

Campbell Island seabirds: Operation Endurance November 2019

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Campbell Island seabirds: Operation Endurance November 2019

Final report to Department of Conservation, Marine Species and Threats

April 2020

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Summary

Seabird population monitoring and survey on Campbell Island was enabled via Operation Endurance in November 2019. Specific objectives were to collect photo-point and ground-truthing data at Campbell and grey-headed albatross colonies, repeat whole-island counts of breeding Northern giant petrels, collect GLS trackers from Southern royal albatrosses, use sound recorders to record burrowing petrel distribution and check the bands of all banded birds seen.

Photo-points for Campbell albatross and grey-headed albatross (*Thalassarche impavida* and *T. chrysostoma*) were revisited to take a new set of photographs for population monitoring. These photo-points have been used for counts since 1987, but some colonies have been photographed since the 1940s. Ground-truthing to help improve the accuracy of counts from photographs was conducted in six areas. We trialed a small drone (DJI Mavic 2 Pro) and showed a drone could be useful for obtaining closer-in photographs of distant sites than a person with a telephoto lens on the main ridge, particularly for the Courejolles Peninsula albatross colonies. Two sets of aerial photographs of these northern albatross colonies were provided by Navy and Airforce helicopter aircrew.

The 1996 census of breeding Northern giant petrels (*Macronectes hallii*) around the island was repeated. Adjusting chick counts to correct for breeding failures gave an estimated 150 (range 134–173) breeding pairs in 2019. This is fewer than the last count in 1996, but considering the area not surveyed in 2019 (south-east coast from Monument Harbour to Erebus Point), the whole island breeding population in 2019 appears broadly similar to the last count in 1996.

Three tracking devices were recovered from Southern royal albatrosses (*Diomedea epomophora*). Numbers of Southern royals in the Col-Lyall colony seemed low, highlighting the need to repeat the island-wide census last done 2004–08, and to resume mark-recapture in the study colony to assess the population's current status.

Sound recorders captured white-headed petrels (*Pterodroma lessoni*) calls at Campbell Island, supporting the idea that a small population may breed there. Recorders also provided evidence that white-chinned petrels (*Procellaria aequinoctialis*) are recolonising multiple areas on the main Campbell from its offshore islets, extending the known distribution northward to Northwest Bay and Switchback Ridge.

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Introduction

The Southern royal (*Diomedea epomophora*) and Campbell albatross (*Thalassarche impavida*) are endemic to New Zealand. Southern royal albatross breed primarily at Campbell Island, while Campbell albatross only breed there. The grey-headed albatross (*T. chrysostoma*) and Northern giant petrel (*Macronectes hallii*) nest at Campbell but also at other islands around the Southern Ocean. Giant petrels breed Aug–Feb, nesting in loose clusters around the whole of Campbell Isl. Campbell and grey-headed albatross nest in mixed colonies around the northern cliffs of Campbell Island (Fig. 1), sharing a similar breeding season (Sept–Apr). Southern royal albatross start later, breeding from late Nov to late Oct, in loose colonies scattered around the island. Southern royal and Campbell albatrosses appear as bycatch in observed fisheries in NZ waters, as do giant petrels, but grey-headed albatrosses are infrequently observed caught in NZ commercial fisheries (Abraham & Thompson 2015).

Substantial declines in the breeding populations of Campbell and grey-headed albatrosses have been documented (Waugh *et al.* 1999; Moore 2004; Sagar 2014). To monitor the breeding population a set of standardised photo-points were established in 1987 for nest counting, building on photographs taken since the 1940s (Moore & Moffat 1990). Trends are estimated from these photo-points, together with ground counts completed during the 1990s, independent demographic work 1984–94 via mark-recapture (Waugh *et al.* 1999), and repeats of the photo-point monitoring (Sagar 2014). Grey-headed albatross showed long-term and apparently continuous declines, followed by what may have been a small increase between 1995 and 2012 (Waugh *et al.* 1999; Moore 2004; Sagar 2014). Campbell albatross numbers have been more variable over time, fluctuating between increases and substantial decreases over the decades (Waugh *et al.* 1999; Moore 2004; Sagar 2014).

By contrast, the current status of Northern giant petrels and Southern royal albatross at Campbell Island is virtually unknown. The only whole-island census of breeding giant petrels at Campbell was conducted in 1996 (Wiltshire & Scofield 2000). Southern royal albatrosses have been monitored since the 1950s via island-wide breeding population surveys and a long-term mark-recapture dataset (e.g. Moore *et al.* 1997; Moore *et al.* 2013) but the last survey in 2004–08 has yet to be repeated. Mark-recapture in the Col study colony has lapsed since PIT tags replaced leg bands in the mid-2000s. Geolocator GLS trackers, deployed 2012–15 to monitor the at-sea movements of Southern royal albatrosses, have only opportunistically and slowly been recovered from birds.

Petrels remain largely unstudied on Campbell Isl. Since cats *Felis catus* died out in the mid-1980s (Moore 1997) and Norway rats *Rattus norvegicus* were eradicated in 2001, it seems likely that abundance and perhaps distribution have changed for species like sooty shearwaters, cape petrels, grey-backed storm petrels, fairy prions, subantarctic diving petrels, grey petrels, and white-chinned petrels (*Ardenna grisea*, *Daption capense*, *Oceanites nereis*, *Pachyptila turtur*, *Pelecanoides urinatrix*, *Procellaria cinerea*, *Pr. aequinoctialis*) (Taylor 2000; Shirihai 2009; Gill *et al.* 2010). However, survey effort for petrels on main Campbell has been limited to grey and white-chinned petrel surveys in 2014 and 2015 (Rexer-Huber *et al.* 2016; Parker *et al.* 2017), so it is unclear whether there has been burrowing seabird recovery. Terrestrial birds like the pipit *Anthus novaeseelandiae* and snipe *Coenocorypha*

aucklandica have increased substantially since rat eradication (Thompson *et al.* 2005; Miskelly & Fraser 2006; Armitage 2007).

With the opportunity to join Operation Endurance to Campbell Island in November 2019 for an anticipated ten working days on the island, we aimed to collect seabird population monitoring data and recover tracking devices. Specific objectives were to collect photo-point and ground-truthing data at grey-headed and Campbell albatross colonies, repeat whole-island counts of breeding Northern giant petrels, collect GLS trackers from Southern royal albatrosses, use sound recorders to identify the distribution of petrels, and collect resighting data for any leg-banded birds encountered.

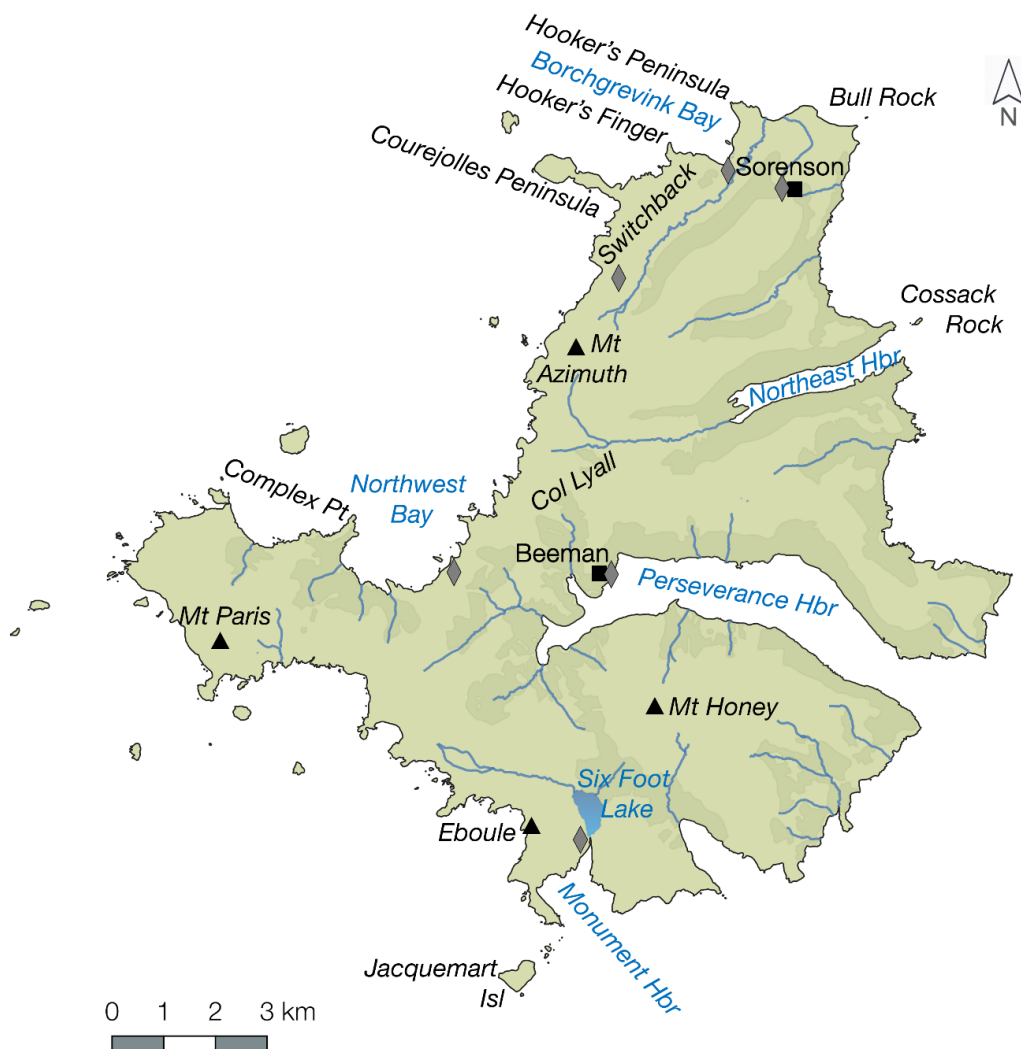


Figure 1. Campbell Island with named sites. Grey diamonds show sound recorder sites.

Methods

Timing and logistics

After quarantine in Invercargill, the field team (Kevin Parker and Kalinka Rexer-Huber) joined the ship HMNZS Canterbury 15 Nov 2019 in Dunedin. The ship arrived at Campbell 18 Nov. We were boated ashore at Beeman Base in Perseverance Harbour by ~9am that day and spent the rest of the day assisting with quarantining expedition cargo as it arrived at the base. Our field work started 19 November, with weather days used for transit. The schedule that resulted is summarised in Table 1.

Table 1. Fieldwork chronology for Campbell seabird team, November 2019.

Date	Progress	Overnight
19 Nov	Beeman Base to Sorenson (wet, no visibility)	Sorenson Hut
20 Nov	Bull Rock albatross colonies vantage points, ground truthing	Camp Sorenson
21 Nov	Hooker's Finger, H. Peninsula vantage points	Camp Borchgrevink Bay
22 Nov	Transit to south end Switchback Ridge (wet, no vis)	Camp Sth end Switchback
23 Nov	Courejolles Peninsula vantage, drone flight, Courejolles Isthmus, return Beeman	Beeman Base
24 Nov	Beeman to Six Foot Lake, giant petrel survey	Camp Six Foot Lake
25 Nov	Giant petrel survey, return Beeman	Beeman Base
26 Nov	Complex Pt giant petrel survey, return Beeman	Beeman Base
27 Nov	Col Lyall Southern royal tracker recovery	evacuated to ship

Field work ended with the unexpected evacuation of all field teams back to the ship 27 November (mechanical issue with a main engine). The ship returned directly to Devonport, Auckland, arriving early on 4 December. Operation Endurance ended with a Hercules flight, arriving in Invercargill late afternoon 4 December.

Campbell and grey-headed albatross

Photo-point survey involved revisiting the twelve photo-points established by Moore (2004) (Fig. 2). To locate photo-points we pooled information from several reports (Moore 1999; Moore & Blezard 1999; Moore 2004). Photographs were taken with a Canon 7DMkII SLR with a 60mm lens, and a 70–200mm telephoto lens for the long-distance photographs into Courejolles Peninsula colonies from photo-points C1 and C2. At every photo-point, enough overlapping images were taken to cover the whole colony. Two to three sets of photographs were taken for each site to ensure best quality available when images are processed and counted. Where a colony overview image might aid image processing, overview photos were also taken.

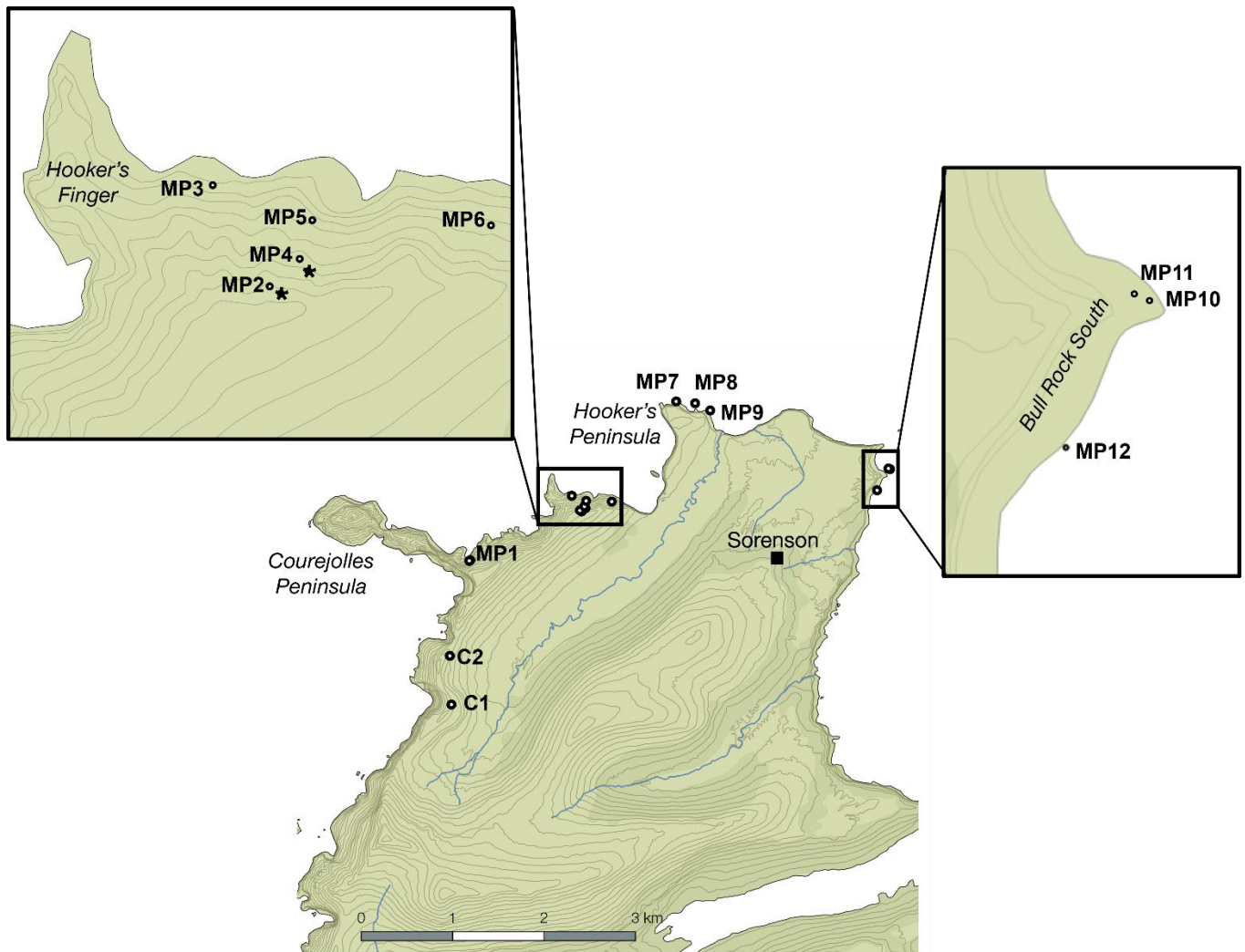


Figure 2. Photo-points for Campbell and grey-headed albatross, Campbell Island. Stars at Hooker's Finger (inset left) give location of wooden marker on main ridge showing that MP2 and MP4 are directly downhill.

Some photo-points are more distant from the colonies than is ideal, and some colonies cannot be viewed from a vantage point at all (i.e. colonies south of Bull Rock South). The Courejolles Peninsula colonies are far enough from the photo-points that even with a high-quality telephoto lens, photographs are challenging to count. To test the potential for a drone to obtain closer-in photographs of distant sites like the Courejolles Peninsula colonies, we trialed a small drone (DJI Mavic 2 Pro) with a high-quality Hasselblad camera (20MP 1" CMOS sensor). Three flight batteries provide about 75min flight time in total, depending on wind conditions. The drone was flown from the Courejolles Peninsula photo-point C2 (Fig. 2). A spotter with binoculars helped the pilot monitor animal responses, particularly any conflict with birds in flight. For this trial, the drone was flown well away from the colonies (at least 150m distant) so disturbance of birds on the ground was unlikely.

Ground-truthing data to help interpretation of photograph counts were collected as widely as possible. Ground-truthing here refers to checks of albatross species via ground counts, and of albatross status (apparently incubating, breeding, loafing). In some photos grey-headed and Campbell albatrosses are too distant to distinguish from each other, so ground counts of grey-

headed albatrosses were undertaken wherever possible. Grey-headed albatrosses were counted throughout the Bull Rock South colonies (GH-1 to GH-3 colonies and terraces 22, 16, D, 1, 2, 3, 4, C, B, A) (Fig. 3). Counts also took place from vantage points at colonies on Hooker's Finger (from MP2, MP5, MP3), Hooker's Peninsula (MP9) and Courejolles Isthmus (MP1) (Fig. 2). Ground-truthing to assess the proportion of birds on nest that actually have an egg (breeders, as opposed to birds apparently incubating but lacking an egg or 'tryers'), and to count loafers (birds not on nests), was conducted in four transects in the Bull Rock South colonies.

Throughout all work in the colonies, we recaptured banded birds, conducting band maintenance where needed (closing bands that had opened to varying degrees, removing overlap in over-tightened bands).

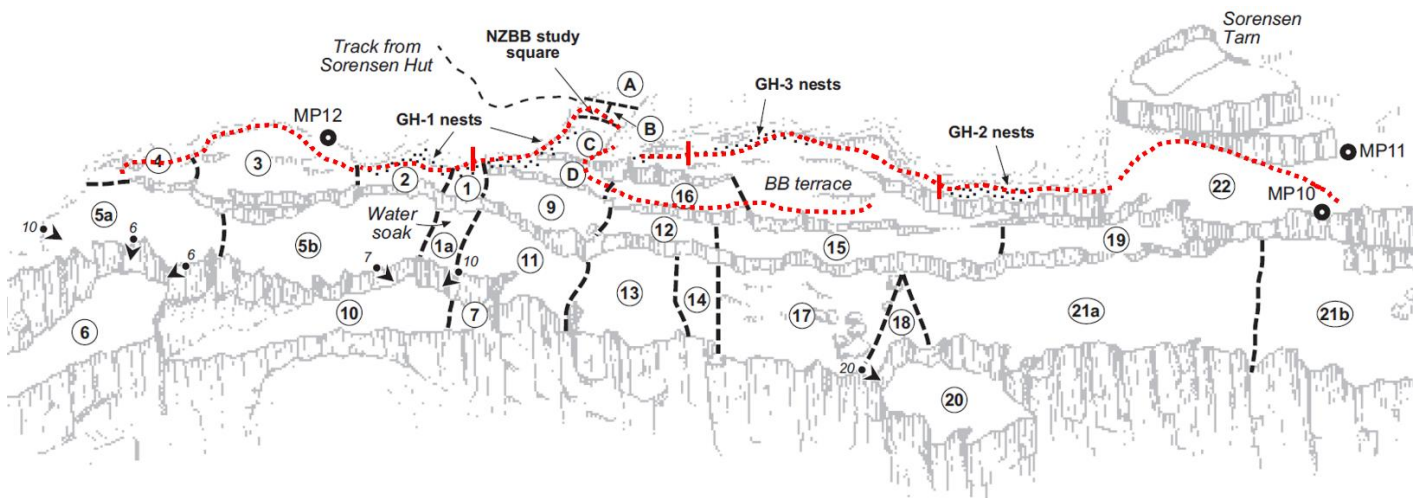


Figure 3. Ground counts of grey-headed albatross nests in Bull Rock South, routes in dotted red lines. Modified from Fig. A1 in Appendix 2 of Moore (1999). Major landmarks and photo-points MP10–12 are shown. Circled labels identify count areas in Moore (1999).

Northern giant petrels

Giant petrel nests were counted across Campbell Island, revisiting as many of the known breeding sites as possible (Wiltshire & Scofield 2000) with the help of other teams moving around the island. Since Northern giant petrels are known to move nesting areas and are often found singly or in small clusters (Parker *et al.* 2020), we also surveyed areas where breeding has not previously been recorded. We differed from Wiltshire & Scofield (2000) only in that we did not record failed nests (empty nests that showed signs of having failed in the current breeding season). Failed nests are less detectable than active nests and can be hard to distinguish from the non-breeding or 'play' nests that adults build. All active nests were marked by GPS, and all adults seen were checked for bands.

To estimate the number of breeding pairs from our nest counts, we corrected for nesting failure during the egg and early chick stage using breeding success data (Wiltshire & Hamilton 2003; Parker *et al.* 2020). The total number of Northern giant petrels breeding at Campbell Island in 2019 was estimated by dividing the number of active nests found in this survey by breeding success from

Macquarie Island 2008–18 (average, lowest and highest breeding success records) (Department of Primary Industries, Parks and Environment Tasmania DPIPWE unpubl. data). Macquarie Island, 390 nautical miles south-west of Campbell Island, is the nearest Northern giant petrel colony where a study colony is monitored for breeding success (Alderman *et al.* 2019).

Southern royal albatrosses

The South Col albatrosses in the wider Col-Lyall colony (Fig. 1) were visited at the very start of the laying period for resightings of leg-banded birds, band maintenance, and to recover GLS trackers deployed 2012–15.

Petrel distribution

To gain insight into the current petrel distribution and detect whether the known distribution has changed, sound recorders (AR4 model, DOC Electronics) were deployed at sites around the island. Recorders were active between 11pm and 4am, deployed for 1–2 nights around Bull Rock, Borchgrevink Bay, Six Foot Lake and by the Clifton memorial near Beeman Base, and for 3–4 nights above Northwest Bay (diamonds, Fig. 1). Sound file review was as follows, taking into account that some recordings were dominated by weather noise. In weather-dominated recordings we listened to every third 15-min segment until other sounds could be detected. Once bird sounds were audible, every second segment was reviewed.

Results

Grey-headed and Campbell albatross

Photo-points

All historic albatross photo-points were relocated, the GPS location updated, and photographs taken for independent counts of apparently incubating albatrosses. Photographic conditions were mostly excellent, with relatively little haze and dry overcast conditions for all but the two Bull Rock South photo-points. High-quality images from these vantage points (~480) have been archived. Work is being undertaken to process the images and get counts of the different species, and will be reported on separately. Updated waypoints for photo-point marker poles and description are provided in Appendix A.

Aerial photographs

A drone was flown successfully out to Courejolles Peninsula from the photo-point C2, giving colony overview across 130 photos. Despite favourable winds (light to moderate, swinging between NNW and NNE) updrafts were substantial at the clifftops, but careful pre-flight testing showed that takeoff and landing were not affected. Once away from the clifftops, no further unpredictable wind movements (swirls or updrafts) affected photography. There was no conflict with birds in the air or other disturbance to wildlife detected, nor was there conflict with helicopter operations.

Resulting photographs appear of sufficient quality to count albatrosses, but not to distinguish grey-headed and Campbell albatrosses. For this, a drone will have to be flown closer to the colonies (80–100m from colony instead of >150m), or a drone camera with better lens specifications used.

Aerial photographs were taken from helicopter into the albatross colonies on 18 and 24 November by the co-pilot and loadmaster of both Navy and Airforce helicopter teams. About 120 excellent overview images resulted.

Ground-truthing

To assess the proportion of grey-headed to Campbell albatrosses across a range of colonies, we counted albatrosses at several colonies via scan counts, or via ground counts in accessible colonies. For accuracy we counted whichever of the two species was least numerous in a given colony. Ground counts for breeding grey-headed albatrosses were undertaken throughout the Bull Rock South colonies (Fig. 3, Table 2). Of the 318 grey-headed albatrosses counted, three-quarters occurred in the northernmost and southernmost areas counted, which included the GH-2 area and part of GH-1 respectively (Fig. 3). We tried to access all areas where grey-headed albatrosses are known to occur in Bull Rock South, so counts should be fairly comprehensive. To sample more widely, we conducted scan counts from three photo-points at Hooker’s Finger as well as at Hooker’s Peninsula (MP9) and Courejolles Isthmus (MP1) (Table 2).

Four transects in the Bull Rock South colonies allowed ground-truthing to assess the proportion on egg vs. birds on nest without an egg (breeders vs. tryers), also counting loafers. Campbell and grey-headed albatrosses are pooled in these figures but transects were chosen to roughly balance Campbell and grey-headed numbers. Overall, 18% of albatrosses were tryers, sitting in incubation posture on an empty nest (mean \pm s.e. 0.18 ± 0.02 , 4 transects) (Table 3).

If loafing birds (birds on the ground between nests or standing on nests) can be distinguished in a photograph from nesting birds, loafers can simply be excluded from the numbers of breeding pairs. However, in photos from distant photo-points birds to be counted will likely just appear as indistinct black and white shapes. For such cases, it is useful to know that in Bull Rock South in late incubation, 24% of all albatrosses present in the colony (or white dots) were loafers and 62% were breeders (birds actually incubating an egg, excluding tryers) (Table 3).

Table 2. Full counts of grey-headed albatross GHA or Campbell albatross CBL in mixed colonies.

Area	Location	Count type	Species	Nesting
Bull Rock S	GH-2 and area 22	Ground counts	GHA	92
Bull Rock S	GH-3 and top of BB terrace	Ground counts	GHA	45
Bull Rock S	Topmost small shelf just north of BB square	Ground counts	GHA	7
Bull Rock S	NZBB square to north part of GH-1 until water soak	Ground counts	GHA	32
Bull Rock S	South part of GH-1 from water soak & areas 3, 4	Ground counts	GHA	142
Hooker’s Finger	From MP2	Scan counts	CBL	111
Hooker’s Finger	From MP5, lower section	Scan counts	GHA	30
Hooker’s Finger	From MP3	Scan counts	GHA	80
Hooker’s Peninsula	From MP9	Scan counts	CBL	41
Courejolles Isthmus	From MP1	Scan counts	CBL	176

Location numbers at Bull Rock S are from Moore (1999), shown in Figure 3. Photo-point locations are shown in Figure 2.

Table 3. Ground truthing to determine status of albatrosses in mixed grey-headed and Campbell albatross colonies. Bird on nest with egg = breeder; bird on empty nest = tryer; bird between nests or standing on nest = loafer. Bull Rock South, 20 November.

transect	Bird on nest			total birds on nest	all birds along line	% no egg of birds on nest	% loaf of all birds	% birds on egg of all birds
	egg	no egg	loafer					
1	101	21	13	122	135	0.172	0.096	0.748
2	31	8	8	39	47	0.205	0.170	0.660
3	80	21	46	101	147	0.208	0.313	0.544
4	43	6	31	49	80	0.122	0.388	0.538
Total	255	56	98	311	409	0.180	0.240	0.623

Band resightings involved 53 grey-headed and 32 Campbell albatrosses (Appendix B). Of these almost a third required maintenance (25 bands, of which 6 grey-headed and 19 Campbell albatross), mostly closing bands but also repairing two that had been overlapped. Despite the high rate of repairs needed, band injuries were not seen. Black-browed albatrosses *T. melanophrys* also occur on a terrace in the middle of Bull Rock South (BB terrace, Fig. 3), but time constraints meant we did not band black-brows present.

Northern giant petrels

Ninety-two active Northern giant petrel nests were detected around the island. Northern giant petrel nests were counted at Penguin Bay, Complex Point, Six Foot Lake, Tucker Cove, Camp Cove, Venus Bay and Shoal Point, with opportunistic records from elsewhere on Campbell Island as giant petrel chicks were encountered (Fig. 4). Loafing adults tend to be present around most chick clusters, and sometimes also in the absence of chicks (e.g. the group of ten loafing adults at De la Vire Point; Fig. 4).

Northern giant petrel chick numbers do not account for failures earlier in the breeding season. To correct for breeding failure, we used data from Macquarie Island where giant petrel breeding success averaged 61.4% (range 53.2%–68.7% over the ten years 2008–18) (DPIPWE unpubl. data). If Campbell Island breeding success is similar to that at Macquarie, and assuming the number of large chicks counted represent the number that fledged, we estimate the breeding population in 2019 to be at least 150 (range 134–173) breeding pairs.

Our survey coverage was largely the same as the previous survey in 1996 (Wiltshire & Scofield 2000) apart from the south-eastern coastline. We could not visit the area between Monument and Southeast Harbours, around Shag Point, and on the coast west of Erebus Point (Fig. 4) in the time available, so our estimate is a minimum. In 1996 there were 52 breeding giant petrels across these sites (Wiltshire & Scofield 2000). If we compare breeding pair estimates just from areas surveyed in both years 1996 (182 pairs) and 2019 (150 pairs), then we see that numbers are broadly comparable with about 18% fewer breeding pairs in 2019.

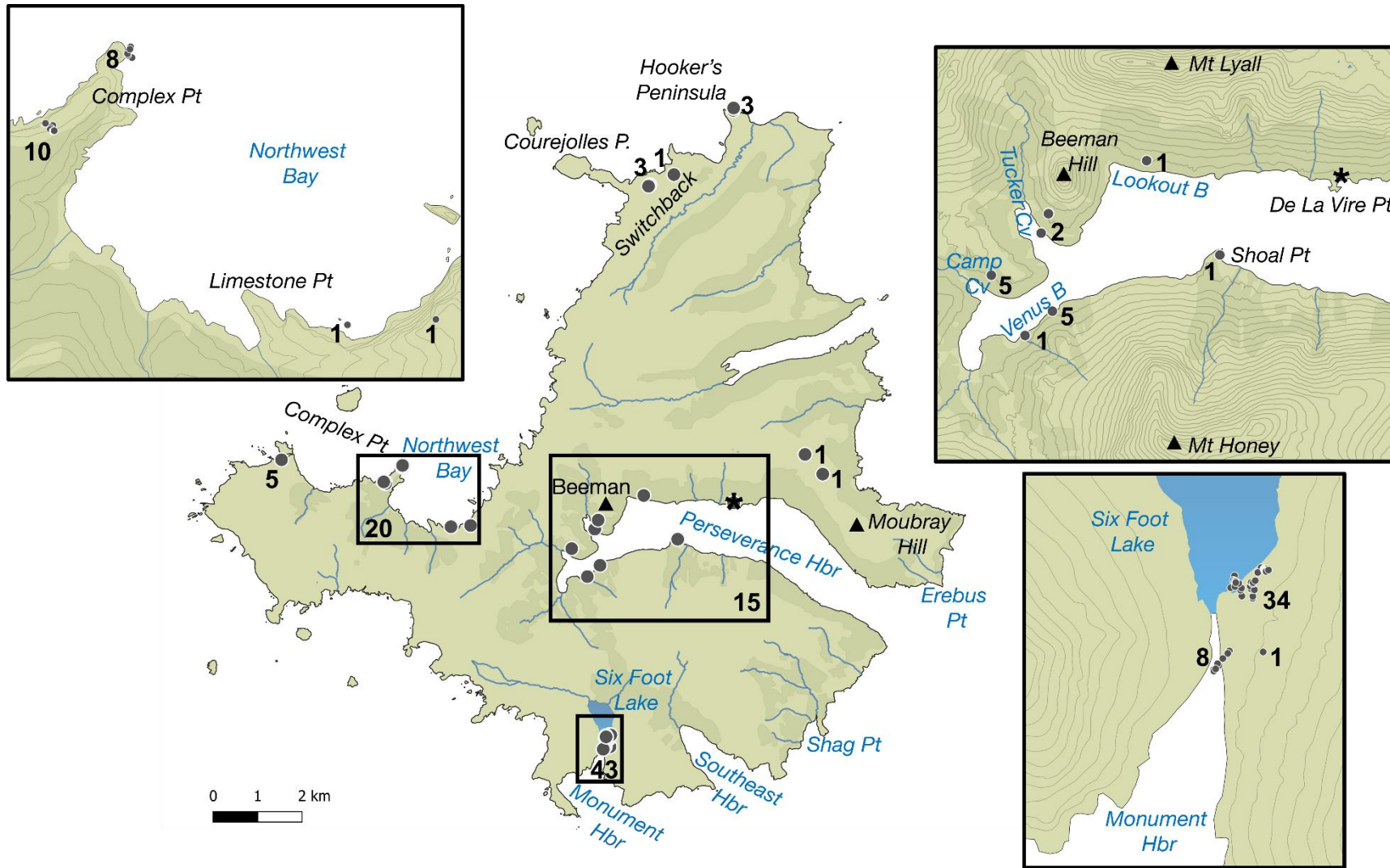


Figure 4. Northern giant petrel chicks in November 2019. Star (inset right, top) indicates group of loafing adults with no chicks found.

Southern royal albatrosses

We recovered three GLS trackers that had been deployed on unbanded Southern royal albatrosses in 2015. Between 518 and 868 days of tracking data have been recovered from the GLS. Three banded birds were recorded (RA 2458, R 62570, and R 62363) and one partially open band was closed properly (Appendix B). Unfortunately we had to leave the island before completing a full search of the South Col colony, so banded birds and GLS-carrying birds will likely have been missed.

Numbers of birds in the wider Col-Lyall area seemed low, with very few birds nesting yet. Those birds present were mainly loafing males.

Petrel distribution

Sound recorders were deployed for 1–2 nights around Bull Rock, Borchgrevink Bay, Six Foot Lake and by the Clifton memorial near Beeman Base, and for 3–4 nights above Northwest Bay (Fig. 1, Table 4).

Sound recordings gave little sign of seabirds near Sorenson Hut, or at the mouth of Six Foot Lake. A diving petrel was heard occasionally from the headland near Beeman Base. Seabird calls were heard regularly at both northern and southern ends of Switchback Ridge (Fig. 1). Prion calls were heard regularly at night in Borchgrevink Bay, most likely fairy prions. Notably, white-headed petrels (*Pterodroma lessoni*) and white-chinned petrels were recorded near the southern end of Switchback Ridge. Two well-used white-chinned petrel burrows were found around S52.4962, E169.15727, about 50m from the Switchback Ridge recorder. The recorder at Northwest Bay also documented white-chinned petrels on the cliffs at the eastern edge of the bay, overlooking the small anvil-shaped island (Fig. 1), as well as occasional calls of diving petrels and sooty shearwaters.

Table 4. Sound recorders deployed for seabirds.

Date at start recording	N nights	Location	Lat/long	Filename(s)	Seabirds heard
19/11/2019	2	Near Sorenson Hut	S52.48186 E169.20933	20151119- 20151120	No seabird calls heard
21/11/19	1	Borchgrevink Bay	S52.47745 E169.18934	20151121	Prion regularly (prob fairy prion)
22/11/19	1	Southern Switchback Ridge	S52.49599 E169.15792	20151122	White-chinned petrel regularly; white-headed petrel; titi
24/11/19	1	Mouth Six Foot Lake	S52.59402 E169.14633	20151124	No seabird calls heard
25/11/19	2	Beeman, by Clifton Memorial	S52.54804 E169.15376	20151125- 20151126	Diving petrel
21/11/19	4	Above Northwest Bay	S52.54920 E169.10621	20191121- 20191124	White-chinned petrel regularly, diving petrel

White-headed petrel calls on Campbell were unexpected as the species is only suspected to be breeding there (Gill *et al.* 2010). A fledgling caught there in 1984 (Graeme Taylor pers. comm.) but breeding has not been confirmed, so the Switchback Ridge recording of one or more white-headed petrels prospecting is encouraging. White-chinned petrel recordings from Switchback Ridge and Northwest Bay extend the distribution of the species on main Campbell from the known handful

of sites, mostly on the southern part of the island (40–50 burrows found on southwest Mt Paris and smaller numbers on Mt Honey, Eboule and Mt Azimuth; Rexer-Huber *et al.* 2016, GP and KRH unpubl. data). White-chinned petrels are thought to have been extirpated from main Campbell by rats sometime after the 1950s (Bailey & Sorenson 1962; Taylor 1986) before rats were eradicated in 2001, but they persisted in large numbers on offshore islands like Monowai and Dent (Rexer-Huber 2017).

Opportunistic data collection

- Snipe were recorded wherever encountered. They occurred throughout the areas walked, including in substantial numbers in the north of the island. Data have been provided to Colin Miskelly.
- Pipit encounter data were collected along sampling transects throughout the southern half of the island. Data should be suitable for estimating abundance.
- A large rockhopper penguin *Eudyptes filholi* colony below the cliffs of southern Switchback Ridge was photographed (from S52.49447 E169.15621). Thirty-five images are available for counting.
- Anecdotal records of other bird species were also collected, comprising redpolls *Carduelis flammea*, blackbirds *Turdus merula*, starlings *Sturnus vulgaris*, dunnocks *Prunella modularis*, silvereyes *Zosterops lateralis*, mallard ducks *Anas platyrhynchos*, a white-faced heron *Egretta novaehollandiae*, two red knots *Calidris canutus* and a turnstone *Arenaria frontalis*.

Discussion

The primary objective of this work—to revisit all photo-points and acquire a full set of photographs for counting nests of Campbell and grey-headed albatrosses—was successful. All photo-points were relocated, and two to three sets of photographs were taken from each photo-point so the sharpest photographs can be chosen for later counting. To improve the accuracy of breeding estimates from photos, ground-counts and scan-counts were conducted in at least one mixed colony per area, and breeding status checks at Bull Rock South showed ~82% of albatrosses that appeared to be incubating had an egg. Similar figures from the dense colonies of white-capped albatrosses *T. steadi* in the Auckland Islands (Walker *et al.* 2020) highlight the importance of ground-truthing for nest counts from photographs.

A small trial showed that a drone can access the albatross colonies most distant from photo-points. For high-quality imagery distinguishing Campbell from grey-headed albatross (and nesting from loafing birds), the drone will need to be flown closer, perhaps 80–100m from a colony. Our observations suggest that this distance is unlikely to be a problem for bird interactions, but a spotter should be used throughout any drone flight. Similarly, aerial photographs from helicopter provided excellent overview images, but to distinguish Campbell and grey-headed albatrosses a series of closer-in photographs of each colony would be needed.

Northern giant petrels are known to move breeding sites, sometimes by substantial distances (e.g. Parker *et al.* 2020). We counted fewer giant petrel nests at Campbell Island than in 1996 but considering site-shifting this may not necessarily mean there are now fewer breeding pairs. For example, we found chicks along the northern coast and on Moubray Hill that were not present in 1996 but were recorded in the mid-1960s (Paull & Surrey 1969 *in* Wiltshire & Scofield 2000). There were fewer chicks around Complex Point than in 1996 (Wiltshire & Scofield 2000) but at nearby Penguin Bay we found chicks where they had been absent in 1996. Similarly, there were fewer chicks at Venus Bay but new colonies in nearby Camp Cove and Tucker Cove. At Shoal Point and around Six Foot Lake chick numbers were notably lower in our survey than in 1996, but several nearby sites along the south-eastern coast could not be visited in the time available. Our estimate of 150 breeding pairs (range 134–173) on Campbell in 2019 is clearly a minimum, considering that the unvisited stretch of south-east coastline had 52 chicks in 1996 (Wiltshire & Scofield 2000). Using local breeding success data would help refine this breeding pair estimate, considering that breeding success on Macquarie—with its very large penguin colonies—is likely higher than on Campbell (Parker *et al.* 2020). Alternatively, survey timed just after eggs are laid would remove the need to correct for breeding success, improving the accuracy of estimates.

To compare Northern giant petrel breeding numbers over time, we compare breeding pair estimates just from areas surveyed in both years 1996 (182 pairs, excluding south-east coast sites) and 2019 (150 pairs). Numbers 1996 and 2019 are broadly comparable, with the 18% difference readily accounted for if we consider semi-biennial breeding and giant petrels' tendency to move sites (Parker *et al.* 2020). Over a similar time period the Auckland Island and Macquarie Island Northern giant petrel populations both appear to have expanded (Alderman *et al.* 2019; Parker *et al.* 2020).

GLS tracker removal from Southern royal albatross was limited by the early stage of the breeding season and our early departure. Few females were present at the start of our visit, most birds being males tending nests in anticipation of females arriving, and no incubating birds were seen. By the end of the trip only a few eggs had been laid and most birds in the colony were still waiting males. This is in line with known breeding timing (date of first lay 20–26 Nov; Waugh *et al.* 1997). There seemed relatively few southern royal albatrosses in the Col-Lyall area, considering that in Jan 2015 there were 67 nests in this area (Parker *et al.* 2015). A comparable count was not possible, but our anecdotal observation was seconded by Jo Hiscock, who has been familiar with the site for much longer than we have.

Decreases of breeding birds in the Lyall survey block, and in several others, were noted during the last island-wide census of Southern royal albatross in 2004–08 (Moore *et al.* 2013). A repeat census effort is due, and a renewed mark-recapture effort (now requiring PIT tag readers) is needed in the Col study area to use the power of the long-term mark-recapture dataset to assess the current status of Southern royals. Southern royal albatrosses are recorded as bycatch in commercial fisheries in New Zealand (Abraham & Thompson 2015), and they feed extensively on the Patagonian Shelf where incidental bycatch occurs (Sullivan *et al.* 2006) but is not well quantified. In New Zealand a significant amount of fishing effort is unobserved (Parker & Rexer-Huber 2019), and in international waters bycatch—and other pressures like intentional harvest—are not quantified at all. Island-wide ground work during a repeat census could provide an opportunity to test other means for more-regular monitoring. For example, ground work could test the usefulness of remote-

sensing methods (Fretwell *et al.* 2017) that have potential for whole-island coverage, and/or aerial methods with ground-truthing (photographs from helicopter or drone of a subset of census blocks).

Seabird recorders collected interesting records, despite weather noise obscuring almost all other sound in many recordings. White-headed petrel calls suggest that the species may indeed breed in the Campbell Island group. Since Graeme Taylor's capture of a fledgling white-headed petrel on Campbell in 1984 (G. Taylor pers. comm.) there has been little indication that white-headed petrels breed there (e.g. Gill *et al.* 2010). They are often seen at sea in the area, and there are strong breeding population in the nearby Antipodes and Auckland Islands (Taylor 2000).

The white-chinned petrel calls recorded extend the known distribution on Campbell Island. Last recorded on main Campbell in the 1950s (Bailey & Sorenson 1962), the white-chinned petrel population appears to have been extirpated from the main island by Norway rats (Taylor 1986) before rats were eradicated in 2001. However, white-chinned petrels persisted in large numbers on offshore islands like Monowai and Dent (Rexer-Huber 2017). It is heartening to find that white-chinned petrels have returned to main Campbell, recolonising not just areas in the southeast that are close to Monowai and Dent islands (Mt Paris, Eboule, Mt Honey; Rexer-Huber *et al.* 2016, GP and KRH unpubl. data) but also Switchback Ridge and on the cliffs of Northwest Bay. Burrows found on Mt Azimuth in 2015 thought to belong to white-chinned petrels were not confirmed at the time, so definite white-chinned petrels on nearby Switchback Ridge (~1.4km between Azimuth and Switchback burrow sites) confirms their northward spread on main Campbell.

Recommendations

Grey headed and Campbell albatross

- Counts from photo-point photographs should correct nest counts for birds 'incubating' empty nest (tryers), and for loafers when these are not distinguishable from nesting birds (i.e. Courejolles). If species cannot be distinguished in photographs, nest counts could use ground- and scan-counts.
- Colony visits planned to allow time for band maintenance.
- Drone flown nearer to colonies than in this trial for better-quality images.
- Any counts from aerial photographs (from drone or helicopter) also apply ground-truthing corrections as for photo-point counts.
- Data quality could be improved via photographs from two consecutive breeding seasons, particularly for biennially-breeding grey-headed albatrosses.

Northern giant petrels

This estimate could be improved substantially by visiting earlier in the breeding season, before many nest failures have yet occurred, removing the need to correct for nest failures using Macquarie data. The estimate would also be more accurate if sites along the south-east coast are surveyed, allowing numbers at these sites to be compared to 1996 data.

Southern royal albatross

- GLS tracker data need analysis.
- Visits to the Col study area should prioritise mark-recapture of PIT tagged birds (current status can then be assessed using the long-term mark-recapture dataset).
- A repeat whole-island census of the breeding population is due.
- Consider testing other low-intensity monitoring methods that are complementary to mark-recapture and could be conducted at more regular intervals than the 10-yearly census (aerial photographic, remote-sensing).

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Appendix A: photo-point waypoints

Updated waypoints for photo-point marker poles, access markers, and description of the type and state of marker. From November 2019.

Photo-point	lat	long		Marker notes
C1	-52.4962	169.15548	Courejolles	Orange plastic pole at edge
C2	-52.4914	169.15538	Courejolles	No marker pole
MP1ACCESS	-52.4821	169.15883	Courejolles Isthmus	Orange pole at access chute
MP1	-52.482	169.159	Courejolles Isthmus	Pole not found
DOWN 2MP2	-52.4775	169.17708	Hooker's Finger	Wooden pole on ridge, quite weathered
MP2	-52.4774	169.17682	Hooker's Finger	Alu pole 20m down fall-line
DOWN TO MPs	-52.4772	169.17772	Hooker's Finger	
MP4	-52.477	169.17753	Hooker's Finger	Alu pole marker
MP5	-52.4764	169.17784	Hooker's Finger	Wood pole
MP3	-52.4759	169.17555	Hooker's Finger	Alu pole wedged hard against rock
MP6	-52.4766	169.18197	Hooker's Finger	Alu pole
MP7	-52.4668	169.19266	Hooker's Peninsula	Pole not found, photo from big white rock
MP8	-52.4671	169.1957	Hooker's Peninsula	Wood and alu poles together
MP9	-52.4678	169.19811	Hooker's Peninsula	Wood at point, alu pole 20m uphill on ridge
MP10	-52.4739	169.22685	Bull Rock South	Alu pole out on spur ~20m E of MP11, just off ridge, in tussock heart with ~20cm clear
MP11	-52.4739	169.2266	Bull Rock North	Alu pole at base of bluff against rocks, clearly visible
MP12	-52.476	169.2247	Bull Rock South	Pole not found

Appendix B: albatross band resightings

Resightings of 53 banded grey-headed albatrosses, 32 Campbell albatrosses and three Southern royal albatrosses in November 2019 are detailed here. Band maintenance and repair was required for 6 grey-headed albatross, 19 Campbell albatrosses, and a single Southern royal albatross.

	Band		Breeder /Loafer	Species	Date	Band repair (mm closed)	Notes
	prefix	number					
1	M	49345	L	Campbell albatross	20/11/2019		
2	M	64632	L	Campbell albatross	20/11/2019		
3	M	50012	BR	Campbell albatross	20/11/2019		
4	M	64898	L	Campbell albatross	20/11/2019		
5	M	48714	L	Campbell albatross	20/11/2019	3	
6	M	61584	BR	Campbell albatross	20/11/2019	2	
7	M	49562	L	Campbell albatross	20/11/2019		
8	M	41818	BR	Campbell albatross	20/11/2019	4	
9	M	64654	BR	Campbell albatross	20/11/2019		
10	M	50008	L	Campbell albatross	20/11/2019		
11	M	49084	L	Campbell albatross	20/11/2019		
12	M	49981	BR	Campbell albatross	20/11/2019		
13	M	89582	L	Campbell albatross	20/11/2019		
14	M	89493	BR	Campbell albatross	20/11/2019		
15	M	90523	BR	Campbell albatross	20/11/2019		
16	M	90522	BR	Campbell albatross	20/11/2019	4	
17	M	90335	BR	Campbell albatross	20/11/2019		
18	M	41565	L	Campbell albatross	20/11/2019	-2	band was overlapped
19	M	90126	BR	Campbell albatross	20/11/2019		
20	M	89113	BR	Campbell albatross	20/11/2019		
21	M	89484	BR	Campbell albatross	20/11/2019		
22	M	89376	BR	Campbell albatross	20/11/2019	Y	
23	M	89528	L	Campbell albatross	20/11/2019		
24	M	64698	L	Campbell albatross	20/11/2019		
25	M	48809	BR	Campbell albatross	20/11/2019		
26	M	82586	BR	Campbell albatross	20/11/2019	Y	
27	M	89546	BR	Campbell albatross	20/11/2019	Y	
28	M	90301	BR	Campbell albatross	20/11/2019	Y	
29	M	61273	BR	Campbell albatross	20/11/2019	Y	
30	M	90575	BR	Campbell albatross	20/11/2019	Y	
31	M	66172	BR	Campbell albatross	20/11/2019	-2	band was overlapped
32	M	89486	L	Campbell albatross	20/11/2019		
33	M	46458	BR	Campbell albatross	20/11/2019		
34	M	49927	BR	Campbell albatross	20/11/2019	Y	
35	M	90304	BR	Campbell albatross	20/11/2019	Y	
36	M	90305	BR	Campbell albatross	20/11/2019		
37	M	90576	BR	Campbell albatross	20/11/2019		
38	M	90347	BR	Campbell albatross	20/11/2019		
39	M	90132	BR	Campbell albatross	20/11/2019		
40	M	49728	L	Campbell albatross	20/11/2019		
41	M	89420	L	Campbell albatross	20/11/2019		
42	M	89479	BR	Campbell albatross	20/11/2019		
43	M	82582	BR	Campbell albatross	20/11/2019	Y	
44	M	89105	BR	Campbell albatross	20/11/2019		
45	M	64686	BR	Campbell albatross	20/11/2019	Y	
46	M	90359	BR	Campbell albatross	20/11/2019		
47	M	90134	L	Campbell albatross	20/11/2019		
48	M	89478	BR	Campbell albatross	20/11/2019		
49	M	90310	BR	Campbell albatross	20/11/2019		

	Band		Breeder /Loafer	Species	Date	Band repair (mm closed)	Notes
	prefix	number					
50	M	90324	BR	Campbell albatross	20/11/2019	Y	
51	M	90361	BR	Campbell albatross	20/11/2019		
52	M	90144	BR	Campbell albatross	20/11/2019	Y	
53	M	90525	BR	Campbell albatross	20/11/2019	Y	
1	M	90325	BR	Grey-headed albatross	20/11/2019	3	
2	M	82596	BR	Grey-headed albatross	20/11/2019		
3	O	29155	L	Grey-headed albatross	20/11/2019		
4	M	90338	BR	Grey-headed albatross	20/11/2019		
5	M	41269	L	Grey-headed albatross	20/11/2019		
6	O	17465	BR	Grey-headed albatross	20/11/2019		
7	O	29156	BR	Grey-headed albatross	20/11/2019		
8	M	90493	BR	Grey-headed albatross	20/11/2019		
9	O	29178	BR	Grey-headed albatross	20/11/2019	2	
10	M	90409	BR	Grey-headed albatross	20/11/2019		
11	M	49545	L	Grey-headed albatross	20/11/2019		
12	M	90439	L	Grey-headed albatross	20/11/2019		
13	O	22580	L	Grey-headed albatross	20/11/2019		Fem, courting male M-61106
14	M	61106	L	Grey-headed albatross	20/11/2019		Male, courting fem O-22580
15	M	49676	BR	Grey-headed albatross	20/11/2019		
16	M	61933	L	Grey-headed albatross	20/11/2019		
17	M	49371	L	Grey-headed albatross	20/11/2019		
18	M	90437	L	Grey-headed albatross	20/11/2019		
19	M	48281	L	Grey-headed albatross	20/11/2019		
20	O	24145	L	Grey-headed albatross	20/11/2019		
21	M	61120	L	Grey-headed albatross	20/11/2019	3	
22	O	29175	BR	Grey-headed albatross	20/11/2019	2	
23	M	61938	BR	Grey-headed albatross	20/11/2019		
24	M	61105	L	Grey-headed albatross	20/11/2019		
25	M	90178	L	Grey-headed albatross	20/11/2019		
26	M	61750	BR	Grey-headed albatross	20/11/2019		
27	M	58556	BR	Grey-headed albatross	20/11/2019	2	
28	M	48512	BR	Grey-headed albatross	20/11/2019		
29	M	89598	L	Grey-headed albatross	20/11/2019		
30	M	34087	L	Grey-headed albatross	20/11/2019		
31	M	45160	L	Grey-headed albatross	20/11/2019		
32	M	58587	BR	Grey-headed albatross	20/11/2019	1	
1	RA	2458	L	Southern royal	27/11/2019	4	
2	R	62570	L	Southern royal	27/11/2019		Male, courting fem R-62363
3	R	62363	L	Southern royal	28/11/2019		Fem, courting male R-62570