Phase 2 of the Tawaki Project got underway with GPS dive tracking of breeding birds from two sites in Milford Sound: camera logger deployments had to be postponed to the coming season as research permits were received too late and penguins entered the post-guard stage by the time field work started. Adjustments have been made to the automatic transponder gate in Harrison Cove to improve its functionality. In October, Thomas joined a DOC and NIWA expedition to the Bounty Islands to survey erect-crested penguins. Ground and drone surveys were conducted on Proclamation Island, with additional drone surveys of other islands. Results indicated that the Bounty Island population has remained stable for at least the last two decades. The expedition also highlighted the efficacy of using drones to survey seabirds in NZ’s sub-Antarctic. In the wake of this expedition, we have submitted a revised proposal for penguin research activities in the sub-Antarctic. A trial kororā GPS tracking programme was initiated with the West Coast Penguin Trust and the national kororā monitoring programme moved forward through time on the ground with community groups.

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Foraging of breeding tawaki in Milford Sound/Piopiotahi

Milestone FP6 – Examine species’ fjord ecology and suitability of fjords as buffer zones in the face of continuing ocean warming

The first breeding season of the Tawaki Project’s Fiordland focused 10-year research has been concluded in late October 2019. We will investigate the foraging movements of tawaki breeding close to fjord entrances with those nesting as far as 40 km from the open ocean across several sites in Fiordland (see 2019 Q2 report). In September and October 2019, we concentrated our efforts on two sites in Milford Sound/Piopiotahi, at our established study site at Harrison Cove (ca. 9 km from open ocean) as well as Moraine, which features the largest tawaki colony in the fjord and is located only about 2 km from the fjord entrance.

Milford Sound is the shortest of all fjords. Yet, despite the short travel distance to reach the open sea, tawaki from Harrison Cove foraged predominantly within the fjord in previous years. As such, we were particularly interested whether penguins from Moraine would also remain in the confines of the fjord. To examine potential differences between both sites, we tracked penguin movements using GPS dive loggers. Additionally, we planned to deploy camera loggers to get first insights into the penguins’ prey composition and hunting strategies.

Permits were only approved in the last week of September, so field work commenced with a two-week delay.
**GPS dive tracking**

Nests were approaching the post-guard stage when we deployed the first devices on 30 September 2019. Despite the late start, we still managed to fit a total of eight birds with GPS dive loggers in Harrison Cove and an additional seven birds from the Moraine colony.

Unlike in previous years, when we tracked penguins with a combination of two different devices (a GPS logger and a separate dive logger), we used TechnoSmart AxyTrek loggers which incorporate all required functionality in one device. These models had been used successfully on Yellow-eyed penguins in the past few years. Unfortunately, four of the deployments in Harrison Cove and one at Moraine yielded poor or no tracking data. This proved to be due to a hardware fault; we received replacement units from TechnoSmart after completion of the field work. Nevertheless, the data already indicate considerable differences between birds from Harrison Cove and Moraine. All tracked penguins from Moraine foraged well outside the fjord some traveling up to 50 km from the coast, while only two of the four Harrison Cove birds we could track foraged to the open sea. Still, this is unusual as in the previous five years, Harrison Cove birds hardly ever left Milford Sound.

Over the coming years we hope to decipher what triggers such different behavioural patterns. Which is the more viable strategy, foraging inside or outside the fjord? And, in turn, which are the better breeding areas, at fjord entrances or deep inside the fjord? Ultimately, this research will allow us to identify which areas should be the focus of conservation activities if the species gets into trouble.

![Image of GPS tracks recorded between 30 September and 15 October 2019 in Milford Sound/Piopiotahi. Penguin movements from Harrison Cove are shown in shades of green, from Moraine in reddish colours.](image-url)
Camera logger deployment

At Harrison Cove, where camera logger deployments were planned, it quickly became apparent that the birds were performing unusually long trips. Several of the penguins stayed at sea overnight and travelled out of the fjord; this may have been due to the birds entering the post-guard stage.

Only one camera logger deployment was made on 30 September, but the bird could only be recaptured on 2 October. Since the cameras only record for about 2-3 hours, having penguins carry devices for more than one-day trips was unjustified. We therefore decided to postpone further camera logger deployments to the 2020 season.

Moreover, the bird left the colony at 2am which we had not anticipated. The camera was programmed to start recording 2 hours after the bird had entered the water. As a result, the camera started recording at 4am, some 2.5 hours before sunrise and footage was mostly recorded in complete darkness. Only at the break of dawn, minutes before the camera’s battery was depleted, some discernible video was recorded, showing that the bird was drifting at the surface off the Bowen Falls. The camera stopped recording before there was enough light for any meaningful footage to be recorded.

Outlook for 2020 season

In the coming 2020 season, the tracking work will be extended to include sites in Doubtful Sound (see also Q3 2019 report). Some of the research will be carried out as part of two student projects, enabling us to work at two sites simultaneously. Jeff White from the University of Miami will be
looking at tawaki trophic niche partitioning using various stable isotope markers as part of his PhD studies. Myrene Otis from the University of Otago will oversee the tawaki tracking work in in Milford Sound for her Master’s degree research. Both have been working with the Tawaki Project in previous years and know full well what to expect when working with a cryptic breeding species in one of the wettest regions world-wide.

In February, we plan to deploy satellite transmitters on tawaki that have completed the moult to investigate if the penguins’ winter migration patterns differ depending on where the birds completed the moult. We will track penguins from Fiordland, the South Island’s east coast (Canterbury, Otago, Southland) as well as penguins that moulted in the care of rehabilitation centres (see also the Q2 2019 report).

Update on automatic monitoring of tawaki in Harrison Cove

Milestone FP2 - Automated monitoring solutions - Establish first transponder gate (TG) in Harrison Cove, Milford Sound

Since February 2019, we maintain an automated monitoring system (‘transponder gate’) at the main tawaki access path in the Harrison Cove colony. The system determines the walking direction and identity of any of the currently 43 Harrison Cove penguins tagged with a subcutaneous transponder (PIT tag or ‘microchip’). Over the course of the unit’s first 10 months of operation, two issues became apparent.

Firstly, the solar panel we installed to provide energy to the control computer operating the light barriers and transponder antennas proved to be not powerful enough to keep the system running continuously. Depending on the prevailing weather, the system’s batteries would last between 10 and 14 days before they were depleted, despite the connected solar panel. This would cause the control unit to shut down which effectively stopped the gate’s functionality until the system was manually re-booted. As a result, several weeks’ worth of monitoring data were missed out on. The problem was less pronounced as daylength increased from October onwards. However, the system still requires regular maintenance. To alleviate this problem, a more powerful solar panel will be installed in January.
Secondly, until September 2019 only nine known birds were registered by the transponder gate. During field work for the GPS tracking study (see above), we noticed that some birds used a small side-path around the transponder gate. Blocking off the access to this path with forest debris improved the efficiency of the gate and, by November 2019, 15 tagged penguins regularly passed through the gate. In the coming season, a concerted effort will be made to mark all penguins that use the main access path.

![Tawaki passing under the transponder gate while walking towards the Harrison Cove nesting area.](image)

It is encouraging that the entire system withstood extreme environmental conditions. Milford Sound experienced extreme weather events this past year with torrential rainfalls and landslips. Except for lowering the efficiency of the solar panel, the weather did not affect the system, and everything remains operational and in good condition after almost one year of deployment. Throughout the winter possums and rats present in Harrison Cove showed an interest in the gear. But no damage has been detected so far.
Erect-crested penguin survey on Bounty Islands

Milestone AP1 - General Biology - Conduct expeditions, data analysis & publication

In October 2019, Thomas Mattern had the opportunity to join an expedition to the subantarctic Bounty and Antipodes Islands that was co-organized by the Department of Conservation’s Marine Threats unit and NIWA. The expedition’s main focus was the recovery of GLS loggers from, and deployment of satellite tags on Salvins albatross. Another proposed activity was the deployment of geolocators on Erect-crested penguins for a PhD student project; however, permits were not issued in time, so this part of the expedition had to be dropped.

Our participation allowed additionally to conduct a population survey of Erect-crested penguins. Owing to the remoteness and ruggedness of the Bounty Islands, there have been very few surveys of penguins and little is known about population size and trends. Therefore, a full count of penguins on Proclamation Island was a worthwhile addition to the other activities. Moreover, a trial of drone surveys was permitted to assess seal (and, by proxy, albatross and penguin) numbers on the island which provided the chance to compare terrestrial and aerial approaches to population surveys. After completion of the work on the Bounties, the expedition was to carry on to the Antipodes Islands to conduct similar penguin counts and to undertake reconnaissance for the future penguin work proposed to be conducted by NZPI.

The expedition left Dunedin on the research yacht *Evohe* on 22 October 2019 and reached the Bounties on the morning of 24 October 2019.

*The *Evohe* approaching the Bounty Islands on 24 October 2019, ca 7.30am.*
**Ground counts of Erect-crested penguins**

Between 24 and 29 October 2019, a total of five landings were made on Proclamation Island. The island has been subject to three penguin surveys, in 1997, 2004 and 2014 that were all conducted using a consistent survey methodology. The island was divided into eight distinct counting blocks which were surveyed by walking to every penguin nest and marking it with a dot of stock marker paint (raddle), after it had been counted using a mechanical tally counter.

The eight counting blocks on Proclamation Island, Bounty Islands originally established by the Totorore Expedition to count Erect-crested penguins and Salvins albatross in 1997.

Counting of the various blocks was completed by Thomas Mattern, with search time varying between 1.5 and 4 hours (mean: 3 hours) depending on block size. The total survey time after five days on Proclamation Island amounted to 22 hours. A total of 2,867 Erect-crested penguin nests were counted. These figures are slightly higher than the respective 1997 (2,774 nests) and 2004 (2,788 nests) counts. However, both previous surveys were conducted in mid-November and it can be assumed that additional nest failures would bring the 2019 figures down to a comparable level.

Assuming that penguin numbers on Proclamation Island are representative for the entire Bounty Island archipelago, it therefore would seem as if the population on the islands has been stable for at least the past two decades.

This is encouraging given that the species is believed to have been undergoing a significant decline since the late 1970s. It furthermore raises the question of why Erect-crested penguins seem to be
doing considerably better on the Bounties when compared to the Antipodes Island population, which is reportedly experiencing an ongoing decline.

\[\text{Image: Erect-crested penguins breeding in a mixed colony with Salvins albatross on Proclamation Island, Bounty Islands.}\]

*Drone surveys of Erect-crested penguins*

On 28 and 29 October, conditions allowed it to fly several missions with a camera drone (DJI Mavic Pro 2). The drone was programmed to fly transects capturing high resolution imagery at regular intervals that could later be merged into a composite of the entire island. Three missions were carried out over Proclamation Island with varying flight altitudes (40, 60 and 80 m). Additional missions were flown over Tunnel, Ranfurly and Spider Islands as well as adjacent Seal Rock. These additional missions were all flown at 60 m, except for Spider Island which was flown at 80 m.

After completion of the missions, photographs were stitched to super-high-resolution composites using the free software Microsoft Image Composite Editor. The 40 m mission of Proclamation Island consisted of 799 individual images each with a 20 Megapixel resolution (5472x3648 pixels) which translates to a ground survey distance (GSD) of 0.94 cm / pixel. This resolution provided ample level of detail to identify individual birds.
Level of detail of drone-based imagery used for Erect-crested penguin surveys on Proclamation Island, Bounty Islands, 28 October 2019. First frame shows the full composite of Proclamation Island generated from 799 single 20 MP images recorded on 28 October 2019. Last frame shows actual image resolution of composite.
The composite images provided an unprecedented level of detail that allowed counting of penguins, albatross, and seals. Using annotation software, a total of 5,468 penguins, 5,119 albatross, and 1,102 seals were counted on the 40 m composite of Proclamation Island. Ground surveys showed that some penguin nests were hidden from view as they were located under rocks or in small caves; these nests were missed during the drone counts. Conversely, some rock ledges occupied by penguins and visible on drone images could not be reached on foot and were therefore likely undercounted. Overall, the number of penguins counted from drone imagery corresponds well with the number of nests determined during ground surveys.

Moreover, neither penguins nor albatross seemed to be affected by the drone in any way. Due to the ambient noise levels on an island occupied by thousands of breeding birds, the drone’s flight noises were sometimes not even perceivable. Drone surveys represent a viable alternative, both in terms of logistical ease and low disturbance impact when compared to extensive ground counts. The flight mission for the Proclamation Island drone survey took a little over 30 minutes compared to the 5 days of ground counting.

However, as number of nests cannot be determined reliably from the drone footage, ground truthing is required. Drone surveys in combination with ground truthing nest counts are likely the most logistically feasible, reproducible, and robust method for colony breeding penguins and other seabirds in NZ’s subantarctic in the future.
Reconnaissance trip to Antipodes Island

The planned reconnaissance trip to the Antipodes Island was called off on 29 October 2019 since unfavourable weather conditions would have prevented landing for several days. One of the core aspects for the Antipodes trip was a penguin drone survey trial which was completed successfully on the Bounty Islands (as part of the seal counts). So even though it would have been very helpful to visit the island and assess field work conditions at various penguin colonies, the continuation to the Antipodes was not vital to the successful outcome of our participation in the expedition.

Revised proposal for penguin research activities in the sub-Antarctic

Milestone AP1 - General Biology - Conduct expeditions

The survey results on the Bounty Islands have highlighted how little we know about New Zealand’s subantarctic penguin populations. Erect-crested penguins are listed as ‘endangered’ by the IUCN as it is believed that its population has ‘declined rapidly over the last three generations and is almost certainly still declining’. However, this does not seem to be the case on the Bounty Islands where penguin numbers on Proclamation Island seem to have been stable at least since the late 1990s. Moreover, current analysis of historic survey data suggests that penguin numbers reported for the Bounty Islands in the late 1970s may have been substantially overestimating the population size.

It is almost certain that on Antipodes Island Erect-crested penguins have dropped in numbers over the past decades. Climate change is believed to be likely one of the driving forces behind this decline. However, why a global phenomenon like climate change would only affect the Antipodes Erect-crested penguin population (i.e. Antipodes) but not the Bounty Island penguins is puzzling.

With this new information at hand, we have revised the proposal submitted to DOC over a year ago and have moved the question what drives population dynamics in Erect-crested penguins more into the centre of the investigation.

We have submitted the proposal to the Marine Threats unit of the Department of Conservation for feedback on 7 January 2020 and are awaiting a response.
Little penguin/ kororā tracking with the West Coast Penguin Trust

Milestones LP5 – Facilitate, support and conduct projects investigating foraging behaviour nation-wide to establish a base understanding of Little penguins’ utilization of the marine habitat.

In the first week of November Richard Seed headed up to Charleston to join Matt Charteris and Kerry-Jayne Wilson from the WCPT and to initiate a trial tracking programme using GPS dive loggers. Kororā from the Buller region were GPS tracked (no dive data) during the 2015, 2016 and 2017 breeding seasons by the WCPT in collaboration with Te Papa. We must improve our understanding of the birds’ marine ecology, in conjunction with land-based monitoring, to best advise conservation efforts.

Using five GPS dive loggers, a total of 6 deployments were made in November 2019 on breeding birds from two Charleston breeding sites – three deployments on birds in the chick-guard stage and three deployments on birds in post-guard. For ease of access, all deployments were made on nest-box breeders.

Nesting birds were only returning to provision chicks every 2-3 days, indicating that foraging conditions were not favourable around the time of the deployments. This is likely related to the persistent rainfall the West Coast experienced over winter and spring, causing high turbidity in coastal waters. The penguins nest attendance patterns were very unpredictable making device recovery extremely challenging. Only two devices could be recovered of which only one recorded meaningful data. Four penguins fitted with devices have not been recovered.

Nest checks and trail cams trained on the nests have not observed birds returning with data loggers or feather loss indicative of a lost device. Three of the four nests in question have, however, successfully fledged chicks. There is a chance that the devices can be recovered if the birds return to the site to moult. Huge thanks to Matt Charteris for his diligent and persistent efforts to recover the devices.

This tracking programme also serves to assess the feasibility of establishing future tracking projects that can be run by community groups, alongside terrestrial monitoring. In principal, the deployment and retrieval of GPS dive loggers is relatively straight forward and the necessary skills are acquired with enough exposure and practice. However, we must consider how labour-intensive device recovery can become, especially where efforts rely on volunteer time or limited funding.
Kororā foraging track and dive profiles recorded between 6 and 8 November 2019. Note the substantial differences in average dive depths between both trips; these are principally due to the bird travelling considerable distances on the second trip. The track component that runs roughly parallel to the coast represents surface drifting during the night of 7 to 8 November.
Working towards a national little penguin/kororā monitoring programme

Milestone LP3 – Work towards adoption of national monitoring plan and adjust monitoring protocols

The national kororā monitoring programme is moving forward. Richard Seed spent some time in early November with the West Coast Penguin Trust (WCPT) and Thomas Mattern met with trustees of the Stewart Island Rakiura Community and Environment Trust (SIRCET) in December. Time on the ground and further discussion with various groups reinforced our awareness of the range of needs and current capabilities of different groups.

The WCPT have run a kororā monitoring programme since 2006, they have well established study sites and bounds of experience and expertise in the field of penguin ecology. Other projects, like that run by Western Bay Wildlife Trust and those in Wellington are similarly well established and autonomously run. At the same time there are groups such as SIRCET who with the support of NZPI are looking to establish new kororā conservation projects.

It is apparent that a ‘one size fits all’ approach to the national monitoring programme is not suitable. We are tweaking the programme to develop a tiered monitoring approach that allows those well-established groups to continue and grow their projects, while helping to build new programmes that are easily undertaken and engage schools and communities.