Nests were visited randomly as they were seen and deployments made until the correct number of males and females (14 and 15, respectively) needed for deployments were found.



a b

Fig. 3. (a) Photo showing GLS tag on wraparound band (female) for southern royal albatross, and (b) map showing locations of GLS deployments on southern royal albatross in the Col study area on Campbell Island (orange – female, blue – male).

Southern royal albatross (Objective 1c)

Nest contents were checked, sex of the bird was determined (using size and plumage colour), and both legs were examined for bands and previously deployed tracking devices (GLS; deployed in 2012/13 and 2014/15 seasons). Bands were also checked for gaps. If no band was present, the back of the neck and the area towards the mantle were thoroughly scanned with a Trovan ISO Multireader for PIT tags. Birds were not removed from the nest or handled as checks for bands and PIT tags could be done without holding the bird. Nervous birds were checked as quickly as possible. All loafing birds were also checked for bands and GLS devices but were not scanned for PIT tags to avoid unnecessary capture and handling. No previously deployed GLS devices were found.

Four breeders were carrying bands, one male and three females (Table 2). None of the loafing birds seen were carrying bands. All birds on nests without a band were checked for a PIT tag, but none were identified. The banding history, including sex, age and season at banding, of each banded and PIT tagged bird seen is outlined in Table 2 (more detailed data in Appendix Table A1). Two of the three females, and the male, were banded as chicks. The oldest female banded as a chick was 32 years old (R-62868), and the youngest was 28 years old (R-62196). The male banded as a chick was 27 years old (RA-2458). The oldest female was banded as a breeding adult in 1994 (R-62269).

Table 2. Sex, age, and season banded for each banded and PIT tagged southern royal albatross seen in the Col study area on Campbell Island. Every recorded breeding season and the identity of the partner of each banded or PIT tagged bird are also shown. All data were collated from P. Moore (pers. comm. and unpublished data). 'F' is female, 'M' is male, 'unk' is unknown.

		Banding History		Breeding History	
Band or PIT	Sex	Age	Season	Breeding Season	Partner (ID)^
RA-2458	M	Chick	1995/96	2019/20	unk
				2022/23	unk
R-62269	F	Adult	1994/95	1994/95	R-43828
				1996/97	R-43828
				1998/99	R-43828
				2004/05	RA-2148
				2005/06	RA-2148
				2006/07	RA-2148
				2022/23	unk
R-62196	F	Chick	1994/95	2004/05	RA-2434
				2022/23	unk
R-62868	F	Chick	1990/91	2007/08	RA-2533
				2019/20	unk
				2022/23	unk

^ partners based on historical data as none seen during 2019/20 or 2022/23 due to short trip duration

Southern royal albatross (Objective 1d)

All 12 cameras (Swift Enduro Outdoor Cameras Australia with 32 GB SD cards) were deployed on southern royal albatross nests due to the Bull Rock colony being inaccessible given the time constraints. Two additional people followed the initial GLS deployment team and set up cameras near the nest (Fig. 4). Distance from the nest varied depending on vegetation type around the nest, but averaged between 2-10 m. This distance was also to allow for ample space in the photograph around the nest for when the chick begins to move around. Cameras were programmed to take one photograph every two hours between 0600 and 2100 hours. Duct tape was wrapped around the outside of the camera to prevent water seeping into the seals. Cameras were attached by a screw into a waratah, and with a strap wrapped around the camera and waratah for additional stability.

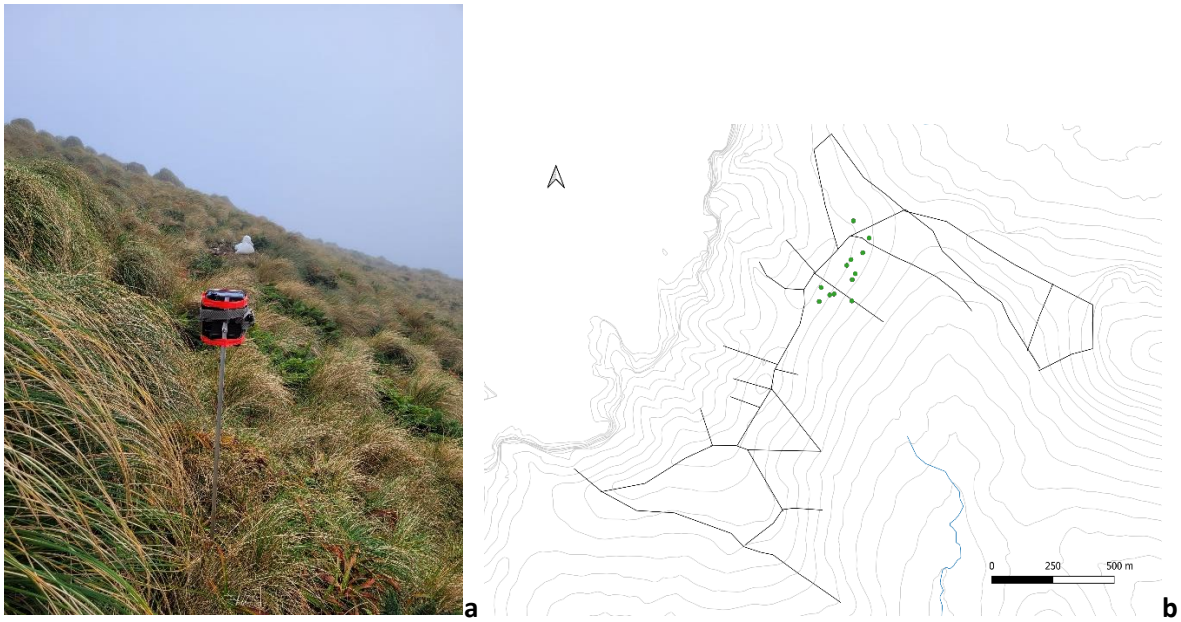


Fig. 4. a) One of 12 remote cameras deployed on southern royal albatross nests in the Col study area on Campbell Island. Cameras were set to take one photo every two hours between 0600 and 2100 hours, and b) map of the southern royal albatross Col study area on Campbell Island showing locations of nests with cameras.

Southern royal albatross (Objective 1e)

There was insufficient time for the mercury sample collection.

Antipodean albatross (Objective 2a - b)

Due to insufficient time, no Antipodean albatross nests could be searched for.

Grey-headed albatross (Objective 3a - b)

Due to insufficient time, the Bull Rock colonies could not be visited, and no cameras could be set up.

Other opportunistic observations

Two sets of plastic were found while working in the Col study area. One was from fishing equipment (squid jigger; Fig. 5), and the other was a white piece which was very brittle. Squid jiggers were observed near nests in the 1980s (G. Taylor, pers. comm.), Moore et al. (2012) mentioned finding small quantities of plastic in regurgitates, and several items were found during the 2019/20 trip (Mischler 2020). Plastics should continue to be opportunistically noted as plastic ingestion presents a problem for albatross species elsewhere around the world (Provencher et al. 2019, Phillips & Waluda 2020).

Fig. 5. Photo of fishing equipment (squid jigger) found within the southern royal albatross Col study area on Campbell Island.

Discussion

Due to the short time available on Campbell Island for work, there is little opportunity for discussion. Nest numbers in the Col study area appeared to be roughly the same as in 2019/20. If numbers had reverted back to 2004-08 numbers, the difference would have been noticeable. It was however difficult to get a true sense of the number of nests due to the foggy conditions on the day. Overlaying the February 2023 track with nest locations from March 2020 show that nest numbers along the track were very similar (49 nests in 2023 compared to 42 nests with a 50 m buffer and 55 nests with a 80 m buffer in 2020). Two buffer distances of 50 m and 80 m were used to indicate the difference in nest numbers because in some areas of Col, nests within 80 m would be easily visible whereas in other areas they would not due to vegetation type. If nest numbers are compared to the 2004-08 survey, the results highlight the large decrease in breeding birds (78 nests in 2006/07 (the lowest nest count during the 2004-08 survey) with a 50 m buffer and 103 nests within a 80 m buffer distance; 97 nests in 2008/09 (the highest nest count during the 2004-08 survey) with a 50 m buffer and 127 nests with a 80 m buffer). It is also alarming that both cohorts of this biennally breeding species appear to be undergoing the same decline. The 2019/20 survey counted one cohort, and the 2022/23 survey counted the other. Breeding pairs which fail in one season do return to nest the following season; however, at least 50% of breeders should remain separated between the cohorts. The data from the two surveys indicate that one cohort will not offset the other, and hence this is a species wide decline of potentially 50-65% of the 2004-08 population. This clearly emphasizes the strong need to carry out thorough counts of the Col and Moubray study areas as well as Faye, Paris, and Honey index areas to fully understand the population trend.

Nest counts of a small breeding population of southern royal albatross on Enderby Island (Auckland Island group) were conducted between 1954-2001 (Childerhouse et al. 2003). During this time, there was an increase in the number of nests, from 3 in 1954 to 33 nests in 1987 (Childerhouse et al. 2003). Between 1992-2001, annual surveys found the mean number of nests on Enderby was 50, with the highest number ever reported for the island in 2001 with 69 nests (Childerhouse et al. 2003). In the 2022/23 season, 47 nests were counted (K. Manno, pers. comm.) potentially indicating a similar decline seen in the Campbell Island population.

GLS devices are regularly used on seabirds as a coarse scale tracking method. The batteries last for several years and can therefore capture a large amount of data. This data will be useful to determine foraging areas both during and outside of the breeding season around New Zealand as well as in international waters. However, fine-scale insights, e.g., through GPS tracking, is still lacking and desperately needed for this species.

In addition to continuing to resight previously banded and PIT tagged birds, it will be equally important to resume banding and PIT tagging of southern royal albatross in the Col and Moubray study areas to increase breeding and survival data quality through capture-mark-recapture analyses. New individuals should be marked as the banded population is continuing to age and relying solely on the available resight data will bias estimates for future survival analyses.

Data from remote cameras will be able to provide insights into nest success, fledging dates, adult departure and arrival dates. It may also be possible to determine adult change-over rates for incubation and chick feeding duties. This deployment will be an useful trial to determine how well the camera set up works for southern royal albatross, and can indicate what changes may be necessary for future monitoring. Data from the cameras can also be used to create a correction factor over time for population estimates in the future as the footage would show when both failed breeders depart from the island during the breeding season and when successful breeders depart at the end of the breeding season.

Recommendations

- Repeat a detailed survey of at least all study (Col and Moubray) and index areas (Faye, Paris, and Honey). Surveys should be conducted for at least two consecutive years due to the biennial breeding nature of the birds and annual variations.
- Collect resighting data (bands and PIT tags) from Col and Moubray to continue building the mark-resight dataset to allow for future survival analyses (e.g., Richard 2021). New individuals should also be marked as the banded population is continuing to age and relying solely on the available resight data will bias estimates.
- Aside from GLS tracking, higher resolution GPS tracking should also be conducted to facilitate detailed fisheries risk assessments and overlap analyses (as has been done for Antipodean Albatrosses; Bose & Debski 2021).
- In addition to southern royal albatross research, further studies on other seabird species on Campbell Island is needed, including Antipodean albatross, grey-headed albatross, and northern giant petrel (*Macronectes halli*) population estimates, among many other research priorities. As such, we recommend conducting future southern royal albatross research in conjunction with priority work on other species.

Acknowledgements

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Appendix

Table A1. Sex, age, and season banded for each banded and PIT tagged southern royal albatross seen in or near the Col study area on Campbell Island. Every recorded breeding season and the identity and history of the partner of each banded or PIT tagged bird are also shown. Any re-banding or removal of bands and PIT tag insertions are also outlined. All data were collated from P. Moore (pers. comm. and unpublished data).

		Banding History			Breeding and Partner History^		
Band or PIT	Sex	Age	Season	Previous bands	Breeding Season	Partner (ID)	Partner history and previous bands
R-62269	F	Adult	1994/95 2004/05	R-45761 Re-banded			Chick in 1987/88 (Seen as non-breeder in 1992/93)
					1994/95	R-43828	
					1996/97	R-43828	
					1998/99	R-43828	
							Chick in 1993/94 (R-45208)
					2004/05	RA-2148	Re-banded as RA-2148
					2005/06	RA-2148	
					2006/07	RA-2148	
R-62196	F	Chick	1994/95 2004/05	R-45832 Re-banded			Chick in 1996/97 (R-48387)
					2004/05	RA-2434	Re-banded as RA-2434 (Bred with R-62890 in 2007/08)
R-62868	F	Chick	1990/91 2007/08	R-44004 Re-banded			Chick in 1972/73 (R-25683) (Bred with R-62497 in 1994/95, 1996/97, 1998/99, 2005/06) Re-banded as RA-2533 in 2005/06
					2007/08	RA-2533	Band removed and insert PIT (668 1D1B)
					2019/20	unk	
RA-2458	M	Chick	1995/96 2005/06	R-48661 Re-banded (but not breeding)	2019/20	unk	

^Partners based on historical data as none were seen during 2019/20 and 2022/23 due to short trip duration