foraging ranges • diving patterns • behavioural plasticity

the **tawaki** project

www.tawaki-project.org

a 5 year project to study the marine ecology, breeding biology and population dynamics of the world's most enigmatic penguin - the Fiordland crested penguin / tawaki

field report - year 1

season 26 August-17 November 2014

Thomas Mattern & Ursula Ellenberg
University of Otago / La Trobe University

Contents

The Tawaki Project so far

The year 2014 saw the realisation of a project that had a considerable gestation time. The need for more research on the enigmatic Fiordland penguins/tawaki was highlighted in Graeme Taylor's 'Action Plan for Seabird Conservation in New Zealand' in the year 2000. Investigations of the species' marine ecology – their foraging ranges, diving behaviour and diet composition – all ranged high in the priority list of required research.

First reconnaissance trips to the West Coast and Breaksea Island for the Tawaki Project were conducted as early as 2003. Since then the Tawaki Project faded in and out of existence for many reasons. In 2010, the collation of available information about tawaki for the publication of a new book on the natural history of penguins rekindled interest in the project. But it wasn't until the 8th International Penguin Conference in Bristol, UK, that discussions between Helen Otley (DOC), Thomas Mattern & Phil Seddon (University of Otago), Ursula Ellenberg (La Trobe University) and Popi Garcia Borboroglu (Global Penguin Society) brought the project finally to life.

It was agreed that the project should be a joint effort of University of Otago and DOC with the prospect of financing the study through community donations and grants from international organisations such as the Global Penguin Society. Throughout the year 2014 funding was sought and eventually could be secured for the required gear – GPS dive loggers – and logistic costs of the field work. Staff costs were covered through fees for field supervision of a Japanese film crew shooting a documentary on tawaki for most of the field season.

Sites

While the Tawaki Project aims at examining the marine ecology of Fiordland penguins across their entire breeding range (see http://goo.gl/eRSryM), the pilot study served primarily the purpose to establish field protocols, trial and assess the proposed methodology, and examine the response of the penguins to research interactions.

Therefore activities were restricted to Jackson Head West for the 2014 season. Work was principally conducted within the perimeters of the four survey plots of DOC's annual tawaki counts.

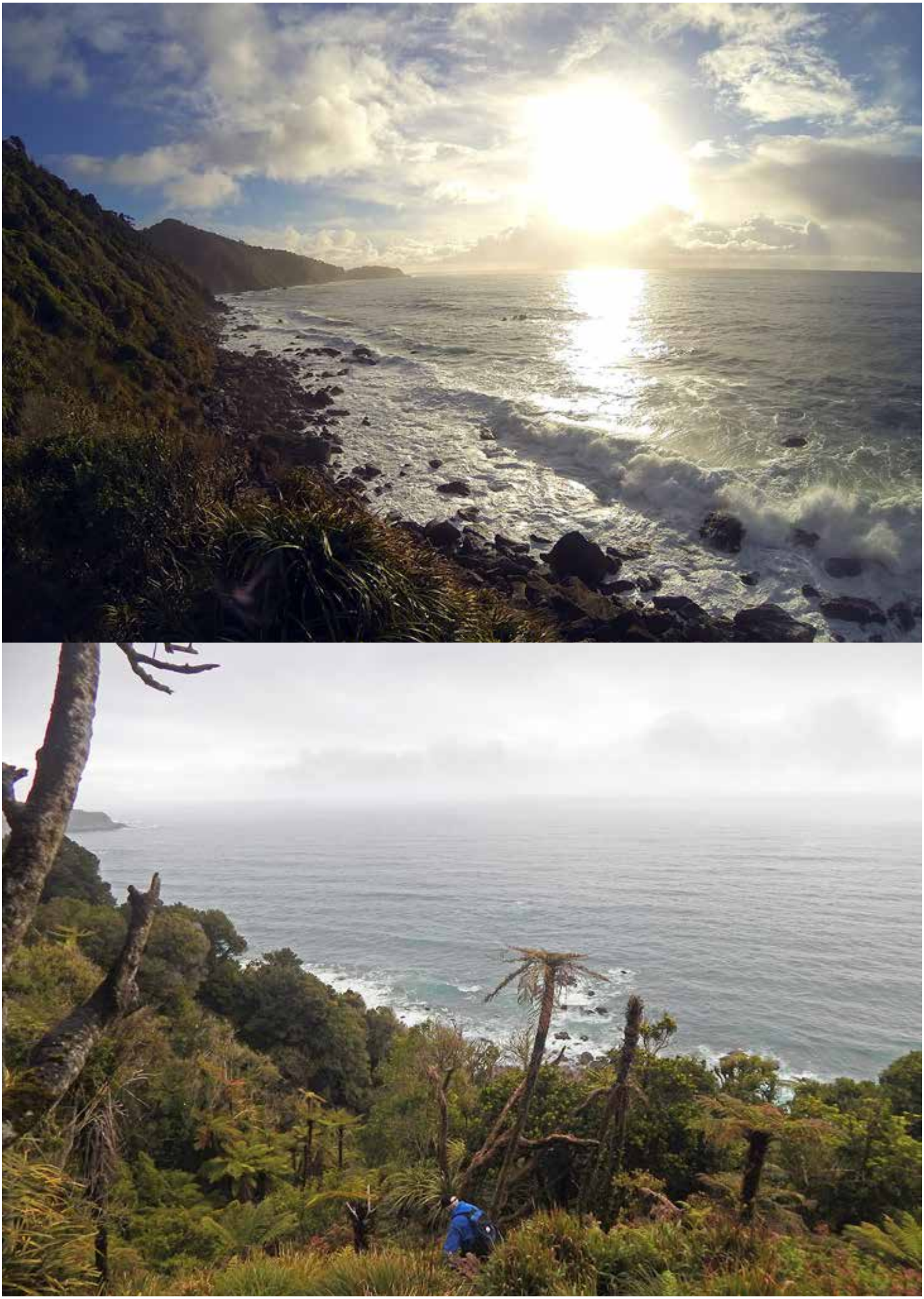
Dates

The Tawaki Project occurred in three distinct phases.

Phase 1: 26 August – 10 September 2014
The first two weeks of the Tawaki Project annual nest searches were conducted at Jackson Head, assessment of different nest types for tracking work (see Phase 2) and deployment of trail cameras to monitor nest attendance patterns and predator impacts.

Phase 2: 11 September – 15 October 2014
During this phase the main research questions were addressed with deployments of GPS loggers on adult penguins from various nest sites.

Phase 3: 24 October – 17 November 2014
Activities consisted mainly of 'camera runs' (i.e. changing of batteries & SD cards) and behavioural observations while supervising the film crew. This phase included a 7-day trip for underwater filming to Stewart Island.



Two views of the study area at Jackson Head. Top: rocky coast where the majority of tawaki come ashore. Bottom: steep terrain in one of the penguins' main breeding areas (note trail camera on fern trunk next to the person).

Research Activities

Trail cameras

A total of 20 trail cameras were deployed principally within the monitoring plots established by DOC;four cameras were placed at a sub-colony ca. 200m to the South of the DOC plots. Two types of cameras were used:

- *Ltl Acorn* trail cameras that were supplied and deployed by the West Coast Penguin Trust to examine the potential impact of terrestrial predators on tawaki. These cameras usually covered multiple pathways and operated on a motion-triggered basis only.
- *Bushnell* trail cameras provided by Tom Hart (University of Oxford) were deployed by our team to monitor nest attendance patterns of breeding tawaki throughout the season using continuous time lapse photography. Cameras were deployed at nests that were deemed suitable for GPS logger deployments.

Battery life of the cameras ranged between 1-3 weeks so that the devices had to be maintained regularly. Roughly every two weeks we performed 'camera runs' during which we would change batteries and SD cards. On camera runs we walked the same route which circled around the major breeding areas to minimize disturbance as much as possible.

During the time of GPS logger deployments (see below) additional trail cameras were deployed on the rocky shore; SD cards were exchanged on a daily basis when we walked to or from the study site.

GPS logger deployments

It was planned to use earth&Ocean GPS dive loggers to track at-sea movements and diving behaviour. However, as the manufacturer failed to deliver the ordered devices in time for the pilto study, we used i-gotU travel GPS loggers as fall back option. These devices were initially intended to be used for "dummy" tests to assess the reaction of the penguins to being handled. However, as it turned out they worked remarkably well.

Initially we waterproofed the GPS loggers in their original casing (dimensions: 46x41.5x14 mm, weight: 37 g) and attached as small nose cone (<1g) to improve the devices' streamline shape. However, after a successful trial the GPS antenna and PCB board were cast in epoxy which reduced size of the units (43x38x12 mm, 32 g).

A total of eight birds were fitted with GPS loggers between 16 September and 9 October. Seven of these birds were females, one GPS logger was fitted to a breeding male penguin. Only after deployment it became clear that the male was the mate of a female which was fitted with a device the same night.

Devices were attached using the well-established Tesa-tape method (http://goo.gl/Tsgqq1) which allows easy recovery of the devices without causing any damage to the plumage. The deployment procedures took an average 10 minutes (from capture to release) and included weighing using a 5 kg spring balance. In September (early chick-guard) birds tended to weigh around 3 kg while in October (post-guard) mean weight dropped to 2.7 kg.

Four of the more than 260,000 timelapse photos recorded to determine nest attendance and landing patterns.

Reconditioned i-gotU GPS logger encased in epoxy resin; SD card for scale.

GPS logger recovery

Devices were recovered after 2-5 days. Device recovery proved to be the most taxing aspect of the research. Particularly during the later stages of breeding, tawaki tended to move away from their original nest site and were extremely difficult to locate. To circumvent this problem and reduce disturbance in the breeding areas, we sttempted to intercept logger birds on the rocky shore shortly after they landed or along the forest paths leading up to their nest sites.

For device recovery we monitored penguin traffic from the early afternoon until approximately 1 hour after sunset. At first, we hid between rocks, but later used a camouflage tent as this proved to provoke less wary behaviour in some of the birds and was more comfortable for the observers particularly in inclement weather conditions.

Penguins fitted with GPS logger could be identified using binocculars although the device was rather inconspicuous and sometimes difficult to see. Birds were captured on the rocky shore. On two occasions, the penguins scuttled under rocks before they could be apprehended. One bird was recovered from underneath the rock. In the other case we could peel off device and tape through a crevice.

Two devices could not be recovered. In the first case the logger fell off a few days after deployment (confirmed via trail camera data). In the second case the bird managed to elude capture but resumed feeding until fledging.

Overall device recovery was made very difficult by the rugged terrain of Jackson Head West's rocky shore (see top image on page 5). The penguins' routes were difficult to predict and birds tended to vanish in the jumble of rocks.

Blood sampling & transponder injection

During the first two logger recoveries, we tried to take blood samples for DNA, stable isotope and blood count analyses. However, the first attempt was severely hampered by torrential rainfall and during our second attempt the penguin had shut down blood flow to the extremities so that it yielded very little blood. As it was more important to established proper logger recovery routines, we decided to cease blood sampling for the rest of the season.

Of the eight birds that were handled, three penguins were marked with subcutaneous transponders (see Table 1). Transponder injections occurred during logger recovery to avoid extra stress to the birds when fitted with loggers. None of the tagged birds showed any obvious adverse reaction to the transponder insertion.

Behavioural Observations

During the many hours of waiting for logger birds to return many behavioural observations could be made and were recorded, both in writing (http://goo.gl/D6i15X) and on video (http://goo.gl/5N1Bfa). Observations were all made from hiding, principally from within a camouflaged tent hide.

Supervision of night time filming activities by the Japanese film crew provided a unique opportunity to examine penguin behaviour at nest sites and social interactions in sub-colonies. At night, artificial lights were set-up at the main filming site, which did not seem to have any effect on the penguins as chick feeding, displaying, mutual preening etc. commenced normally in the open and in clear view.

The Appendix features more detailed accounts of noteworthy observations.

Table 1. *Details of three female tawaki that were tagged with subcutaneous transponders*

Tag ID	Date	Location	Sex	Age	Status	Weight	Tagger
982000063645213	18.09.2014	Jackson Head	F	adult	2 chicks	3100g	Mattern
982000063644166	20.09.2014	Jackson Head	F	adult	1 chick	3000g	Mattern
982000063644832	07.10.2014	Jackson Head	F	adult	1 chick	2900g	Mattern

View from the tent hide that offered the opportunity for behavioural observations.

Observation of a male & female tawaki returning simultaneously to both feed their chick suggesting cooperative foraging in pairs (see also Appendix). The male (1179) was banded as an adult at Munro Beach in 2000.

Assessment of research impact

Tawaki are generally described as being very timid and sensitive to human presence. Therefore, it was important to establish whether field protocols adequate while working with other timid penguin species (e.g. Yellow-eyed penguin, Humboldt penguin) were also suitable for tawaki.

Our main aim was it to **keep interactions at the nest site to a minimum** so as to avoid risk of nest abandonments. Therefore, only device deployments occured at the nest which was important to ascertain identity of the bird. **Logger deployments only occured after the chicks had hatched**, i.e. during a period when adult penguins have a strong bond to their offspring and are less likely to abandon them. We furthermore **avoided entering the breeding area** as much as possible and relied on trail cameras to subsequently determine a logger bird's nest attendance patterns if recovery proved to be difficult. Finally, we aimed at **recovering loggers at the penguin landing sites** away from the nest.

It is difficult to objectively assess the impact of our research activities on the penguins by only judging from visible behavioural reactions. However, **all nests chosen for logger deployments remained active**, all penguins resumed their **normal feeding routines while fitted with devices** and after logger recovery.

Over the course of the past 15 years we have worked with five different penguin species, including Humboldt penguins and Yellow-eyed penguins, both species that are particularly sensitive to human disturbance. More specifically we studied the impact of human disturbance on their breeding biology, behaviour and physiology. We have also conducted similar research on the tawaki's closest relative, the Snares penguin.

Based on our previous experiences we can make comparisons of the behavioural responses we observed in tawaki in response to our presence and interaction with them.

In our opinion, the Humboldt penguin remains the species that is by far most sensitive to human disturbance and consequently research impact. While Yellow-eyed penguins are more robust than Humboldt penguins, they are still considerably more sensitive to human approach than Snares penguins, which is the species that is less susceptible to anthropogenic disturbance stimuli.

In the field, **tawaki proved to be remarkably resilient to our interactions**. Although not comparable to the placidness of Snares penguins, tawaki tended to show **less extreme responses when handled than either Humboldt or Yellow-eyed penguins**. Chicks (https://vimeo.com/111941154), juveniles (https://vimeo.com/112613971) and even some adults approached us curiously, a behaviour that indicates a certain degree of boldness in this species which we have not observed in Humboldt or Yellow-eyed penguins to this extent.

Our previous research has shown that interactions with penguins in the wild have to be kept at an absolute minimum, regardless of the degree of timidity they exhibit. We will continue to follow and enhance this code of practice in the future.

Close inspection of the photographer by curious tawaki: chick (top), juvenile (middle) & adult (bottom)

Preliminary results

Trail cameras

More than 260,000 images were recorded with the 10 Bushnell trail cameras which recorded nest attendance patterns at 1-minute and later 5-minute intervals (see top image on page 7). Due to the sheer amount of data, the analysis has not progressed far at the time of this writing.

However, analysis of some of the data already shows that during the chick-guard stage, females tend to exhibit consistent nest attendance patterns. Individuals depart from their nests around the same time every morning, usually an hour before sunrise, and return (most of the time) around the same time of the day on subsequent trips suggesting a temporal consistency in their foraging behaviour.

During the early crèching stage, chicks start to wander around the nesting area freely, sometimes forming small groups with chicks from neighbouring nests. During the first weeks of this stage, many of the male penguins tend to remain at the nest site, probably guarding it (rather than the chick) from intruders such as non-breeders. At this time, females return mostly every night, although sometimes the birds may stay at sea for two or three days.

During late crèching, image data gets difficult to analyse as many of the chicks only infrequently returned to their nest. This is contrary to what John Warham reported, i.e. that chicks always return to their nest site at night waiting to be fed. Interestingly, in some cases pairs left and returned together a day or two later. The potential that pairs forage cooperatively certainly warrants further investigation (see also Appendix).

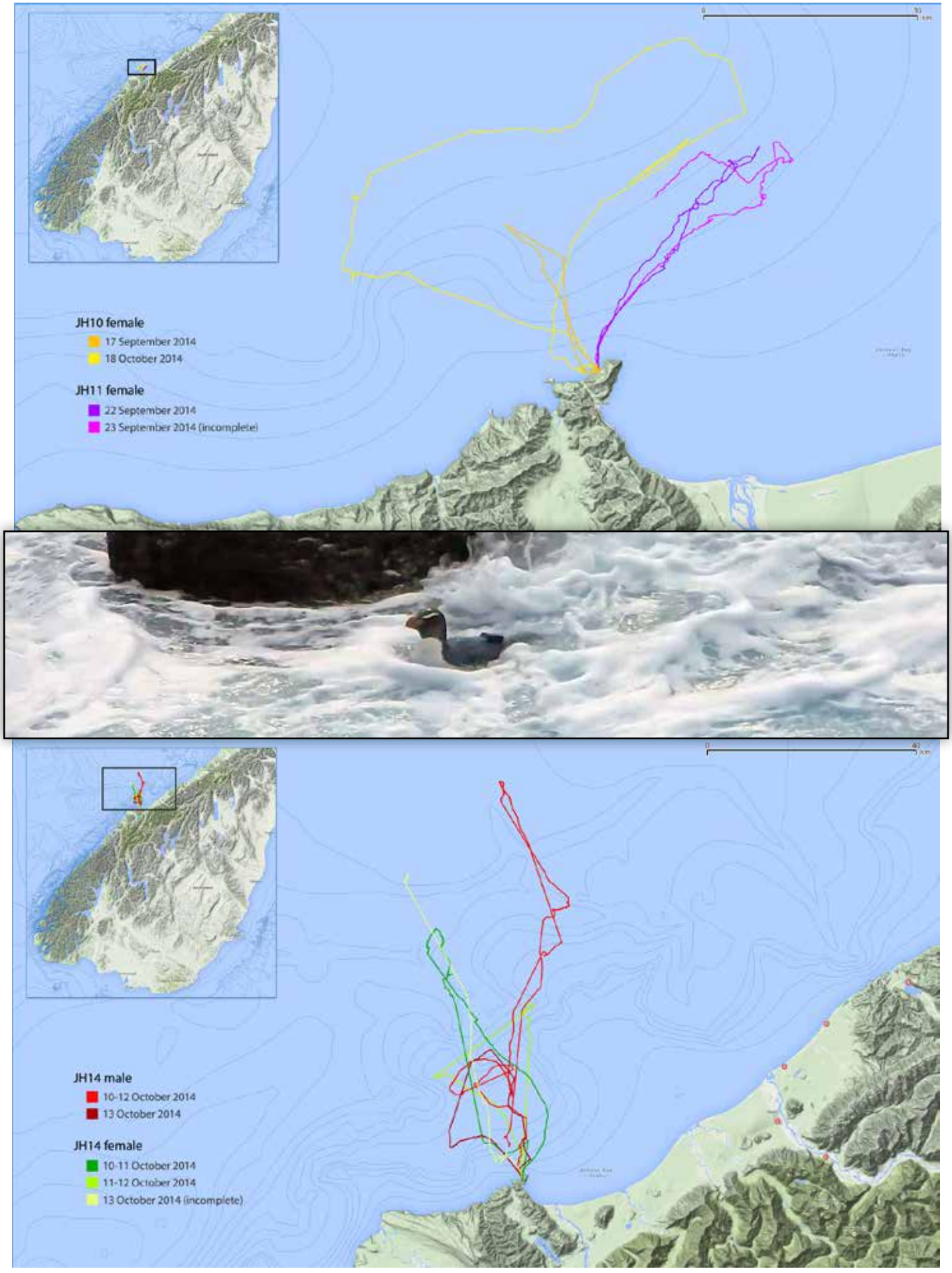
GPS loggers

Of the loggers that were deployed on eight tawaki, four yielded tracking data. Two devices could not be recovered (see page 8), two further devices were destroyed as a result of water leakage. The four successful deployments allowed reconstruction of 9 foraging tracks.

Initial analysis of the tracks suggest considerable differences in foraging ranges during the chick-guard stage, when the female penguins return to their nest every night, and the crèching stage, when both male and female forage for up to three days at a time.

During chick-guard foraging trip lengths of two females averaged 8.3 hours and 18.3 hours, respectively. However, the latter bird on both occasions left Jackson Head between 2 am and 3 am slowly making her way north-westwards at the surface only starting to foraging in 250m+ deep waters after sunrise. The other bird performed two very similar foraging trips following the 150m depth contour. Foraging ranges were between 7.9 and 11.5 km which is surprisingly close inshore given tawaki are considered typical offshore forages.

During crèching the male and female fitted simultaneously with devices did not forage cooperatively. Their trip lengths (15.8-63.8 hrs) and foraging ranges (18.1-50.4 km) varied considerably but were overall substantially greater than the chick-guard trips we recorded. Interestingly the average travel speeds were similar during both stages of breeding suggesting that the birds did not "work harder" during crèching; they just stayed longer at sea. However, we will get more detailed information about foraging effort from the deployment of dive loggers in the following seasons.



Foraging trips recorded with GPS loggers on breeding tawaki during breeding season 2014. Top graph: two females during chick-guard. Bottom graph: pair of tawaki (male & female) during the crèching stage. Middle: the male tawaki from JH14 returning from his last foraging trip with GPS logger on 13 October 2014

Outlook for breeding season 2015

Dates
Currently we plan to conduct field work around the same dates as during the pilot study, i.e. 15 September-15 October 2015.

Sites
We plan to continue our work at Jackson Head as we are now familiar with the site and even have a few marked individuals that we hope we can work with.

We would also like to carry out a recce trip to Gorge River. Not only could the presence of the Long family there be a substantial asset for the project, both in terms of their local knowledge and potential participation in the research. Also it was mentioned that beach access might be a lot more favourable for logger recovery.

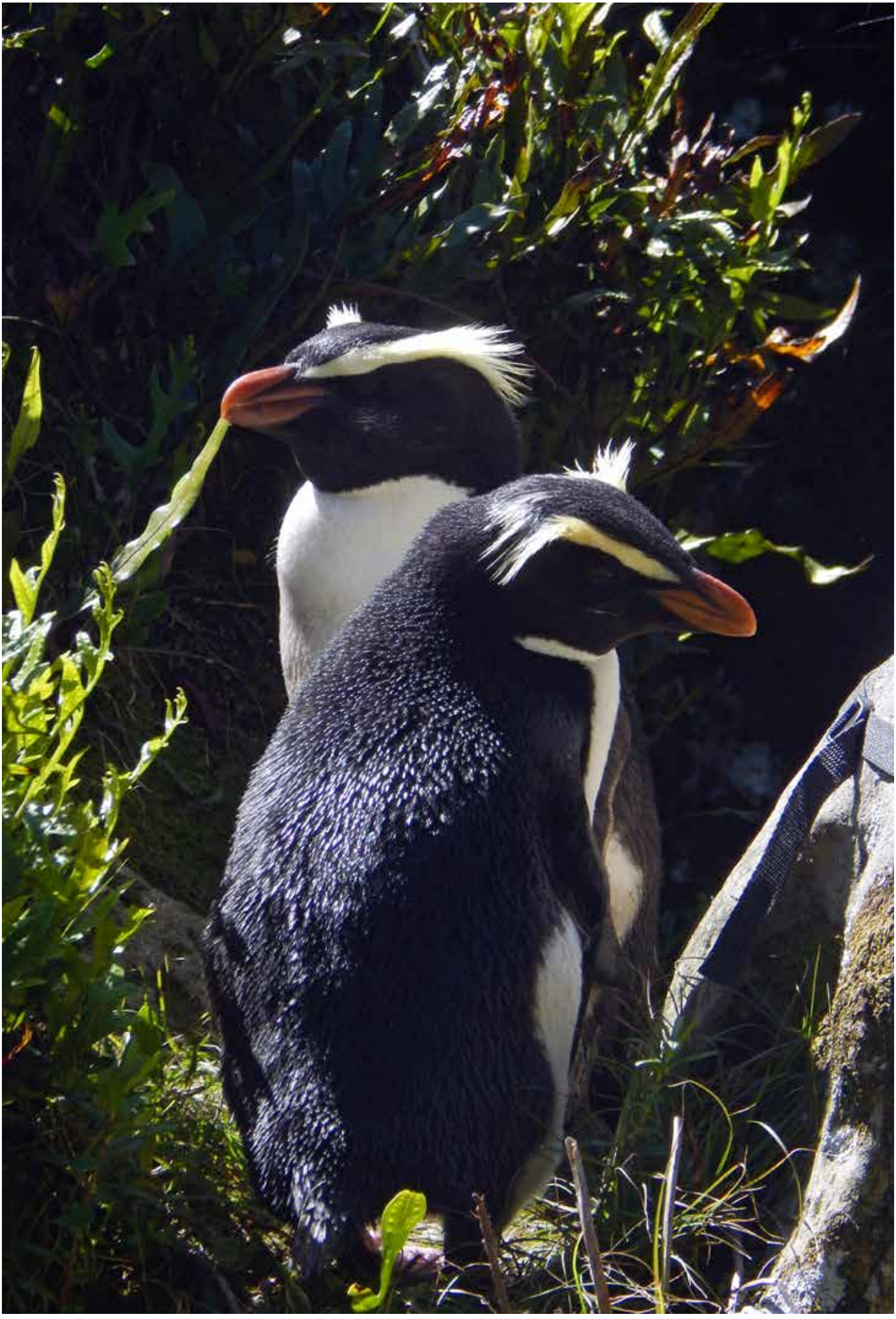
In order to cover another marine breeding habitat of the species, we plan to deploy data loggers on tawaki breeding in Milford Sound. There seems to be considerable interest by local stakeholders and businesses to get more information about tawaki. We hope to receive additional support (logistics and funding) for the project.

Research
We plan to carry out the same type of research as during the pilot study. The main difference will be that we will be using a combination of GPS and dive loggers so as to record the penguins' movements at sea in three dimensions. We will commence taking blood and feather samples from birds returning to the breeding colony (logger and control birds) as outlined in the project proposal and permit application.

Research team
The research team will be expanded to allow us simultaneous logger deployments at both Jackson Head and Milford Sound. In addition to the principal investigators **Thomas Mattern** (University of Otago) and **Ursula Ellenberg (**La Trobe University), **Popi Garcia-Borboroglu** (Global Penguin Society), **Klemens Pütz** (Antarctic Research Trust), **Dave Houston** (DOC) and **John Darby** have already indicated their participation. Particularly for our work at Jackson Head and the proposed recce trip to Gorge River, it would be fantastic if **Robin Long** (DOC) could join our team. The Tawaki Project will benefit greatly from Robin's local knowledge and familiarity with tawaki. And it would be great if DOC representatives could be part of both field teams.

Funding
The funding situation has not changed and the project is still dependent on external funding. Funding for field gear – i.e. GPS loggers, dive recorders, trail cameras – have been obtained. However, both costs of logistics and staff time still need to be secured.

Donations
Donations to the Tawaki Project can be made either through the West Coast Penguin Trust (http://givealittle.co.nz/donate/org/wcpt, make sure to mention the **Tawaki Project** as intended recipient in the comment field) or through the project website (http://www.tawaki-project.org/support-us/). Alternative funding option can be discussed with us directly (contact: t.mattern@eudyptes.net).



Acknowledgments

The Tawaki Project received considerable support in the past few months. Special thanks are due to the Department of Conservation. **Helen Otley** got the ball rolling, **Bruce McKinlay** threw his weight in for us when the permitting process suffered from a few hiccups, and **Jacinda Amey** provided the best possible collaboration environment in Haast one can wish for.

Thanks are due to our helpers in the field. First, **Popi Garcia-Borboroglu** bravely tackled the rough terrain and inclement weather for the first two weeks of GPS logger deployments (quite a change from his usual working conditions in the arid climate of the Patagonian lowlands). **Horst Mattern** took up the baton and suffered considerable bumps and bruises in the process without complaining once.

This project would not have been possible without the financial support from **Geoff Robson**, Greenstone Helicopters, whose donation covered the costs of all of our field logistics. We are also extremely grateful for our collaboration with the Japanese film crew (NHK) led by **Akihido Ida** and assisted by **Sam Aoki**. Their financial contribution to the Tawaki Project (in the form of consulting fees) also made this pilot study possible.

Our collaboration with the West Coast Penguin Trust proved to be a major asset to the project. Particularly, we would like to thank **Kerry-Jayne Wilson** for fruitful discussions and a lot of fun during our time together in the field. **Inger Perkins** helped out not only in getting the funding situation sorted but also spreading the word about the Tawaki Project on social networks. Thanks are also due to **Paul Elwell-Sutton** for his help in the field and one or the other cup of tea at his home. **Dave Houston** provided thoughts and comments on the project and this field report.

Liz and Jeff Dibben gave us with access to their home at Neil's Beach which offered us a retreat from the West Coast weather with a comfort none of us knew from our own homes.

The greatest thanks, however, are due to the **tawaki from Jackson Head**, who tolerated our presence and interactions and (mostly) cooperated during our tracking work. They were fascinating companions during long, cold and wet hours in rock caves and tent hides and kept the promise to be one of the most interesting penguin species to work with.

Further information

http://www.tawaki-project.org
Our project website provides information about the project and a detailed account of our research activities in the form of a research diary.

https://vimeo.com/album/3086774
We have produced a series of mini-documentaries that we have published on the online video platform Vimeo. Above URL links to material we recorded in 2014.

The Tawaki Project also keeps presences in social media:

http://facebook.com/TawakiProject

https://twitter.com/TawakiProject

http://goo.gl/xWJiXs

Thomas Mattern & Ursula Ellenberg

Appendix: Noteworthy observations

Stewart Is.: Cooperative foraging of tawaki and barrcouta (*Thyrsites atun*)

Together with the film crew from Japanese National Television (NHK) we spent six days moored at Gull Rock, a small rocky outcrop between Bungaree Bay and Murray Beach, north-east Stewart Island.

Tawaki would frequently forage in large numbers close to the rock, feeding on schools of whitebait and other fish larvae. On two days, they were joined by groups of barracouta. Judging from what was observable both barracouta and tawaki seemed to be circling the same prey patches with individuals then lunging into the circle presumably to feed.

Yellow-eyed penguins reportedly suffer severe bite injuries from encounters with barracouta. Our observations did not suggest any hostile interactions between tawaki and the predatory fish. Instead their activities suggested mutual benefit.

Stewart Is.: Breeding in inaccessible sea caves

The at times substantial numbers (50+) of tawaki foraging in the waters around Gull Rock stood in stark contrast to the population assessment of tawaki on Stewart Island as published in the 1990s (32 birds recorded around Southern Stewart Island; Notornis 41:133-143). Moreover, between Oban and Gull Rock we recorded tawaki standing in front of caves and crevices in at least eight locations.

On 7 November, during low tide, our team was dropped off on Golden Beach and examined the cliffs on either side of the Beach for signs of tawaki. On a stretch of about 100m of cliffy coastline that could be surveyed on foot we found groups of breeding tawaki (as indicated by the presence of chicks). We recorded six caves ranging from large caverns to small crevices occupied by tawaki. The entrance to at least one of the caves is completely submerged at high tide.

In this light, it appears that conventional methods (i.e. terrestrial searches) have shortcomings when it comes to surveying tawaki populations especially along rugged coastlines. More details, images and video can be found here http://goo.gl/os3ttq.

Jackson Head: Cooperative foraging in pairs

Particularly during the crèching stage, we often observed tawaki leaving or arriving on shore as pairs, generally male and female birds. In one instance we observed a pair of penguins arriving at their nest site simultaneously (see image on page 9) both partaking in feeding the chick. It seems, therefore, as if breeding pairs may forage cooperatively.

Jackson Head: Post-fledging parental care

When fledging was underway we observed that chicks were accompanied by adult penguins, generally a female and a male. In one instance the behaviour and body posture of the adult penguins indicated that they might have been the parents of the fledgling.

When the chick slipped off the rocks and into the water, both adults craned their necks looking after the chick, a behaviour which resembled that of Snares penguins that had an egg or chick roll out of their nest bowl. Finally both adults dove into the ocean and joined the chick, all three swimming mostly at the surface out to sea for quite some time.

It is known that Gentoo penguins sometimes look after their chicks after fledging. Our observation indicates that this might also occur in tawaki. It will certainly be worthwhile to examine this behaviour in the coming seasons.

Top: one of the more cavernous caves occupied by breeding tawaki on the north-east coast of Stewart Island. Bottom: pair of adult tawaki accompanying a fledgling on its maiden voyage.