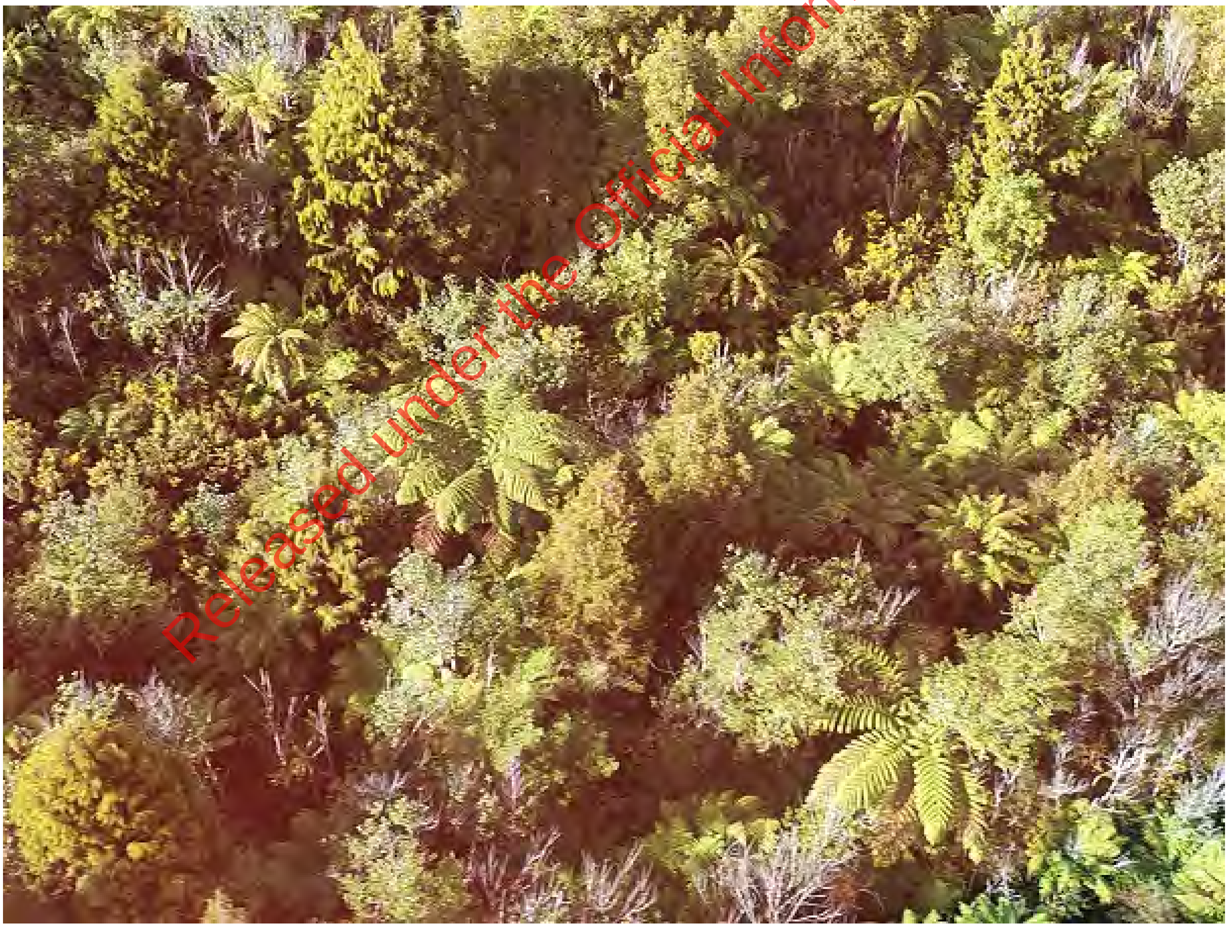
Heaphy and Denniston Biodiversity Projects

Annual Report

1 July 2019 – 30 June 2020



The Heaphy and Denniston Biodiversity Projects are Department of Conservation programmes established using compensatory funding from Bathurst Resources Limited in recognition of the adverse effects of coal mining activities on Brunner Coal Measure ecosystems at Denniston Plateau.

Report compiled by Jane Williams with assistance from Jess Curtis
Cover: Heaphy native vegetation *Photo:* Jane Williams

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Introduction

The Denniston and Heaphy biodiversity management programmes commenced operations in 2014 as compensation following the granting of Resource Management Act 1991 consents to Bathurst Resources Limited and an Access Arrangement with the Department of Conservation (DOC) allowing the company to undertake opencast mining activities on Denniston Plateau.

Two sites were selected for funds to be spent to manage biodiversity values and threats – Denniston Plateau and parts of the Heaphy River catchment. Biodiversity management activities to be undertaken by DOC at each site were agreed and documented in each of two biodiversity management plans – DOC Denniston Plateau Biodiversity Management Plan 2013–2063 (Farrell 2013a) and DOC Heaphy *Whakapoai* Biodiversity Management Plan 2013–2048 (Farrell 2013b). These plans identify the management areas and describe the management and monitoring activities required to achieve and measure anticipated biodiversity outcomes as specified in the Access Arrangement and resource consents. Both plans recommend updating every 5 years to embrace the benefits of adaptive management. The first review of these plans is scheduled for 2021.

Details of the allocation and spread of funds between the two sites are set out in a Compensation Deed that forms part of the Access Arrangement and in the resource consent conditions. A variation to the Compensation Deed in 2018 increased the compensation funding for the following 5 years. This subsequently changed the priorities of the project, allowing for more intensified predator control by aerial 1080 in the Heaphy catchment.

2019/20 is the sixth financial year that compensation funds have become available to implement the Denniston and Heaphy biodiversity management programmes. The Denniston programme focuses on biodiversity threat management, with Bathurst Resources Ltd undertaking monitoring of *Powelliphanta* snails and kiwi in accordance with the relevant resource consent conditions. The Heaphy plan covers a wide range of biodiversity management, including biodiversity outcome and result monitoring, inventory and survey, and pest management.

In the project's sixth year of operation, $809,000 was available to administer and implement management plan actions across both sites. This report summarises progress in 2019/20 towards achieving the management and monitoring activities set out in the two biodiversity management plans.

Work achievements against the Biodiversity Plan priorities discussed at the Technical Advisory Group meeting are presented in Appendix 1 (Denniston) and Appendix 2 (Heaphy). Project management was minimal from October 2019 when the project management role was vacated until it was filled in May 2020 post-Covid lockdown.

Denniston

Pest plant management

Weed control

A range of weeds have been introduced to Denniston plateau, primarily associated with human activity. Gorse (*Ulex europaeus*) and heath rush (*Juncus squarrosus*) are widely distributed, with more localised pockets of broom (*Cytisus scoparious*) around sites of road and track development, human habitation and centres of historic mining activity. A range of other introduced plants have established around old house and community building sites. Target species and priorities for control of weeds at Denniston are set out in the *Denniston Weed Control Plan 2015–2020* (Belton & Marshall 2015). In 2019/20, weed control operations again focused on gorse and broom, with maintenance control at previously treated sites. In addition to this core work, control of montbretia (*Crocosmia × crocosmiiflora*) was also completed.

Gorse and broom management

Gorse and broom have been controlled by DOC and mining licence holders intermittently along road verges and at mining sites. In 2015 a coordinated control programme involving the various agencies and companies with responsibilities for weed control in the Denniston plateau area (DOC, BT Mining, BCL and Electronet Services Ltd) was developed to target all known infestations of gorse and broom. This work continued in the current year with good progress being made. Control of gorse and broom was undertaken by MBC Environmental Ltd using 4×4-vehicle-mounted and quad-bike-mounted spray units, with special attention being given to reducing impacts to non-target native vegetation. Areas searched and treated by contractor staff were recorded using tracks from handheld GPS (Fig. 1). BT Mining and Transpower funded the weed control on mining licence and access easement areas, pylon sites and access tracks.

Control of other weeds

Control of heath rush (*Juncus squarrosus* Fig 2.) in and around *Euphrasia wennsteiniana* populations was planned for 2019/20. However, due to other commitments, it was unable to be started. This will be a priority for the 2020/21, along with the control of a small population of *Juncus canadensis* and weed control along walking tracks (Figs 3–5).

Survey and monitoring

A survey of the distribution and relative abundance of gorse and broom was completed in September 2019 to enable comparison compare with abundance in previous years (see Fig. 1).

In 2003, DOC established 18 photopoints at sites with noticeable gorse infestations. These sites were photographed in 2006 and then every year since 2014. In Feb 2020 they continued to show suppression of gorse regeneration along roads.

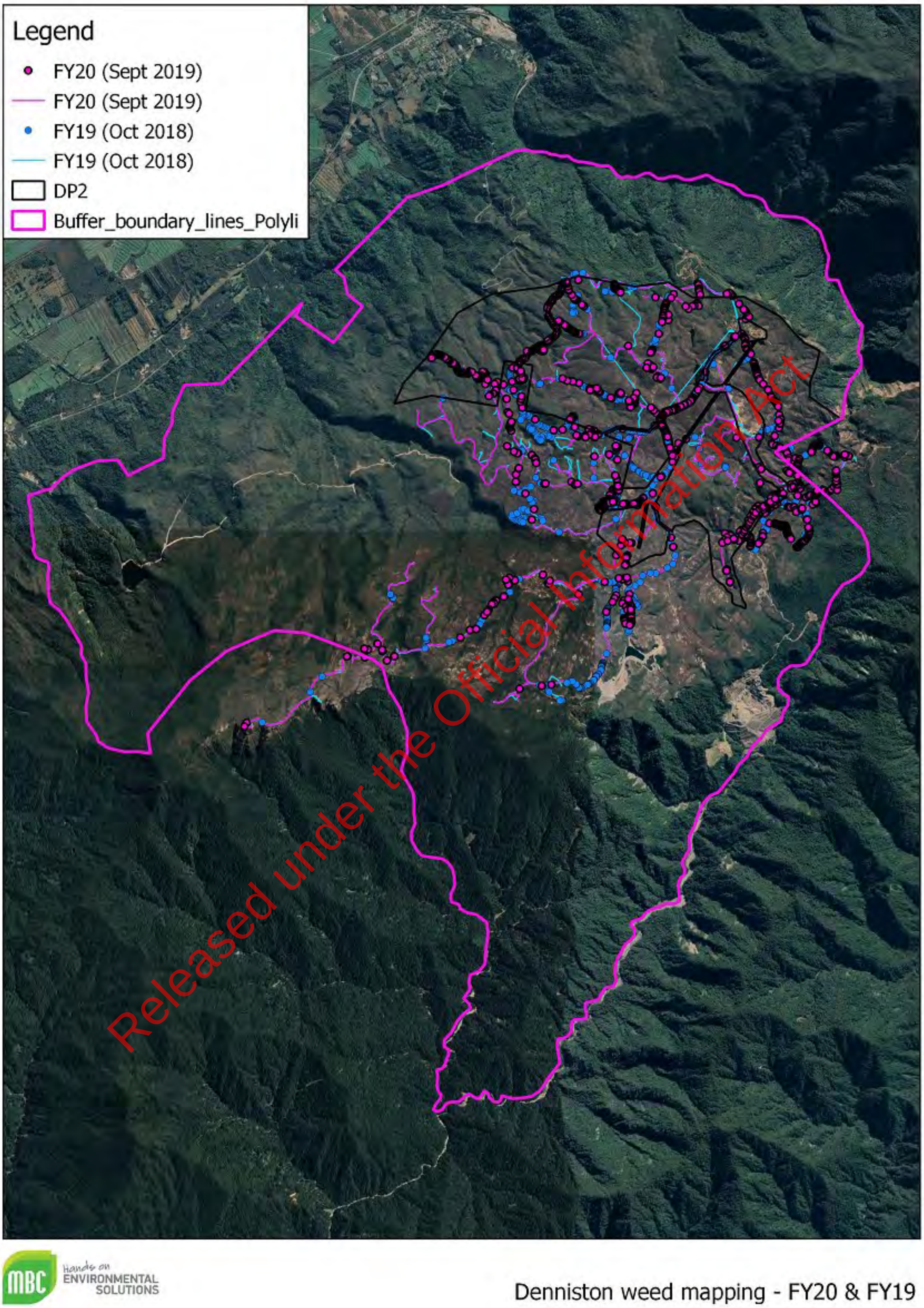


Figure 1. Weed control operations tracks and gorse waypoint 2018 to Sept 2019. The map shows the difference between GPS points of all gorse plants surveyed along roads and tracks in Oct 2018 (pink dots) with those surveyed in Sept 2019 (blue dots).

Figure 2. *Juncus squarrosus* (forming circular clumps) outcompeting native species on the Denniston Plateau.

Figure 3. *Nardus stricta* along the Coalbrookdale track.

Figure 4. Broom along the Coalbrookdale track.

Figure 5. Gorse and broom regrowth along the Brakehead track.

Surveillance and monitoring over the 2019/20 year have provided evidence of successful progressive weed control. Operators generally reported a significant reduction in the biomass and extent of both target species compared with the previous season. Most plants being treated were the result of germination from seedbanks, being small young plants at time of treatment.

Pest animal management

Pest animal control

No animal pest control operations were completed in the Denniston Biodiversity management area during the 2019/20 year. Pest animal control was last carried out in 2015 as part of DOC's Tiakina Ngā Manu programme and a future operation is planned for Spring 2020 as part of the joint DOC/OSPRI New Creek operation.

Pest trend monitoring

Seed fall monitoring

Potential irruptions of rats, mice and, subsequently, stoats can be predicted by monitoring production of seed from canopy beech and podocarp trees. These tree species exhibit periodic mass seed production (seed masting) which provides a large food source for rats and mice and the stoats that feed on them, triggering rapid population growth for these species. When the seed supply is exhausted in autumn, rats and mice turn to other food sources and when the numbers of rats and mice decline, stoats turn to native animals (such as birds and lizards) with potentially catastrophic consequences for local populations of these species.

The predominant canopy species present on, and adjoining, Denniston Plateau, that may drive rodent irruptions through seed masting events are mountain beech (*Fuscospora cliffortiodes*), silver beech (*Lophozonia menziesii*), hard beech (*Fuscospora truncata*) and, possibly, rimu

(*Dacrydium cupressinum*). Red beech (*Fuscospora fusca*) seed is an important driver of rodent irruptions in forests where it is a dominant canopy component, but it does not contribute significantly to forest cover on the Denniston plateau. Currently, seed fall traps are established under mountain beech, hard beech, silver beech and rimu (Fig. 6).

Seed production is monitored from February through to May, with all seed caught in funnels cleaned, sorted by species, counted and checked for viability (seed in which endosperm has developed is considered viable). When large numbers of seeds are collected, viability is determined from a subsample of 100 seeds per species from each funnel.

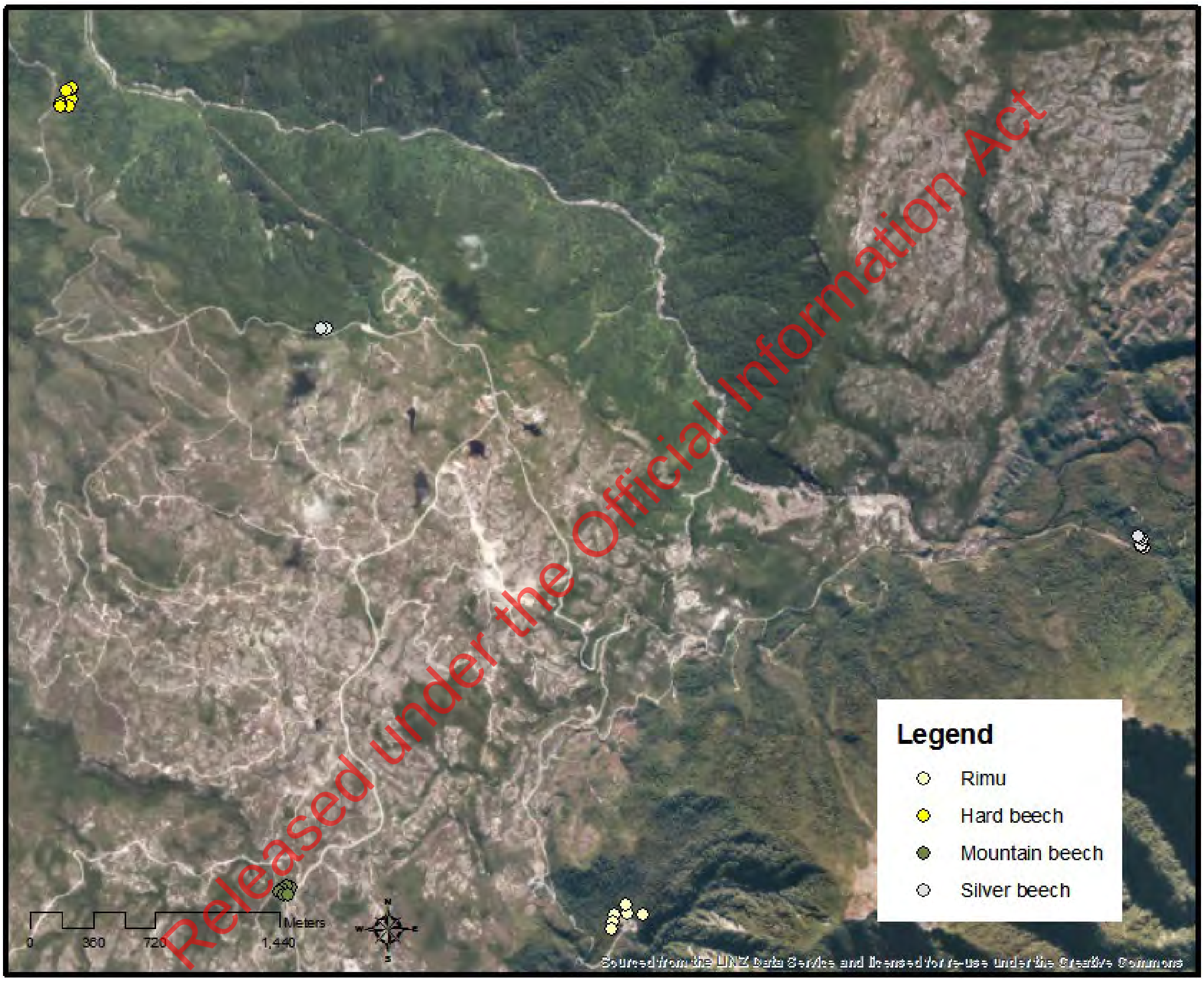


Figure 6. Location of 26 seed fall traps for mountain beech, hard beech and silver beech.

Seed collection results from January to June 2020 indicated low levels of seed productions in all species. The main source of seed production was rimu (Fig. 7). Viability of the seeds was <1%.

Rodents

Thirty-three tracking tunnel lines are well established on Denniston Plateau, with 18 centrally located on the plateau pavements and a further 15 established in peripheral forest and shrubland (Fig. 8).

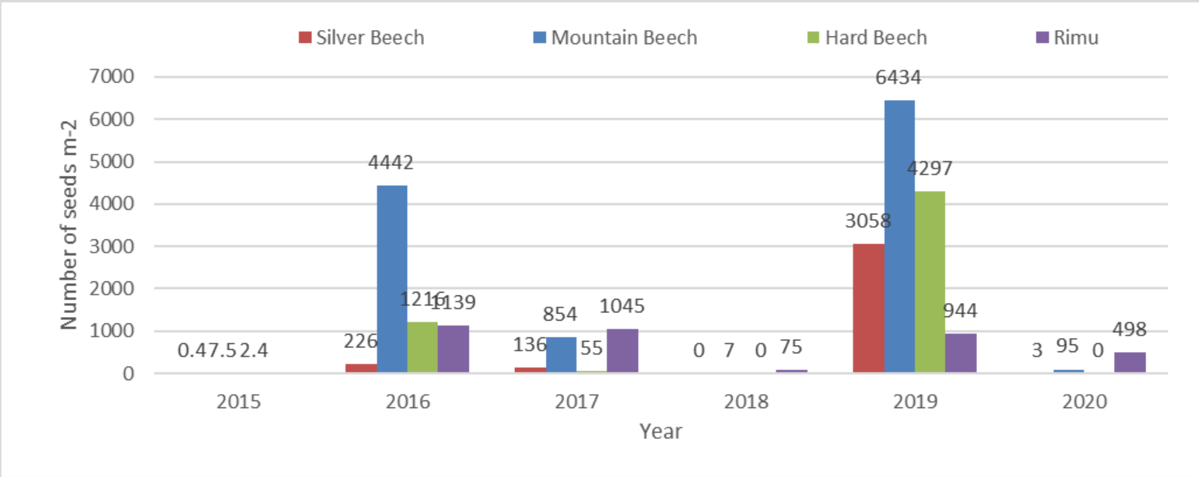


Figure 7. Total number of silver beech (red), mountain beech (blue), hard beech (green) and rimu (purple) seeds/m^2 collected in seed fall traps at Denniston Plateau from January 2020 to June 2020.

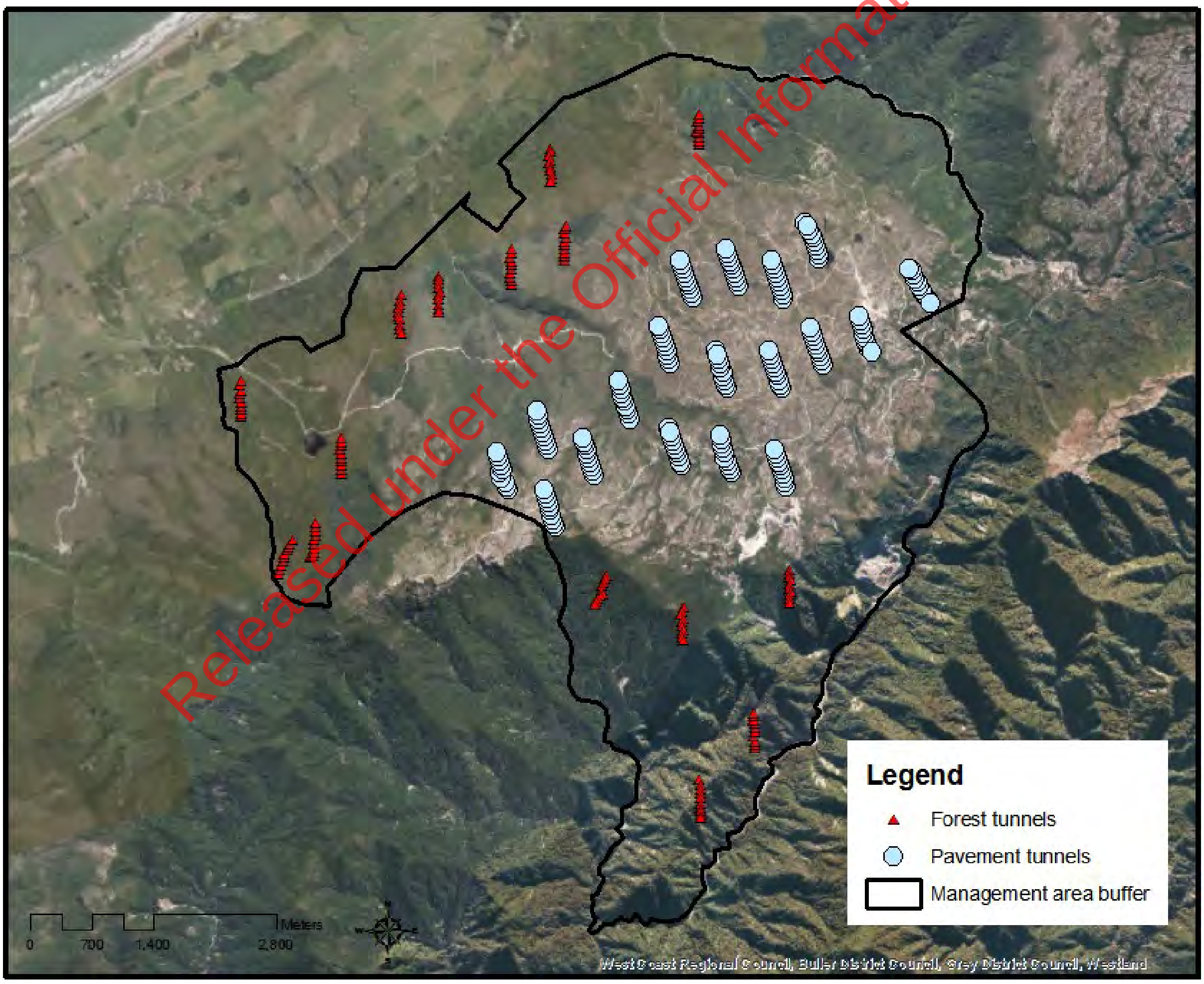


Figure 8. Rodent tracking tunnel locations on Denniston Plateau.

Tracking tunnel sessions were run four times in 2019/20 (Sept, Nov, Feb, May) by MBC Contracting Ltd for both the 21-day pavement (18 lines) and 1 day forest (15 lines) rodent monitoring periods. The Denniston Enhancement Management Plan gives three trigger levels for control operations, including a rat tracking index of above 60% over winter. As the 'forest' and 'pavement' are measured differently the two measures are not comparable and are analysed separately when considering control triggers.

With an aerial 1080 bait application (New Creek block) covering Denniston, Stockton and parts of the Mokihinui planned for Spring 2020, an additional run of 1 night Pavement tracking tunnels was completed in May 2020 to gauge rodent levels using the same index as tracking tunnel lines in the wider treatment block. This was used to inform whether aerial 1080 application would be required over the pavement area or if it should be excluded from treatment. Due to 33% of tracking tunnels showing stoat prints on the combined forest and pavement run, a decision was made to include the pavement area in the New Creek aerial 1080 control operation.

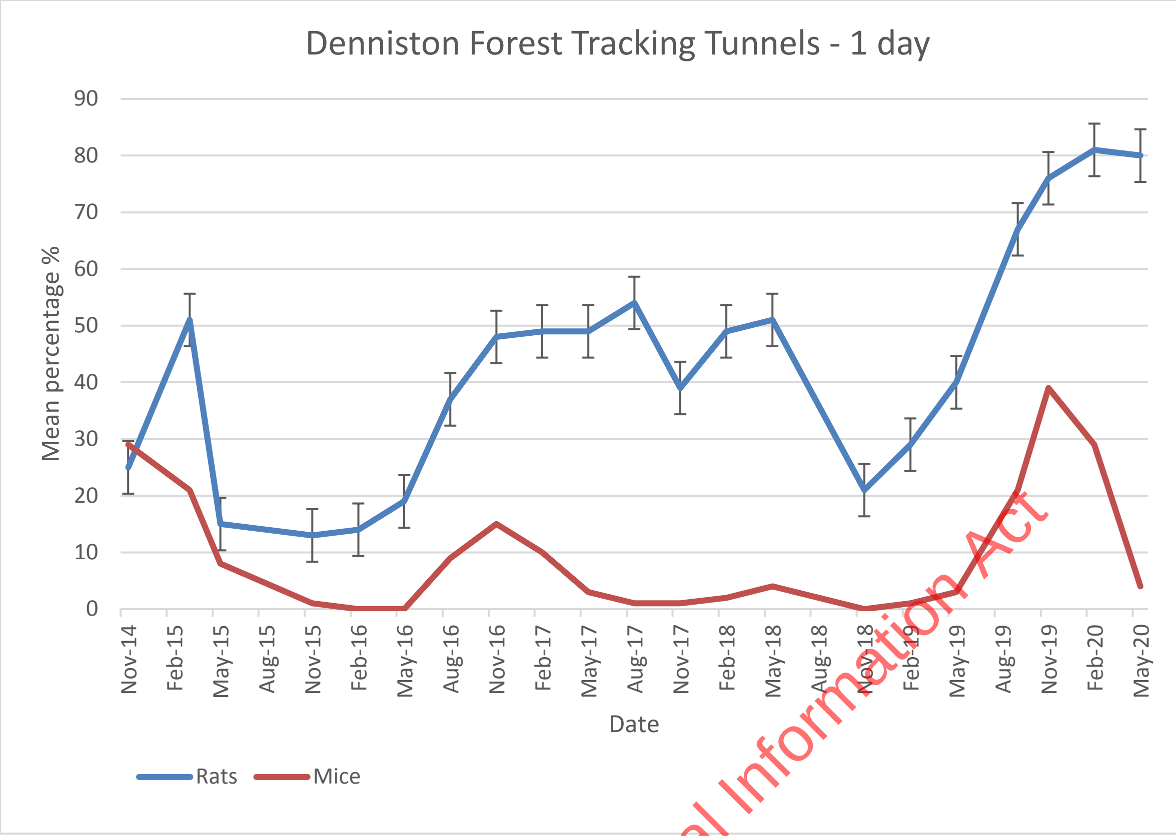
By November 2016, rat tracking indices at the 15 perimeter 'Forest' locations had increased to levels similar to those seen before the September 2015 1080 operation. Since then, tracking indices have remained high in the forest areas following consecutive mast and partial mast events (2016 and 2017 respectively). Apparent drops in tracking rates in November 2017 and November 2018 are unlikely to be significant and the error bars indicate numbers are patchy for both forest and pavement lines. In May 2019, 40 ± 8% of tunnels were tracked over 150 tracking nights (Fig. 9).

A similar increasing trend after the September 2015 1080 operation can be seen for rats at the 18 'Pavement' tracking locations. As with the forest lines, the apparent spike in February 2019 is likely to be insignificant due to the error bars indicating patchy results. Overall, the results indicate a sustained presence of rats in very low numbers on the Denniston Pavement area, with 10 ± 3% of tunnels detecting rats over 21 nights in May 2018. As a result of this, it was decided to reduce the number of tracking tunnels monitored and use the money not spent on this for extra monitoring.

On the pavement area, both mouse and rat tracking rates were very similar, in contrast with the forested areas where mouse tracking averaged 24% with rat tracking averaging 76%.

On the Denniston 'Pavement' locations rat tracking indices spiked at 37% in November 2019 along with 34% mice causing concerns for the nationally threatened gecko and skink species known to inhabit this ideal lizard habitat.

Waxtag monitoring for possum indices is scheduled for 2021/22.



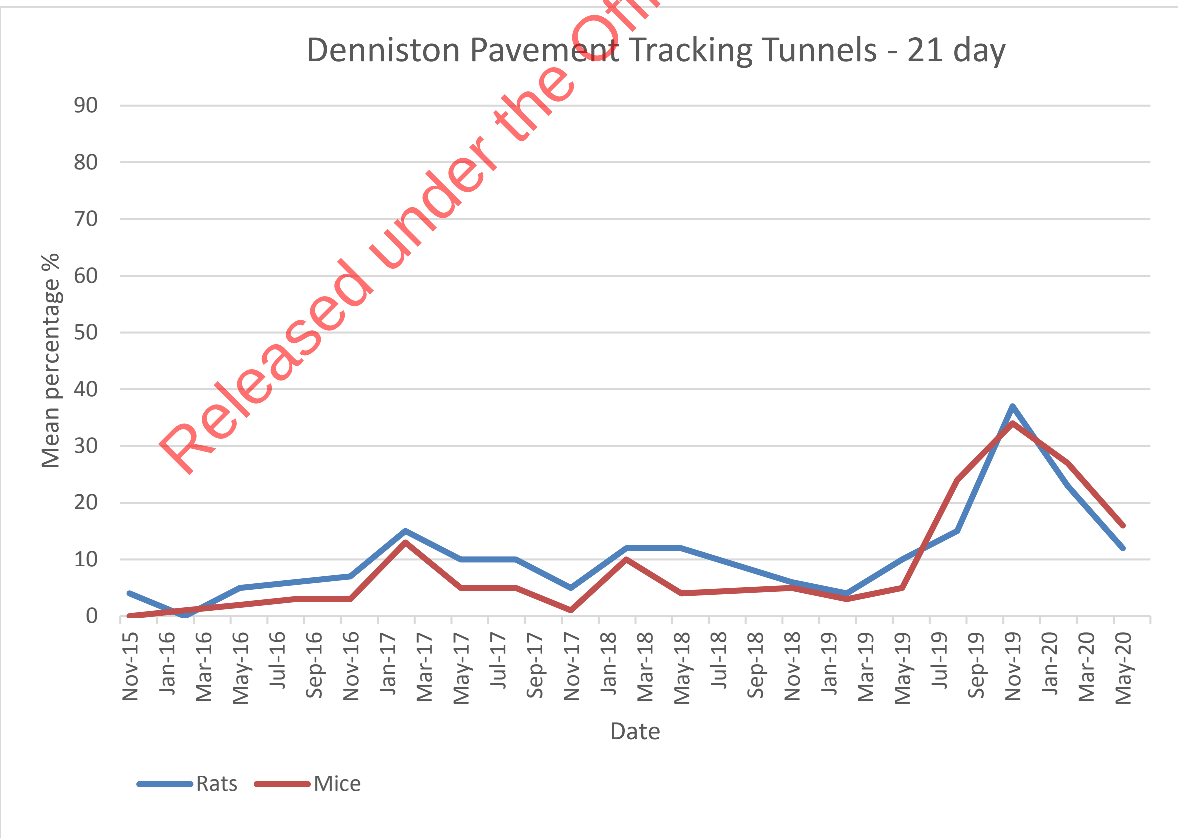


Figure 9. Percentage of tunnels tracked by rats and mice at Denniston 'Forest' locations for 1 night compared with 'Pavement' locations over 21 nights.

Biodiversity management

Threatened plants

The eyebright *Euphrasia wettsteiniana*, listed as Threatened – Nationally Vulnerable under the New Zealand Threat Classification Scheme (NZTCS), is found in cushion bogs, herbfields and sedgelands on the Denniston Plateau. Survey and weed control were planned for late summer 2020 to instigate recommendations from Nichol 2019; however, higher priorities resulted in the work being postponed to Feb 2021.

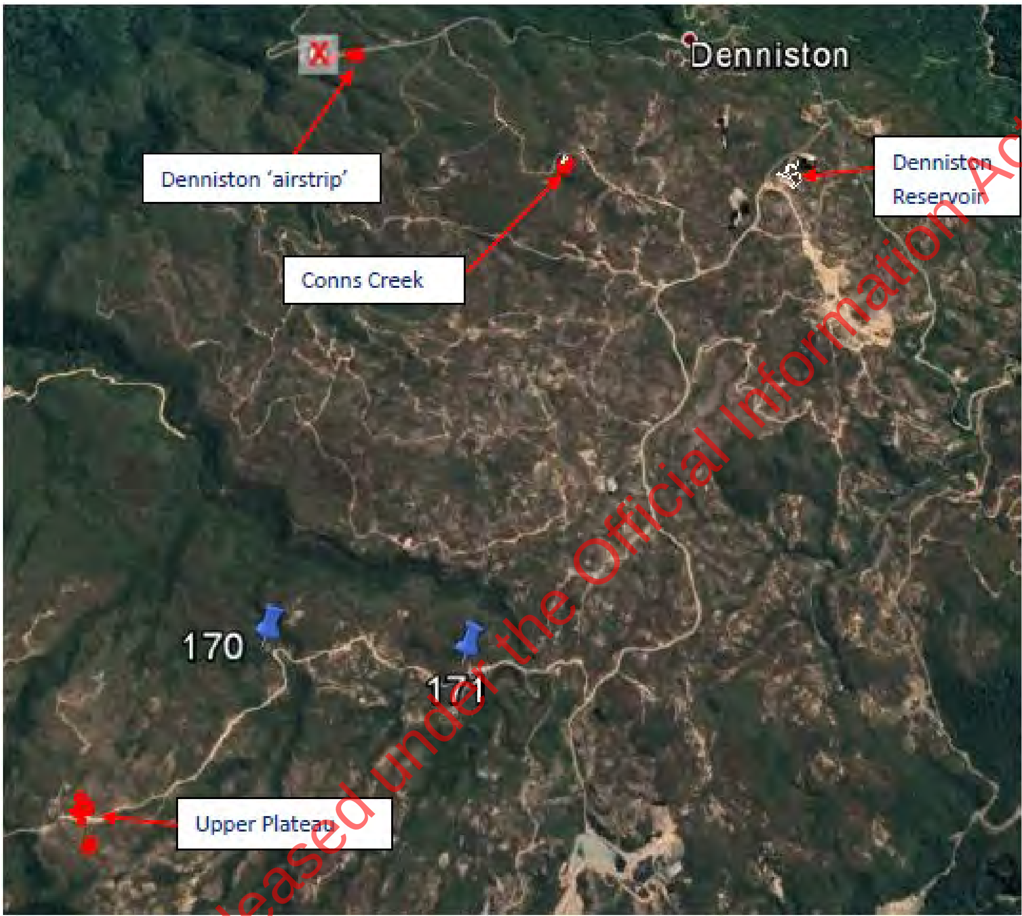


Figure 10. Map of Denniston Plateau showing four main sites recommended for *Euphrasia wettsteiniana* monitoring and additional sites 170 and 171.

The four sites identified for future *E. wettsteiniana* monitoring (Fig. 10) and weed control are:

- Denniston airstrip
- Denniston reservoir – a highly disturbed site including weeds and 4-wheel drive use
- Conns Creek – largely unmodified; however, some *Juncus squarrosus* present
- Upper Plateau – some *Juncus squarrosus* present

Based on the initial survey, these sites have been divided up to be either treated or not treated for control of *Juncus squarrosus*. A baseline survey for each site counting *Euphrasia wettsteiniana* plants along a transect at each site is planned for the 2020/21 summer, with a further survey post treatment for weeds. Follow-up monitoring of *E. wettsteiniana* will also be planned for the 2021/22 summer to compare pre- and post-control numbers.

Visitor information

Denniston biodiversity panel

In 2019/20 a biodiversity panel design was completed for installation in Oct 2020 (Fig. 11).

Figure 11. Denniston Biodiversity panel May 2019.

Heaphy

Pest plant management

A limited range of weedy exotic plant species have become established in the Heaphy Project area, with gorse, tree lupin (*Lupinus arboreus*) and marram grass (*Ammophila arenaria*) being the most visible. Other weeds with the potential to spread much further than their current range are present outside of but adjoining the project area (e.g. Kahili ginger (*Hedychium gardnerianum*), German ivy (*Delairea odorata*), karo (*Pittosporum crassifolium*), pohutukawa (*Metrosideros excelsa*)). A full list of target species and priorities for weed control in the Heaphy project area are set out in the *Heaphy Weed Control Plan 2015–2020* (Belton & Marshall 2015). This was updated in August 2020 (Appendix 3).

Survey and monitoring

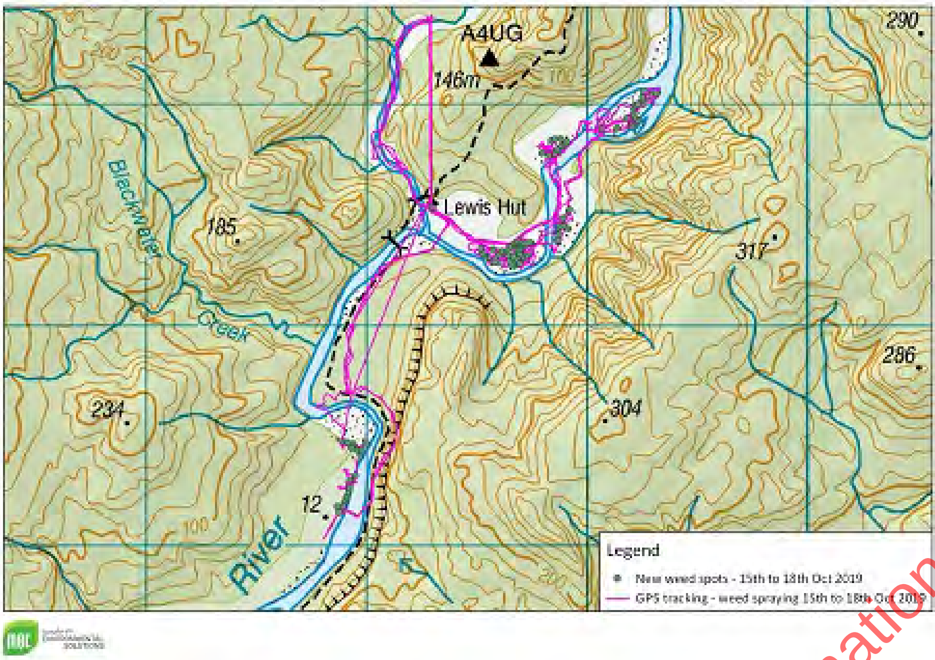
Photographs were taken at photopoints in January 2020. An aerial and ground survey was conducted in June 2020 to inform on future areas to target for weed control and success of previous control (Fig 12).

Control operations

MBC Contracting carried out 88 hours of gorse control along the Heaphy and Lewis Rivers in October 2019 (Fig. 13) and DOC staff carried out 70 hrs of gorse and lupin control along the coast south of the Heaphy River and along the Heaphy River in Jan–Feb and June 2020. Wild ginger was also controlled at Kohaihai shelter in June 2020.

Fewer weed control operations were carried out in the 2019/20 year due to high costs of aerial rodent control in the Heaphy valley.

Figure 12. The old airstrip along the Heaphy River pre-weed-control in June 2020.



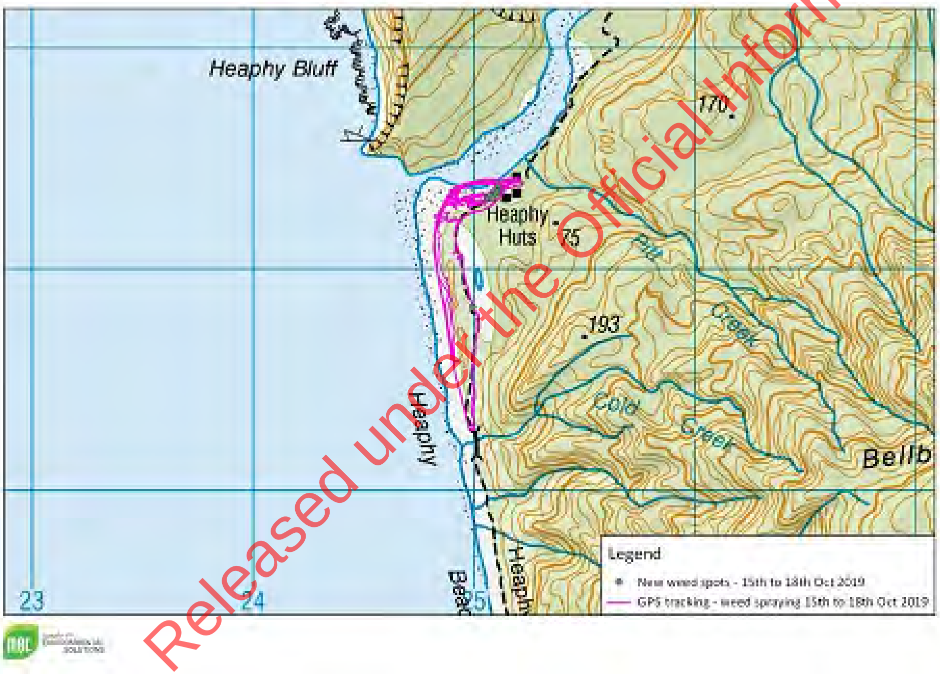


Figure 13. Areas weed controlled by MBC Contracting in October 2019.

Pest animal management

Pest animal control

Possum and rodent control

A 33,700-ha aerial 1080 operation targeting rats was completed as part of Tiakina Nga Manu operations in response to the beech mast in the summer of 2018/19 (Fig. 14). This operation included the Heaphy Lowlands block that was treated in 2018 as part of a wider research trial testing the benefits of annual aerial rodent control (Table 1). This research trial incorporates four sites with differing treatments.

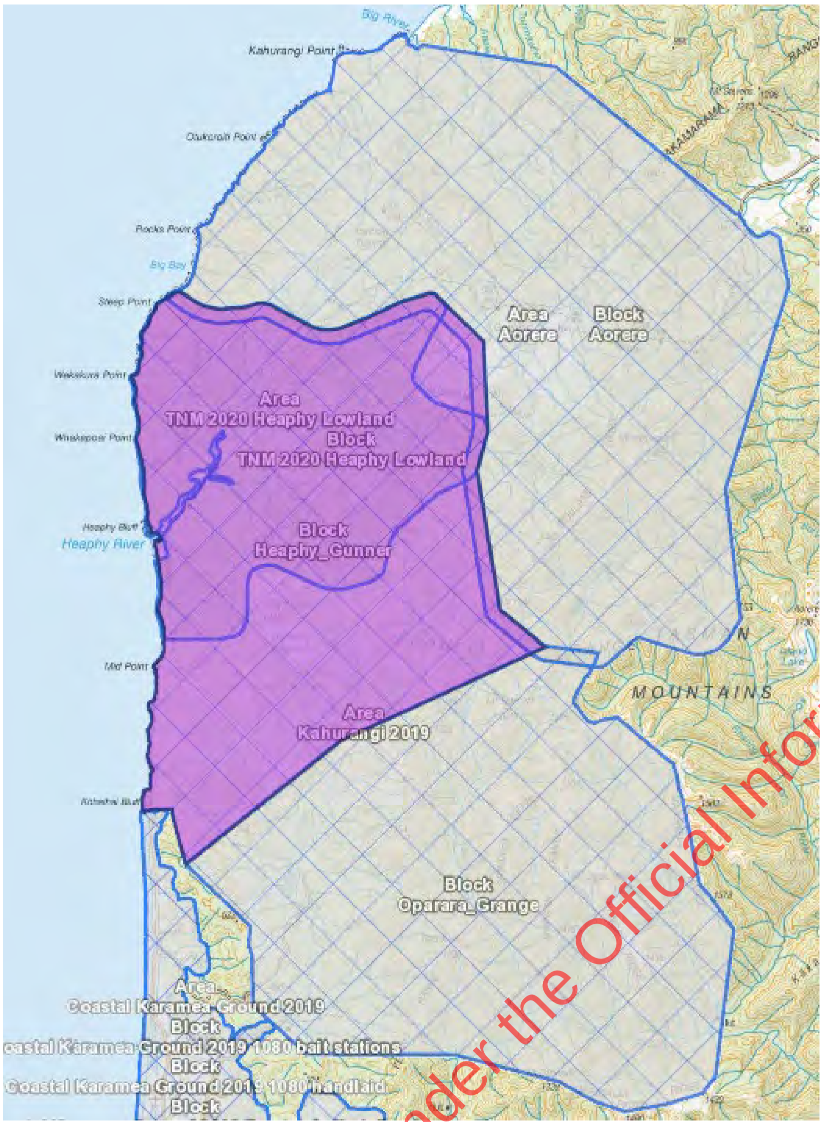


Figure 14. Heaphy-Gunner aerial predator control Tiakina Nga Manu operational area in purple.

Table 1. Record of aerial rodent control in the Heaphy lowlands area.

Site	Control frequency	2016	2017	2018	2019	2020
Heaphy lowlands	Annual	Yes	Yes	Yes	Yes	No

Result monitoring from the 2019 operation showed only a minor reduction in the Heaphy lowlands rat tracking (from 80% to 49%) and by February 2020, rat tracking was up to 81%. As part of the wider research project, a further aerial 1080 operation was planned for Spring 2020; however, due to the poor results from the 2019 operation it was considered too risky and no operation is planned for Spring 2020. The effectiveness of the operation in reducing rat numbers is discussed in the Pest Trend Monitoring Section later in this report.

Pig control

Pigs are known to predate *Powelliphanta* snails and damage vegetation by systematically turning over soil when rooting for food (Fig. 15). Pig sign has been seen mid-2020 along the coast north of the Heaphy River and on the northern bank of the Heaphy River around the Lewis Hut. Most pigs found in August 2019 where around Kahurangi Point.

Hunters with trained pig dogs searched the Heaphy coastline immediately north of the Heaphy River mouth to Kahurangi Point in August 2017 and controlled 31 pigs. In August 2019, 11 pigs were controlled in the same area and along the Heaphy River (Fig. 16).

Pig management in 2020/21 will focus on continuing control along the Heaphy River and the coastline to the north to prevent southward spread. Establishing the extent of their spread inland from the coastal occupation sites is a priority.

Figure 15. Nīkau palm (*Rhopalostylis sapida*) damage caused by pigs, Tiropiuhi Stream area, Heaphy Valley. *Photo: Jane Williams*

Figure 16. August 2019 Pig hunters' maps showing area searched, with 7 boars, 4 sows, 2 hinds and 1 stag shot. Three deer and a possum were shot along the Heaphy River. One boar and sow were shot at Big Bay, the rest at Kahurangi Point.

Pest trend monitoring

Rodents

Rodent tracking lines have been established and run by DOC over a number of years in the Heaphy catchment, providing information about when 1080 operations are needed, and also helping to build a national picture about the relationship between beech tree seed production and rodent population levels. Twenty tracking tunnel lines are currently established within the Heaphy project area. Ten lines are in low-altitude forests in the Heaphy Valley (lower Heaphy), with a further ten lines in high-altitude vegetation at Mackay Downs and Gouland Downs (Upper Heaphy).

After a successful aerial 1080 bait operation to reduce rat numbers across Kahurangi National Park in November 2014, rat tracking rates steadily increased, hitting pre-treatment levels within 1 year. High tracking rates have been recorded, particularly in the lower Heaphy, even in years when low amounts of seed are produced by beech or podocarp canopy trees. Possible explanations for this include:

- High productivity of all rodent food sources in lowland mild-climate rainforest sustains naturally high numbers of rodents.
- The presence of treatment exclusion zones around track and hut facilities is providing a breeding reservoir from which rats can migrate and rapidly repopulate treated areas.

The Heaphy area received further aerial 1080 applications over two blocks in September 2016 (Block 1) and February 2017 (Block 2). While tracking tunnel results for Block 2 decreased from 95% to 5% following the February 2017 treatment, tracking levels remained high for Block 1 (Woolmore 2017). Due to persistent high rat tracking indices following the 2016/17 treatment, the Heaphy area received both aerial and ground pest control in September 2017 at low altitude sites (< 500 m asl) targeting rodents as part of DOC's Tiakina Ngā Manu programme.

Aerial 1080 pest control over the Heaphy lowlands (33,700 ha) was completed in November 2019 as part of a 4-year annual control trial in the area. The 2019 operation was considerably less successful than previous control operations. Following the November 2019 operation, tracking tunnels in the lower Heaphy valley recorded 49% rat tracking and 20% mice tracking, and 81% rat and 43% mice tracking in Feb 2020 (Figs 17, 18).

Reasons for this were discussed in the report 'Maintaining 1080 effectiveness in repeat-use regimes, with attention to the proposed Heaphy 2020 re-treatment by Josh Kemp (Appendix 9), excerpt below.

'The poor kill in 2019 cannot be easily attributed to most of the usual suspects. Heaphy 2019 was double prefed at high sowing rates and fully overlapping flight paths. A prefeed interval from the second prefeed to the toxic operation was relatively long at 44 days, but other operations in 2019 performed poorly with much shorter prefeed intervals and others performed well with longer ones. The bumper seed crop of 2019 is a tempting reason, but the operation was in November, making the context similar to the successful Oparara 2014 operation. Plausible reasons other than genetic resistance, and some unique combination of bad timing relating to the long prefeed and the possibility that the mast seed of 2019 was not completely germinated are difficult to produce. Learned aversion seems plausible at first glance, with only 11 months elapsed since the Heaphy 2018 operation, but Heaphy 2019 would have contained many new rats recruited during this period. In any case, the double-prefeed of 2019 should theoretically have overcome remaining learned aversions. Genetic resistance and a long prefeed interval at the end of a super mast seem the most likely reasons.'

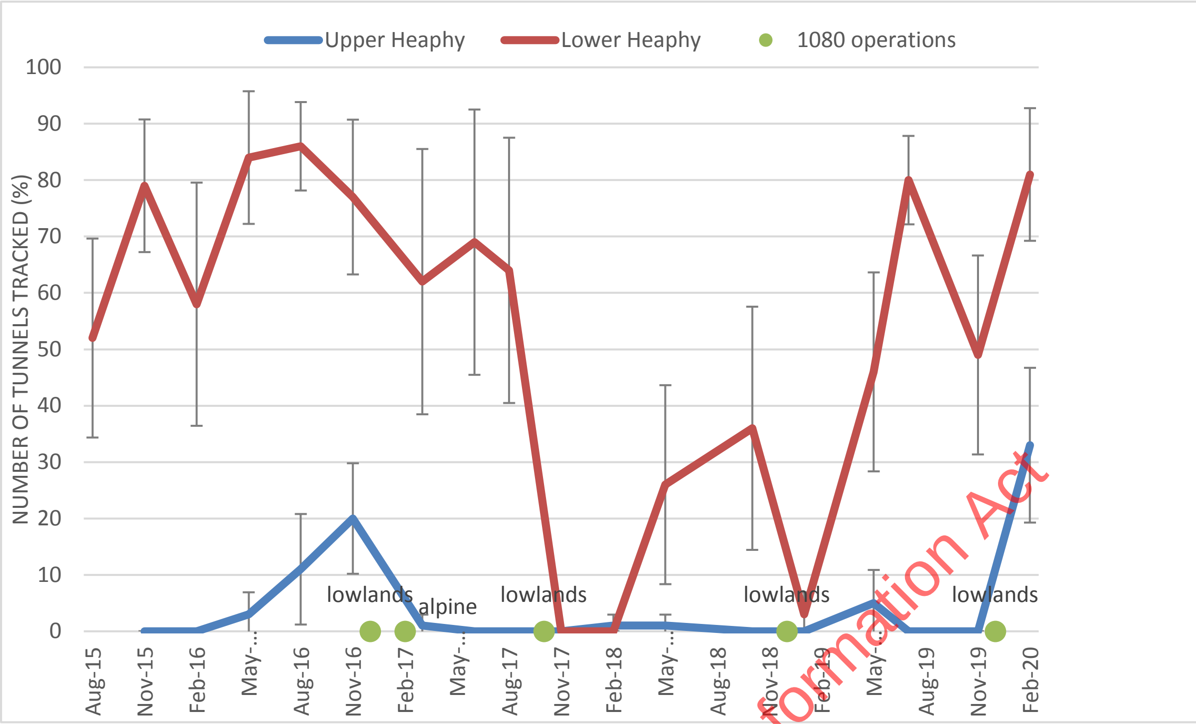


Figure 17. Percentage of tunnels tracked by rats in the Lower Heaphy areas from August 2015 to Feb 2020.

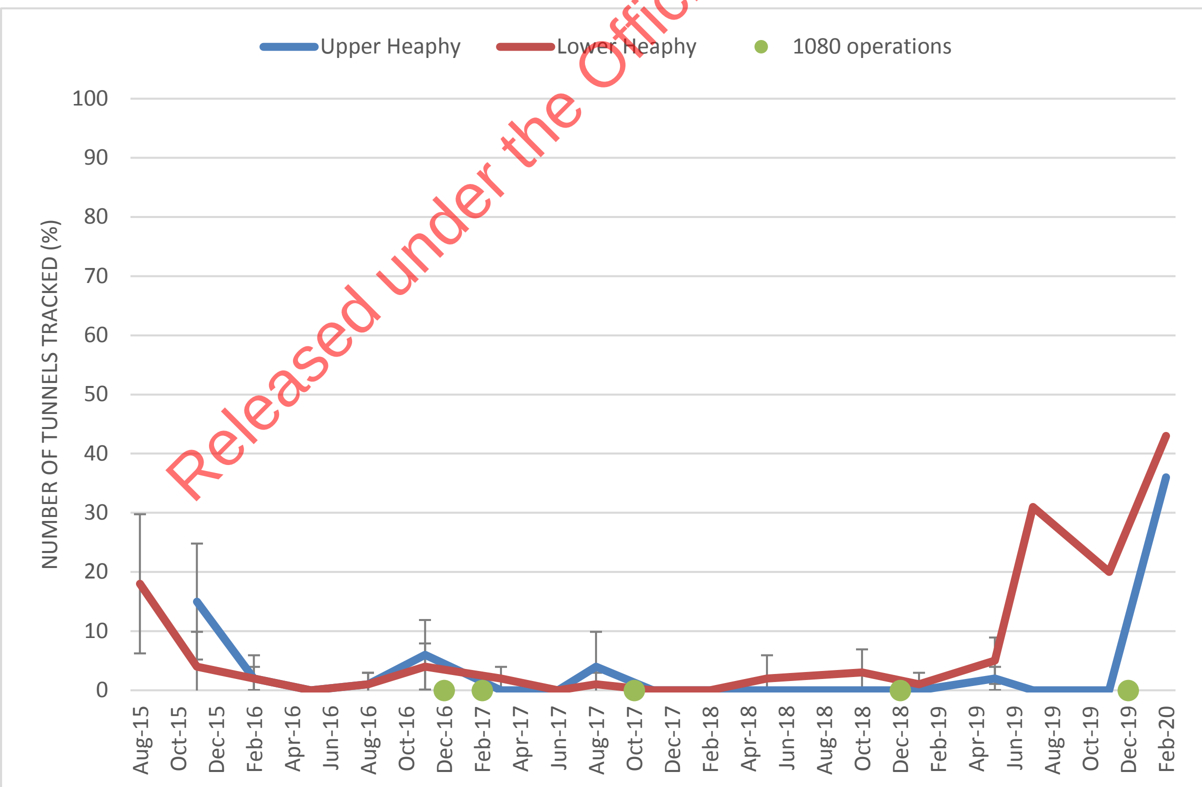


Figure 18. Percentage of tunnels tracked by mice in the Upper and Lower Heaphy tunnels from August 2015 to Feb 2020.

Foliar Browse Index (FBI) monitoring

FBI monitoring was carried out at the same time as the measuring of the 20×20m vegetation monitoring plots set up in 2009. The trees in these plots, plus additional fuchsia and wineberry trees, were re-measured between December and March 2019/20.**Summary** from Foliar Browse Index report: Heaphy 2010–2020 by Cielle Stephens (Appendix 4):

'Foliar Browse Index (FBI) monitoring in the Heaphy area suggests that possum control in the form of aerial 1080 operations has been successful in maintaining the condition of possum-sensitive tree species such as fuchsia, wineberry, mahoe, lancewood, northern rātā and southern rātā. We found foliage cover of these species to be at healthy levels (>50%), suggesting tree canopy in the area is in good condition. Mortality was raised compared to what are assumed to be natural background levels, but we attributed this to catastrophic events in the area (flooding and slips) and the young age of the trees. Browse incidence was raised in the latest measurement, suggesting recently increased impact of possums. As possum numbers have not been monitored since 2012, we suggest conducting an RTCI or waxtag measurement. This will ascertain whether the annual predator control operations targeted at rats are successful at reducing possum densities. Ground-based possum control around the Great Walk huts is suggested to remove remaining pockets of possums from these exclusion zones. Future FBI monitoring will be helpful in continuing to assess the long-term effectiveness of possum control.'

Seed fall monitoring

A total of 24 seedfall traps were established in the Heaphy valley in 2015 in silver beech (8), hard beech (8) and rimu (8) forest (Fig. 19). These traps have been installed to allow more accurate predictions of potential rodent irruptions within the catchment and are located under key canopy species where heavy seeding is likely to drive rodent irruptions. Rimu and hard beech produce large seeds which provide a good food source for rodents and are mainly present in forests at lower elevations, while silver beech produces much smaller seeds of lower food value to rodents but is a widespread canopy tree. Seed is collected and counted using the same methods described for Denniston seed traps.

Seed traps are run from January to June when the bulk of seed production occurs. Heaphy seed collection results from January to June 2019 were lower than the results in Denniston; however, both indicated a high level of seed production. Total volume of seed produced by the species monitored was substantially less than in the previous 2016 mast year. Rimu produced 1158 seeds/m^2 and silver beech produced 1399 seeds/m^2 (Fig. 19). However, hard beech seed production increased from 8 seeds/m^2 in 2018 to 3545 seeds/m^2 in 2019.

Rimu produced a high level of viable seed in 2019 at 75% viability while hard beech had a 61% viability rate (Fig. 20). Silver beech had the lowest viability rate at 38%.

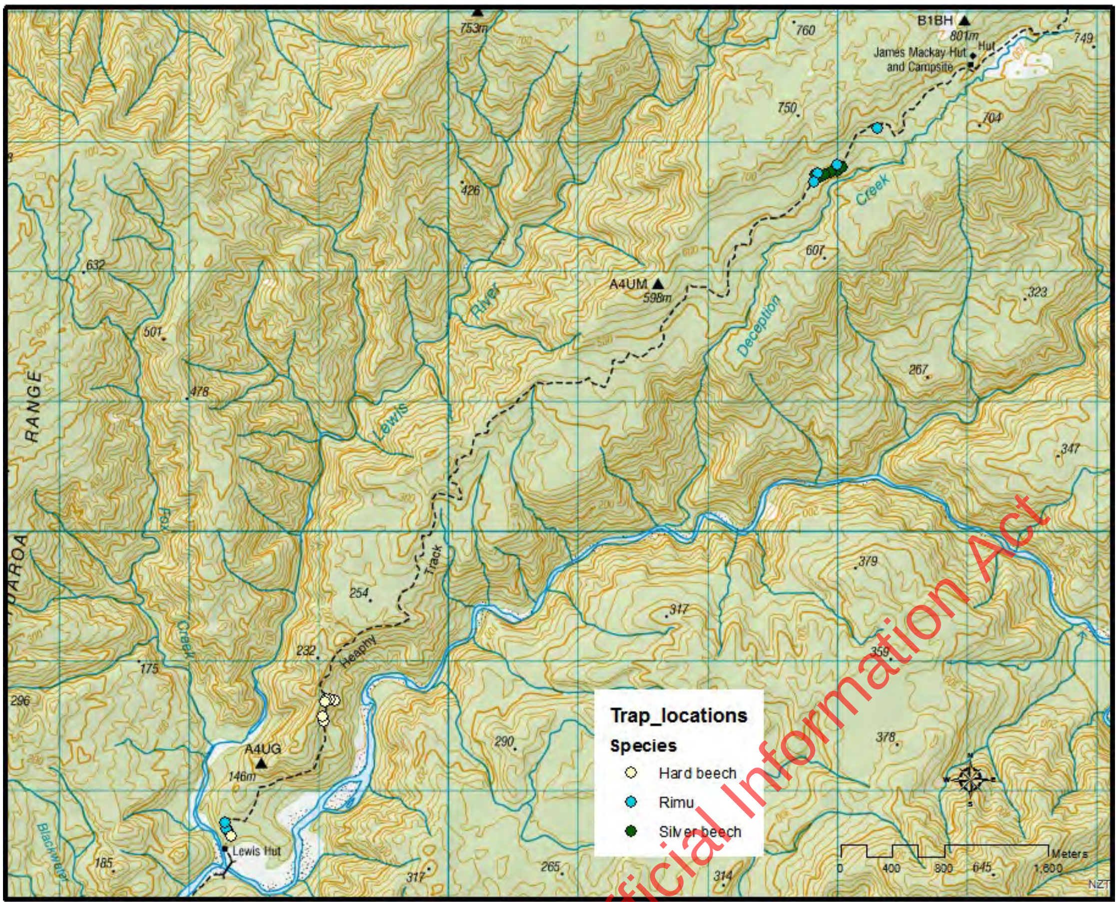


Figure 19. Location of 21 seed fall traps for hard beech, rimu and silver beech in the Heaphy Valley.

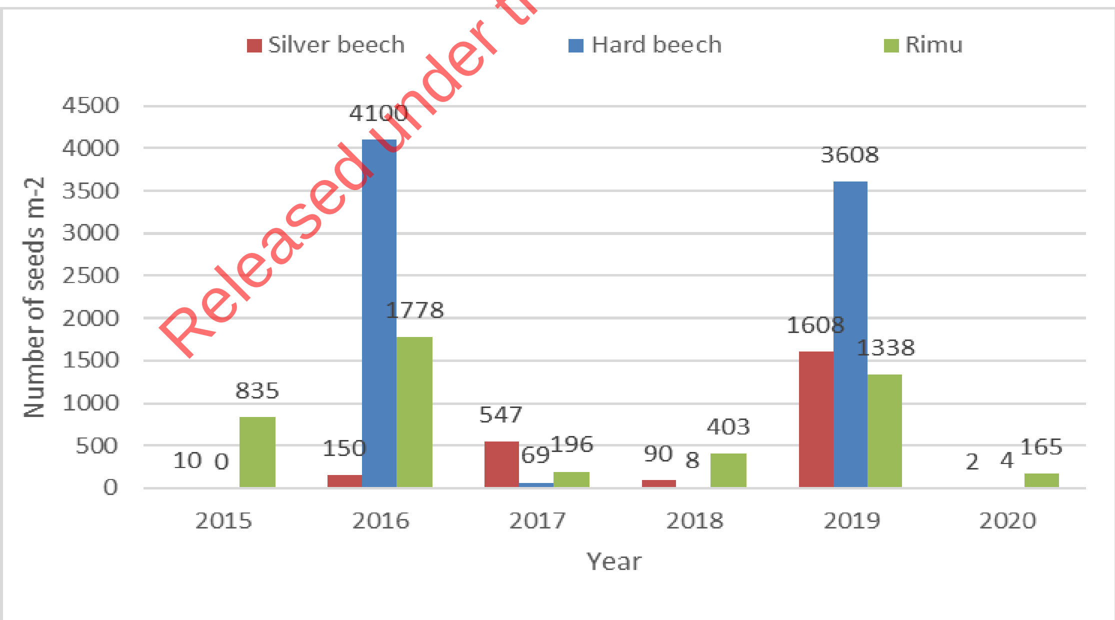


Figure 20. Total number of silver beech (red), hard beech (blue) and rimu (green) seeds/m^2 collected in seed fall traps in on the Mackay Hill in the Heaphy from January 2019 to June 2019.

Biodiversity management

Bat survey

Since 2017, 50 bat detectors have been set out at repeated survey sites along the Heaphy and Gunner Rivers specifically targetting long-tailed bats (*Chalinolobus tuberculatus*). This study will be used to model the number of detectors and recording time required to confidently detect changes in bat indices at the monitored sites over time periods of 5 years or less. The survey in 2020 followed the same method, with detectors being set up over a minimum period of two and a half weeks between 24 Feb and 30 March 2020. The number of passes at each recorder was analysed and plotted on a map in a report by Moira Pryde in Appendix 5.

Discussion from Pryde 2020: Kahurangi bat analysis 2019/20 (Appendix 5):

'It appears that the bat activity has increased this year, but the difference is not significant. The 2020 survey reduced the number of stations to 25 from 48 based on the previous data. Unfortunately, some of the recorders did not last the full number of days so the amount of data was reduced. This resulted in larger confidence intervals and a decreased ability to assess the change in activity. Recommendations by Jane Williams are to replace all the Powerex batteries. The number of monitoring days should be increased to 12 based on the current data.'

Great spotted kiwi call counts

Summary from Stephens 2020: Great spotted kiwi, roroa, call count monitoring report for Heaphy Valley and MacKay Downs 2019 (Appendix 6):

'Great spotted kiwi roroa (*Apteryx haastii*) is listed as a threatened species, categorised as Nationally Vulnerable. Kahurangi National Park is one of the species' strongholds. To follow trends in the kiwi population over time, kiwi call count monitoring was established in the Heaphy valley in December 1994 with repeat measures in December 1995–97, 2002, 2007, 2012, 2016 and 2019. Call count monitoring in the MacKay Downs was established in March 2015 with remeasures in March 2016 and 2017, and December 2019.

The observed average of 6.33 calls/hour in MacKay Downs in 2019 matches call count rates observed in other high-altitude areas nearby. In contrast, the call rate observed in the Heaphy valley (10.3 calls/hour) was much higher than reported for nearby lowland sites. For both sites, our data suggest an increase over time, but the large variability and the change from March to December measurement at MacKay Downs cast doubt on these trends.

Further monitoring and a comparison of call rates between March and December are required to gain more confidence in the results. This is particularly important as the monitoring is intended to assess the effect of intensive predator control in the area. We recommend continuing with the observer-based monitoring at both sites as planned in three years' time, i.e. 2022/23, to continue this historic data set. Monitoring using acoustic recorders should be implemented at higher frequency to better understand variability of call rates during and in between years. Consistent annual data collection is likely to pick up trends in call rates and presumably the kiwi population sooner.'

Figure 21 shows locations of MacKay Downs and Lower Heaphy kiwi listening stations.

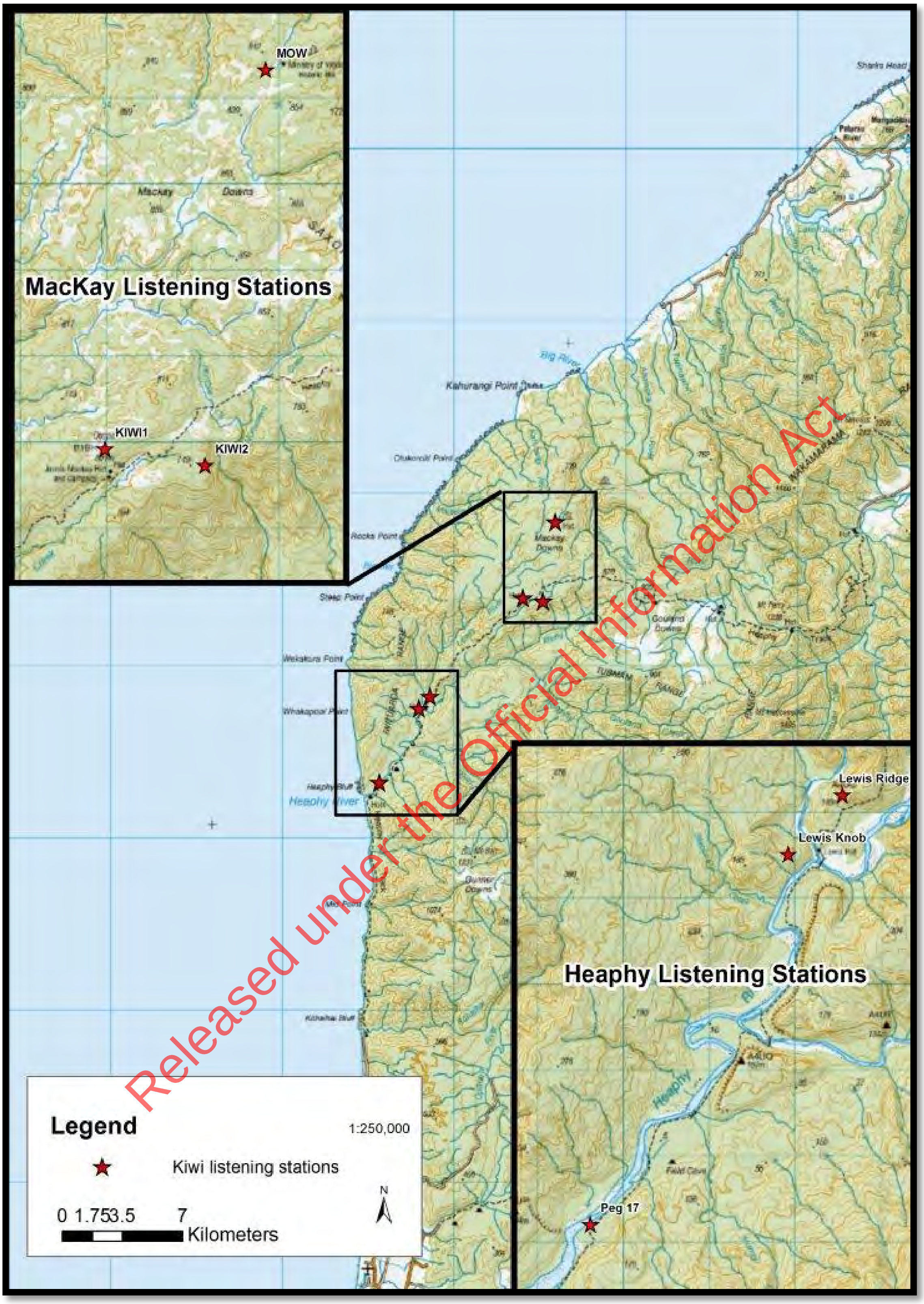


Figure 21. Location of the MacKay Downs and Lower Heaphy listening stations.

5-minute bird counts and distance sampling

Five-minute bird counts (5MBC) provide indices of relative abundance and population estimates using distance sampling and are standard monitoring methods used nationally to detect changes in forest bird populations over time. The intention of this work in the Heaphy area is to establish a baseline assessment against which any changes in diversity and relative numbers of forest birds can be recorded as predator management proceeds. Baseline measurements using bird counts and distance sampling where undertaken from 2015 to 2017. The ongoing programme consists of the Lewis valley being surveyed annually, with the higher-altitude Mackay sites being surveyed every 3 years.

Methodology and layout of distance sampling and five-minute bird count locations are the same as the previous 4 years, using the six lower-altitude (<500 m asl) grids of 25 systematically arranged sample points with surveys undertaken following the methodology currently used in DOC's Tier 1 monitoring programme (Fig. 22).

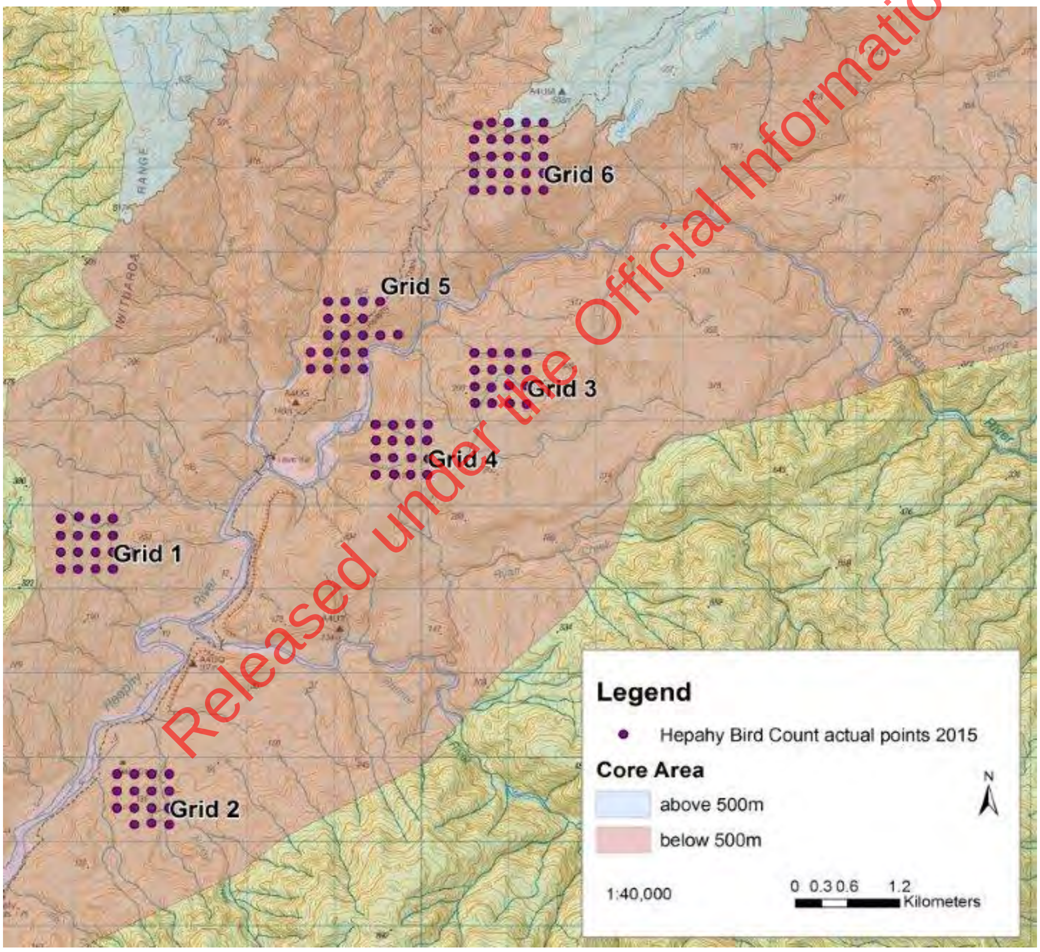


Figure 22. Location of the five-minute bird count and distance sampling points in the Heaphy management area in the area below 500 m asl (Lewis) as measured in 2015.

Results from the 2019/20 counts are documented in an unpublished report (Appendix 7). A summary of this is provided below. An article was released to the media on the results of the bird monitoring over the past 5 years (Appendix 8).

Discussion from Stephens 2020: Heaphy Management Area bird survey September 2019 (Appendix 7):

'This report presents results from bird population monitoring in the lower altitudes (< 500 m asl) of the Heaphy valley. The monitoring was undertaken to assess management efficacy, as the Heaphy area is managed for biodiversity enhancement in compensation for biodiversity losses incurred due to coal mining on the Denniston Plateau. We conducted five-minute bird counts and distance sampling on randomly placed monitoring grids to assess the status and trend of the local bird populations between 2015 and 2019. The five-minute bird count data detected increasing relative abundance for several native forest species (bellbird, fantail, grey warbler, kākāriki, robin, silvereye, tomtit, tūī and weka). The distance data also suggested increasing population densities for bellbird, fantail, silvereye, tūī and weka. The results are encouraging, as the intensive predator management implemented in the area appears to benefit the local bird populations. We recommend continuing with the annual monitoring to gain confidence in the results and establish the long-term outcomes of the management. Both methods, five-minute bird counts, and distance sampling should continue to be used to align the present study with the Department's national biodiversity monitoring system.'

20×20 exclosure plots

Nineteen exclosure plots were re-measured in early 2020 by the Tier 1 monitoring team. No significant ecological change was noticed in comparison with the previous measurements in 2016/17.

Powelliphanta monitoring

Due to the COVID-19 lockdown, the *Powelliphanta* monitoring was unable to be completed. The next plots due for monitoring will be completed in March 2021.

Takahe

Takahe on Gouland Downs are managed by a team based in Takaka. This is the second wild population outside of the Murchison Mountains in Fiordland. The takahe were released in 2018 into an area protected by intensive trapping. One takahe, Kapakapapanui, is often seen around the Mackay Hut area – see Kapak20 in Fig. 23. Trials of takahe uptake of non-toxic 1080 baits were carried out in 2017 and 2020.

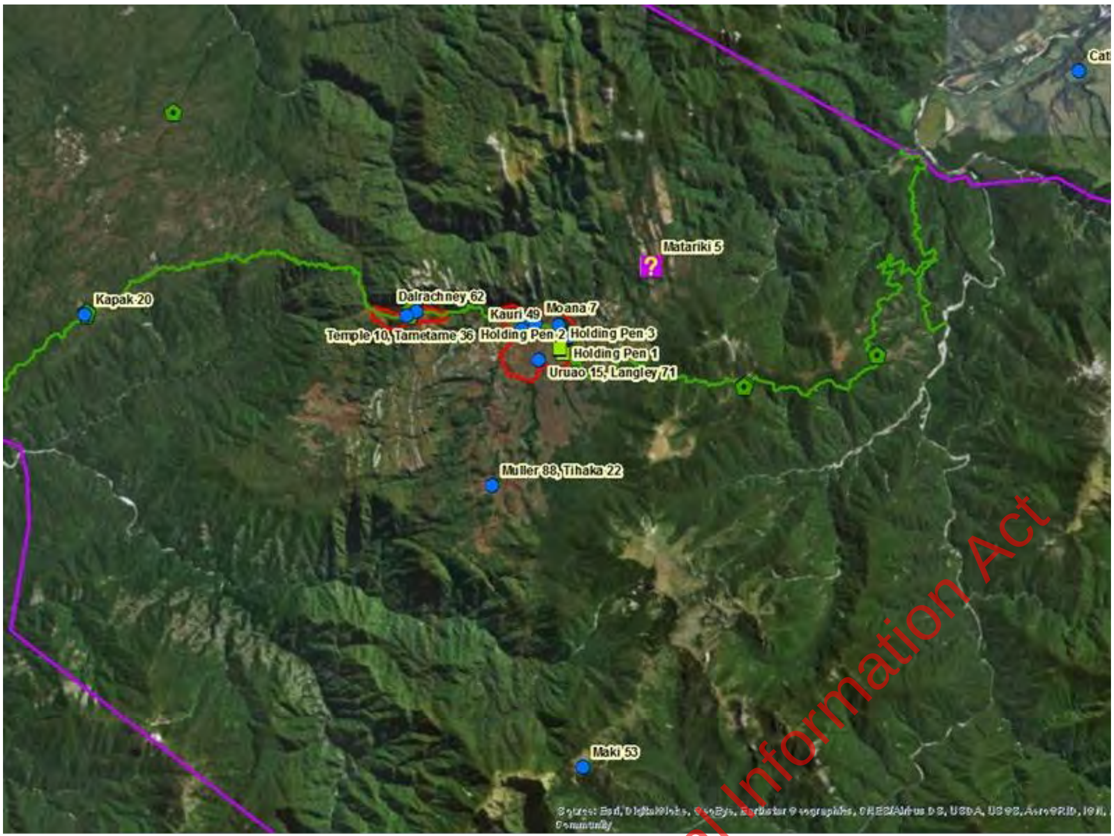


Figure 23. Location of takahe on the Gouland Downs bordering the Heaphy management unit Jul 2020.

Threatened plant monitoring

The coastal cress *Lepidium flexicaule* is found in only a few places in New Zealand: Auckland, Coromandel, Buller and Westland. While it can exist in a range of sites, it typically grows in fine sandy material between boulders or in rock crevices. Often found where few other plants are present, *L. flexicaule* is associated with areas of regular disturbance and high fertility resulting from sea spray, presence of sea birds and decomposition of stranded material (Norton 1995). The major threats to *L. flexicaule* are natural disturbances such as severe storms inducing coastal erosion, rabbits, insect browse and habitat loss.

In the 2019/20 season, only the Scotts Beach and Koura Point sites of coastal cress *Lepidium flexicaule* were revisited, and a census count completed. Eight plants were identified, one less than the previous year for the Scott's Beach sites. Individual plants were counted, and their diameter and reproductive status recorded. Seed collection was delayed a year due to the Covid-19 lockdown.

Five people surveyed for *Caprosma talkbrockiei* on Gouland Downs, but no plants were discovered. A tracklog of the area searched is provided in Fig. 24.

Figure 24. Search area for *Caprosma talbrockiei* on Gouland Downs outlined in green. Purple line is the Heaphy track.

Financial summary

Table 1. Summary of expenditure by task for the project from 1 July 2019 to 30 June 2020.

Heaphy	Programme	Costs ($)
Pest plant management	Weed survey	–
Pest plant management	Weeds ground	29,849.17
Pest animal management – control	Pig control ground	19,414.00
Pest animal management – control	Rodent control	257,888.43
Pest animal management – trend	Small mammal index monitoring –	34,339.43
Pest animal management – trend	Possum waxtags	–
Pest animal management – trend	Seedfall monitoring	4,508.00
Biodiversity outcome monitoring	Bat survey	12,727.91
Biodiversity outcome monitoring	Kiwi monitoring	15,000.00
Biodiversity outcome monitoring	Snail monitoring – Mackay	–
Biodiversity outcome monitoring	5 min bird and distance counts	12,289.86
Biodiversity outcome monitoring	20×20	20,000.00
Biodiversity outcome monitoring	Foliar Browse Index	5,770.40
Biodiversity outcome monitoring	Threatened plant management	12,064.75
Programme management	Project management costs	16,789.86
	Total Heaphy	**440,641.81**
Denniston	**Programme**	**Costs**
Pest plant management	Weeds control	22,949.50
Pest plant management	Weeds survey	1,000.00
Pest animal management – control	Rodent control	7,279.00
Pest animal management – trend monitoring	Small mammal index monitoring - Stoats and rodents	32,817.00
Pest animal management – trend	Seedfall monitoring	508.70
Biodiversity outcome monitoring	Snail monitoring	–
Programme management	Project management costs	15,489.04
	Total Denniston	80,043.24
	2019/20 Project Total	**520,685.05**

Acknowledgements

Many thanks to the people who contributed to the completion of this workJess Curtis, Morgan Newburry and MBC Environmental Ltd employees, Barry Chalmers, Brent Fagan, Moira Pryde, Graeme Quinn, Kate Simister, Dan Sawyers, Scott Freeman, Cielle Stephens and the Hokitika Tier 1 monitoring team for implementing various parts of the programme.

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Appendix 1: Project tasks achieved – Denniston

Type	Task	Summary	Rank Key priority 1–10 Secondary priority A	Status 2019/20
Control	1080 aerial full	Aerial 1080 for possum and rat control applied over 4400 ha. Carry out approximately every 4 years, either when possum density > 25% BMI, when required by TbfreeNZ for TB control, or when beech seed fall and rat monitoring indicate a mast year and predicted rodent irruption. Apply 1000 g 10 mm RS5 prefeed bait per ha broadcast. Apply 2000 g 20 mm RS5 toxic cereal bait per ha broadcast. Add 0.17% d-pulegone as a bird repellent to both prefeed and toxic bait. Use cinnamon lure at 0.3%. Allow a minimum of 4 nights between prefeed and toxic bait application. Treat narrow gullies (250 ha) with trickle-sown bait. Timing: late winter-spring.	1	Not programmed
Control	Possum/rat ground	Ground-based possum control over areas on Denniston plateau where aerial baiting cannot be used, such as the area around Denniston township and water catchment at Lake Stream/Christmas Stream. Use lured chew cards to detect possum presence in forest/scrub areas and deploy appropriate kill trap devices or poison baits. Near Denniston, use devices less risky to domestic animals.	2	Not programmed
Result	Seedfall monitoring	Set up approximately 16 beech seedfall traps. Open traps every year beginning of Feb and collect seed end of May. Assess viable seed and counts by beech species.	3	Achieved
Result	SMI monitoring	Random placement of 15 rodent tracking tunnel lines in beech forest on the forested margins of the plateau.	4	Achieved
Result	Possum/rat (WaxTag) and chew card monitoring	Minimum 15 lines of WaxTag method using random start points in forest and scrubland strata. Carry out following each aerial pest control operation and at 2-year intervals for trend monitoring. Deploy chew cards in scrub-covered pavement areas to detect possums and rats. 10 chew card lines in plateau shrubland and pavement habitat in Nov, Feb and May, plus Aug if a seed mast event is indicated. Chew cards placed along transects in plateau forest, shrubland and other likely habitat; twice a year.	5	Not programmed

Type	Task	Summary	Rank Key priority 1–10 Secondary priority A	Status 2019/20
Control	Rat and stoat control	Stoat by-kill from aerial possum and rat control. Localised trapping or poison baiting when SMI and/or chew card surveys indicate rats or stoats in habitat patches on the Denniston plateau. Use 1st generation rat baits, rodent kill traps and DOC 200 kill traps in tunnels if stoats are indicated.	6	Not programmed
Control	Weed control/ monitoring	Annual or biannual Nov, Mar. Ground spraying of target weeds. No aerial weed control 2019/20. Weed surveillance annually. Weed photopoints re-photographed Nov.	7	Achieved
Control	Goat control	Aerial search 3x per year first 2 years then reduce – target all DBEA potential goat habitat. Ground hunters with indicator dogs search potential goat habitat – 400 hours PA initially then reduce.	A	Not programmed
Control	Deer control	Aerial hunting 3x PA in conjunction with goat control. Ground hunting 400 hours PA then reduce to appropriate level.	A	Not programmed
Control	Cat control	As required. Assess occupancy. Deploy detection devices and where necessary use cage traps to capture and remove cats.	A	Not programmed

Appendix 2: Project tasks achieved – Heaphy

Type	Task	Summary	Rank Key priority 1–10 Secondary priority A–D	Status 2019/20
Control	Possum rat aerial 1080	Aerial 1080 for rat control over 16,000 ha.	1	Achieved
Control	Stoat control Whole area	By-kill from aerial 1080 operations	1	Achieved
Control	Possum rat 1080 ground aerial excluded area	Aerial baiting exclusion zones around huts will require regular localised possum and rat control. This will be achieved by: • Placement of A12 gas-operated possum kill traps in areas within 200 m of Heaphy, Lewis and Mackay Downs huts • Placement of weka-safe rodent bait stations within 200 m of Heaphy, Lewis and Mackay Downs huts • Use of captive (wired-in block) 1st generation pesticide, i.e. diaphacinone or bromadiolone • Service traps and bait stations at least twice per year.	2	Partly achieved – A24 placement only
Result	Seedfall monitoring	Set up approximately 16 beech seedfall traps. Open traps every year beginning of Feb, collect seed end of May. Assess viable seed and counts by beech species. Select a sample of podocarp trees and monitor for flowering and fruiting; March podocarp	3	Achieved
Result	Rat index monitoring (all)	Annual. Stratified, 4x per year. Tracking tunnels (rats) low valley/coastal strata < 500 m asl– 10 lines, mid upper slopes >500 m asl – 10 lines, infertile uplands – 5 lines. Run tracking tunnels in Nov, Feb, May and Aug (only if May results indicate rodent survival over winter).	4	Achieved
Result	Possum index monitoring	Biannual and post aerial pest control. Forest stratified. Wax tags (possums). NPCA protocol. 40 lines in 4 forest strata within 3 months of treatment and at 2-yearly intervals (trend monitoring).	5	Not programmed
Outcome	Bat monitoring	Develop and implement measures for monitoring long-tailed bats.	6a	Achieved

Type	Task	Summary	Rank Key priority 1–10 Secondary priority A–D	Status 2019/20
Outcome	Snail monitoring	Permanent plots – there are three snail sites already set up, two treatment sites and one non-treatment site. A fourth site will be established for *Powelliphanta superba prouseorum* and *P. s. gillesi*. Sites will be monitored every 3 years @ one site per year. (3 sites only).	6	Not achieved
Outcome	Whio monitoring	Whio populations will be monitored with four walk-through surveys per annum covering those rivers where birds were found during initial surveys. Unoccupied rivers with suitable habitat will be surveyed once a year. This will provide population trend data over time. The outcome target is to achieve a sustained increase in the population with birds occupying all suitable rivers in the project area.	7	Not programmed
Outcome	Kiwi monitoring	Kiwi call count monitoring over a range of altitude and vegetation types. Three hours of call counts will be done for six nights at each listening station. This procedure was repeated for three consecutive years for baseline data and next will be 22/23 and annual acoustic recording at the same time of year (Dec).	8	Achieved
Outcome	Foliar Browse Index FBI	Five species monitored 3-yearly; including northern rātā, wineberry, fuchsia.	9	Achieved
Outcome	Five minute bird counts 5MBC and distance sampling	Set up approximately 200 bird monitoring stations, a minimum of 200 m apart. Due to change of 1080 regime, now carried out annually; Mackay every 3 years.	10	Achieved
Outcome	Seedling Ratio Index SRI	3-yearly; 20 lines 200 m apart in deer/goat-used habitat if ungulate control is instigated.	A	Not programmed
Survey	Ungulate – goat, pig?	Surveys to establish locations for control and establishment of SRI plots.	A	Not programmed
Survey	Survey and Inventory	As required – kākā, kea, whio, mistletoe, bats, sand tussock, pīngao, *coprosma talbrockiei*, lizards, invertebrates, freshwater fish. Aerial and ground surveillance, pitfall traps, bat recorders, call back counts.	A	Not programmed
Control	Deer control	Annual. Aerial search and cull operations 3x per year in spring and autumn. Record search area with GPS and observations/kills. Ground search and cull operations 1x per year. Record search areas with GPS and sign observations and kills.	B	Not programmed

Type	Task	Summary	Rank Key priority 1–10 Secondary priority A–D	Status 2019/20
Control	Goat control	Annual. Aerial search and cull operations 3x per year. Record search area with GPS and observations/kills. Ground search and cull operations 200 hours. Record search areas with GPS and sign observations and kills.	B	Not required
Outcome	5x5 canopy gap exclosures establish	Establish and measure up to 40 5x5 vegetation plots. The first year will require a flight around the Heaphy Management Unit to locate gaps in the canopy to place plots. The initial set up on the plots will be labour intensive due to the establishment of the exclosures. The plots will be monitored on a 5-yearly basis but should also be checked yearly to ensure they still exclude ungulates (looking for damage due to windfall etc.).	B	Not programmed
Outcome	5x5 canopy gap exclosures	5-yearly remeasure, annual maintenance.	B	Not programmed
Survey	Small predator surveys	Surveys will be undertaken to establish the presence of other predators such as feral cats, hedgehogs and hares in the management area.	B	Not programmed
Control	Stoat control Heaphy Track	Establish kill traps from Kohaihai road end to past Lewis Hut.	C	Not programmed
Control	Stoat control targeted (WhiONE)	Establish kill trap lines using DOC 200? kill traps in double trap wooden boxes along sections of river (to be determined after survey). Assess new stoat killing devices, traps or poisons, as developed. Service monthly.	C	Not programmed
Control	Pig control	Annual if required. Cull if observed during aerial or ground search and surveillance operations. Record search areas, sign observations and kills with GPS. Targeted control with hunters and dogs.	D	Achieved
Control	Threatened plant management	A number of management activities will be undertaken to enhance populations of threatened or at risk plant species. • Coastal cress: collection and scattering of seed at suitable sites along the coastline, annually. • Sand tussock and pīngao: divide and plant tillers at the same or adjacent beaches, annually. • *Coprosma talbrockiei*: seed collection, ex-situ propagation and subsequent planting of nursery raised plants, annually from year 2.	H	Programmed - Not achieved

Type	Task	Summary	Rank Key priority 1–10 Secondary priority A–D	Status 2019/20
Control	Weed control/monitoring	Annual or biannual Nov, Mar. Aerial and ground spraying of target weeds. Weed surveillance annually.	H	Achieved
Outcome	20x20 remeasure	Remeasure of 20 plots in 'cool' forest ecosystems. Stratified by forest.	H	Achieved
Outcome	Threatened plant monitoring	Plant populations of sand tussock, pīngao, gossamer grass, coastal cress, *Coprosma talbrockiei* and *Gratiola concinna* will be monitored to measure their response management activities. Permanent transects or total counts will be used depending on distribution and abundance. The management target is to achieve an increase in abundance or extent for all species. Red mistletoe will be monitored by repeatedly assessing individuals for mortality, growth, foliage cover and browse damage. Mistletoe recruitment will be assessed by searching for new plants in permanent plots. This may be achieved as part of the permanent vegetation plots and FBI monitoring	H	Partly achieved

Appendix 3: Heaphy Weed Control Plan 2020–2025

Heaphy Weed Control Plan 2020–2025

Wekakura Point south – pīngao, a native dune stabiliser thriving as a result of marram grass control.

Compiled by Jane Williams, Brent Fagan, Graeme Quinn and Lynne Huggins

August 2020

Authorisation Signature: 

Updated	**July 30th 2020**

Amended Date	**Who**	**Amendment**	**Version**
15 August 2020	**Lynne Huggins**	**Plant id and read over document**	**2**
8 September 2020	**Jane Williams**	**Added sea spurge incursion response and Montbretia to Scotts Beach**	**3**

Introduction

The Minister of Conservation has issued an Access Agreement (AA) for Buller Coal Limited to undertake opencast coal mining on Denniston Plateau under Minerals permits and resource consents held by the company. Part of the AA makes provision for compensation to be paid by Buller Coal Ltd in recognition of impacts the mining operation will have on conservation values. These funds are specifically designated for biodiversity enhancement programmes in the Heaphy River catchment and on the Denniston Plateau. Management plans broadly outlining the enhancement work to be undertaken by the Department of Conservation (DOC) have been prepared by DOC for the Heaphy catchment and Denniston Plateau. Funding for the enhancement work is clearly tied to the AA between Buller Coal Ltd and DOC.

The purpose of this plan is to set in place weed control initiatives and practices which will provide greatest benefit to the indigenous communities and species, as well as protecting or enhancing historic and recreational values of the Heaphy Biodiversity Enhancement Project (HBEP) area. It provides a working document that supports the outcome objectives identified in the Department of Conservation Heaphy *Whakapoai* Biodiversity Management Plan 2013–2048 (Gruner 2013).

1. The site

The project area lies entirely within Kahurangi National Park in the north-west of the South Island. It extends from the Moutere River in the north to the Kohaihai River in the south and east to the Gunner and Gouland Downs (Figure 1). The area is centred on the Heaphy River catchment. It is approximately 29,000ha in size with a core management area of about 13,000 ha encompassing the lower and mid Heaphy Valley and the Iwituaroa Range. The core area is surrounded by a buffer zone to minimise reinvasion of pest species and thus increase effectiveness of management.

The project area covers an altitudinal range from sea level to approximately 1000 m. The dominant topographical features include forested hill country dissected by several large rivers and streams, limestone outcrops and bluffs, coastal escarpments and the Mackay Downs, a highly weathered granite plateau.

The Heaphy area has long been recognised as a place with high conservation values. The area was initially a regionally highly ranked management unit where threatened endemic land snail species (*Powelliphanta annectens, P. superba, P. gilliesi*) and possum vulnerable plants were managed. In 2011, the area was selected as a nationally representative Ecosystem Management Unit (EMU).

Human disturbance within the project area is relatively minimal and is largely centred around the Heaphy Track and associated huts and structures.

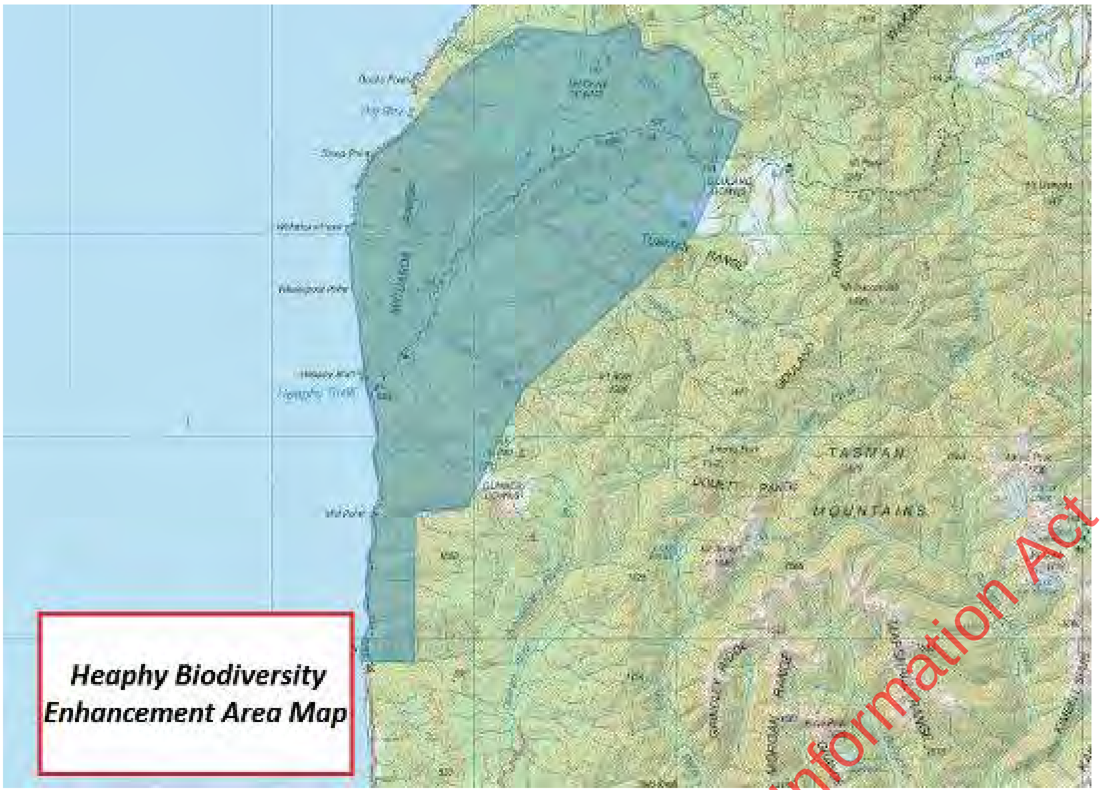

Figure 1. Map of Heaphy Biodiversity Enhancement Area.

2. Responsibilities

The Department of Conservation has a responsibility to control weeds that have the potential to "significantly and adversely affect the long-term survival of native species, the integrity or sustainability of natural communities, or genetic variation within indigenous species" (DOC Strategic Plan for Managing Weeds;" Owen, 1998). In addition, DOC has a responsibility to control significant environmental weeds under the Conservation Act 1987, the Reserves Act 1977 and Regional Pest Plant Management Strategy (RPMS) weeds under the Biosecurity Act 1993.

The Department also has responsibilities to manage historical features and sites under the Conservation Act 1987, the Reserves Act 1977, and the Historic Places Act 1993.

Weed control zones

For management purposes this plan will separate weed control areas into the following zones (Fig. 2):

Zone 1: Kohaihai River to Heaphy River

Zone 2: Heaphy River catchment including parts of Gouland, Mackay and Gunner Downs

Zone 3: Heaphy River to Rocks Point/ Cannington Creek

Figure 2. Weed control zones 1–3 as described in this section.

Zone 1: Kohaihai River to Heaphy River

Zone 1 includes the Kohaihai River mouth area which provides a potential seed source for weed invasion further north (Figs 3, 4). As a buffer zone it also includes from mossy Burn Creek on Kohaihai Rd north to the Kohaihai Shelter. Several weed species, not currently present in the core management unit, are present in this area, and in the absence of control they will continue to spread and have more significant impacts.

High priority weed species in this area include gorse, Kahili ginger, pōhutukawa seedlings, German ivy, karo, nasturtium, blackberry, cape gooseberry, scotch thistle and kikuyu grass. Secondary priority (because it is already well-established further north) is marram.

Lynne Huggins stated: "Pōhutukawa (*Metrosideros excelsa*) and karo (*Pittosporum crassifolium)* should be controlled at the Kohaihai shelter, they are a very real threat to the ecological integrity of this area".

In his book "Native Trees of New Zealand", Salmon states that karo is well established throughout the North and South Islands. However, in discussions with DOC botanists, while it may be established in the South Island, it is not endemic to these areas. It is indigenous to Great Barrier Island (Aotea Island) and the north of the North Island. It has become naturalised (lives in an area where it is not indigenous) in the South Island. In areas of high value all plants should be controlled to prevent them overtaking the local endemic forest.

Figure 3. Kohaihai River mouth and road end showing area of gorse infestation requiring boat access.

Figure 4.   Looking south from Heaphy Beach to Scotts Beach and Kohaihai Point.

Pōhutukawa, likewise, is noted as throughout the North Island and planted throughout the South Island. It has been suggested that a sample be taken and formally identified as some plantings undertaken in the 1970s included hybrids.

Both karo and pōhutukawa species are plants in the wrong place. They will have an impact on the environment, they will exclude native species, colonise areas making them into a monoculture, with no native regeneration. By displacing plant species there is the roll-on effect on native animals and insects, whose important food source or hiding place is no longer growing in sufficient numbers. They can change the pH, affect water uptake and could harbour pests and diseases.

Ngaio (*Myporeum laetum*) and akeake (*Dodonaea viscosa*) have also been planted. These plants are endemic to this area and are not an issue.

Zone 1 includes a variety of coastal habitat types including sandy beaches, rocky beaches and bedrock outcrops, as well as coastal slips, creek beds, tidal river mouths, abandoned pasture and disturbed track margins.

The highest priority weed species for control in this zone are gorse and tree lupin, which both have localised populations that have seeded in recent years.

Nasturtium and iceplant have several discrete patches north of Scotts Beach which are also a high priority for control.

High priority weeds that are currently not visible along the coast of zone 1 include Kahili ginger, pampas, pohutukawa, German ivy, karo, hydrangea, tutsan, broom, arum lily, montbretia, buddleia, blackberry, tibouchina. Surveillance for and control of these species needs to be ongoing.

Second priority for control is marram grass where pīngao, sand tussock or spinifex are present. (sand tussock and spinifex are not known from zone 1 at present (2020)). Marram grass control is to be undertaken only where potential coastal erosion due to the loss of marram has been carefully considered. Marram can be controlled using the herbicide Gallant (haloxyfop) which does not kill Pīngao.

Marram control methods in Table 1 are those recommended from Stewart Island / Rakiura operations.

Table 1. Marram control methods.

Chemical	Mixing ratios	Penetrant Oil
Hurricane (100 g/L haloxyfop-p-methyl)	Heli: 15 L per ha. Gun: 1000 ml per 100 L (1:100) Knapsack: 300 ml per 10 L	4 L per ha crop oil 250 ml per 100 L 300 ml per 10 L
Gallant Ultra (520 g/L haloxyfop-p-methyl)	Knapsack: 60 ml per 10 L Gun: 200 ml per 100 L	Uptake (60 ml per 10 L)

Kikuyu grass may need to be controlled in some places where it is smothering *Lepidium flexicaule* on the north end of Scotts Beach.

In the past, nasturtium, hydrangea, iceplant, lampranthus (trailing ice plant), kikuyu, blackberry and osteospermum have all been recorded and controlled in the Scotts Beach area south of Koura Point. Occasional Kahili ginger plants have been controlled in the past on the north side of the Kohaihai River and up around Scotts Saddle. Surveillance and control of ginger in this area is vital to protect the Park from reinvasion.

Sea spurge (*Euphorbia paralias*) (unwanted organism) was found at Scots Beach in August 2020. Confirmation of the identification of the one mature sea spurge plant found was made by the Ministry of Primary Industries (MPI). MPI will lead the incursion response. Sea spurge can drop up to 5000 seeds all year round, seed stays viable in the seed soil bank for up to 7 years and up to 2½ years in the sea. Regular surveillance and weed control of this species is the highest priority due to its "unwanted" status. DOC will be working with MPI for this response.

DOC is happy to carry out the operational work on elimination of this incursion. Fiona Thomson will lead the Scotts Beach incursion response, with Keith Briden having oversight. Rod Hitchmough and Verity Forbes will be kept in the loop. The operational work involves:

1. Removal of all existing plants, after providing opportunities for staff from Greymouth, Hokitika and Takaka offices to familiarise themselves with the plants, and for Fiona Thomson to visit the site and provide guidance on what data need to be gathered to inform future eradications. Follow up every 4 months over 10 years, removing all plants and collecting appropriate data each time. It is suggested that some plants be dried/preserved and kept as educational material.

2. As soon as possible after the plants are removed, either sieve or remove and deep bury sand to 30 cm deep over an area surrounding the site of the original parent plant, over a circle of radius of the distance

to the furthest-out seedling found. This is to remove as much as possible of the seed bank, to reduce occurrence of future seedlings at the site and to prevent storm-assisted dispersal along the shore. This will happen only once.

3. Once per year for 10 years, search 15 km of coast in each direction from the incursion site to look for satellite plants derived from seeds which may already have been dispersed by storms.

4. This coming summer (20/21), carry out a one-off helicopter survey of a much broader stretch of coastline to look for other populations.

Sea spurge (Fig. 5) lives in the surge zone, often amongst driftwood. It is a poor dune stabiliser and invades rapidly. The potential impact on biodiversity and the economy is great, as can be seen from Australia's example. An early coloniser, it grows in place of threatened native seabird nesting sites and threatened plants like sand tussock, coastal cress and pīngao. It can invade pasture and is toxic to stock. Its sap can blind temporarily and contact with skin causes inflammation. Seeds can stay viable in the ocean for 2 years and seed banks on shore for 7 years.

Use gloves and eye protection when handling this species and double bag any plants controlled.

Figure 5. The Euphorbia paralias *plant, exotic sea spurge, on Scotts Beach, is a minimum of 3 years old.*

Zone 2: Heaphy River catchment including parts of Gouland, Mackay and Gunner Downs

The most significant weed issues in zone 2 are gorse and tree lupin on the river flats of the Heaphy (Fig. 6) and Gunner valleys. There are three main categories of infestation here:

1. Gorse along track edges with tall native vegetation adjoining
2. Gorse away from river margins in relatively stable regenerating sites
3. Gorse along river margins and islands with frequent flood disturbance.

Gorse in category 1 sites need to be controlled for track clearance and aesthetic reasons, and to knock out the seed source for riparian areas.

Most of the gorse in category 2 sites inhabits areas that are in the early or middle stages of natural succession to riparian forest. Gorse in these areas will eventually be suppressed by larger native trees, so control is a lower priority. The reason for control here is to knock out the seed source for riparian areas when floods run through the young forest. Gorse in the regenerating forest can be controlled by cutting and pasting with Vigilant, which has no negative effect on surrounding vegetation.

Gorse in category 3 sites is a high priority for control. This gorse is displacing early successional vegetation and, due to the ongoing disturbance from flooding, is either unlikely to complete succession to native dominant vegetation before subsequent disturbance events or will supply seed to freshly disturbed sites downstream resulting in a "permanent" gorse ecotone. Gorse in this actively disturbed riparian area should be controlled, especially since the current level of infestation is relatively small.

Figure 6. Heaphy River.

Gorse control is best carried out in the winter when it is flowering. The aim of control is to work from the most upstream locations towards the lower river, ideally preventing any flowering gorse from setting seed. Ideally, each site where gorse has been found will be visited at least three times a year, with the aim of depleting the seed bank in the soil, after stopping any more seeding.

The lower Heaphy river has areas where access for gorse control is best via the river. These areas will require a boat to be used, particularly for the true right of the Heaphy river from mouth to approximately 2 km upstream (Fig. 7).

Figure 7. Gorse pre-control in July 2020 on the old airstrip north of Lewis Hut.

Gorse on the river flats and beaches (Fig. 8) is considered an issue where it impacts on access and or the visitors experience of "naturalness" along the Heaphy Track.

Tree lupin is also present in the Heaphy River valley at least as far up as the flats above Lewis Hut. Wherever practical, tree lupin should be controlled during gorse control operations to reduce impacts and seeding. Tree lupin flowers in the spring and there needs to be an effort at this time to remove all plants before they set seed. Hand pulling of Tree lupin is easy while plants are small and cutting and pasting with vigilant is effective on larger plants.

Areas and weeds marked for surveillance are shown on the map in Figure 9.

Figure 8. Gorse infestation on the north side of the Heaphy River in July 2020.

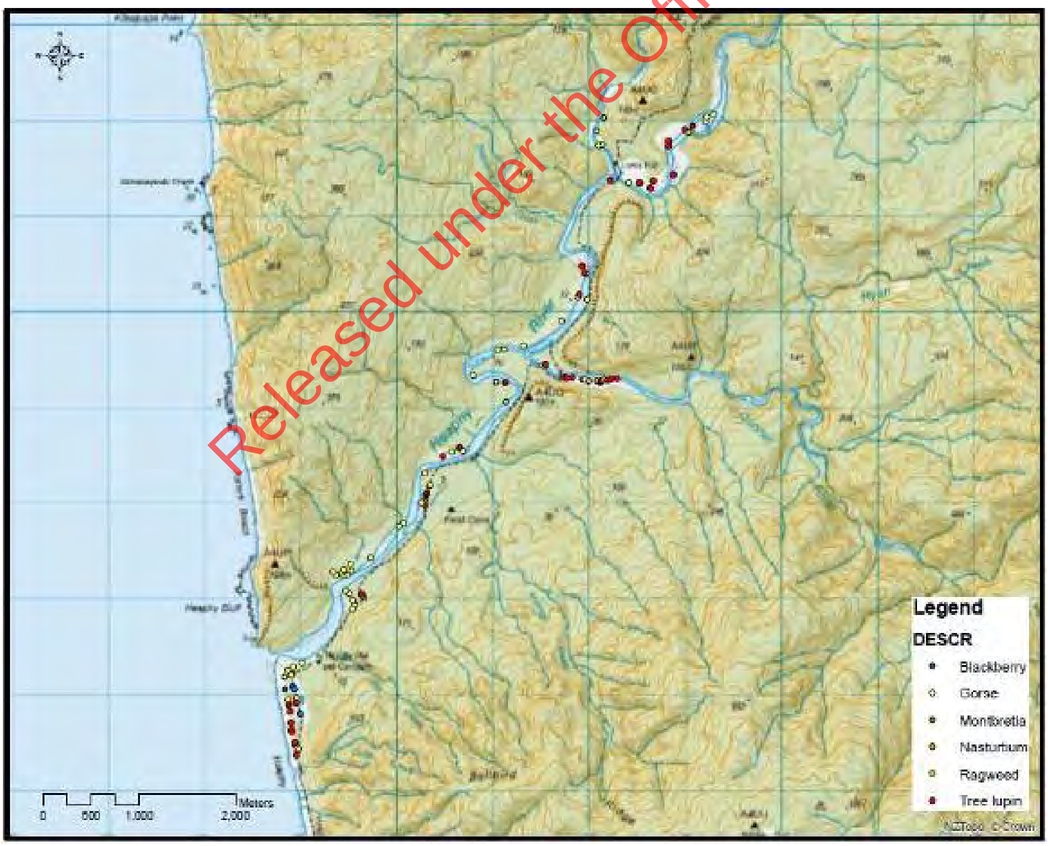

Figure 9. Location of infestations – Jan 2019 survey by Brent Fagan.

Zone 3: Heaphy River north to Moutere River

Most weed control north of the Heaphy River is confined to the coastal zone (Fig. 10) and is mostly marram and gorse control. Occasional tree lupin is also present. Tordon brushkiller is recommended for gorse in this zone and Gallant (haloxyfop) is recommended for marram control.

Due to the presence of the native sand tussock *Poa billardierei* in localised areas, special attention must be given to the protection of this species, as the sand tussock will also be susceptible to Gallant during marram spraying. Target gorse and marram on the beaches where sand tussock is present. It is recommended that all known populations of sand tussock are clearly marked prior to the spraying operation, to avoid applying herbicide. A suitable non-permanent method may be marking the sand with fluorescent marker paint (dazzle) around 1 m radius from each population.

During the 2015 biodiversity survey of the Heaphy coastline, one pampas plant was found and controlled amongst gorse near the south end of Porters Beach, reinforcing the importance of regular surveillance for new weeds along this coastline. The nearest known record of pampas to Porters Beach is previously controlled plants at Kohaihai.

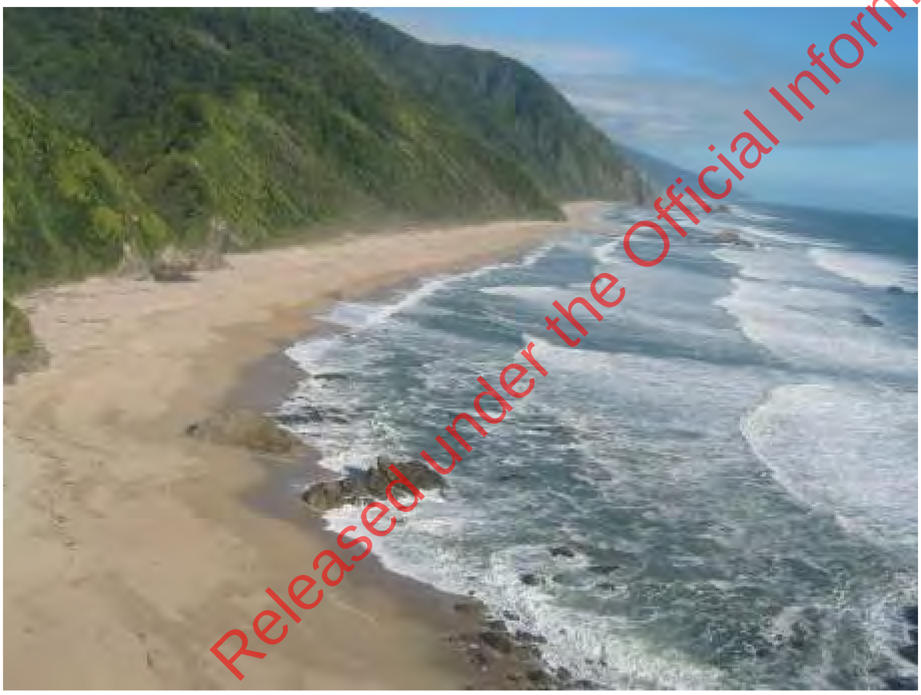

Figure 10. Coastline looking south from Wekakura Point.

Some slips in this zone have been invaded by significant populations of gorse (Fig. 11). While gorse on these slips does provide a significant seed source for gorse to spread onto beaches below, it is likely that residual gorse seed in the beach sands as well as seed spread from other sources along the coast are equally significant. Therefore, gorse will continue to invade along the beaches regardless of whether it is present on slips. Where gorse infestations on slips are well established and mature, the benefit of control is debatable. These mature populations are likely to already be supporting some recruitment of native seedlings which (in the absence of further slip disturbance) will eventually outgrow the gorse. Attempts to control the gorse will only set back the successional timeframe in these situations. Unless gorse is identified as being a relatively recent arrival on particular slips and its widespread establishment can be prevented by early control, gorse control on the coastal slips is not considered a priority.

As the vegetation in the gullies is infested with gorse, and low lying due to the harsh conditions, biocontrol may be an option.

Figure 6: Gorse well established high on slips above Porters Beach

3. Priority setting

Setting control priorities ensures that a wide range of the most important values are protected, and the greatest conservation benefit is attained for the resources committed.

The approach to weed management taken in this plan follows the Principles and Objectives set out in the Department of Conservation Strategic Plan for Managing Invasive Weeds (Owen 1998).

The highest priority is the prevention of new weed problems. This involves early identification of new weed incursions and minimising the numbers and containing the distribution of significant new invasive weeds where this is feasible. For the HBEP these efforts will be directed at:

- Surveillance to detect new incursions of invasive weed species at an early stage
- Controlling or managing any new weed incursions appropriately
- Containing, eradicating or reducing existing invasive species which have a very limited distribution and a high potential impact.

The second priority is site management, or the protection of important ecological, historic or recreational values at specific sites. This work will:

- protect the values of specific priority areas from a range of invasive weeds already well established in the HBEP area.
- Prevent further invasion of a range of weeds already well established in the parts of the HBEP into relatively weed free priority places.

Three main criteria are considered when deciding which areas to focus work in. These are:

- the number and significance of conservation values present
- the naturalness or degree to which conservation values are already degraded by weed or other threats
- the stage of infestation at which target weeds are established, and the risk of further spread.

Priorities are assigned subjectively based on assessment of the above criteria. Highest priority is given to the protection of nationally or regionally important conservation values in sites which remain largely unmodified.

Tasks in priority order include:

1	At least annual surveillance for new weed incursions in all three weed control zones, including control of any new incursions found. Surveillance should be undertaken by suitably experienced people.
2	Control to zero density of the following species anywhere they occur in the HBEP, on the basis of their current very limited distribution and potential for impact in the absence of control: • Kahili ginger – Kohaihai area up to Scotts Saddle. • Pampas – previously controlled at Kohaihai and one plant at Porters Beach in 2015. • Pohutukawa – all seedlings spreading upslope towards Kohaihai Lookout from the few mature trees at the Kohaihai Shelter. • German ivy – localised around Kohaihai and in forest margins along access road. • Karo – seedlings spreading upslope towards Kohaihai Lookout from several mature trees. • Tutsan – known from trackside and slips near track down to Scotts Beach from Scotts Saddle, and also around Kohaihai and further south. • Nasturtium – near eradicated along the track north of Scotts Beach, but more common around Kohaihai Road. • Kikuyu grass – anecdotal evidence suggests that where kikuyu grass is growing along forest margins near Heaphy Hut it provides favourable habitat for *Powelliwhanta*. Until more is known about this, no control of Kikuyu grass should be undertaken except for areas around *Lepidium flexicaule*, in particular on Scotts Beach. • Blackberry – infestation to be controlled at the Heaphy River mouth, and it is possible that there is more in the area. This is a priority.
3	Sustained control of gorse where it impacts access or visitor experience along the Heaphy Valley section of the Heaphy Track in Zone 1 and 2: • Gorse • Tree lupin

4	Control to zero density of the following species in Zone 3 where pīngao and/or sand tussock populations exist, to prevent their impact on coastal vegetation and to minimise their extent: • Gorse • Marram (Note the exception to the above being where gorse is well established on particular slips, where it should be left to allow natural succession by native forest species).

4. Species list

The following is a list of key weed species recorded from the Heaphy Biodiversity Enhancement Area including the buffer of Zone 1 beginning at Mossy Burn Creek continuing north to the Kohaihai Shelter. The Weedbuster program controls and reports on weed work south of Mossy Burn Creek along Kohaihai Rd, including around the old roadman's hut site.

Common name	**Botanical name**	**Comments**
Blackberry	*Rubus fruticosus* agg.	Occasional at Kohaihai Shelter and along Kohaihai Road. Large patch near Heaphy mouth lagoon and spreading around Heaphy River mouth coastal vegetation. Control Sept and Feb annually.
Cape gooseberry	*Physalis peruviana*	Occasional along Kohaihai Road.
German ivy	*Delairea odorata*	Kohaihai Road Shelter to Kohaihai River Bridge.
Ginger (Kahili)	*Hedychium gardnerianum*	Occasional in forest along Kohaihai Road, particularly uphill from the old roadman's hut site, and on the hillside above Kohaihai roadend (up towards lookout). Also controlled on the north side of Kohaihai River.
Gorse	*Ulex europaeus*	Common along the coast and Heaphy Valley, and on some high coastal slips.
Iceplant	*Carpobrotus edulis*	Scotts Beach. Control by hand pulling and digging out roots. Note: native iceplant *Disphyma australe* is the most common form around Scott's Beach and along the entire coastline. It has small purple flowers. Check credibility for exotic iceplant seen in past.
Karo	*Pittosporum crassifolium*	Infestation around Kohaihai shelter and on the eastern slopes behind.
Kikuyu grass	*Cenchrus clandestinus*	Fairly common along Kohaihai Road and Shelter. Also present at Scotts Beach and Heaphy Huts/Lake, and probably other sites in between.
Lupin (tree)	*Lupinus arboreus*	Fairly common in the Heaphy Valley up to at least Lewis Hut, common along coastline.
Marram	*Ammophila arenaria*	Common along sandy parts of the coast. Control around sand tussock and pingao populations.
Montbretia	*Crocosmia* x *crocosmiiflora*	On Scotts Beach north end.

Nasturtium	*Tropaeolum majus*	Localised patches along Kohaihai Road. Controlled in the past at Scotts Beach to Big Rock Beach. Three patches north of Scotts Beach 2020.
Pōhutukawa	*Metrosideros excelsa*	Several trees at Kohaihai road end and spreading up slope nearby.
Scotch thistle	*Cirsium vulgare*	Occasional on disturbed ground but not a major threat.
Sea spurge	*Euphorbia paralias*	On MPI "Unwanted" list. GPS, photograph and leave marker. Contact Senior Ranger Bathurst Project and MPI immediately. Do not touch! Response led by national incursion team and MPI. After given the go ahead, double-bag mature plants, being careful to not disturb the seeds.
Tutsan	*Hypericum androsaemum*	Occasional along Kohaihai Road, and as far north as Scotts Beach.
Velvety nightshade	*Solanum chenopodioides*	Common on disturbed ground and along coastal Heaphy Track.

Weed species in previous plan rarely seen in the last 5 years. Control if seen.
KR = Kohaihai Rd, SB = north of Scotts Beach.

Angels trumpet/datura	*Brugmansia candida* KR
Arum lily	*Zantedeschia aethiopica* KR
Broom	*Cytisus scoparius* KR
Buddleia	*Buddleja davidii* KR
Dimorphotheca	*Osteospermum fruticosum* SB
Foxglove	*Digitalis purpurea*
Greater bindweed	*Calystegia sylvatica* KR
Hydrangea	*Hydrangea macrophylla* KR, SB (south)
Lampranthus	*Lampranthus spectabilis* SB
Macrocarpa	*Cuppressus macrocarpa* KR
Pampas	*Cortaderia selloana* KR
Radiata pine	*Pinus radiata* KR
Rambling rose	*Rosa spp* KR
Three cornered garlic (onion weed)	*Allium triquetrum*
Tibouchina	*Tibouchina urvilleana* KR
Track rush	*Juncus tenuis*

5. The weeds

In alphabetical order by common name. Weblinks are provided giving further information and photographs of each species. For sea spurge, see the species list table in section 5.

Blackberry (*Rubus fruticosus*)

Blackberry is relatively limited in distribution, mostly confined to Kohaihai Road, with large patch near the Heaphy river mouth.

Objective: To prevent further spread and establishment of blackberry and minimise impacts.
Action: Check known sites annually and control any plants found. Undertake annual surveillance for infestations in new areas.
Method: Spray plants with picloram / triclopyr (Tordon Brushkiller, etc.) or metsulfuron.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=2973

Cape gooseberry (*Physalis peruviana*)

Occasional cape gooseberry plants have been recorded in forest margins and beach front along Kohaihai Road in the past, with some potential for it to spread.

Objective: Ensure cape gooseberry remains confined to its current distribution and does not spread north.
Action: Check known sites annually and control any plants found. Undertake annual surveillance for infestations in new areas.
Method: Spray with Grazon or Tordon Brushkiller or cut and paste with Vigilant gel.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=3017

German ivy (*Delairea odorata*)

German ivy has only been recorded around Kohaihai and Kohaihai Road and is a threat to lowland forests.

Objective: Achieve zero density of German ivy to protect Kahurangi National Park (KNP) from invasion.
Action: Undertake annual surveillance and control any German ivy found.
Method: Spray with metsulfuron or Tordon Brushkiller.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=2749

Ginger (Kahili) (*Hedychium gardnerianum*)

Kahili ginger has only been recorded south of the saddle to Scotts Beach. It is mostly common on the hillside above the Kohaihai Roadend, and along roadsides and in forest near Kohaihai Road, particularly near the old roadman's cottage site.

Objective: Maintain a zero-density buffer for kahili ginger to stop it spreading further in forested areas and impacting KNP.
Action: Undertake annual surveillance and control any kahili ginger found.
Method: Spray with metsulfuron.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=4063

Gorse (*Ulex europaeus*)

Gorse is present in most areas of suitable habitat along the coastline and in the Heaphy Valley.

Objective: To minimise impacts of gorse and prevent further spread and establishment.
Action: Zone 1 and 2: undertake aerial and ground-based control of gorse along coastal and riparian sections to minimise impact on coastal and riparian ecosystems and prevent further spread. Zone 3: undertake aerial and ground-based spraying along coastal section with goal of achieving localised zero density of gorse along the coastal strip north of the Heaphy by 2025.
Method: Spray plants with picloram/ triclopyr (Tordon Brushkiller, et.c) while flowering (before seeding). Cut and paste with Vigilant.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=2610

Iceplant (*Carpobrotus edulis*)

Previously controlled at one site at north end of Scotts Beach.

Objective: Maintain zero density of iceplant.
Action: Undertake annual surveillance and control any iceplant found.
Method: Hand weed and remove to site where plants won't survive (e.g. deep shade) or spray with glyphosate or triclopyr.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=3638

Karo (*Pittosporum crassifolium*)

A few mature karo trees have been planted in the past at Kohaihai. They are not native to the area and are likely to spread.

Objective: Remove karo from Kohaihai area.
Action: Cut and remove trees.
Method: Cut plants down with chainsaw and spray fresh stumps with metsulfuron or apply Vigilant gel.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=1133

Kikuyu grass (*Cenchrus clandestinus*)

Kikuyu grass is fairly common around Kohaihai, Scotts Beach and Heaphy hut. It is absent north of the Heaphy River.

Objective: Contain kikuyu grass to current distribution.
Action: Undertake annual surveillance for infestations in new areas, particularly north of Heaphy River. Control any new outliers found.
Method: Spray with metsulfuron, glyphosate or haloxyfop (Gallant).
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=3023

Lupin (tree) (*Lupinus arboreus*)

Tree lupin is fairly common in the Heaphy Valley with occasional plants also along the Coast in zones 2 and 3.

Objective: Minimise impacts and further spread of tree lupin.
Action: Undertake annual surveillance and control any tree lupin found.
Method: Spray with metsulfuron or Tordon Brushkiller.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=3143

Marram (*Ammophila Arenaria*)

Common along sandy parts of the coast.

Objective: Control marram to zero density north of Heaphy River. Sustained control elsewhere.
Action: Annual aerial spray. Possible ground control of smaller infestations once bulk is bought under control.
Method: Aerial helicopter boom or spot spray using haloxyfop (Gallant, etc.).
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=2521

Montbretia (*Crocosmia* x *crocosmiiflora*)

Montbretia is localised along Kohaihai Road particularly around roadsides and abandoned house sites. Plants produce dense colonies of woody corms which layer often making it hard to kill this plant. It is important to remove any infestations as quickly as possible to stop further spread.

Objective: To prevent further spread and establishment of montbretia, and to minimise impacts.
Action: Check known sites annually and control any plants found. Undertake annual surveillance for infestations in new areas.
Method: Spray plants with metsulfuron. Repeat treatments are likely to be necessary over a number of years until all underground bulbs are exhausted.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=3789

Nasturtium (*Tropaeolum majus*)

Localised patches of nasturtium occur along Kohaihai Road, and it has been present at Scotts Beach in the past but is thought to have been eradicated from there.

Objective: Ensure nasturtium does not establish in the Heaphy Unit.
Action: Check known sites annually and control any plants found**.** Undertake annual surveillance for infestations in new areas.
Method: Spray with Tordon Brushkiller or small infestations can be carefully hand pulled, bagged and removed.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=2580

Pōhutukawa (*Metrosideros excelsa*)

Several pōhutukawa trees have been planted around Kohaihai in the past and seedlings have spread up the nearby hillside.

Objective: Protect KNP from invasion by pōhutukawa. Coastal cliffs and slips are particularly at risk.
Action: Cut down and remove all pōhutukawa at Kohaihai.
Method: Cut down and treat stumps with metsulfuron or Vigilant gel.
More info: http://www.stuff.co.nz/world/americas/4073469/San-Franciscos-pohutukawa-curse or https://en.wikipedia.org/wiki/Metrosideros_excelsa

Scotch thistle (*Cirsium vulgare*)

Scotch thistle is occasionally found in disturbed sites but isn't considered a major threat. Control along tracks may be necessary.

Objective: Only control where Scotch thistle is a nuisance.
Action: Only control where Scotch thistle is a nuisance.
Method: Spray with glyphosate, metsulfuron or Tordon Brushkiller.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=3706

Tutsan (*Hypericum androsaemum*)

Tutsan is currently only known from the southern part of the unit from Scotts Beach southwards, particularly on old slips near the track.

Objective: Minimise the establishment of tutsan in KNP.
Action: Check known sites annually and control any plants found. Undertake annual surveillance for infestations in new areas.
Method: Pull seedlings and bag for disposal.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=4097

Velvety nightshade (*Solanum chenopodioides*)

Velvety nightshade is common along roadsides, track margins, forest margins and semi open sites from Kohaihai Road to the lower Heaphy Valley.

Objective: Contain velvety nightshade to current distribution; in particular, preventing establishment along the coast north of the Heaphy River.
Action: Undertake annual surveillance for infestations in new areas.
Method: Hand pulling of small infestations can help reduce seeding. Spraying with Tordon Brushkiller is effective for larger infestations. Metsulfuron is ineffective on this species.
More info: http://www.nzpcn.org.nz/flora_details.aspx?ID=2771

6. Weed surveillance and monitoring

The purpose of surveillance is to find populations of new invasive weed species at a stage when eradication or containment is still possible at a landscape scale. This scale may be a specific site, catchment, area, district or region or nationally. Early action reduces the cost of controlling the weed species and helps preserve ecological values of an area which would otherwise be threatened by these weeds. Surveillance effort is focused on high risk species at key sites.

Weed species new to New Zealand are relatively unlikely to make their first appearance in the Heaphy Unit, however it is possible. International visitors could potentially introduce new weed species, and some species (sea spurge for example) have potential to arrive on ocean currents, so vigilant surveillance is always important. The Appendix has some photos of a selection of the less common weeds for control if seen.

Key sites

It is well established that new weed introductions are often closely associated with human activity. In particular:

- Along roads and tracks, especially road ends, and areas of recent construction or ground disturbance.
- Near areas of habitation, such as around hut and camping sites.

Therefore, weed surveillance activities will largely be targeted around these areas, as well as along the coast to check for weeds spread by ocean currents.

Objective: To prevent establishment of any new weed species in all areas.
Action: Undertake surveillance for new infestations at least annually and control any priority weeds found. This work is to be undertaken by a suitably experienced person with a strong knowledge of introduced plants and their impacts.

Method: The majority of weed surveillance will be undertaken by ground surveys. Occasionally it may be appropriate to survey some areas from the air, particularly where access is difficult, or the surveillance area can be more effectively and thoroughly covered if surveyed from the air. Record infestations by GPS and photograph, and control new infestations of key weed species using appropriate method for each species/site.

Periodic photographic records of target species locations, infestation size, density and control progress are to be maintained.

It is suggested that a Q: drive folder of existing photographs is compiled to provide a baseline for monitoring. This should consist of photographs of areas infested by weeds and should become a useful indicator of the success of the control programme. Photographic monitoring is quick and easy to establish and provides useful before and after images.

It is suggested that quantitative monitoring such as establishment of transects or plots may not be particularly useful for monitoring of most weed control in the Heaphy Unit. Photographic monitoring for the more common weeds, and mark and map with associated photographs for uncommon weeds is likely to be the most useful monitoring method.

7. Stakeholder consultation

Landholders

The Proprietors of Mawhera own a 40.4 ha block of land on the coast south of the Heaphy River mouth and should be consulted about any weed control or other activity the Department intends to undertake in this area.

8. Performance measures

Review of this weed control plan

Review this weed control plan at least every 5 years, with the next review due mid-2025. Review earlier if significant issues arise which require amendments to the Plan.

Annual weed report

An annual weed report shall be written as part of the Bathurst Annual Report detailing location and density of all weeds and control methods.

9. Conclusion

Weed control within all zones will require ongoing commitment to ensure that the weeds that are present are managed effectively. Weed surveillance in all areas is a high priority, and while the recommendation is that active weed surveillance should be undertaken at least annually, weed surveillance should be considered an ongoing activity by anyone frequenting the area. Any new weed species that are found, or significant changes in distribution, should be added to the Weed Management Plan.

10. References

Department of Conservation Bioweb Weeds Database http://docintranet/bioweb/weeds.asp

Gruner, I. 2013: Department of Conservation Heaphy *Whakapoai* Biodiversity Management Plan 2013–2048. Department of Conservation, North and Western South Island Region. Internal Report.

NZ Plant Conservation Network website http://www.nzpcn.org.nz/

Owen, S.J. 1998: Department of Conservation Strategic Plan for Managing Invasive Weeds. Department of Conservation, Wellington.

West Coast Regional Council 2010: Regional Pest Plant Management Strategy for the West Coast

Appendix 1. Plant Identification

Sea spurge (*Euphorbia paralias*)

Habitat

Coastal – on sandy beaches and sand dunes in surge zones often amongst debris.

Karo (*Pittosporum crassifolium*)

What does it look like?

Bushy small tree with greyish leathery oval leaves that are white underneath. Clusters of small dark red flowers.

Habitat

Coastal and offshore islands.

Purple glory bush (*Tibouchina urveilleana*)

What does it look like?

Evergreen shrub up to 6 m tall. Ovate leaves which are slightly hairy with conspicuous veins. Stems reddish and hairy when young. Rich purple flowers 5–7 cm across.

Habitat

Dry areas, frost tender when young.

Osteospermum (*Dimorphotheca fruiticosa* syn *Osteospermum fruiticosum*)

What does it look like?

Perennial herb, becoming woody at the base often forming dense mats. Leaves are alternate, fleshy, toothed up to 10 x 2.5 cm. Daisy-like flowers in white, pink, purple and lilac.

Habitat

Sand and coastal sites.

Trailing ice plant (*Lampranthus spectabilis*)

What does it look like?

Mat forming plant with moist translucent leaves. Vibrant daisy-like flowers in red or pink.

Habitat

Sand and coastal sites.

Track rush (*Juncus tenuis*)

What does it look like?

Stiffly upright leafy tufts orange green in colour up to 60 cm tall. Leaves tough (wiry). Flower heads arranged singly along branchlets; occasionally with several clusters of flowers arranged in groups on the branchlet tips. Seeds 3 mm long.

Habitat

Wet conditions.

Ice plant (*Carpobrotus edulis*)

What does it look like?

Matt forming trailing perennial herb. Leaves sharply 3-angled and fleshy. Flowers red, pink, yellow.

Habitat

Terrestrial, coastal.

Cape gooseberry *(Physalis peruviana)*

What does it look like?

An evergreen perennial plant producing a cluster of branched stems that are hairy, up to 1 m tall. The stems become more or less woody, especially at the base, and can grow 50–200 cm tall. Flowers pale yellow with a touch of purple at the base. Orange fruit covered in a papery husk.

Habitat

Terrestrial, coastal.

Tutsan *(Hypericum androsaemum)*

What does it look like?

Small evergreen shrub to 1.5 m tall. Stems are semi woody and winged, usually reddish. Oval leaves, usually bluish underneath, turn red in autumn. Yellow 5-petalled flowers, with long stamens followed by round red berries.

Habitat

Cool, damp conditions.

Greater bindweed (*Calystegia silvatica*)

What does it look like?

Strong rampant climber with extensive and far creeping rhizomes. Leaves dark green and arrow shape. Large showy white trumpet flowers up to 9 cm in diameter.

Habitat

Terrestrial. Gardens, waste places, forest edges, roadsides etc.

Appendix 4: Foliar Browse Index report: Heaphy 2010–2020

Internal Correspondence

Our ref: NHT-02-16-51

To: Suvi Van Smit, Operations Manager (Acting), Jane Williams, Jess Curtis and Scott Freeman, Senior Rangers Operations

Date: *27 May2020*

From: Cielle Stephens

Report Reference: DOC-6260417

Subject: **Foliar Browse Index report: Heaphy 2010–2020**

Summary

Foliar Browse Index (FBI) monitoring in the Heaphy area suggests that possum control in the form of aerial 1080 operations has been successful in maintaining the condition of possum-sensitive tree species such as fuchsia, wineberry, māhoe, lancewood, northern rātā and southern rātā. We found foliage cover of these species to be at healthy levels (>50%) suggesting tree canopy in the area is in good condition. Mortality was raised compared to what are assumed to be natural background levels, but we attributed this to catastrophic events in the area (flooding and slips) and the young age of the trees. Browse incidence was raised in the latest measurement, suggesting recently increased impact of possums. As possum numbers have not been monitored since 2012, we suggest conducting an RTCI or waxtag measurement. This will ascertain whether the annual predator control operations targeted at rats are successful at reducing possum densities. Ground-based possum control around the Great Walk huts is suggested to remove remaining pockets of possums from these exclusion zones. Future FBI monitoring will be helpful in continuing to assess the long-term effectiveness of possum control.

Introduction to the site

The Heaphy area in Kahurangi National Park has long been recognised as a place with high conservation values. The area was initially a regionally highly ranked management unit where possum vulnerable plants and threatened endemic land snail species (*Powelliphanta*) were managed for persistence. In 2011, the area was selected as a nationally representative Ecosystem Management Unit (Department of Conservation 2013).

Since 2014, Buller Coal Limited (BCL) provides compensation funding to the Department for the loss of biodiversity resulting from the Escarpment Mine operation on the Denniston Plateau. A portion of the compensation funds is specifically designated to enhance, for 35 years, biodiversity values within a management area centred on the Heaphy Valley.

The compensation management area lies within Kahurangi National Park, in the north-west of the South Island. It extends from the Moutere River in the north to the Kohaihai River in the south and east to the Gunner and Gouland Downs. It is approximately 29,000 ha in size with a core area of about 13,000 ha encompassing the lower and mid Heaphy Valley and the Iwituaroa Range. The core area is surrounded by a 3 km wide buffer zone to minimise reinvasion of pest species and thus increase effectiveness of pest management in the core area.

Monitoring, including Foliar Browse Index monitoring, has been undertaken in the area to assess whether management is successful in achieving positive biodiversity outcomes.

Possum control in the Heaphy Area

Possums have been present in the area prior to 1970. Pest control in the Heaphy area was initiated in 1993/94 with localised ground control of possums along the coast and on the Heaphy Valley flats, and a small-scale aerial 1080 operation also targeting possums south of the Heaphy River (Department of Conservation 2020). Since then, pest control efforts have increased with the first full scale aerial 1080 operation over the entire management area, targeting rats and possums, conducted in 2007/08. Subsequent full-scale aerial operations occurred in 2012/13, 2014/15 and 2016/17. Since November 2017, all areas below 500 m asl in the Heaphy catchment have received annual aerial pest control to suppress the local rat population. In November 2019, the Heaphy and Gunner sections of the Aorere and Karamea operational blocks were treated

This programme of possum and rat control has generally maintained a low background level of possums in the area. The intervention density for possums is 5% RTC (Residual Trap Catch; Department of Conservation 2020). The possum population in the Heaphy has not reached this level since the late 1990s (Fig. 1), although no monitoring of possum numbers has been done since 2012.

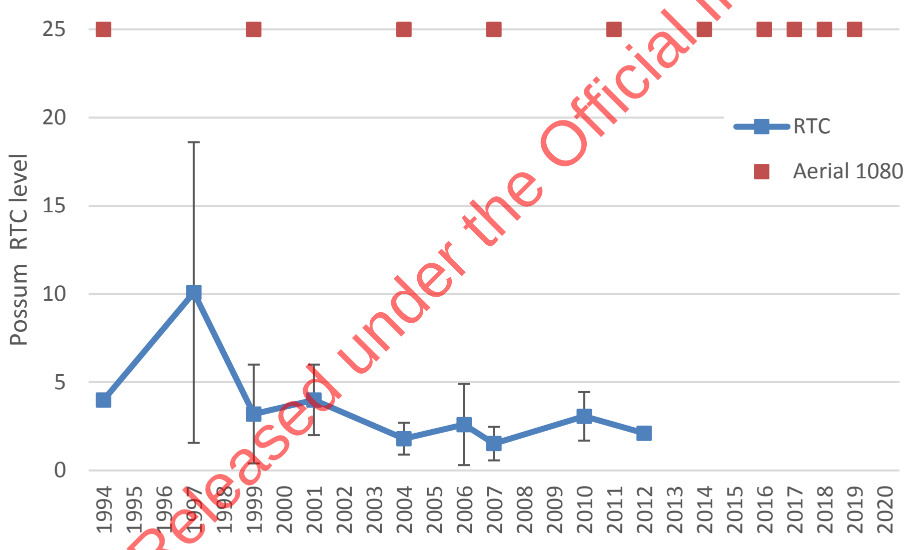

Figure 1. Possum density and aerial operational history in the Heaphy valley. The blue line represents the possum RTC results with the error bars displaying the standard error. The orange squares display when aerial 1080 operations occurred.

FBI monitoring in the Heaphy Area

The Foliar Browse Index (FBI) method uses a ground-based assessment of sensitive plant indicator species to determine the impact of possums on forest health (Payton et al. 1999). Measurements include browse impact, foliage cover and mortality. FBI monitoring provides relatively short-term feedback on the effectiveness of possum control (Farrell 2013).

FBI monitoring in the Heaphy area was first carried out in 1995 with three monitoring lines established in the possum control area of Ryan Creek, Heaphy River. In 2004, conclusions from this monitoring were that possum control had helped to reduce browse on the indicator species and there was no further decline in forest condition since 1995. It was noted that the chosen indicator species within the Ryan Creek area (kāmahi, toro, tōtara, northern and southern rātā) were not as sensitive to possum browse as some other species (e.g. fuchsia), and future monitoring in the Heaphy area should take this into account (Sabadell 2004). The Ryan Creek monitoring lines have not been re-measured since then.

In 2010, FBI data were collected on southern rātā (*Metrosideros umbellata*), northern rātā (*Metrosideros robusta*), lancewood (*Pseudopanax crassifolius*) and māhoe (*Melicytus ramiflorus*) on a series of permanent 20x20m forest plots, and in 2015, these plots were re-measured. In 2015, wineberry (*Aristotelia serrata*), tree fuchsia (*Fuchsia excorticata*) and extra māhoe (*Melicytus ramiflorus*) were added to the sample, these trees were actively searched for outside of the 20x20 m plots (Fig. 2).

In 2020, the 20x20 m FBI trees and the additional māhoe, wineberry and fuchsia from 2015 were measured again.

Figure 2. Location of Heaphy FBI plots.

This report focuses on the species with the biggest data sets from 2010 to 2020, southern rātā (*Metrosideros umbellata*), northern rātā (*Metrosideros robusta*), lancewood (*Pseudopanax crassifolius*) and māhoe (*Melicytus ramiflorus*), and on the data for wineberry (*Aristotelia serrata*) and fuchsia (*Fuchsia excorticata*) collected since 2015.

The 2020 FBI monitoring occurred from December 2019 to March 2020. It was completed by Cielle Stephens, Sonya McArthur, Klayre Cunnew, Mats Olsthoorn, Kerstin Schmidt, Inga Booiman and Pete Lei. All data analysis and graphs were prepared using Excel and the Statistical Package R (R core team 2016). The master data can be found in: DOCDM-588057 and the data analysis spreadsheet can be found in: DOC-6257703. The R-code is saved on the WSCCO server S:\3_Tech Support\WAM\1. R\FBI\Heaphy.

For data analysis, a simple linear regression was fitted to average foliage cover scores to assess the trend in foliage cover over time. The proportion of individuals impacted by browse or stem use was calculated for each species for each measurement. Annual mortality rates for each species (in %) were calculated using the following equation: 100-((number alive in measure/number alive in previous measure)^(1/number of years between measures)*100), excluding trees that were newly tagged in the subsequent measure. Trees that were not found during the 2020 measure were included as dead in the data analysis, as experience with FBI data has shown that the majority of trees not found in one measurement are not re-discovered alive in subsequent measurements.

Results

Mortality

No māhoe died in the 10 years of measurement. No northern rātā or lancewood died in the last 5 years. Otherwise, the mortality rate for all species was 4% or less per year (Table 1).

Table 1. Sample size of living trees and annual rates of mortality (in %).

	Count of living trees			Annual mortality (%)	
	2010	2015	2020	2010–2015	2015–2020
Wineberry		79	65	NA	3.83
Fuchsia		70	57	NA	4.03
Māhoe	13	19	20	0	0
N. rātā	53	52	52	0.38	0
S. rātā	12	13	11	0	3.29
Lancewood	10	9	9	2.09	0

Average foliage cover

There has been little change in foliage cover for all species over time (Fig. 3). Foliage cover for most species is above 50%.

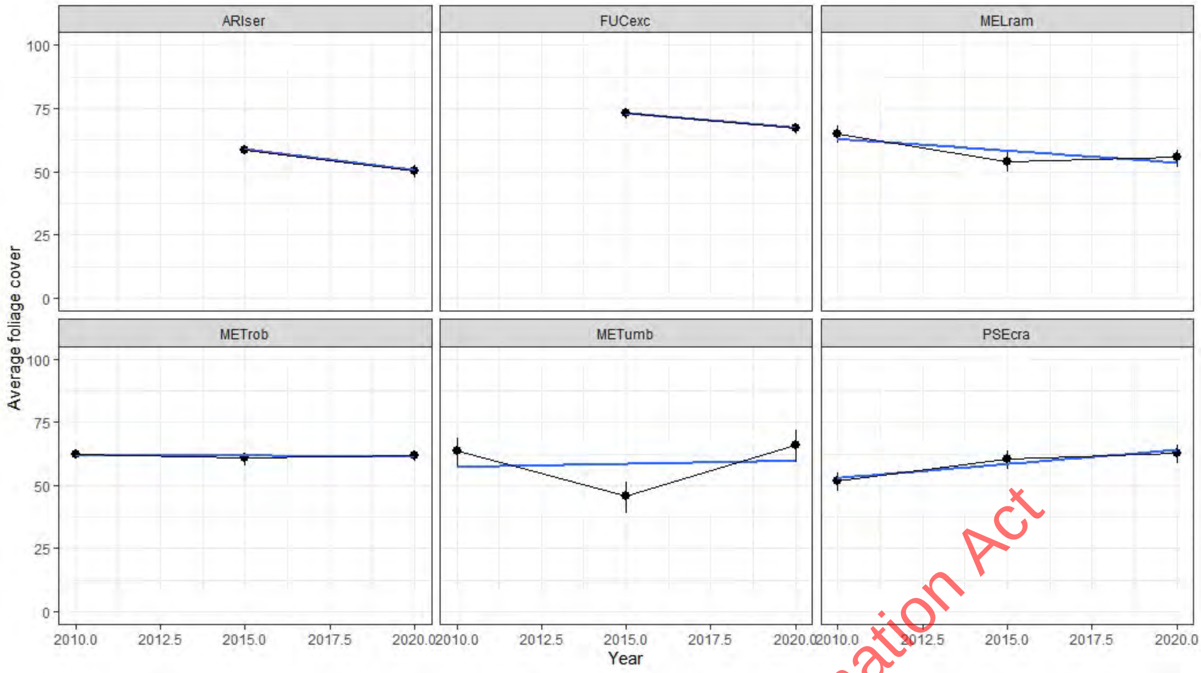

Figure 3. Average foliage cover in the Heaphy (error bars depict the standard error) for wineberry (ARIser), fuchsia (FUCexc), māhoe (MELram), northern rātā (METrob), southern rātā (METumb) and lancewood (PSEcra). The blue line represents the linear regression model from the graphed data.

Proportion browsed

The majority of trees were not browsed in any of the years measured. However, there was an increase in the incidence of browse for all species over time bar lancewood (PSEcra). The severity of the browse increased for wineberry (ARIser) and southern rātā (METumb). Almost all of this browse was rare or light (Fig. 4).

Figure 4. The proportion of individuals that were noted to have browse on them and the severity of that browse. Rare browse means <5% of all leaves were browsed by possums, light 5–25% of leaves, moderate 25–50% of leaves and heavy 50–75% of all leaves. No tree had severe browse (75–100% of leaves browsed).

Discussion and Recommendations

The management of the Heaphy valleys seems to be maintaining forest health. Overall, foliage cover remained stable; all the tree species monitored were within the range that is considered healthy, i.e. at or above 50% (Ewans & Knightbridge 2009). Browse was classified as rare or light for most species. However, the incidence of browse had noticeably increased in 2020, especially for wineberry, māhoe and southern rātā.

The annual mortality levels observed in the Heaphy were slightly higher than what is believed to be the natural background rate of mortality based on measurements in the Hope, in South Westland. Here, mortality is thought to be close to natural, as possum numbers in this valley have never reached much above 5% RTC. For example, in the Hope Valley, fuchsia and wineberry had mortality rates of 2.22 and 2.86 respectively during the last FBI measurement (McArthur 2015).

However, we still believe that the observed mortality rates reflect natural mortality in the observed populations. Seven wineberry trees were wiped out by flooded rivers or slips and another tree was cut down. This accounted for half the observed wineberry mortality. Most tagged fuchsia were small (young) trees due to the absence of bigger (older) trees in the valley. These young trees might naturally have a higher mortality rate than more established bigger trees, as are monitored in the Hope.

The results from this survey suggest that possum numbers are maintained low enough to prevent serious negative impacts on forest health. This is supported by *Powelliphanta* snail monitoring in the Heaphy which found possum control had effectively limited possum predation on snails (Stephens 2018, 2019). The Heaphy valley has had annual aerial operations since 2016. This is thought to keep possum numbers very low. However, these operations have been targeted at rats rather than possums. No result monitoring for possums has occurred. Possums have been seen around both, Lewis and Heaphy huts (pers. obs.). However, both these sites are excluded from aerial operations for public health and safety reasons. The increase in browse observed in our survey suggests increasing possum impacts.

Future FBI monitoring will be helpful in continuing to assess the long-term effectiveness of possum control. Measuring possum density in the form of waxtags or RTCI in the near future is recommended to help ascertain possum numbers and whether the annual operations targeted at rats are also successful at reducing possum densities. Ground based possum control around the Great Walk huts is also suggested to remove the pockets of surviving possum populations.

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This report was reviewed and approved for release by Ingrid Gruner, Bio Monitoring Ranger.

Appendix 5: Kahurangi bat analysis 2019/20

Kahurangi bat analysis 2019/20

Moira Pryde

02/07/2020

Context

The production of low-cost bat acoustic recorders by the Department of Conservation's electronics section has enabled more comprehensive bat surveys to be completed nationwide. Bat monitoring using mark-recapture techniques produces robust results but is expensive and resource intensive. We wanted to test a low-cost index method using bat recorders in the lower Heaphy catchment of Kahurangi National Park to test the predator management. We have done five years of data collection so far; – the first year was a wider survey to assess activity in the area and then a more focused survey was completed for the next four years to look at long-term trends. Added to this a mark-recapture study was done for one year (2017/18) to find out where the bats were roosting and give an estimate of colony size. The mark-recapture will be repeated in 2022/23 years to see if the colony size or roosting area has changed over time and will be used to verify the index method.

Objectives

The objectives of the long-tailed monitoring:

a) determine the number of stations and the number of years monitoring to detect a trend in the population of long-tailed bats in the lower Heaphy catchment area using the power analysis tool SIMR (Green & MacLeod 2016) and update this analysis as more data is collected.
b) To determine the location of roosts and estimate the size of one of the colonies (the details of this work in Appendix 1).
c) To assess the trends in bat activity over time.

Methods

Automatic bat recorders (AR4s) were placed across the Kahurangi area in January 2016 to determine bat activity over the area to give an indication of the feasibility of long-term monitoring sites and to determine hotspots for likely places for catching. The design of the 2016 survey was based along the Heaphy, Lewis and Gunner rivers (Fig. 1).

Long-tailed bats forage preferentially on the edges of forests or on still waterways, so the automatic recorders were placed in areas that were likely to detect bats. The recorders have a range of 50 m, therefore each recorder needs to be placed at least 50 m away from the next one to be independent. In general, the distance between recorders was between 100 and 200 m. In 2017 the survey was modified and focused on the lower Heaphy catchment as that was the area where we wanted to know what was happening to bats. The lower

Heaphy catchment was considered as an achievable area to do long-term monitoring and to test the hypothesis that if the predator control is good enough there will be an increase in bat activity in the lower valley. The recorders were equally spaced at 200 m intervals following bush edge and rivers in the study area (Fig. 2). The survey was repeated again in

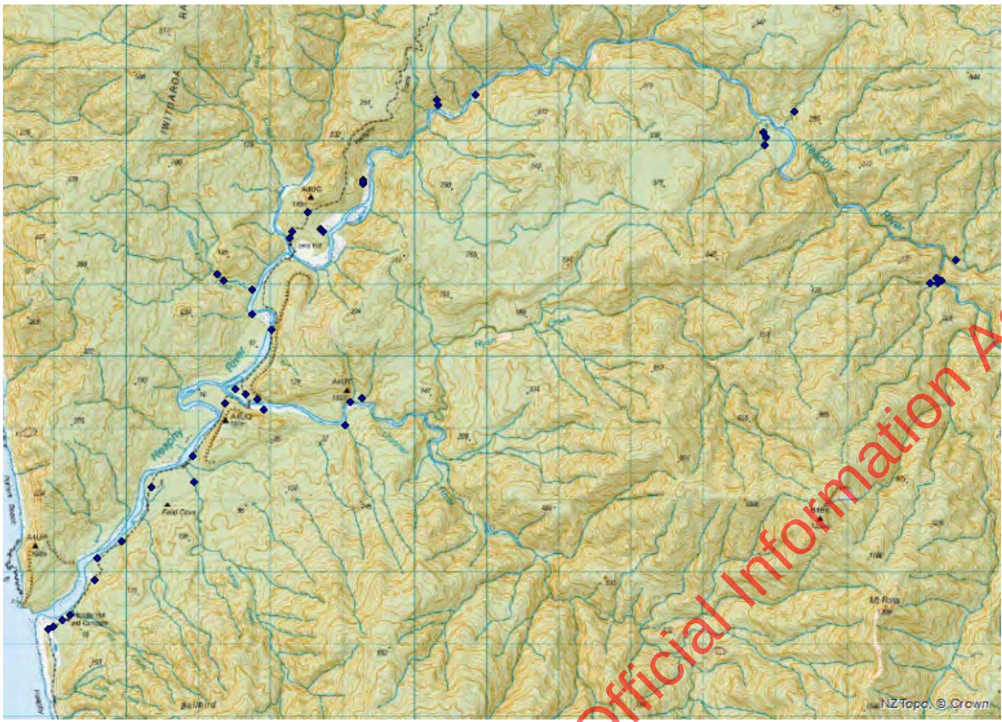

Figure 1. The placement of the recorders in the 2016 February survey within the Heaphy catchment.

Figure 2. Locations of the recorders for the revised survey in February 2017.

2018 and 2019. Monitors were placed on edges of forest, fly ways, by still water areas – all places where bats are more likely to be detected. Out of the three surveys, 48 sites were able to be used for the analysis as they had been done at the same place for the 3 years.

Based on the results of the power analysis the number of recorders was reduced to 25 (Fig. 3) in 2020. This still allowed an adequate sample size for analysis of the data. All the data was used from every station for each year for the analysis.

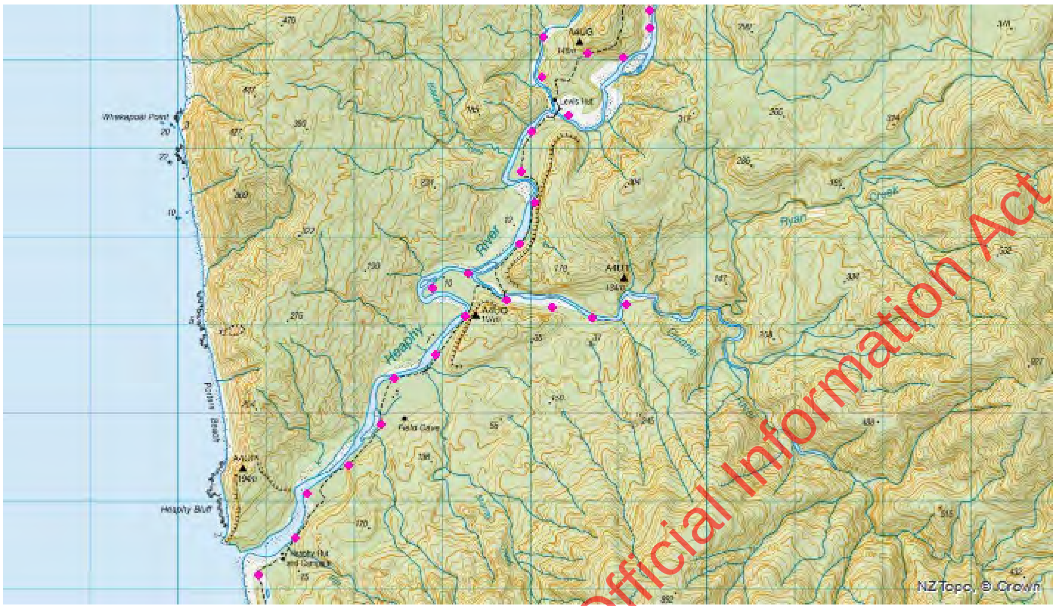

Figure 3. Locations of the recorders for the 2020 survey (the number of recorders was reduced to 25).

Data analysis

A power analysis was done on the data using the methods outlined in Green & MacLeod 2016 to determine the number of years to have 80% power to detect an annual decline of 5% or lower in the population. This involves using generalized mixed models and the power calculations are based on Monte Carlo simulations.

Results

Bats were detected in 74% of the 2017 surveys, 71% of the surveys done in 2018, 72% in 2019 and 82% in 2020 (Table 1).

Table 1. results of the 4-year survey.

Year	Total sites	Detected bats	No bats detected	Recorder failed
2017	50	37	13	0
2018	48	34	14	0
2019	48	33	13	2
2020	25	19	4	2

Surveys were done in February 2017 (20 Feb – 6 March), February 2018 (15 Feb – 6 March) and March 2019 (21 Mar – 8 Apr), Feb/March 2020 (24 Feb – 27 March).

Activity varied between years (Figs 4–7) and the higher activity areas were the upper Gunner and the Heaphy/Lewis junction. These were the areas where the catching of bats was focused.

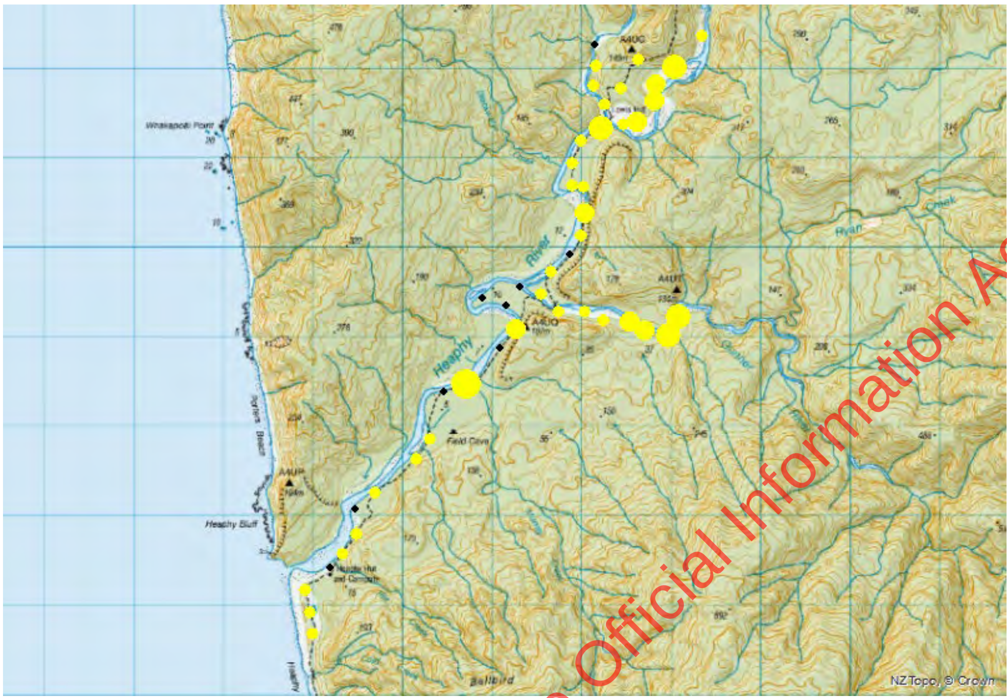

Figure 4. Activity in the 2017 season, black dots show no bat activity, yellow dots show amount of activity.

Figure 5. Activity in the 2018 season, black dots show no activity, green dots show amount of activity.

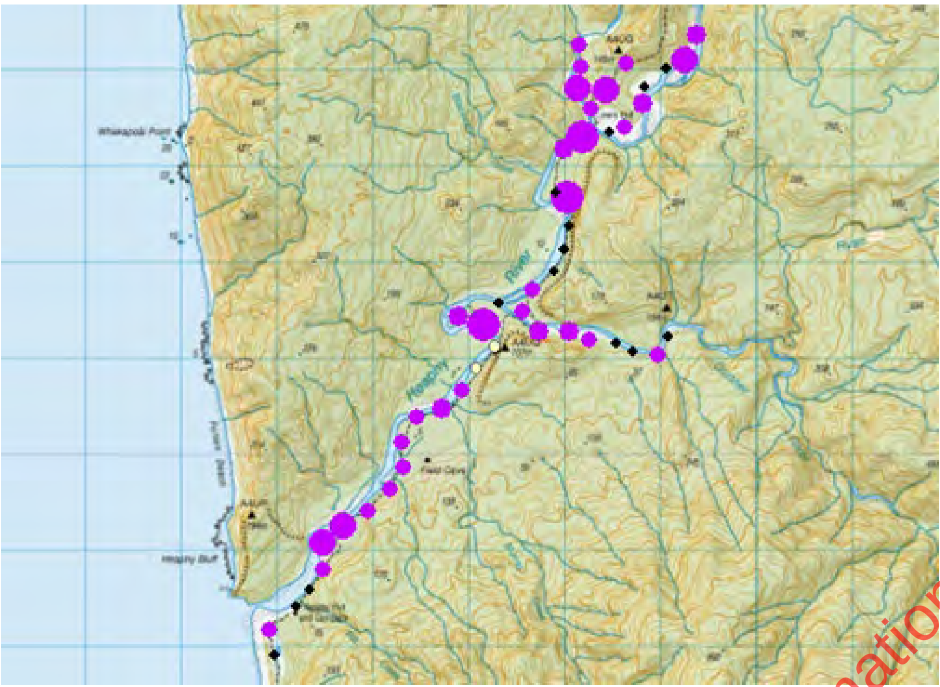

Figure 6: Activity in the 2019 season – black dots no activity, purple dots show amount of activity and white dots the recorder failed.

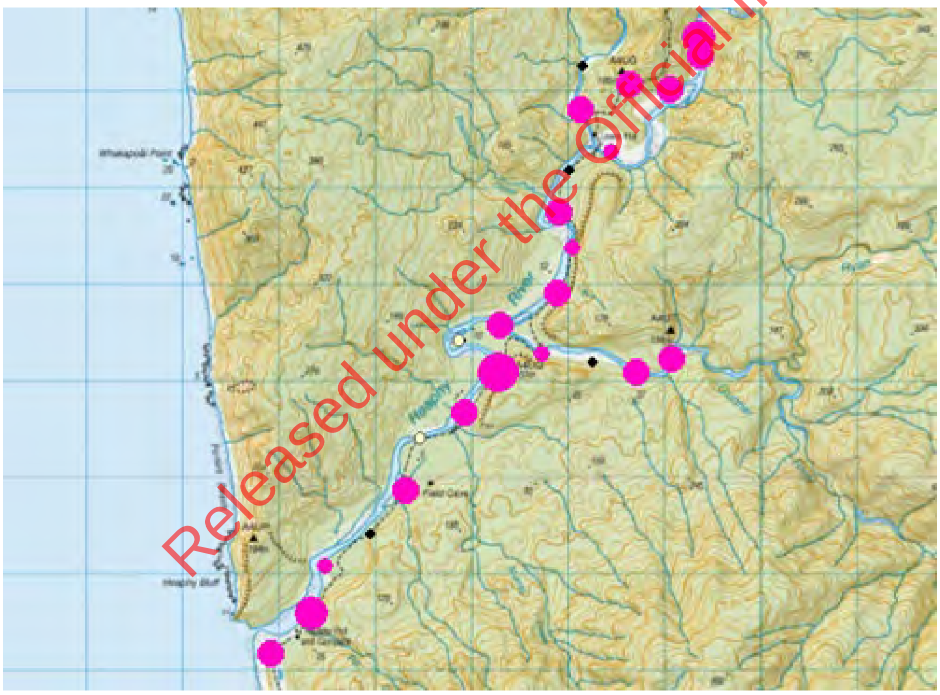

Figure 7: Activity in the 2020 season -black dots no activity, white dots recorder failed, pink dots show amount of activity.

Simulated modelling

The data was analysed for the 48 sites for the 3 years and 25 sites from 2020 and re-run with the power analysis. Not all the recorders ran for the full amount of time as there were problems with the batteries. Thirteen out of the 25 recorders ran for the full 10 days – the other recorders only ran for between 2 to 7 days. Janes Williams (Biodiversity Ranger, Westport) established that the problem was the Powerex batteries. The number of days that the recorders are left out reaches 80% power to detect a 2% change after 12 days (Fig. 7). Extending the data for year using simulated data shows that with the current number of stations and days it would take 5 years to have 80% power to detect a 5% change (Fig. 8).

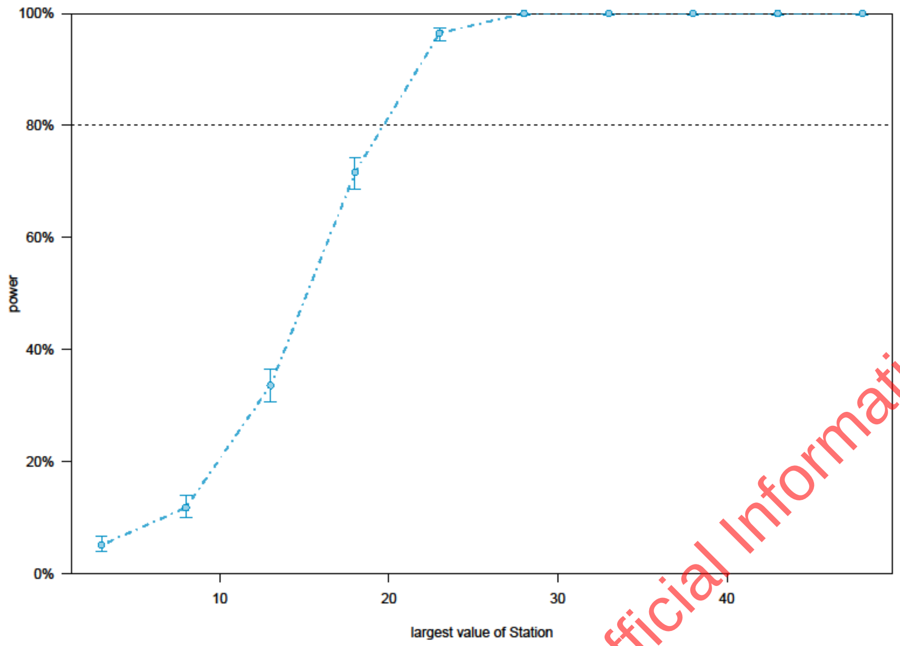

Figure 6. Analysis of the current data showing how many stations is required to have 80% power to detect a 2% annual change in population.

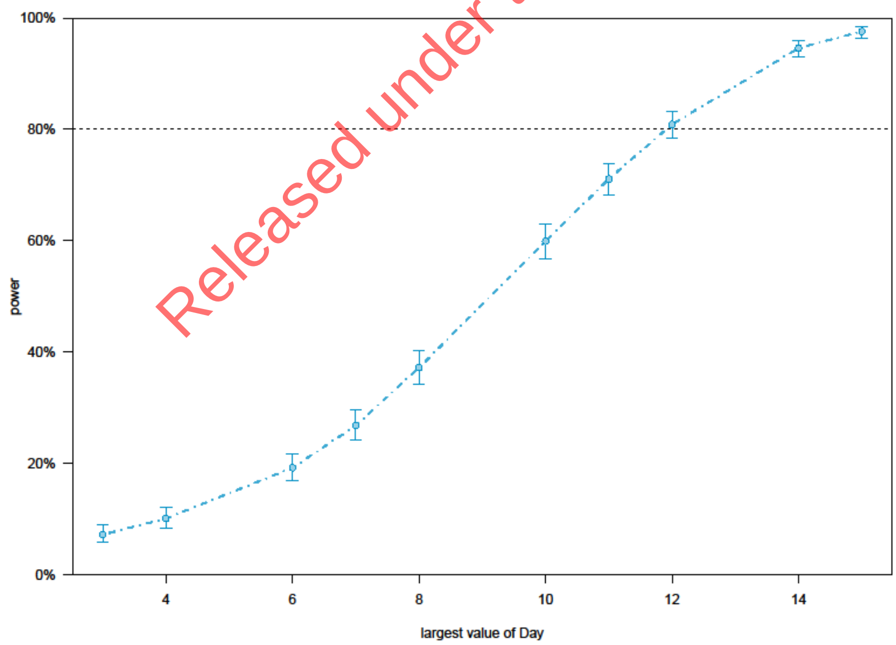

Figure 7. Analysis of the current data showing how many days are required to have 80% power to detect a 2% annual change in the population with the current dataset.

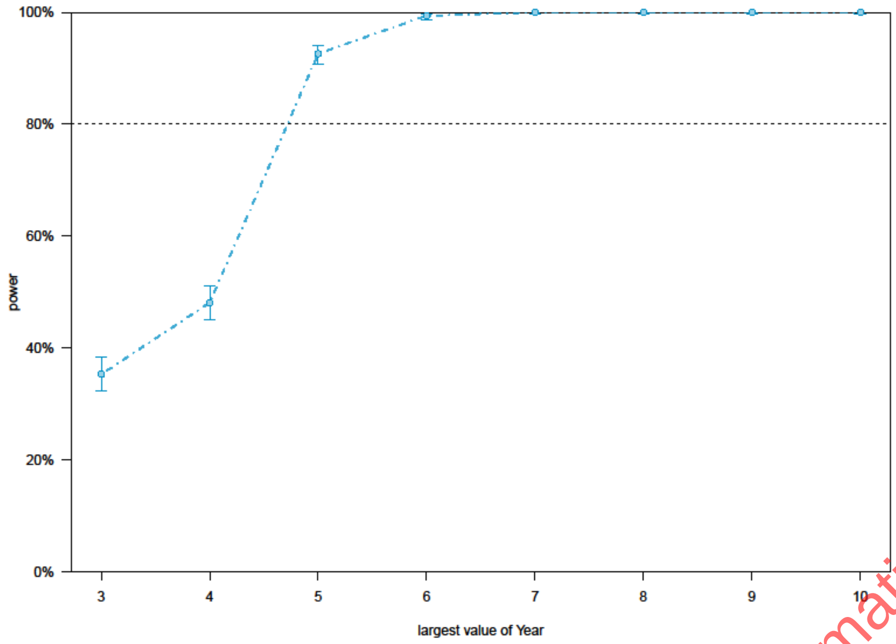

Figure 8. Analysis of an extension of the current data showing how many years are required to have 80% power to detect a 5% annual change.

Based on the current results, the model was then simulated with 25 and 12 days to look at the power of data in the future if this regime is continued. With the current dataset using this regime it will take 5.5 years to detect a 5% annual change with 80% power (Fig. 9). If you wanted to detect a smaller amount of change, for example 2% with 25 stations and 12 days then it would take over 10 years with 80% power (Fig. 10).

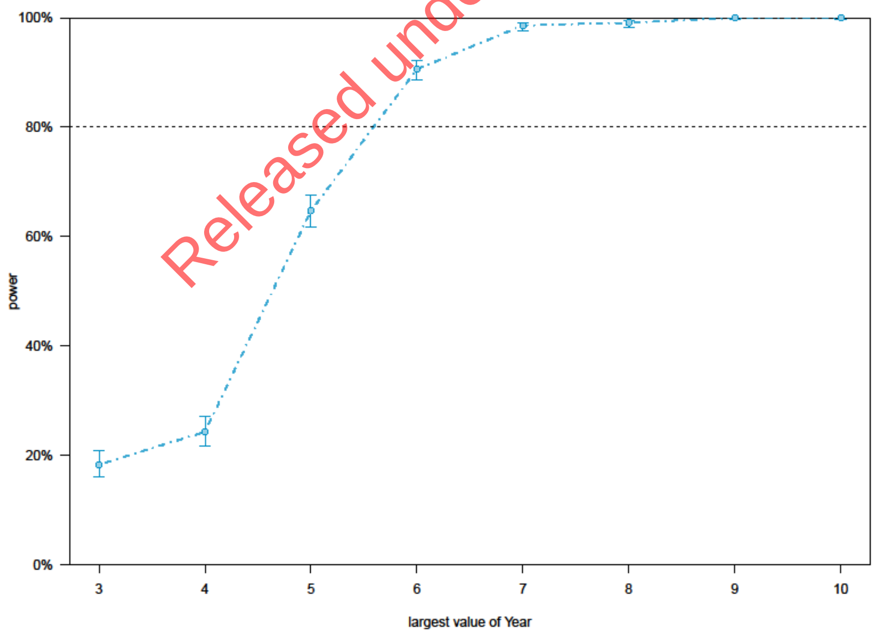

Figure 9. With 25 stations over 12 days it will take 5.5 years to have 80% power to detect a 5% annual change.

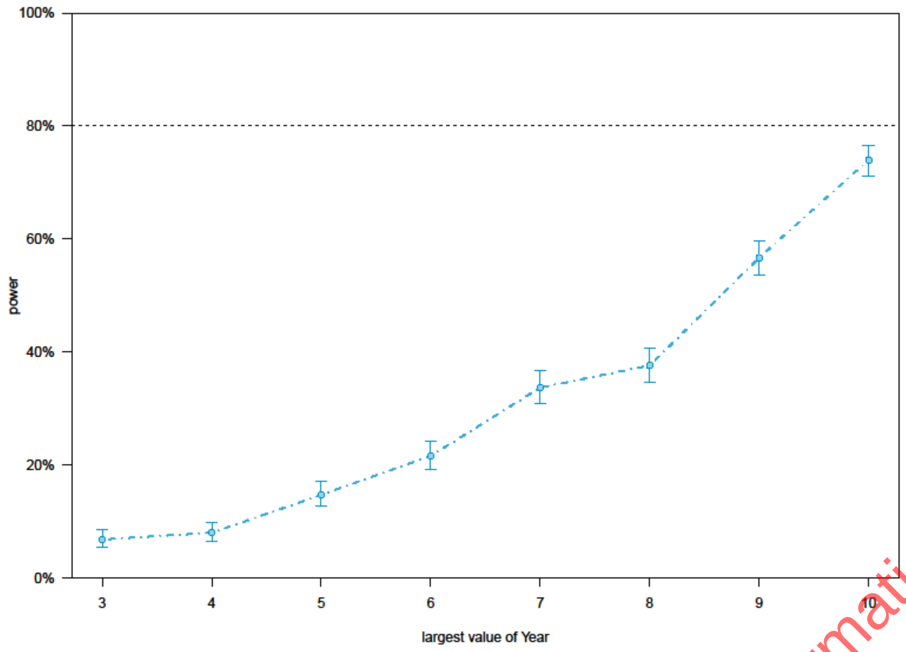

Figure 10. to detect a 2% change with 80% power using 25 stations over 12 days would take over 10 years.

Modelling to show a change between years

The mean count of activity looks consistent for the first three years and then appears to increase in 2020 (Fig. 11). Modelling of the data to test whether there is a significant increase does not show a significant linear increase from 2017 but it does show that activity is different between years (Table 2).

Figure 11. showing the average bat activity between years.

Discussion

It appears that the bat activity has increased this year, but the difference is not significant. The 2020 survey reduced the number of stations to 25 from 48 based on the previous data. Unfortunately, some of the recorders did not last the full number of days so the amount of data was reduced. This resulted in larger confidence intervals and a decreased ability to assess the change in activity. Recommendations by Jane Williams are to replace all the Powerex batteries. The number of monitoring days should be increased to 12 based on the current data.

Table 2: model results showing year as a factor and a fixed effect with station and the number of days as random effects. AIC (Akaike's Information criteria).

Model no.	Model name	AIC	Deviance	Chi sq	P value
1	Call rate~ Year+1|station+1|Day	6311	6299	34.05	<0.05
2	Call rate ~ 1+1|station+1|day	6339	6333		

References

Green, P.; MacLeod, C.J. 2016: SIMR: an R package for power analysis of generalized linear mixed models by simulation. *Method in Ecology and Evolution 7*: 493-498.

Appendix 1

A survey of the newly discovered long tailed bat colony along the gunner river, Kahurangi National Park; Nov–Dec 2017

By Jono More

Field team: Moira Pryde, Brent Fagan & Jono More

Introduction

The South Island population of endemic long-tailed bat (*Chalinolobus tuberculatus*), with a Nationally Critical threat ranking (O'Donnell et al. in press), is extremely prone to predation from mammalian invaders such as stoats, rats and possums which are now plaguing New Zealand's forest ecosystems. In recent decades, the distribution of this species has been fast shrinking and in order to stop local extinctions from happening, we must first find out where they are surviving to be able to make the appropriate steps for their conservation. Over the 2015–16 and 2016–17 field seasons, fifty-one automatic bat recorders were distributed along the Heaphy River and up some of its tributaries to start a long-term bat monitoring programme in the catchment as a measure for pest management. The pass rate was relatively low in the lower Heaphy but higher near the confluences of two of the river's tributaries; the Gunner and Lewis Rivers (Woolmore 2017). Detectors at these sites recorded a modest amount of activity near dusk and dawn which suggested the potential of bat colonies roosting nearby. In order to follow this up and to see if the bat's roosting range was within the predator management area, an attempt was made to catch and transmitter individuals near the Lewis River confluence in the 2016–17 field season. Unfortunately, due to a lack of suitable trap sites, no bats were able to be caught. Better luck was had recently when efforts were made to catch bats along the Gunner River in late November and December 2017 during the mid-stages of the long-tailed bat breeding season.

Free standing harp trapping

In order to identify the roosting distribution of bats along the Gunner River as well as assess their population, an initial 'Judas' breeding female had to be caught and fitted with a transmitter. To do this, free standing harp traps were put out over streams and backwaters along a stretch of the Gunner River where a decent amount of bat activity had been recorded by automatic detectors in the previous field season (Woolmore, 2017). In the first trapping stint of five nights, four sets of free-standing harp-traps failed to catch any bats despite optimal weather conditions (Table 1). Not only were no bats caught, an automatic bat recorder which was shuffled around the various trap sites indicated that there was no bat activity at any of these locations. During this initial work stint, the only hope of there being any bats in the area came from a few brief bat sightings whilst being by the river with a handheld bat detector at dusk. Each evening over the first three nights, one to two bats were spotted flying hastily down river not long after emergence time. This indicated that the bats were likely roosting further up the river valley, so efforts were made to search for potential free-standing harp-trap sites upstream. One such site was found and subsequently had a set of harp-traps erected at it in the beginning of the second work stint. Success came in this trap's first night when it caught an adult female. She was of breeding age and looked to have bred in previous years but didn't appear to be breeding this season. Regardless, she had a transmitter attached (Tx 40) before being released and radio-tracked.

Roosts and roost trapping

In the five days which this first transmitter stayed on the bat, she was only able to be located one day when she was roosting in a dead-standing red beech on Ryan Creek, just above its confluence with the Gunner River. Luckily it was a trappable communal roost containing forty-two bats. Thirty-nine of these bats were caught and a second transmitter was attached to another member of the colony, this time a clearly lactating female (Tx 66). This transmitter bat helped identify a further four roosting locations, all a bit further up the Gunner River to the initial trapping location. Eventually, a second communal roost tree was able to be successfully trapped, catching forty of the forty-six individuals present. An additional two lactating females had transmitters attached (Tx 27 & Tx 69) which subsequently lead to the discovery of a further three roosts. The third (and last) roost catch was able to be made at one of them, capturing seventy-seven of the eighty individuals present. This large catch only contained four breeding females which hadn't been caught during the previous roost catches, thus suggesting that the majority of the breeding colony had already been accounted for. With the question of the colony's population answered, three more breeding females had transmitters attached (Tx 08, Tx 91 & Tx 41) purely to increase our understanding of their roosting range. Unfortunately, ground based telemetry wasn't enough to find them and so after a few days of extensive searching, a helicopter was called in to assist with the radio-tracking and located a further two roost sites.

In total, a collective twenty-three transmitter days uncovered ten roosting locations while an additional roosting location was determined from a random observation of multiple bats emerging from a group of trees near camp one evening (Fig. 1 and Table 2). Five roosting locations were only able to be estimated from either helicopter or ground based triangulation as steep hillsides and significant tree fall made it extremely difficult to access and identify the actual roost trees. The five roost trees which were able to be accessed were mainly dead-standing red or hard beech trees. One silver beech roost was also identified.

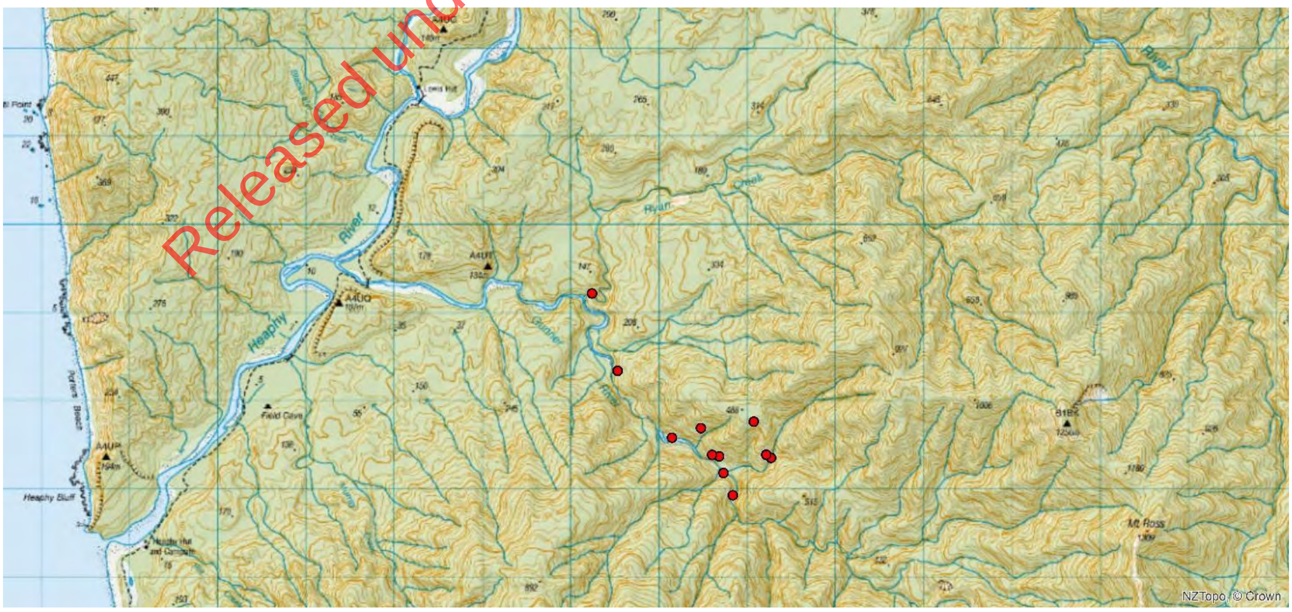

Figure 1. The Gunner River Long-Tailed Bat Roosting Locations, Dec 2017.

Population assessment

In the three roost catches which were made, a total of one-hundred and fifty-five captures accounted for eighty-one individual bats. This was made up of fifty-two breeding females, thirteen young females yet to breed (nulliparous) and sixteen males (Table 3). The ratio of new to recaptured breeding females fell consistently during the trappings and the fact that only four out of the forty-eight breeding females caught in the final trap session were previously uncaught suggests that the vast majority of the colony's breeding population was successfully accounted for.

Discussion

This investigation was hugely successful, especially considering that prior to this, long tailed bats had never been caught and intensively studied in Kahurangi or on the West Coast. Now, not only do we have a good insight into the roosting distribution of this Gunner River colony, we also know roughly how many breeding females it contains. Considering this bat colony has remained unknown until now and hasn't received any specific management attention, it was incredibly heartening to catch fifty-two breeding females. This reasonably good number may be due to the fact that the colony's roosting range falls within the area of the Heaphy catchment which has received recent mammalian pest control with the aerial application of 1080. It was interesting to note that this appeared to be young population with very few individuals appearing to be old and greying. The numerous young individuals may be due to an influx of recruitment in response to lower predator numbers after recent 1080 treatments. The lack of older individuals is however a concern as it suggests that individuals have been getting predated before they've gotten too old and that perhaps the population has only recently built up from very low numbers.

Despite our successes, this was an extremely problematic bat colony to research. Good free-standing harp trap sites were limited and getting the initial transmitter on a member of the group came as quite a challenge. The steep and hilly topography in the colony's roosting range meant that radio-tracking was difficult and quite often transmitter signals couldn't be heard, even after hours of intensive searching. Some roost sites were unable to be accessed due to significant areas of tree-fall while others would have been inaccessible had the river not been running low from an unusual lack of rain. These multiple issues mean that the Gunner colony is not a good candidate for any intensive long-term population monitoring but activity levels should be annually monitored with the use of automatic bat detectors placed along the river. The regular use of 1080 in the area should be maintained, especially in response to rising rat numbers which, left untreated would have the potential to cripple the colony. To help safeguard the future of long tailed bats in Kahurangi, new colonies should be continually searched for through the use of automatic detectors, and when possible, catching and radio-telemetry should be conducted to identify their roosting areas so predator control can be applied.

Acknowledgements

Thanks to Helicopter Charters Karamea for flying us and all our equipment in and out, as well as helping to radio-track our bats. Thanks also to Chris Woolmore, Jess Curtis and Graeme Quinn for all the support, administration and logistics.

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APPENDIX

Table 1. Gunner River Free-Standing Harp-Trap Sites, Nov-Dec 2017.

Free-standing harp-trap location	Number of nights set	Number of bats caught
E1529060 N5465000	6	0
E1529083 N5465370	6	0
E1529110 N5465391	5	0
E1529060 N5465216	3	0
E1529608 N5465083	1	1

Table 2. Roost Trees of the Gunner Long-Tailed Bat Colony, Dec 2017.

Roost number	Date found	Tree species	Number of bats	Coordinates
1	Dec 3	Red or hard beech (*Fuscospora* sp.) -dead standing	42	E1530242 N5465220
2	Dec 5	-	-	E1531476 * N5463695
3	Dec 6	-	-	E1531684 * N5463376
4	Dec 7	-	-	E1531603 * N5463392
5	Dec 8	Red beech (*Fuscospora fusca*)	46	E1531732 N5463187
6	Dec 12	Red or hard beech (*Fuscospora sp.*) -dead standing	-	E1531839 N5462934

7	Dec 12	Silver beech (*Lophozonia menziesii*)	-	E1532273 N5463359
8	Dec 13	Red or hard beech (*Fuscospora* sp.)	Multiple bats randomly seen circling a group of trees on dusk	E1531149 ** N5463586
9	Dec 13 & 14	Red or hard beech (*Fuscospora* sp.) -dead standing	80	E1532217 N5463395
10	Dec 17	-	-	E1532076 *** N5463768
11	Dec 17	-	-	E1530533 *** N5464345

*Exact roosting location not determined. Coordinates estimated through triangulation
**Roost location assumed from random observation of bats emerging at dusk
***Approximate roosting location determined from Helicopter radio-tracking.

Table 3. Long-Tailed Bat numbers at each of the Gunner River Trapping Sessions, Dec 2017

Date	**Trapping session**	**No. of individuals caught**	**No. of breeding females**	**Number of nulliparous females**	**Number of males**
Dec 2	FSH	1 (new)	1 (new)	-	-
Dec 3	Roost 1	39 (38 new)	37 (36 new)	2 (both new)	-
Dec 8	Roost 5	40 (12 new)	39 (11 new)	1 (new)	-
Dec 14	Roost 9	76 (30 new)	48 (4 new)	12 (10 new)	16 (all new)
Totals		156 Captures of **81** Individuals	125 Captures of **52** Individual Breeding Females	**13** Nulliparous Females	**16** Males

Appendix 6: Great spotted kiwi, roroa, Call Count Monitoring Report for Heaphy Valley and MacKay Downs 2019

Department of Conservation
Te Papa Atawhai

Internal Correspondence

NHT-02-16-51

To: Suvi Van Smit (Acting Operations Manager, Buller), Jess Curtis, Jane Williams and Scott Freeman (Senior Rangers)

Cc: Mike Perry (Monitoring Manager)

From: Cielle Stephens (Biodiversity Monitoring Ranger)

Report Reference: DOC-6246645 *Date: 20 May 2020*

Subject: Great spotted kiwi, roroa, call count monitoring report for Heaphy Valley and MacKay Downs 2019

Summary

Great spotted kiwi (roroa, *Apteryx haastii*) is listed as a threatened species, categorised as Nationally Vulnerable. Kahurangi National Park is one of the species' strongholds. To follow trends in the kiwi population over time, kiwi call count monitoring was established in the Heaphy valley in December 1994 with repeat measures in December 1995–97, 2002, 2007, 2012, 2016 and 2019. Call count monitoring in the MacKay Downs was established in March 2015 with remeasures in March 2016 and 2017, and December 2019.

The observed average of 6.33 calls/hour in the MacKay Downs in 2019 matches call count rates observed in other high-altitude areas nearby. In contrast, the call rate observed in the Heaphy valley (10.3 calls/hour) was much higher than reported for nearby lowland sites. For both sites, our data suggest an increase over time, but the large variability and the change from March to December measurements at MacKay Downs cast doubt on these trends.

Further monitoring and a comparison of call rates between March and December are required to gain more confidence in the results. This is particularly important as the monitoring is intended to assess the effect of intensive predator control in the area. We recommend continuing with the observer-based monitoring at both sites as planned in 3 years' time, i.e. 2022/23, to continue this historic data set. Monitoring using acoustic recorders should be implemented at higher frequency to better understand variability of call rates during and in between years. Consistent annual data collection is likely to pick up trends in call rates and presumably the kiwi population sooner.

Introduction

Great spotted kiwi are listed as a threatened species, categorised as Nationally Vulnerable (Robertson et al. 2013). Stoat and cat predation on the young are thought to be the primary reasons for the decline in the population (McLennan et al. 1996). The decline is estimated to be about 5.8% per year (Robertson 2003). Roroa are found in three locations throughout the South Island: in North-west Nelson (Kahurangi), the Paparoa ranges and in the central Southern Alps, between Harpers Pass and Arthurs Pass (Tilson 2007, Robertson 2003). Kahurangi National Park is a stronghold for the species (Farrell 2013). In the Heaphy Valley and the MacKay Downs (Western Kahurangi National Park) roroa are relatively widespread and can be found in forests, scrub, upland tussock grasslands and subalpine scrub. Nichol (2015) found roroa preferred foraging around bush edges and in the open tussock at MacKay Downs.

To follow trends in the kiwi population in Kahurangi National Park, kiwi call count monitoring was established in the Lower Heaphy valley in 1994 with repeat measures in 1995–97, 2002, 2007, 2012 and 2016. Under the Heaphy Whakapoai Biodiversity Management plan (Farrell 2013), it was suggested that this monitoring continue, and, to provide a more representative picture of population trends in the area, additional listening stations covering a range of altitudes be established. In 2015, three listening stations were established in the MacKay Downs; two stations were near James MacKay hut and one near the Ministry of Works hut. These new stations were to be monitored for three consecutive years to provide a baseline. From then on, they were to be monitored every 3 years. The outcome target for management of the area is to achieve an increasing or at least stable trend in kiwi call counts at all sites (Farrell 2013).

The method of kiwi call counts was developed in 1992 as a measure to index changes in kiwi abundance and distribution by monitoring the changes in the number of kiwi calls per hour (McLennan 1992). As kiwis are secretive, nocturnal birds it is very difficult to count all birds in an area. Call count surveys give an indication of presence and activity in an area (relative abundance). Calls are used as kiwis are known to be territorial, and to call regularly and loudly. In ideal listening conditions, the calls can be heard over a distance of 1.5 kilometres. As males and females produce different sounding calls, it is also possible to estimate the number of pairs in an area (Robertson 2012).

The MacKay Downs counts were originally conducted in March to align with counts undertaken on the nearby Gouland Downs, and the Lower Heaphy counts in December to align with previous measures. Ideally, both sites would be measured at the same time of year. The MacKay measurements were moved to December this year to align with the Lower Heaphy counts, as the Lower Heaphy counts date back to 1994 experts believe retaining the historical dataset is more important than moving the counts to align with neighbouring sites. Colbourne and Digby (2016) recommend all kiwi call count monitoring occur between January and April.

This report details the results from the MacKay Downs counts and the latest measurement of the Lower Heaphy call counts in 2019. The MacKay Downs survey provides the first measurement since the 3-year baseline surveys, although completed at a different time of year, and the Heaphy measurement is the ninth measurement of a data set first measured in 1994.

Methods

There are three stations in the MacKay Downs and three stations in the Lower Heaphy valley, all stations were permanently marked (Fig. 1).

Methods followed the best practice call count guide in Robertson (2012) and Hunt (2015). Each station was measured for six nights during each survey. The listening at each station started 45 minutes after sunset as noted on the GPS. The listening period was three hours long. The standard protocol (Robertson 2012, Hunt 2015) prescribes a 2-hour listening period. However, we used a 3-hour period, because the existing Heaphy stations were measured for 3 hours, and the aim was to keep the MacKay counts consistent and comparable with the Heaphy stations.

During the listening period, each kiwi call heard was recorded. The time of the call, the sex of the bird, and the direction and estimated distance of the bird from the observer were recorded on the standard kiwi call sheets (Robertson 2012). After the 3-hour period, the average temperature, wind strength and direction, moon light, cloud cover, noise levels and ground conditions were recorded for each site. The presence of possums, weka and morepork was also noted.

In 2019, there was one windy wet night where one hour was recorded for all three MacKay stations and Peg 17 (the Lower Heaphy station). This gave a total of 48 listening hours for Mackay and 52 for the Heaphy stations. All stations were measured on the same nights. The MacKay survey was completed by Rose Beagley, Mats Olsthoorn and Klayre Cunnew and the Lower Heaphy survey was completed by Kerstin Schmidt, Inga Booiman and Cielle Stephens between 9 –15 December 2019. Please see the previous reports for the details of the earlier surveys (Stephens 2017, Stephens 2016).

Analysis

Data were recorded in the following files: MacKay observer data: DOC-2570216 , Heaphy observer data: DOC-2954657 and acoustic data: DOC-3044340. Data were analysed using R (R core team 2016) and Excel 2007 (pivot table and t-tests). The data analysis file can be found in: DOC-6265189. The observer data were analysed using the mean number of calls per hour, as a total and by station.

Estimated bird distribution was mapped using ArcMap 10.3.1.

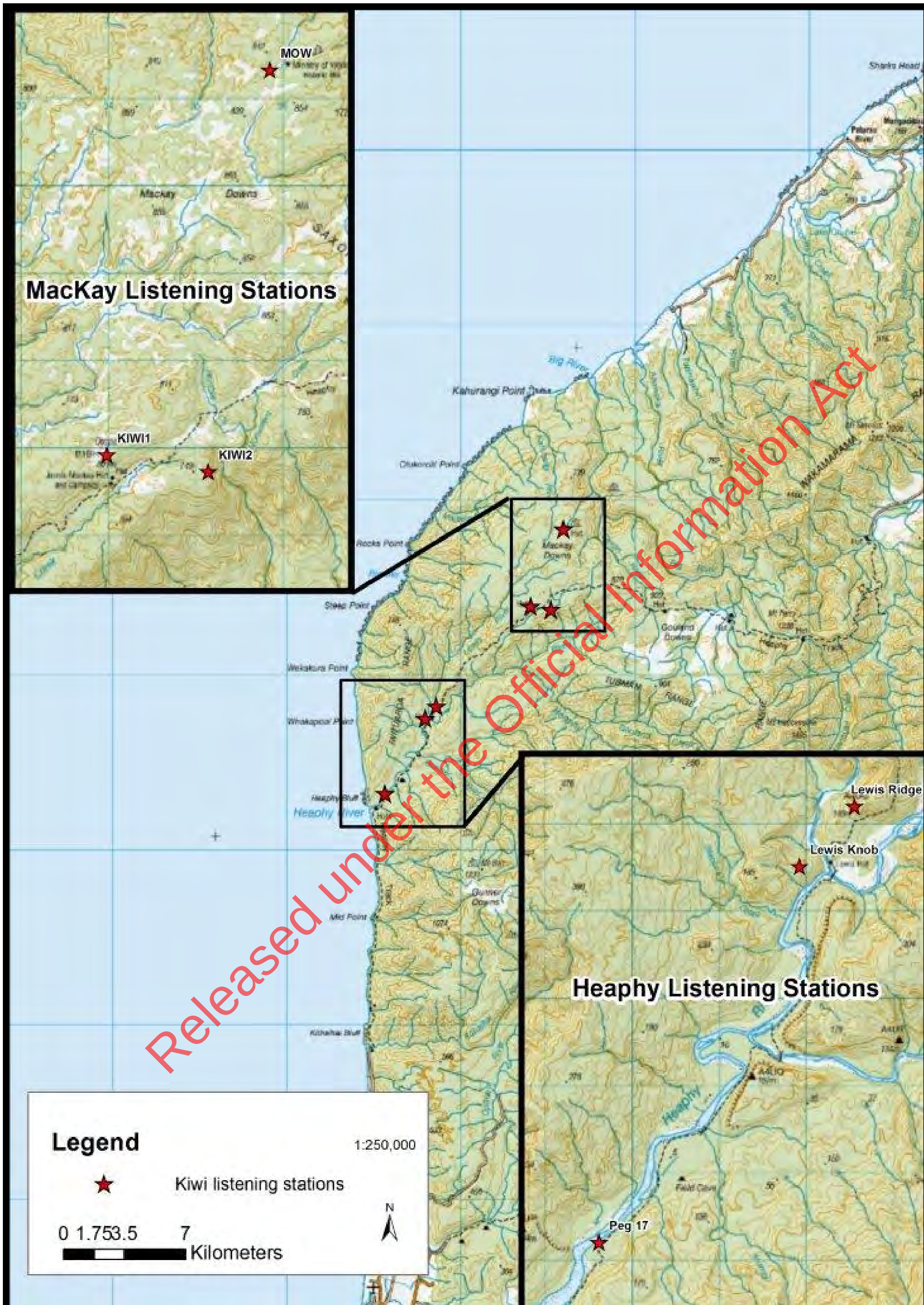

Figure 1. Location of the MacKay Downs and Lower Heaphy listening stations.

Results

Lower Heaphy

Great spotted kiwi call rates in 2019 were higher than in 2016 but lower than the 2012 peak (Fig. 2). Between 1997 and 2007, call rates declined before rising to the peak in 2012. The 2019 call rate was 10.35 (+/- 1.56 95%CI) calls per hour. Linear modelling (kiwi calls per hour ~ time) suggests that since 1994, the average call rate has increased by 0.071 calls per year (p=0.0151).

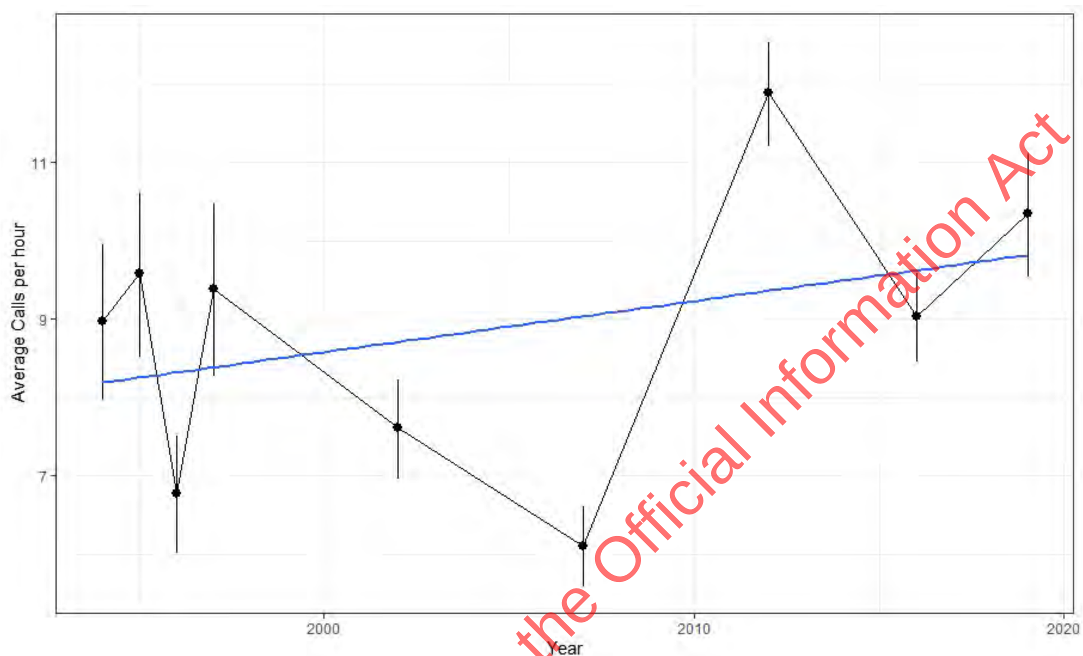

Figure 2. Average calls per hour over time in the Lower Heaphy. Error bars show one standard error from the mean. The blue line shows a simple linear regression model.

In all years, the station closest to the Heaphy river mouth (17 km peg) recorded fewer calls than the other two stations in the Lower Heaphy (Figure 3). All three stations display wide variability from year to year, but overall, the trend is positive (Figure 3). In 2019, calls declined at Peg17, whereas they climbed at the other two sites.

MacKay Downs

The latest measurement was much higher than the three baseline measurements. However, the baseline measurements were made in March, while the 2019 measurement was done in December (Fig. 4). The 2019 call rate was 6.33 (+/- 1.2 95%CI) calls per hour. Linear modelling (kiwi calls per hour ~ time) suggests that since 2015, the average call rate has increased by 0.57 calls per year (p=0.004).

Count station Kiwi 1 consistently recorded more calls than the other two stations at the MacKay Downs. (Fig. 5). All three stations showed a positive trend over time.

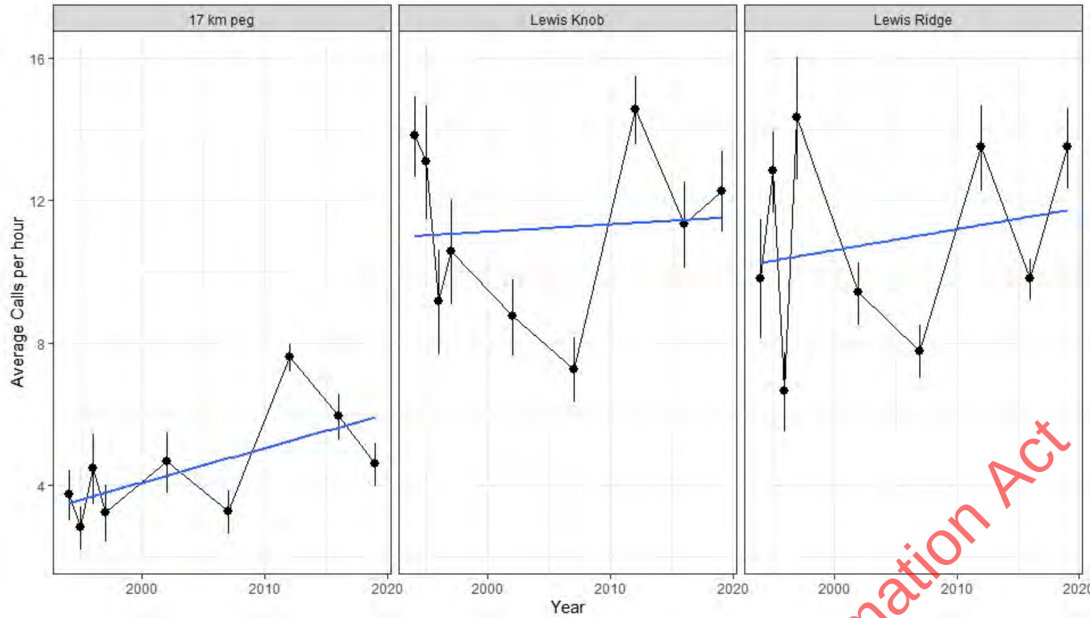

Figure 3. Average calls per hour over time at the three Lower Heaphy count stations. Error bars show one standard error from the mean. The blue lines show a simple linear regression model.

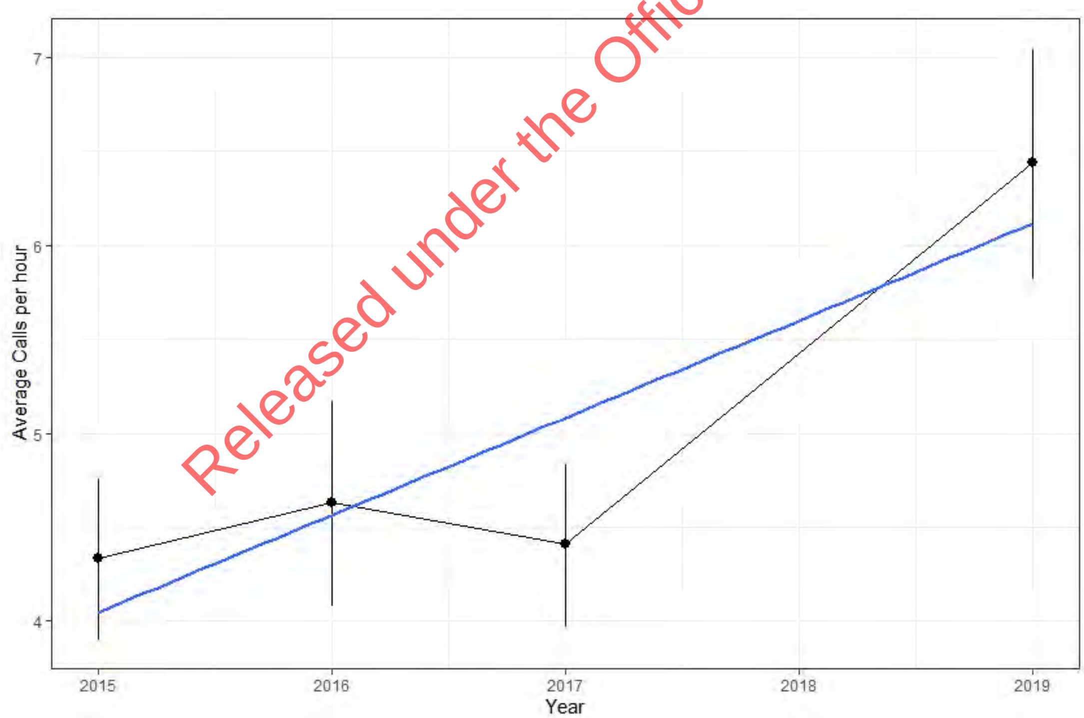

Figure 4. Average calls per hour over time at the MacKay Downs. Error bars show one standard error from the mean. The blue line shows a simple linear regression model.

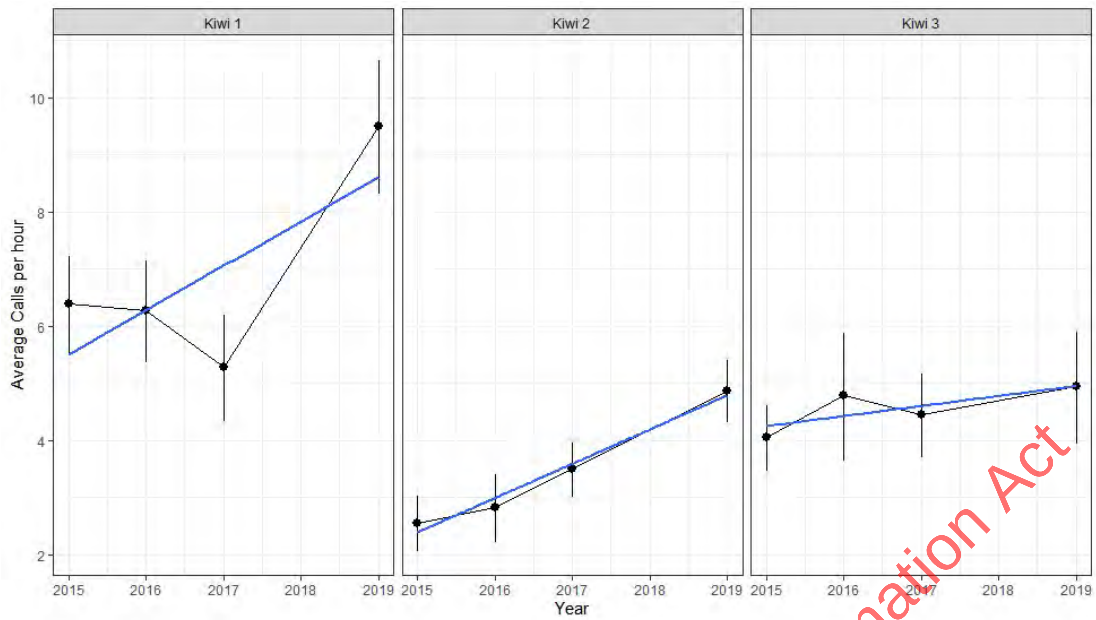

Figure 5. Average calls per hour over time at the three MacKay Downs count stations. Error bars show one standard error from the mean. The blue line shows a simple linear regression model.

The average call count rates in the lower Heaphy area (6.5–11.5 calls/hour) were higher than those at MacKay Downs (4.5–6.5 calls/hour), although there was variability between count stations. Kiwi 2 and 3 at MacKay Downs recorded the lowest numbers (2–4.5 calls/hour) followed by '17 km peg' in the lower Heaphy (3.5–8 calls/hour).

Sex distribution

The Mackay Downs kiwi had an almost equal sex distribution, with 50–54% of all calls noted as being from females (Fig. 6). This varied slightly by site, with Kiwi 2 recording the lowest proportion of females (41–47%) and Kiwi 3 the highest (54–63%). Calls noted to be duets varied over the years from 18–23% from 2015–17, and 16% in 2019.

The Lower Heaphy kiwi population showed an unequal sex distribution, with the majority of calling birds being male in almost all counts. In 2012 and 2016, 31% of calls were from female birds (Fig. 7). This increased to 39% in the 2019 survey. At individual count stations, the proportion of females varied from 22–56%. Duets increased from 16% to 25% of all calls. Sex of birds was not recorded prior to 2015.

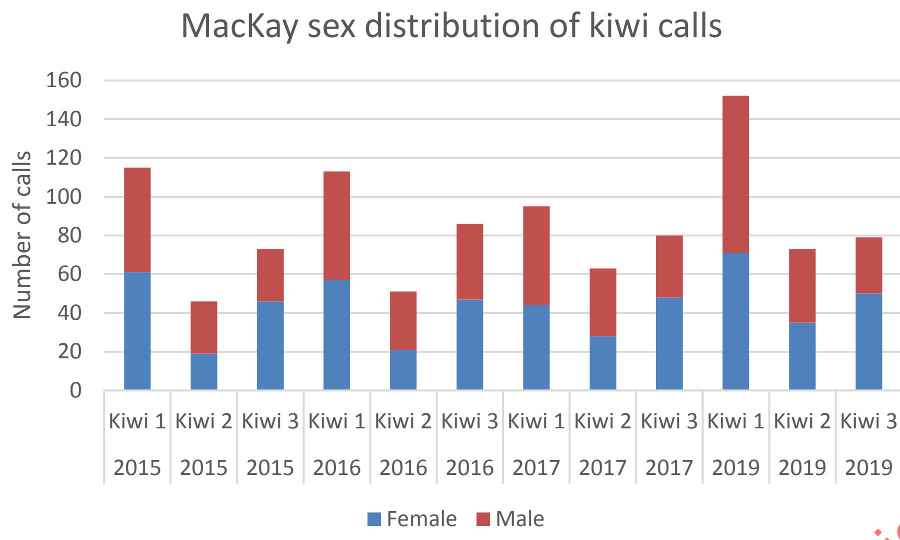

Figure 6. Sex distribution of kiwi calls at MacKay Downs

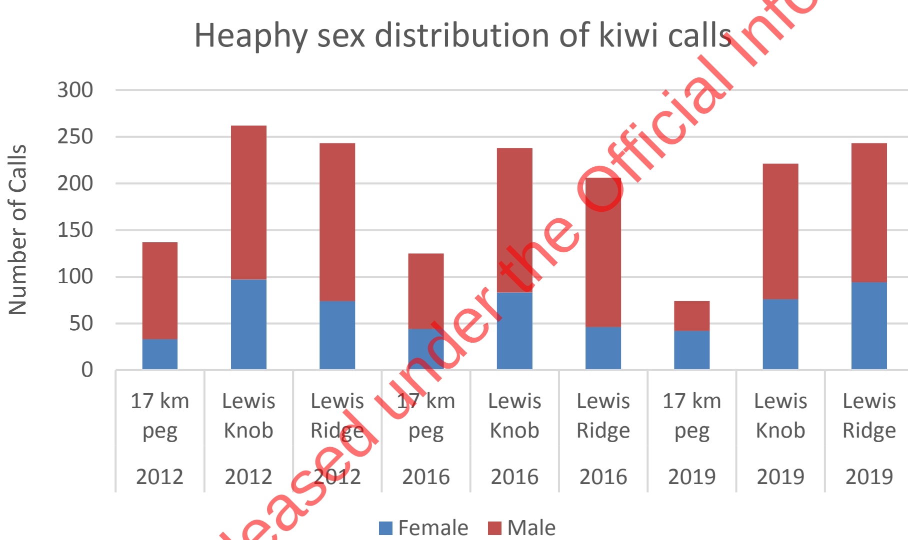

Figure 7. Sex distribution of kiwi calls in the Lower Heaphy valley

Mapping bird distribution

At MacKay Downs, the estimated spatial distribution of kiwi was relatively consistent over the four measurements, although more calls were recorded closer to the observer in 2019. At listening station Kiwi 3 (MOW), in 2017, most birds were located to the west, whereas in the other three years, calls were recorded more evenly around the station (Fig. 8). Calls heard at Kiwi 1 and Kiwi 2 appeared to overlap spatially.

At the Lower Heaphy sites, birds heard at station ‘Peg 17’ were predominately located on the other side of the Heaphy river (Fig. 9). In 2019, most birds were upstream of those recorded in 2016. There was considerable spatial overlap in the calls recorded at the Lewis Knob and Lewis Ridge listening stations (Fig. 9).

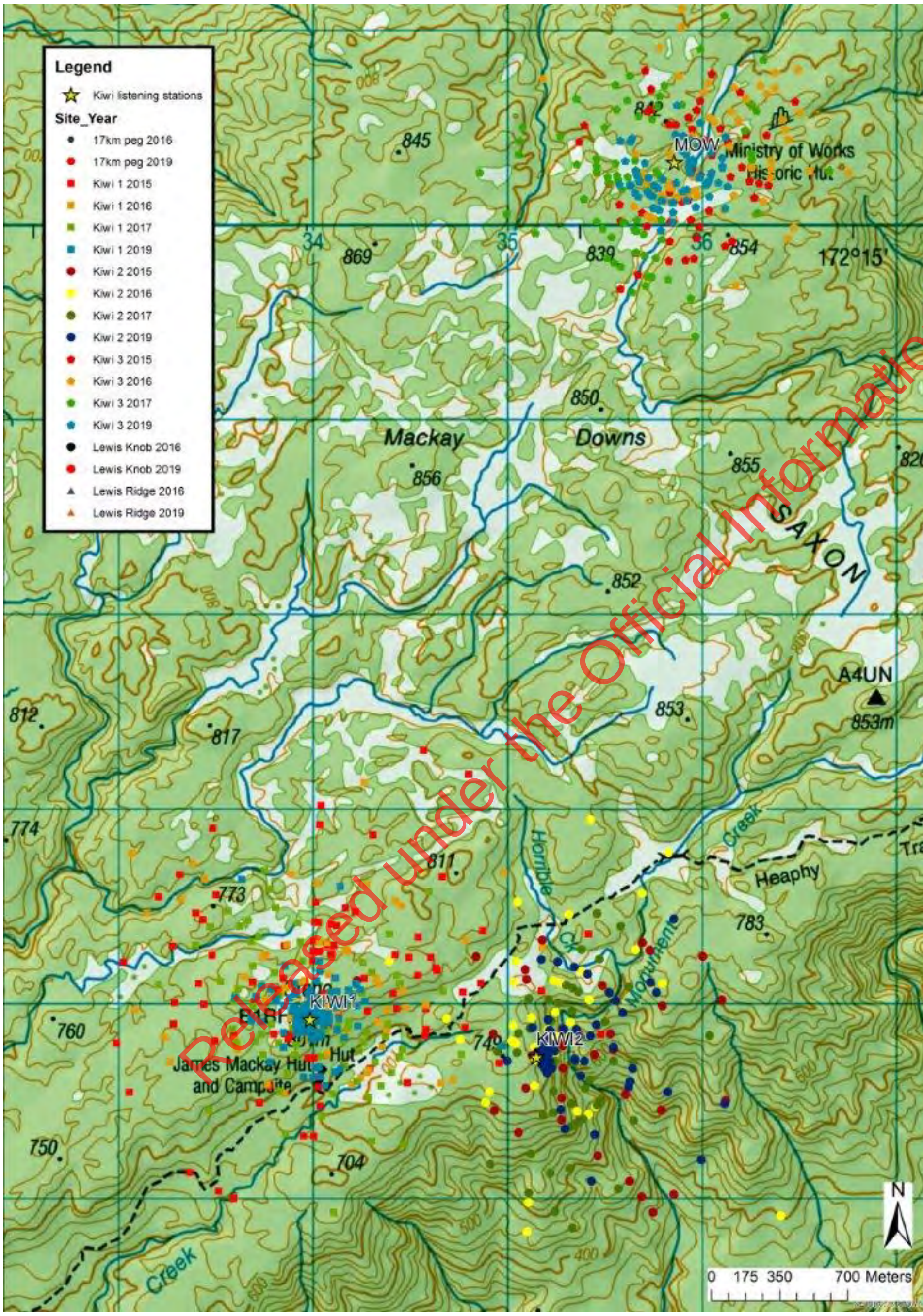

Figure 8. Estimated kiwi distribution at MacKay Downs 2015–19.

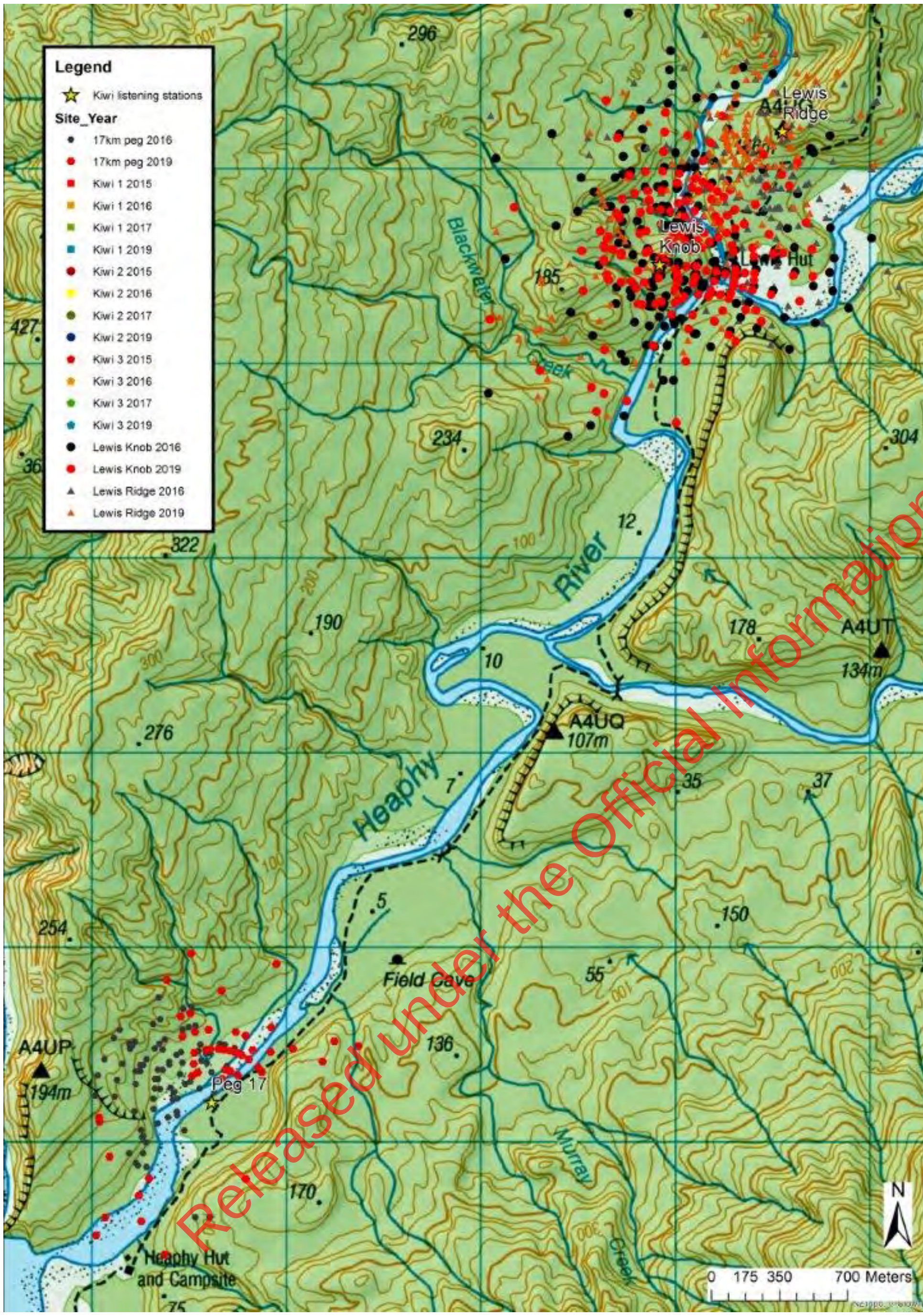

Figure 9. Estimated kiwi distribution in the Lower Heaphy valley 2015–19.

Discussion and recommendations

The average call count rate in the MacKay Downs was 6.33 calls/hour. This was substantially lower than that in the Lower Heaphy (10.35 calls/hour). This suggests that kiwi were less abundant in the Mackay Downs. This difference might be due to environmental factors, as the MacKay Downs are a much harsher environment to live in (higher altitude, colder, less fertile with shrubby vegetation). A study in the Gunner Downs found a call count rate of 5.1 calls/hour (Toy 2012a) in habitat similar to that in the MacKay Downs. Robertson et al. (2014) found an average of 4.0 calls per hour at Blue Duck Creek and 10.2 calls per hour at Weka Creek on the Gouland Downs. The MacKay rate falls within these rates.

The Robertson et al. (2014) study also found a decline in call rates of 4% and 1.8% per annum at Blue Duck and Weka Creek, respectively, between 1994–2012. In contrast, the 2019 MacKay call rate was higher than what was found in previous measures. This may suggest an increasing population at MacKay Downs.

However, the 2019 call counts at MacKay Downs were done in December, rather than in March like the three baseline measurements. This makes the observed increase in calls rates difficult to interpret, as the different time of year may have affected call rates. Great spotted kiwi call frequency is negatively related to the breeding season (Colbourne and Digby 2016). The peak calling is thought to occur from November to March (Robertson 2012). This includes both, the December and March measurement, suggesting they might be comparable. Furthermore, acoustic recorder data from the Lower Heaphy from March 2017 showed similar call rates to what was found by observers in December 2016 (Stephens 2017). This also suggests that the March and December measures might be comparable. It was planned to conduct monitoring using acoustic recorders at both sites in March 2020. Recorders were placed into the lower Heaphy, but not at the MacKay Downs, as the country went into lockdown due to the Covid19 situation. We recommend to undertake this acoustic monitoring next year to establish whether the March and December measures can be compared.

In the Heaphy, the 2019 call rate was around 10 calls/hour, between the 2012 peak and the 2017 measurement. In comparison, other low land sites (Roaring Lion and New Creek) have been found to have substantially lower call rates at 2.3 call/hour (Toy 2012b) and 3 calls/hour, respectively (Toy 2012c). Freeman (2012) associated the increase in call rates from 1995-2012 with the large landscape-scale aerial 1080 operations that have occurred in the Heaphy valley since 2007/08. It was thought that the suppression of stoat numbers over a large area allowed for an increase in juvenile survival (Freeman 2012). However, the call rate declined between 2012 and 2017 despite ongoing predator control. We are unsure of the reasons for this. High numbers of rats were noted during the 2016 measure, and these may have negatively impacted on the kiwi call rate, as high numbers of rats can lead to high numbers of stoats. Annual aerial operations in the Lower Heaphy valley started in 2016. Since then, the regular suppression of rodent and stoat numbers may have contributed to the increase in kiwi calls observed in 2019. Further monitoring will help to assess the effect of the more intensive predator control.

Our data show large variability and trends should be interpreted with caution. Robertson (2012) notes that call counts are subject to a range of variables: changes in the calling behaviour of birds (e.g. birds may call more frequently if they are in a new partnership), differences in the calling behaviour of individuals (some birds may naturally call more frequently than others), the effect of recent weather conditions and differences in observer ability. The latter two factors can be controlled to some degree by using experienced and well-trained observers and undertaking surveys under constant weather conditions, ideally mild, calm and moonlit nights (Robertson 2012). Other variability needs to be balanced by large sample sizes and frequent measurements. Our sample sizes are relatively large, with around 50 listening hours at each site (although they are not independent). With only 3-yearly measurements, it is likely to take some time to confirm trends.

The unequal sex distribution observed in the Heaphy call counts, is not a reason for concern as male kiwis generally call 2–3 times more frequently than females and the lower pitch call of the female does not travel as far as the whistle like calls of the males (Richardson 2012). The equally sex distribution in MacKay is interesting. We unsure of the reason behind this or to why the two sites are different.

To continue the historic data set, observer monitoring should be conducted at both sites in 3 years' time, i.e. in 2022/23. However, increased monitoring using acoustic recorders should also be considered, as this method allows more frequent assessments to compare call rates at different times of the year and to pick up trends in call rates and therefore the kiwi population sooner.

Acknowledgements

This report was peer reviewed signed off for release by Ingrid Gruner, Biodiversity Monitoring Ranger.

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Appendix 7: Heaphy Management Area bird survey – September 2019

Department of Conservation
Te Papa Atawhai

Internal Correspondence

To: Jane Williams and Jess Curtis, Senior Ranger Bathurst Project; Scott Freeman, Senior Ranger, Buller and Suvi Van Smit, Operations Manager Buller Kawatiri (Acting)

From: Cielle Stephens, Ingrid Gruner

Date: 30/04/2020

Report Reference: DOC-6139719

Subject: **Heaphy Management Area bird survey – September 2019.**

Summary

This report presents results from bird population monitoring in the lower altitudes (< 500 m asl) of the Heaphy valley. The monitoring was undertaken to assess management efficacy, as the Heaphy area is managed for biodiversity enhancement in compensation for biodiversity losses incurred due to coal mining on the Denniston Plateau. We conducted five-minute bird counts and distance sampling on randomly placed monitoring grids to assess the status and trend of the local bird populations between 2015 and 2019. The five-minute bird count data detected increasing relative abundance for several native forest species (bellbird, fantail, grey warbler, kākāriki, robin, silvereye, tomtit, tūī and weka). The distance data also suggested increasing population densities for bellbird, fantail, silvereye, tūī and weka. The results are encouraging, as the intensive predator management implemented in the area appears to benefit the local bird populations. We recommend continuing with the annual monitoring to gain confidence in the results and establish the long-term outcomes of the management. Both methods, five-minute bird counts, and distance sampling should continue to be used to align the present study with the Department of Conservation's national biodiversity monitoring system.

Introduction

The Heaphy area in Kahurangi National Park has long been recognised as a place with high conservation values. The area was initially a regionally highly ranked management unit where possum vulnerable plants and threatened endemic land snail species (*Powelliphanta*) were managed for persistence. In 2011, the area was selected as a nationally representative Ecosystem Management Unit (Department of Conservation 2013).

Since 2014, Buller Coal Limited (BCL) provides compensation funding to the Department for the loss of biodiversity resulting from the Escarpment Mine operation on the Denniston Plateau. A portion of the compensation funds is specifically designated to enhance, for 35 years, biodiversity values within a management area centred on the Heaphy Valley.

The compensation management area lies within Kahurangi National Park, in the north-west of the South Island. It extends from the Moutere River in the north to the Kohaihai River in the south and east to the Gunner and Gouland Downs. It is approximately 29,000 ha in size with a core area of about 13,000 ha encompassing the lower and mid Heaphy Valley and the Iwituaroa Range. The core area is surrounded by a 3 km wide buffer zone to minimise reinvasion of pest species and thus increase effectiveness of pest management in the core area.

Pest control in the Heaphy area was initiated in 1993/94 with localised ground control of possums along the coast and on the Heaphy Valley flats, and a small-scale aerial 1080 operation also targeting possums south of the Heaphy River (Department of Conservation 2020). Since then, pest control efforts have increased with the first full scale aerial 1080 operation over the entire management area, targeting rats and possums, conducted in 2007/08. Subsequent full-scale aerial operations occurred in 2012/13, 2014/15 and 2016/17. Since November 2017, all areas below 500 m asl in the Heaphy catchment have received annual aerial pest control to suppress the local rat population. In November 2019, the Heaphy and Gunner sections of the Aorere and Karamea operational blocks were treated (Fig. 1).

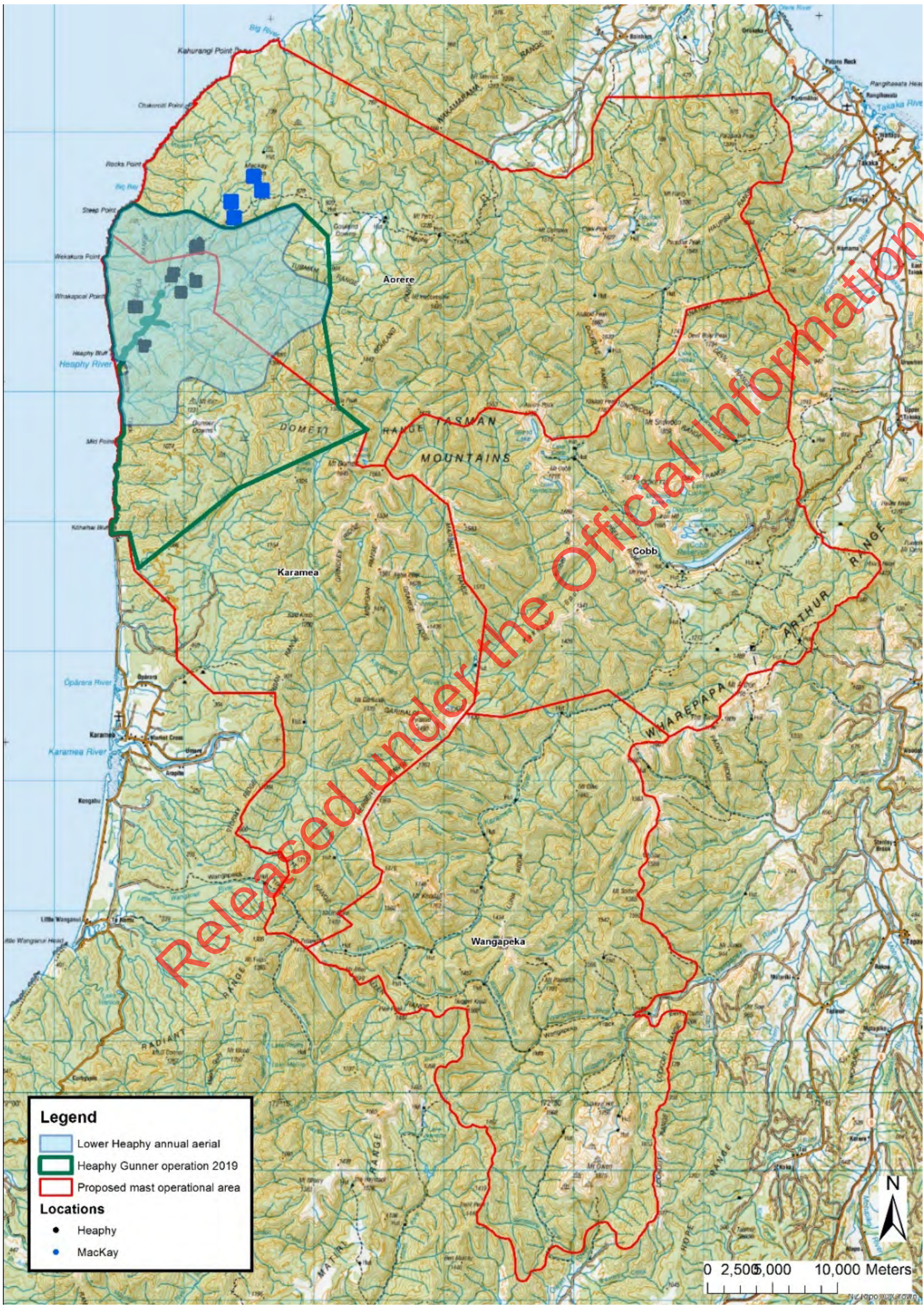

Figure 1. Kahurangi National Park. Extent of aerial pest control operations. The proposed full operational area to be treated after a beech mast is outlined in red. The green outline shows the treatment area following the 2019 mast. Annual operations cover the area below 500 m asl in the Heaphy valley (light blue). The grey squares show the location of the Lewis bird monitoring grids and the blue squares show the MacKay grids (see Methods section).

The management plan for the Heaphy compensation project (Department of Conservation 2013; DOC-1226988) includes a comprehensive biodiversity monitoring programme that aims to assess the effectiveness of management, identify possible improvements to management practices and enable reporting on biodiversity enhancements achieved over time. This monitoring programme includes the monitoring of local bird populations, as intensive predator control is hoped to benefit these.

This report presents the results of annual bird counts done in the lower altitude area (< 500m asl) of the Heaphy management area over the last five years. Using distance sampling and five-minute bird count data, it reports on species richness, frequency of occurrence, distribution, relative abundance and estimated population densities of bird species within the survey area over time.

Methods

Six monitoring grids, each with 25 systematically arranged sample points (Fig. 2) were available for survey in the lower Heaphy area (< 500 m asl, subsequently called 'Lewis'). Within each grid, sample points were located 200 m apart (as measured by a GPS) to ensure independence of individual counts. Each grid was set up in a north-south/east-west orientation based on a random starting point (aligned with the Department's spatially balanced Tier 2 monitoring master sample). Grids and points within grids were mapped using ESRI ArcMap 10.3.1 prior to the first field visit.

During the first visit, not all 25 sample points in each grid were surveyed because of unsafe terrain (e.g. sinkholes, bluffs, windfall) or time constraints. In subsequent years, some sample points were added, but others not measured, again due to time constraints or additional hazards, e.g. slips (Table 1).

Table 1. The number of sample points by survey year.

Year	Number of points visited
2015	106
2016	113
2017	115
2018	111
2019	111

At each sample point, distance sampling (Buckland et al. 2001, 2004) and standard five-minute bird counts (Dawson and Bull 1975) were undertaken. We followed the methodology currently used in the Department's Tier 1 monitoring programme (DOC-828397). This means, at each sample point, birds were surveyed for a total of ten minutes: distance sampling was conducted during the first five-minutes followed by a standard five-minute bird count during the second five-minute period. Both types of counts were unbounded, and birds were recorded within predefined distance categories. The distance sampling counts used the following distance categories: 0–8 m, 9–16 m 17–25 m, 26–45 m, 46–100 m and >100 m. The five-minute bird counts used three, coarser categories: Near (0–25 m), Far (26–100 m) and >Far (100 m+). Environmental variables (temperature, wind, noise, minutes sunshine and precipitation type and amount) were also recorded. Incidental observations, i.e. outside the formal count periods, were recorded for any additional species observed. Both, native and introduced bird species were included.

The main difference between distance sampling and five-minute bird counts is that distance sampling aims to record a snapshot in time of bird presence and location. This means that the recorded distances are supposed to reflect the location of each bird at one point in time, taken to be the start of the five-minute observation period. Birds moving into or over the sample area during this period are not recorded. Five-minute bird counts, in contrast, record all birds seen or heard during the survey period. Both, distance sampling and five-minute bird counts attempt to record each individual only once.

The first three years of monitoring in the Heaphy area (2015–17) are considered a baseline assessment against which future assessments could be compared. In these years, monitoring was done in the Lewis as well as the MacKay Downs area (Heaphy catchment > 500 m asl). Subsequently, the Lewis area was surveyed annually, while the MacKay area was put on a three-year re-measurement cycle. The annual monitoring in the Lewis area hopes to detect a trend in the local bird populations in response to the more intensive, annual predator control in the area.

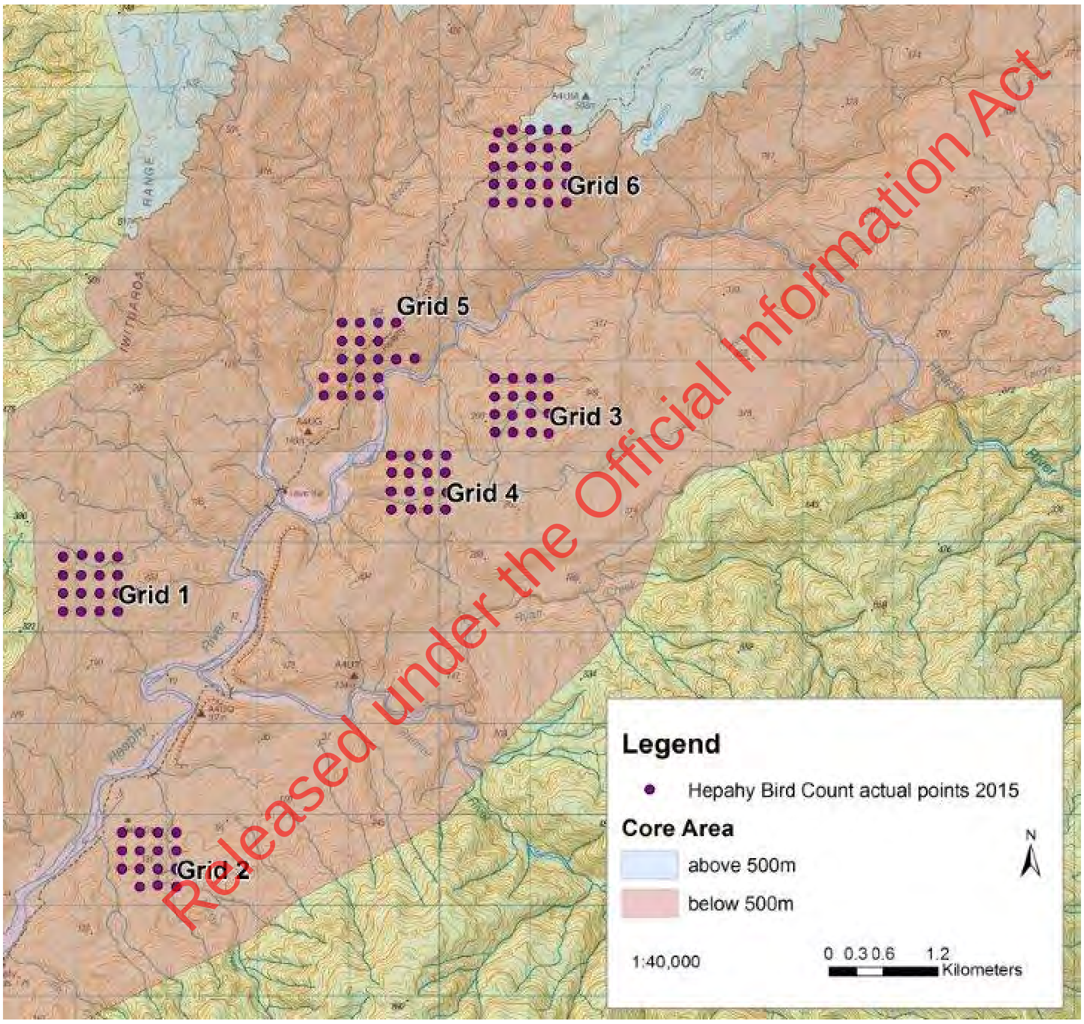

Figure 2. Location of the five-minute bird count and distance sampling grids and points in the Heaphy management area in the area below 500m asl (Lewis) as measured in 2019.

The monitoring was undertaken by experienced bird observers in September or October of each year. Counts were completed between 8 am and 4 pm. The field data sheet template can be found in DOCDM-828398. A post-operational report detailing the logistics of the field work is stored in S:\3_Tech Support\WAM\Post operational summaries\2019_20.

Analysis

Species richness reports the total number of bird species detected within the survey area during the entire survey, i.e. including distance sampling, five-minute bird counts and incidental observations. This is to capture the full complement of species present in the area.

We analysed five-minute bird count data for all species for which at least 30 individuals had been recorded over the five survey years. The frequency of detection for each species was calculated as the percentage of sample points at which a species was encountered. This provides a measure of how widespread the species occurred throughout the survey area. To analyse this geographically, we mapped bird distribution using ArcMap 10.3.1 GIS software. Species were mapped at each station where they were recorded as present. Definition queries were used to map the species by year and display the number of individuals recorded.

Relative abundance, defined as the mean number of individuals of a given species detected per sample point, was also calculated using the five-minute bird count data. It provides a simple index of species abundance (Dawson and Bull 1975). We analysed the trend over time for species using generalised linear mixed effects models. We assumed that the bird counts followed a Poisson distribution and analysed the data for each species separately. Models allowed for random effects of observer, grid and sample points within grids. Environmental variables (temperature, wind, noise, sunshine, precipitation type and amount) were included as covariates and eliminated by backwards selection. Year of measurement remained in the model as change over time was our main interest. An effect was deemed significant when the relevant p-value was < 0.05. We identified the favoured model based on the lowest AIC. The five-minute bird count data were analysed using Excel 2007 and R statistical software (R Core Team 2016).

Distance sampling data allows estimation of population densities in the survey area as the number of individuals per ha. The analysis models the probability of detecting an individual bird as a function of its distance from the observer (detection function). This detection function is then used to calculate population densities. A minimum of about 80 counts per species is required to attain reasonably accurate and precise estimates of population density (Buckland et al. 2001). The distance sampling data were analysed using the programme Distance 6.0 (Thomas et al. 2010, 2018). After the five survey years, distance sampling provided sufficient data to estimate population densities for nine species (Table 2).

Table 2. The nine species for which distance sampling provided enough data to estimate detection functions and population densities in the 2015–19 surveys with the total number of counts achieved over this period.

Species	Total counts 2015–2019
Bellbird	1570
Fantail	289
Grey warbler	599
Rifleman	73
Robin	221
Silvereye	267
Tomtit	483
Tui	346
Weka	106

For all nine species, a global detection function was used based on the pooled 2015–19 data for each species, with estimates of density obtained separately for each year, as well as for the entire monitoring period (2015-2019). The sample points were used as the basic sampling unit, as they were deemed to represent independent measurements. Sampling effort was included in the analysis as the number of counts undertaken at each survey point during each survey year.

Cluster data was entered for all species, but the impact of clusters on population density estimates was thought to be minimal for all species, as most occurred as individuals. We therefore present individual density, rather than cluster density.

Selection of the best model for the detection function in each analysis was guided by AIC, Chi-square model fit statistic, coefficient of variation and visual inspection of probability density plots (Buckland et al. 2001, 2004).

The five-minute bird count data are stored electronically in DOC-2600272, the distance sampling data in DOC-2608373. Raw data for both are held in a box file in the Hokitika office of the Department's Biodiversity Monitoring Team. Relevant R-code can be found in S:\3_Tech Support\WAM\1. R\Bird\Heaphy\2019. The Distance analysis projects are stored in Q:\GIS_Users\Hokitika\Data\Biodiversity\Biodiversity_Monitoring_Team\NHT Heaphy -02-16-51\bird counts\Analysis\Distance analysis\2019. Excel based analyses, graphs and pivot tables can be found in DOC-6140179.

In the following, we only use common names for the bird species observed during our survey. The corresponding scientific names and species' threat statuses are tabled in Appendix 1.

Results

Species richness

Overall, 31 bird species were observed during the 5 years of bird surveys in the Lewis area. Of these, eight species are introduced – blackbird, chaffinch, dunnock, goldfinch, greenfinch, redpoll, skylark and song thrush (Table 3). Five are listed as threatened or at risk – New Zealand falcon, fernbird, kākā, kea and great spotted kiwi (Robertson et al. 2013). While most of the threatened or at risk species were only observed occasionally, the increase in kākā observations in 2019 was notable.

Frequency of detection and species distribution

Frequency of detection was highest for bellbird which was detected at almost all sample points in every survey year (Fig. 4). Grey warbler was the second most frequently observed species. Silvereye, tūī and weka showed a notable increase in their frequency of detection over time.

Some species did not seem evenly distributed across the survey grids. Robin were most frequently observed in the highest altitude grid (Grid 6), although frequency of detection in the other grids appeared to increase over time (Fig. 5). Rifleman and brown creeper were only found in the Grid 6. Grey warbler occurred with lower frequency in Grid 1.

Table 3. Species observed during five-minute bird counts (5MBC) and distance sampling in the Lewis area 2015–19 with the number of individuals detected in each year. No additional species were recorded incidentally. For a list of scientific species names and threat statuses see Appendix 1.

Species	5MBC					Distance sampling				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Bellbird (mainland)	354	304	212	395	432	331	271	204	360	404
Blackbird*	2	8	3	12	11	1	8	3	7	8
Brown creeper	5		10	10	7	6	2	7	11	5
Chaffinch*		19	7	5	12		15	7	3	13
Dunnock* (hedge sparrow)		1								
Long tailed cuckoo										1
Falcon, NZ		1			3		2			3
Fantail, South Island	39	29	65	84	76	41	27	69	65	87
Fernbird, South Island	1				1	1			2	
Goldfinch*					7					5
Greenfinch*		4		1	10				1	4
Grey warbler	108	117	114	137	156	112	102	115	126	144
Harrier			1	1	7				1	4
Kākā, South Island				1	5					5
Kea	1	1	2	4	4	1		1	3	
Kererū		3		2	6	3	4		4	4
Kingfisher				1					1	
Kiwi, great spotted			1					1		
Morepork									1	
Paradise shelduck			2	5	2		1	2	1	3
Parakeet/kākāriki spp.	6	19	1	12	38	4	11	1	9	21
Redpoll*		10			6		10			1
Rifleman, South Island	31	13	9	11	23	23	13	8	10	19
Robin, South Island	26	48	63	30	63	28	40	65	29	59
Skylark*					1					1
Silvereye	3	74	64	38	152	2	61	49	35	120
Swallow, welcome				2	2					1
Thrush, song*	6		2	4	13	6		2	2	6
Tomtit, South Island	76	70	117	115	118	76	66	121	117	103
Tūī	15	55	25	128	213	17	39	23	97	170
Weka, western	3	19	19	19	63	4	16	19	14	53
Grand total	676	797	717	1016	1431	656	688	698	902	1245

* - introduced species

For weka and tūī, the observed increase in frequency of detection seemed relatively evenly spread over the six survey grids, although in the 2019 measure only three weka were observed in Grid 2 compared to 23 in Grid 6 (Fig. 6). Tui were present in all grids in 2019, with highest numbers found in Grids 3 and 4 (Fig. 7). Kakariki have been found in all grids over the survey period. In 2019, they were not observed in Grid2, while Grid 1 and 4 recorded the highest numbers (Fig. 8).

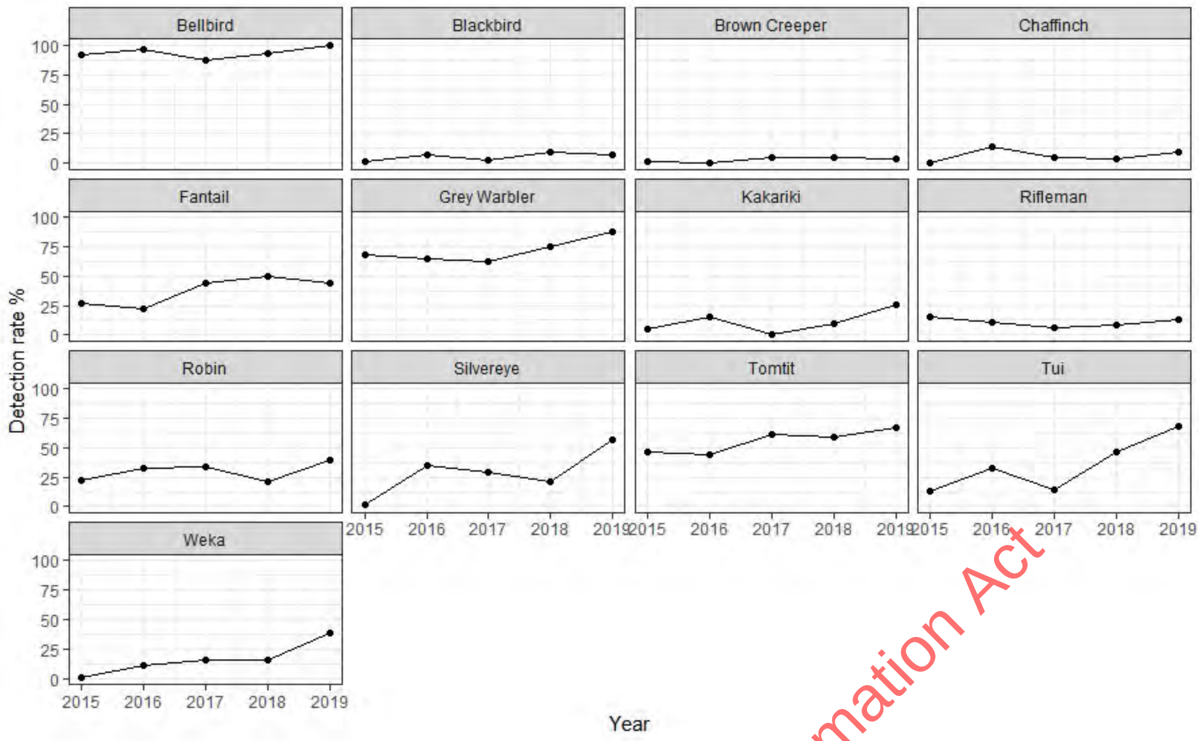

Figure 4. Frequency of detection (detection rate %) by survey year (2015–19) based on the five-minute bird count data for the most frequently observed species.

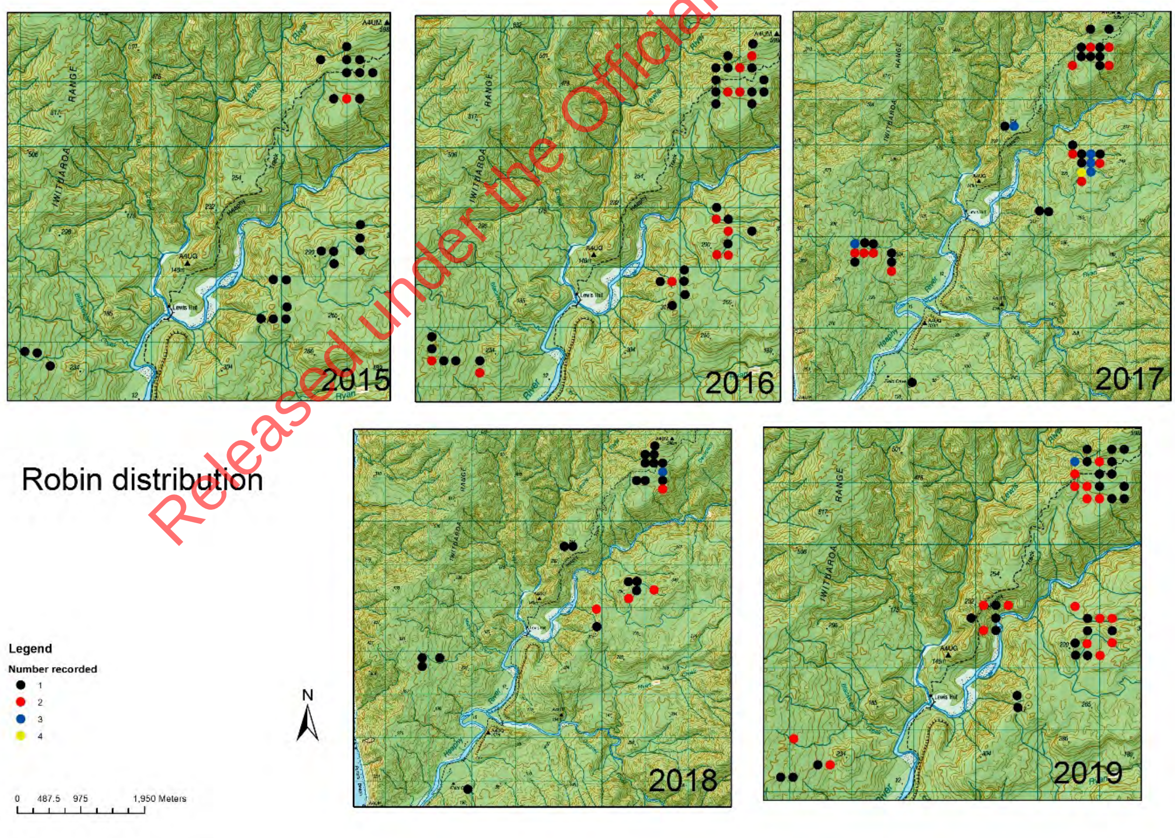

Figure 5. Robin distribution in the Lewis monitoring grids 2015–19.

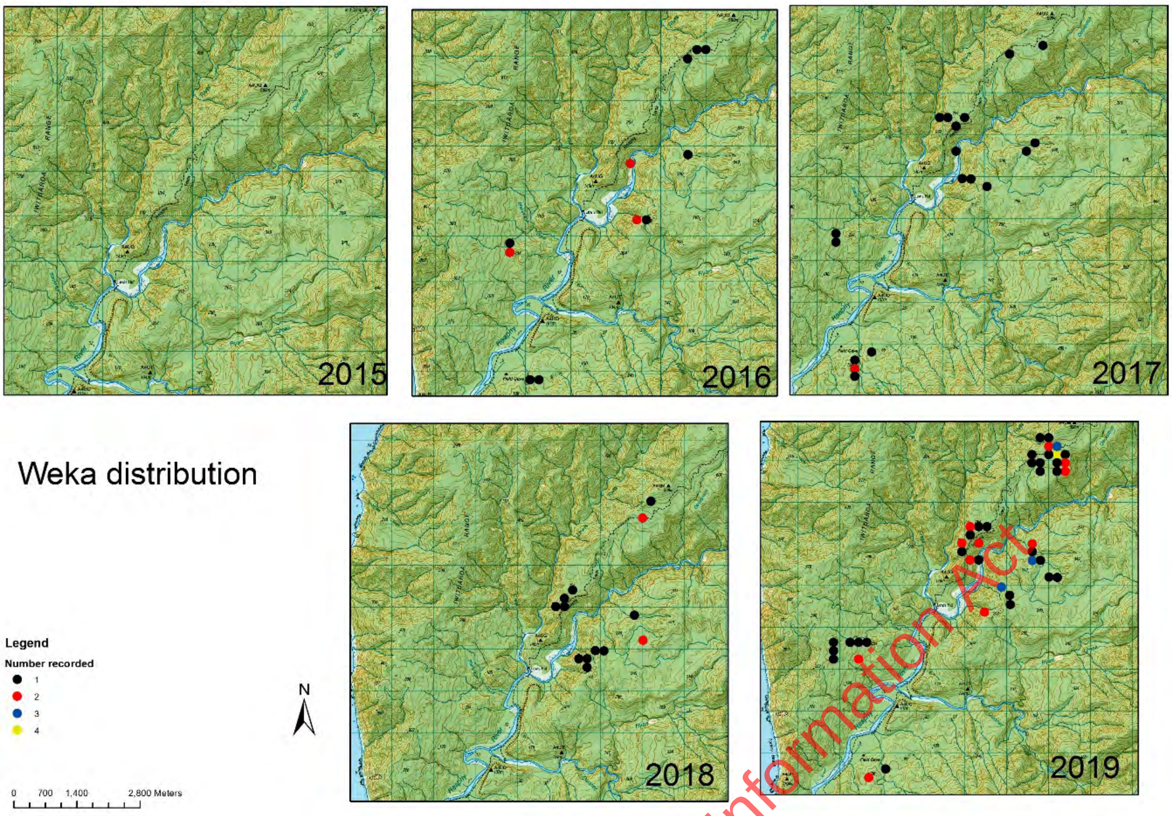

Figure 6. Weka distribution in the Lewis monitoring grids 2015–19.

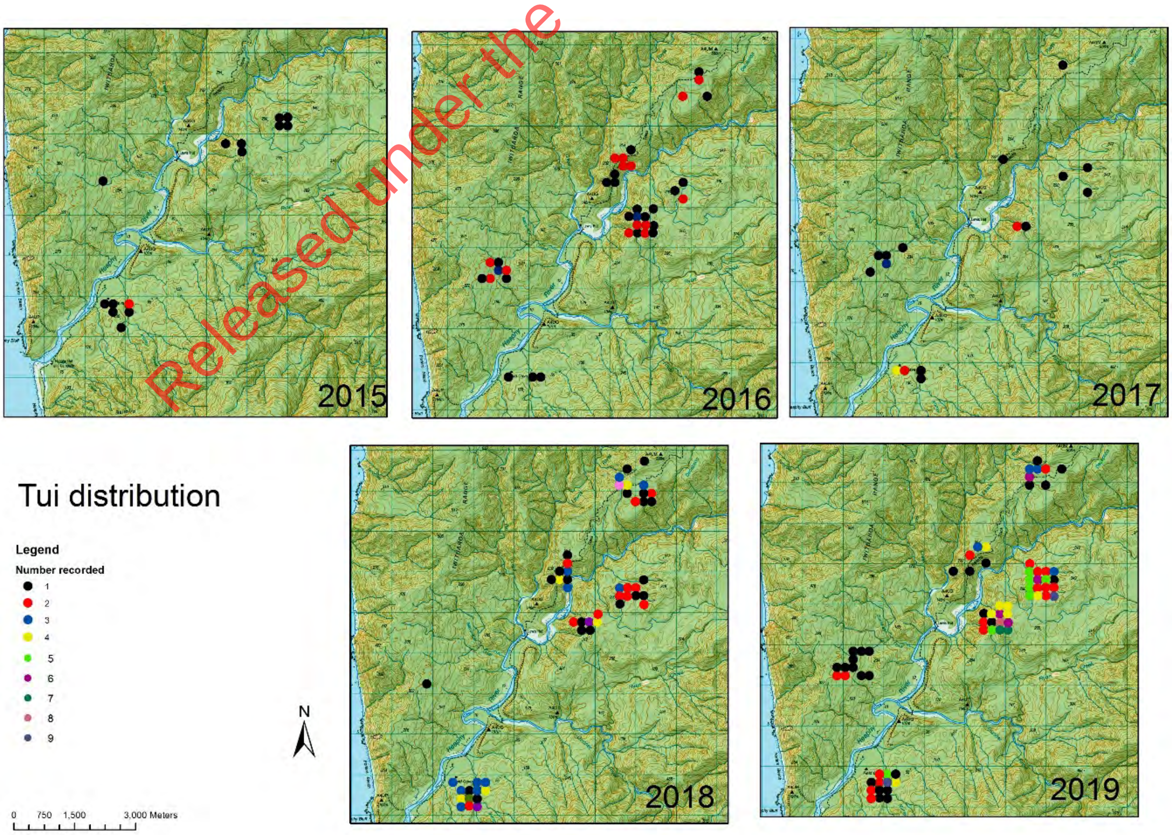

Figure 7. Tūī distribution in the Lewis monitoring grids 2015–19.

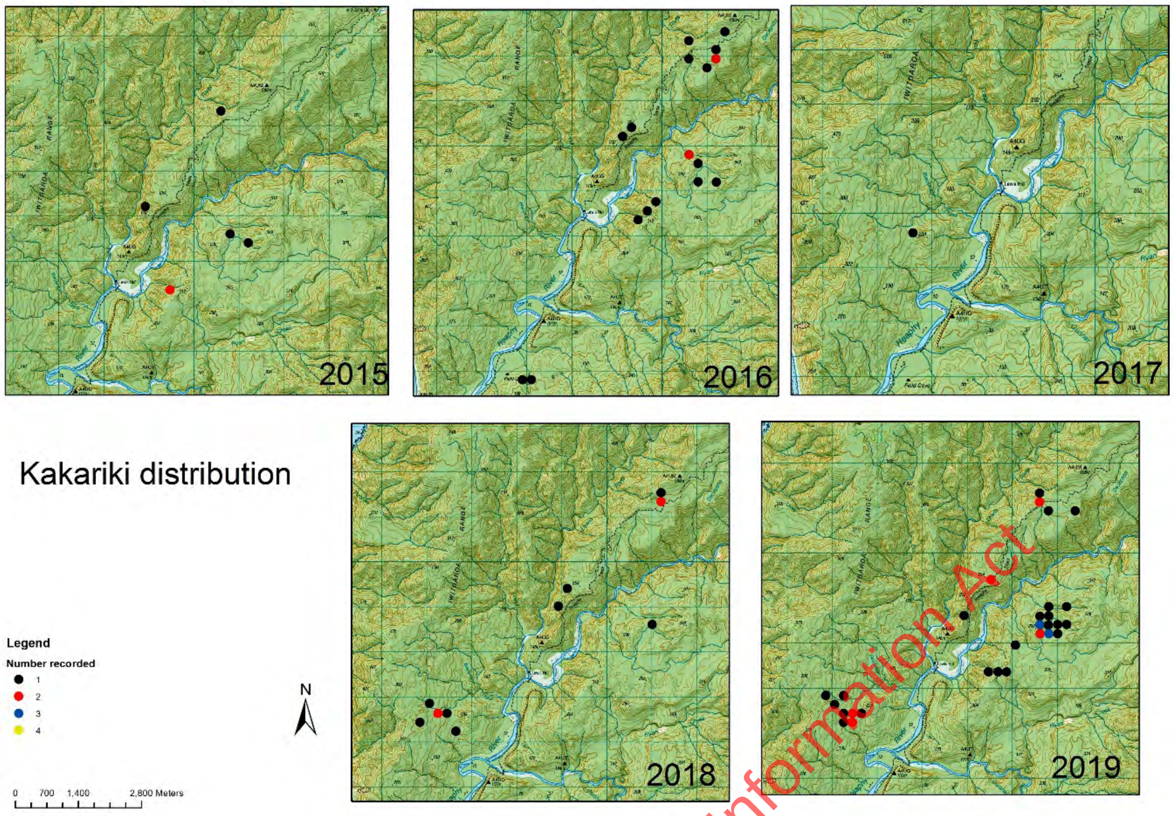

Figure 8. Kakariki distribution in the Lewis monitoring grids 2015–19.

Relative abundance

The relative abundance of bird species provided a similar picture. Bellbird were by far the most abundant species, with nearly four individuals per sample point in 2019. All native species bar rifleman and brown creeper showed a significant upward trend over time (Fig. 9, Table 4).

Figure 9. Relative abundance (+/- 95% Confidence Interval) for the bird species most frequently detected during five-minute bird counts.

Table 4. Estimated annual change in relative abundance with 95% confidence intervals and p-values from generalised linear mixed effects models accounting for random effects of observer, grid and sample point as well as effects of environmental covariates.

Species	Estimated annual change	95% Confidence Interval	p-value
Bellbird	0.086	0.06 to 0.11	**<0.001**
Fantail	0.228	0.17 to 0.282	**<0.001**
Grey warbler	0.10282	0.06535 to 0.14029	**0.00607**
Kakariki	0.297	0.1915 to 0.4025	**0.00487**
Rifleman	-8.709e-02	0.238e-02 to -17.60e-02	0.33033
Robin	0.14157	0.08531 to 0.19783	**0.011863**
Silvereye	0.43029	0.38798 to 0.4726	**<0.001**
Tomtit	0.10951	0.06633 to 0.15269	**0.011204**
Tūī	0.62364	0.54615 to 0.70113	**<0.001**
Weka	0.54291	0.46378 to 0.62204	**<0.001**

Population density

In the analysis of the distance sampling data, the preferred detection function for all species was a hazard rate function. The estimated mean population densities in 2019 were higher than those in previous years for all species but tomtit and robin (Fig. 10). Many species displayed an increasing trend over time, particularly fantail, silvereye, weka and tūī.

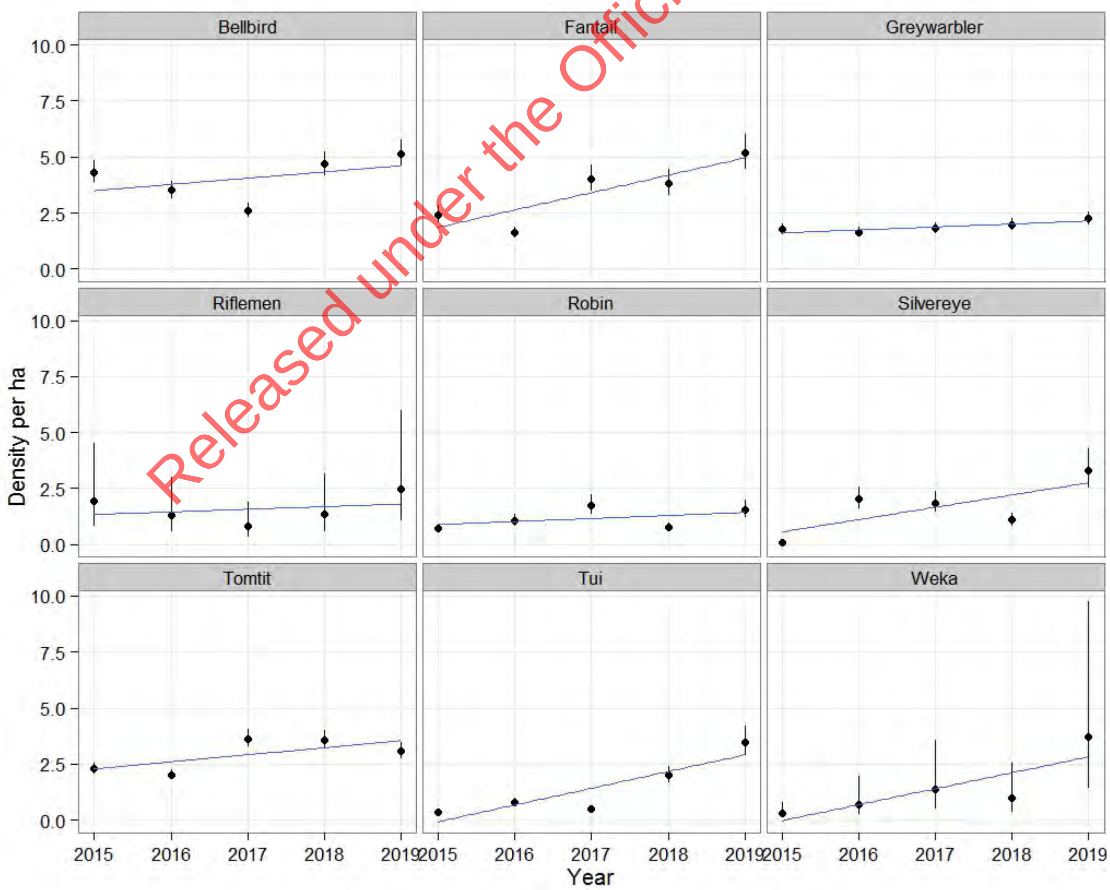

Figure 10. Population densities (individuals/ha) for birds in the Lewis area over time. The blue line represents a simple linear regression model for the overall trend over time.

Discussion

The increases in relative abundance and population densities observed for several of the monitored bird species in the Lewis area could be a first indication that the intensive, annual predator management in the area is benefitting the local bird populations.

It has been documented elsewhere that predation by introduced predators can lead to the decline of local bird populations including species generally regarded as common or widespread (Elliott et al. 2010, Innes et al. 2010), and that sustained control of these predators in turn can induce the recovery of these species (Moorhouse et al. 2003, O'Donnell & Hoare 2012, Elliott & Kemp 2016, Beagley et al. 2019).

The monitoring in the Lewis area was set up to assess the difference made for local biodiversity, as any improvements here are intended to compensate for biodiversity losses elsewhere. When the compensation programme started in 2015, it was assumed that improvements would have to be made from a relatively high baseline, because sustained predator control had already been in place in the area for over 20 years. The first bird survey in 2015 suggested that the local bird community was relatively intact. It was dominated by native species and otherwise widespread introduced species were largely absent. However, particularly predator-sensitive native species, such as kākā, were notably sparse or absent (McArthur & Gruner 2016).

After five years of monitoring, the results are encouraging. Several of the common and widespread species appear to be increasing both in numbers and in distribution. For the first time, kākā were repeatedly encountered during the survey. The results still need to be treated with caution. Five-minute bird count and distance sampling data are characterised by large variability, as counts are strongly influenced by factors such as weather or observer experience. However, despite accounting for these factors in the relative abundance model, observed trends were deemed significant.

The positive trends could be the result of the increasingly intensive predator management implemented in the area. Since 2012/13, predator control operations have occurred every two years; since 2017, every year. This is to reduce the otherwise continuously high rat numbers in the lowland forests of the Heaphy catchment. Mast years, in which the dominant beech trees produce vast amount of seeds triggering irruptions of predator populations, present another serious threat that is managed with targeted predator control. However, these control operations have not always been successful. The last two operations following beech mast years (2016 and 2018) did not achieve their control targets. This means predation levels remained higher than intended.

Long-term bird monitoring in another beech forest area, the Te Maruia management area, has shown that while the sustained predator control there benefits local bird populations, it is not quite enough to reverse declining trends for all species (Stephens 2018). It is recommended to continue with the annual bird monitoring in the Lewis area to gain more confidence in the observed trends and understand their long-term trajectories. Only this will allow us to reliably assess whether the intended biodiversity compensation is achieved.

Five-minute bird counts and distance sampling appear to yield similar results. It is questionable whether both methods need to continue. However, the present study is tied into the Department's wider national biodiversity monitoring system. The sample is aligned with the national monitoring master sample to allow comparisons and potential pooling of data. For this reason, the use of both methods should continue until a decision in favour of one of the methods is made at the national level.

Acknowledgements

This report was peer reviewed by Jess Curtis, Senior Ranger Kawatiri Buller office, and signed off for release by Ingrid Gruner, Biodiversity Monitoring Ranger. Staff that conducted the field work over the five survey years were Patrick Crowe, Ruth Garland, Richard Nichol, Moira Pryde, Sonya McArthur, Rebecca Jackson, Cielle Stephens, Ingrid Gruner, Lara Wilcocks, Jeroen Lurling, Gemma Hunt, Josh Kemp, Claire Kilner, Jenny Chandler, Rowan Hindwall-Marsh, Kat Reynolds, Cameron Eddy and Yanike Sophie.

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Appendix 1

Bird species observed during bird surveys in the Heaphy management area 2015–19.
Threat status according to Robertson et al. (2013).

Common name	Scientific name	Threat status
Bellbird (mainland) /korimako	*Anthornis melanura melanura*	Not threatened
Blackbird *	*Turdus merula*	Introduced
Brown creeper/pīpipi	*Mohoua novaeseelandiae*	Not threatened
Chaffinch *	*Fringilla coelebs*	Introduced
Dunnock (hedge sparrow) *	*Prunella modularis*	Introduced
Falcon, NZ/kārearea	*Falco novaeseelandiae*	Nationally vulnerable
Fantail, South Island/pīwakawaka	*Rhipidura fuliginosa fuliginosa*	Not threatened
Fernbird, South Island/mātātā	*Bowdleria punctata punctata*	Declining
Greenfinch *	*Chloris chloris*	Introduced
Grey warbler/riroriro	*Gerygone igata*	Not threatened
Harrier	*Circus approximans*	Not threatened
Kākā, South Island	*Nestor meridionalis meridionalis*	Nationally vulnerable
Kea	*Nestor notabilis*	Nationally endangered
Kererū/New Zealand pigeon	*Hemiphaga novaeseelandiae novaeseelandiae*	Not threatened
Kingfisher	*Todiramphus sanctus*	Not threatened
Kiwi, great spotted	*Apteryx haastii*	Nationally vulnerable
Morepork/ruru	*Ninox novaeseelandiae*	Not threatened
Paradise shelduck	*Tadorna variegata*	Not threatened
Parakeet /kākāriki spp.	*Cyanoramphus spp.*	Not threatened
Redpoll *	*Acanthis flammea*	Introduced
Rifleman, South Island/titipounamu	*Acanthisitta chloris*	Not threatened
Robin, South Island/toutouwai	*Petroica australis australis*	Not threatened
Silvereye/tauhou	*Zosterops lateralis lateralis*	Not threatened
Swallow, welcome	*Hirundo neoxena*	Not threatened
Thrush, song *	*Turdus philomelos*	Introduced
Tomtit, South Island /ngiru ngiru	*Petroica macrocephala macrocephala*	Not threatened
Tūī	*Prosthemadera novaeseelandiae novaeseelandiae*	Not threatened
Weka, western	*Gallirallus australis australis*	Not threatened

* - introduced species

Appendix 8: Media article – 'Heaphy survey shows birdlife on the rise'

Appendix 8: Media article – 'Heaphy survey shows birdlife on the rise'

Heaphy survey shows birdlife on the rise

02 SEP 2020

Anecdotal reports of more birdlife on the Heaphy Track have been backed up by a five-year study showing increased numbers of some forest birds.

The Department of Conservation (DOC) has been monitoring birds in the lower Heaphy Valley in Kahurangi National Park since 2015 to assess whether management is making a difference for wildlife.

Results show a trend of increasing numbers of nine native species - korimako/bellbird, piwakawaka/fantail, riroriro/grey warbler, kākāriki/parakeet, toutouwai/robin, tauhou/silvereye, miromiro/tomtit, tūī and weka.

Rarer birds such as kārearea/New Zealand falcon, fernbird, kākā, and kea were only occasionally observed although there was a promising increase in kākā seen in 2019.

DOC Buller operations manager Suvi Van Smit says the results are encouraging as intensive predator management in the Heaphy valley appears to be benefiting the local bird populations.

"It's early days in this long-term biodiversity enhancement project but we are already seeing some native birds becoming more plentiful, confirming anecdotal reports from visitors to the Heaphy Track.

"We've increased the frequency of predator control in an area centered on the Heaphy Valley since 2013 and have undertaken annual aerial 1080 predator control to suppress rats since 2016.

"Further monitoring is needed to be confident that increased predator control is causing the upswing in birdlife, but so far this appears to be the case."

Korimako/bellbird was the most frequently detected bird. In 2015, 354 bellbirds were observed during five-minute bird counts at monitoring sites, increasing to 432 in 2019.

Toutouwai/robin (26 to 63), kākāriki/parakeet (6 to 38), tūī (15 to 213) and weka (3 to 63) also showed notable increases over that time. A second survey method, distance sampling, produced similar results.

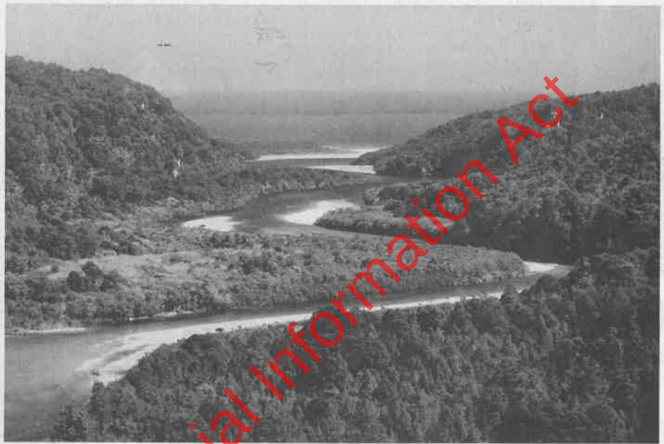
The 35-year project to enhance native wildlife in the Heaphy valley is funded from Bathurst Resources Limited's 2014 compensation for the loss of biodiversity values from the Escarpment Mine operation on the Denniston Plateau.

The management area is about 29,000ha with a core area of 13,000ha including the mid-lower Heaphy Valley and Iwituaroa Range, which is the focus of intense predator management.

Due to the warm conditions in the lower Heaphy, rats breed and rebound more quickly than in upland areas. DOC monitors the effectiveness of rat control after each operation and results for this site have varied.

Last year's results were disappointing with more rats surviving the operation than was desirable. This may have been due to the massive forest mast and very high rat numbers. DOC is doing research into these and other results as part of work to improve predator control regimes.

Localised possum control began in the Heaphy Valley in the mid-1990s and was ramped up in 2007 with the first large-scale aerial 1080 predator control operation over the management area. Subsequent operations occurred in 2012 and 2014 and annually since 2016. Further predator control is planned for 2021 as part of DOC's Tiakina Ngā Manu programme.



Heaphy Valley river. Photos: Richard Rossiter DOC

Robin, Heaphy Valley.

Weka, Heaphy Valley.

Appendix 9: Maintaining 1080 effectiveness in repeat-use regimes, with attention to the proposed Heaphy 2020 re-treatment

Maintaining 1080 effectiveness in repeat-use regimes, with attention to the proposed Heaphy 2020 re-treatment

Josh Kemp, 11 May 2020

Summary

Efficacy of 1080, or any single pest control method, should generally decline with repeated use. The speed at which efficacy declines should be related to use-patterns, reinvasion context, and natural events that sometimes suppress pests to very low levels, such as extreme climate or parasites and disease. Under some combinations of these, efficacy of 1080 may not decline at all, despite repeated use. Under others it might decline within a few generations.

As a rule, apparent phenomena rarely result from a single cause. We should expect multiple mechanisms to operate concurrently. What we seek is to understand how the relative importance of alternative mechanisms changes with use patterns and use context. Understanding this will enable us to predict when we might usefully build tangible steps into our plans in order to maintain efficacy for the future.

The reason for repeatedly using 1080 is to save birds, snails, bats, lizards and plants, not to study 1080 efficacy. The only reason that alternative tools have not been used is a lack of alternative tools. The only current broadscale alternative, pindone, costs a lot and aren't in the habit of using it. At some sites broadscale aerial 1080 is integrated with small-scale nodes of ground control and these might be needed more in the future to prevent and remedy declining efficacy of 1080.

Mechanisms of declining efficacy

This section discusses identifies alternative pathways to surviving a bait encounter, in order to postulate hypotheses about the use patterns and use contexts that favour them and therefore might result in declining efficacy.

The root cause of any reducing efficacy from *Op N* to *Op N+1* has to be either 1) individuals surviving *Op N*, and/or 2) reinvasion of vacant habitat created by *Op N* by individuals that have either a) survived an adjacent Op or b) are descendants of survivors of an adjacent Op that survived via heritable mechanisms.

Pathways to surviving a toxic bait encounter

1. No prefeed => toxic bait novel => small meal safety test => sublethal symptoms => learned aversion
2. Prefeed => small meal safety test and/or social transmission => accepted familiar => finds toxic fragment => sublethal symptoms => learned aversion/confusion
3. Prefeed => accepted familiar => finds toxic bait but prefers alternatives => sublethal dose => learned aversion/confusion
4. Prefeed => accepted familiar => finds and eats toxic bait but high physiological tolerance => sublethal symptoms => learned aversion/confusion + genetic Type A resistance

5. Prefeed => accepted familiar => finds and eats toxic bait but high physiological tolerance => no sublethal symptoms => genetic Type A resistance
6. Prefeed => bait still considered novel after 1 test (hyper cautious animal) => finds toxic bait, 2nd test despite hunger => sublethal symptoms => learned aversion + genetic Type B resistance (selection for hyper caution)
7. Prefeed => accepted familiar => finds and eats toxic bait but hyper sensitive to sublethal symptoms (sensitive tummy) => sublethal symptoms => learned aversion / confusion + genetic Type C resistance (selection for physiological traits that hasten onset of sublethal symptoms).

Learned aversion and genetic evolution

Learned aversion

The contribution of learned aversions to reduced efficacy in *OpN+1* must be a function of

a) Animal lifespan / Time elapsed (between operations).
b) The ratio of Post Op abundance at Op 1 / Pre Op abundance at Op 2. That is, if rat numbers have increased between ops then most rats present in Op 2 will be a) new rats or b) dispersers from adjacent lands. While dispersers could have learned aversion, new rats cannot.

Prefeeding, both of *Op N* and *Op N+1* has been shown to both prevent and remedy, respectively, learned aversions through creation of confusion, at least for possums. For rats, studies of social transmission of information about foods suggest similar effects of prefeeding for rats on the development and persistence of learned bait aversion.

Genetic evolution

The material on which evolutionary selection works is genetic variation within a population. Therefore, the idea that development of genetic resistance to 1080 has occurred or might occur requires there to be genetic variation in a) ability to metabolize 1080 without interruption of the Krebs cycle, b) general behavioural shyness / boldness and c) sensitivity of the nervous system to sublethal symptoms.

Weak selection pressure can act on a broad base of genetic variation over long time scale to produce what we call 'adaptations'. Strong selection pressure can act on a narrow base of variation to produce adaptations within a few generations.

Assuming that b) and c) exist in the wild ship rats of New Zealand seems reasonable enough.

Types of places least likely to maintain efficacy

Low altitude (warm) sites lacking periodic climatic control of rats, especially those surrounded by 1080-treated areas.

Case studies

This Section examines some case studies where 1080 has been repeatedly used and discusses the possible relative contribution of alternative pathways to declined efficacy at some sites, and possible reasons for maintained high efficacy at others. In all cases we concurrently consider other potential causes of variation in kills, such as alternative food supply, weather, and bait sowing specifications.

Note on data collation for case studies

The tracking tunnel database is the only current means by which to explore this phenomenon in New Zealand. Other means of gathering data on predator abundance are in either too new (e.g. trail cameras) or haven't been used much recently (waxtags, leghold traps).

Examination and analysis of tracking tunnel data is complicated by historical changes in a) aerial 1080 boundaries and b) tracking tunnel locations, both of which have moved around unhelpfully over time and c) time lags between operations and surveys. The difficulties introduced by these artifacts are compounded by the inconvenient fact that animals move, and that animal movement is not a constant process.

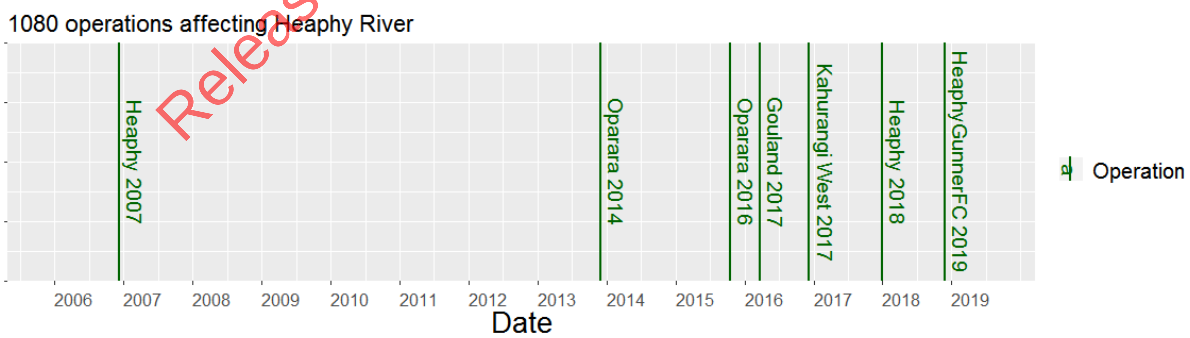
The proper way to examine the tracking tunnel dataset for evidence of declining efficacy, is to control for the fifteen or so other variables that possibly affect 1080 success in a global analysis of the entire dataset with all the variables included. This dataset for this analysis is largely assembled but we are still struggling to give it the attention it deserves with other demands on our time and limited computer programmer resources available.

In the absence of all this, case studies from sites with the most intensive histories of 1080 use are still worth writing, provide that a spatial representation of the tracking data and 1080 operations over time is concurrently viewed. These have been prepared and can be viewed using the DOC GIS system (ask Josh for a demo).

Heaphy River

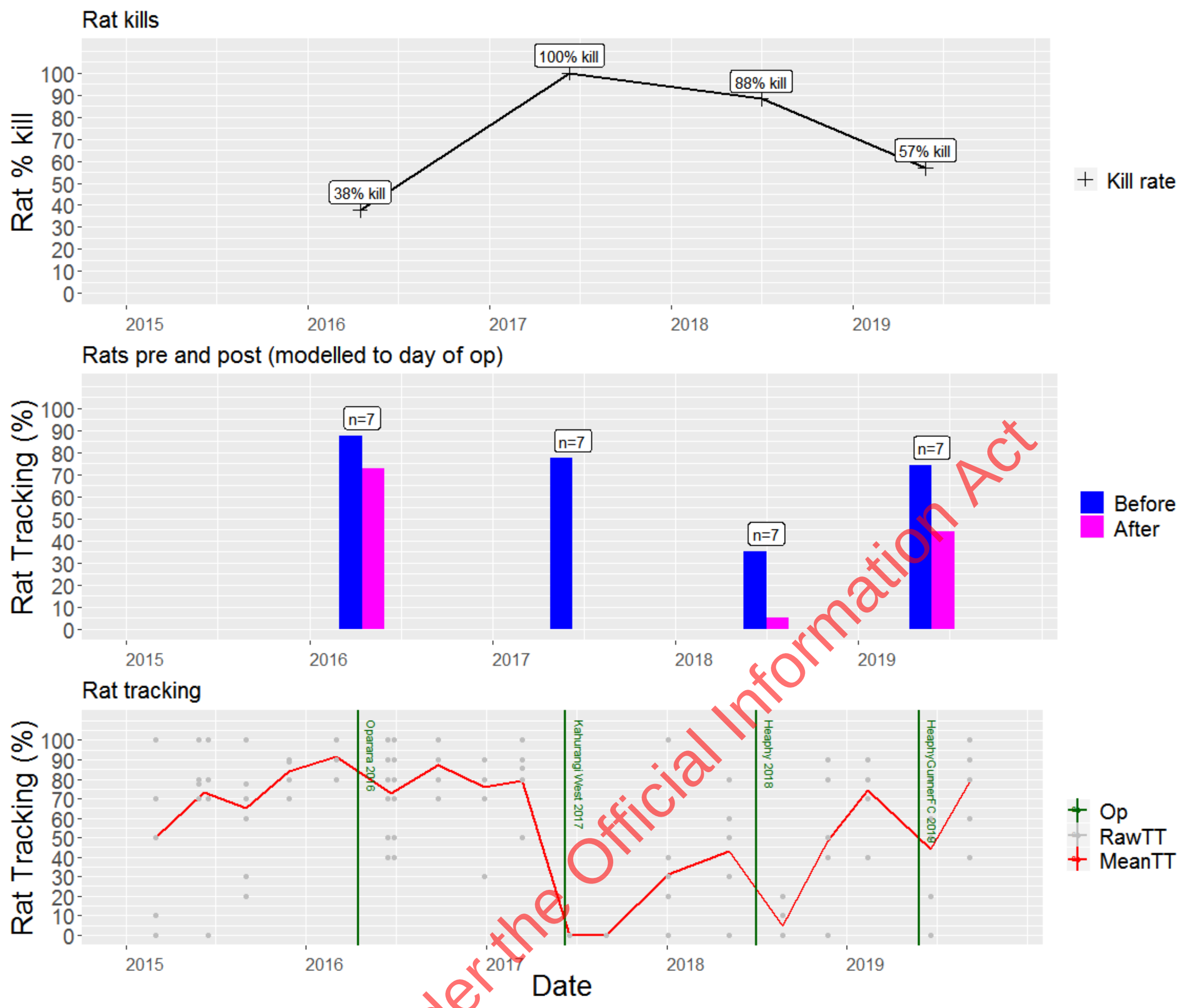
This analysis aims to evaluate % kills on ten tracking lines, known as the Lower Heaphy lines. Treatment of one or more of these line locations has occurred in at least seven 1080 operations (Fig. 1), but the lines were active in the last five of them. All ten lines were in the last three operations, but only eight were in Oparara 2016 (the other two were in Gouland 2017). All ten line locations were in Oparara 2014 and Heaphy 2007, but there are no measures. There are, however, measures from other lines for these two earlier operations.

Figure 1.



The dataset from the 8 lines most-consistently treated, shows a poor kill in 2016, a good kill in 2017, and then worsening kills to 2019 (Fig. 2). The 2014 and 2007 operations both achieved 100% kills on the lines that were active at the time.

Figure 2.



Discussion

The worst kill of all (Oparara 2016) was in September of a mast year (pre-germination), with abundant rats using wide flight path spacings at a moderate sowing rate of 250 pellets/ha (Table 1). Conversely, the Oparara 2014 got 100% kill in November (c. germination time) of a mast year, also with abundant rats and with even wider spacings and a longer prefeed interval and less bait.

Table 1.

Operation	Date	PFI	PPPH	TPPH	FPS
Heaphy 2007	18/11/2007			333	150
Oparara 2014	7/11/2014	25	167	167	220
Oparara 2016	22/09/2016	12	250	250	200
Gouland 2017	28/02/2017	12	250	250	180
Kahurangi West 2017	17/11/2017	29	250	250	180
Heaphy 2018	7/12/2018	27	250	250	
HeaphyGunnerFC 2019	2/11/2019	44			

The poor kill in 2019 cannot be easily attributed to most of the usual suspects. Heaphy 2019 was double prefed at high sowing rates and fully overlapping flight paths. A prefeed interval from the second prefeed to the toxic operation was relatively long at 44 days, but other operations in 2019 performed poorly with much shorter prefeed intervals and other performed will with longer ones. The bumper seed crop of 2019 is a tempting reason, but the operation was in November, making the context similar to the successful Oparara 2014 operation. Plausible reasons other than genetic resistance, and some unique combination of bad timing relating to the long prefeed and the possibility that the mast seed of 2019 was not completely germinated are difficult to produce. Learned aversion seems plausible at first glance, with only eleven months elapsed since Heaphy 2018, but Heaphy 2019 would have contained many new rats recruited during this period. In any case, the double-prefeed of 2019 should theoretically have overcome remaining learned aversions. Genetic resistance and a long PFI at the end of a super mast seem the most likely reasons.

Options for Heaphy 2020

While the Heaphy River is a prime candidate for development of genetic resistance (no natural climatic control, surrounded by other control operations), we cannot yet be sure that it is primarily responsible for the failure of Heaphy 2019 (remembering that failures will not be caused by one sole mechanism). There remains a chance that a Heaphy 2020 1080 operation might work, but we shouldn't be surprised if it doesn't.

The reason for using so much 1080 in the Heaphy is to save birds, snails, bats, lizards and plants, not to study 1080 efficacy. The only reason that an alternative tool has not been used is that the only alternative, pindone, costs a lot and aren't in the habit of using it on a broadscale.

I think aerial pindone should be the first option for 2020. If we can't use it in 2020 because we haven't started planning for it early enough, then we should definitely use it in 2021.

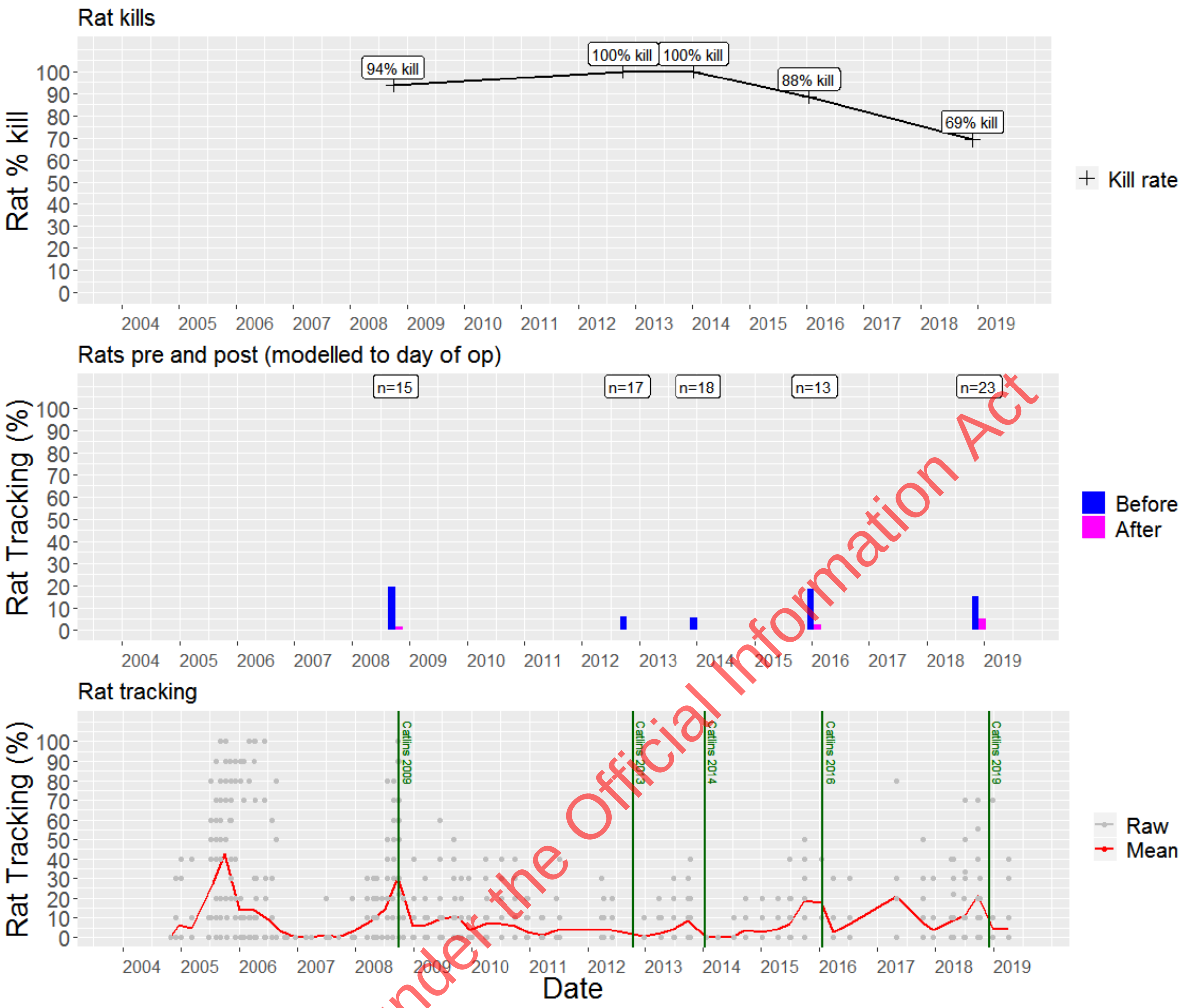
Assuming we can't use pindone in 2020, we then need to decide whether to use 1080 instead. If we use it, we should probably do whatever experimentation we can to distinguish between possible cause of failure. By using a different bait type in part of the block we could potentially rule out learned aversion. Ideally this would be a different matrix and a different flavour, such as orange flavoured carrot. But we can't use carrot so orange flavoured Wanganui #7 is about as different as we can get. If we do it, I propose 1–2,000 ha of orange #7, and the balance as cinnamon RS5.

If we do this, we should also entertain catching rats before and after the operation and taking them to the lab to help rule out potential contributors to failure by 1) somehow testing them for bait aversion and 2) somehow testing them for genetic resistance (breeding some generations and feeding some 1080?).

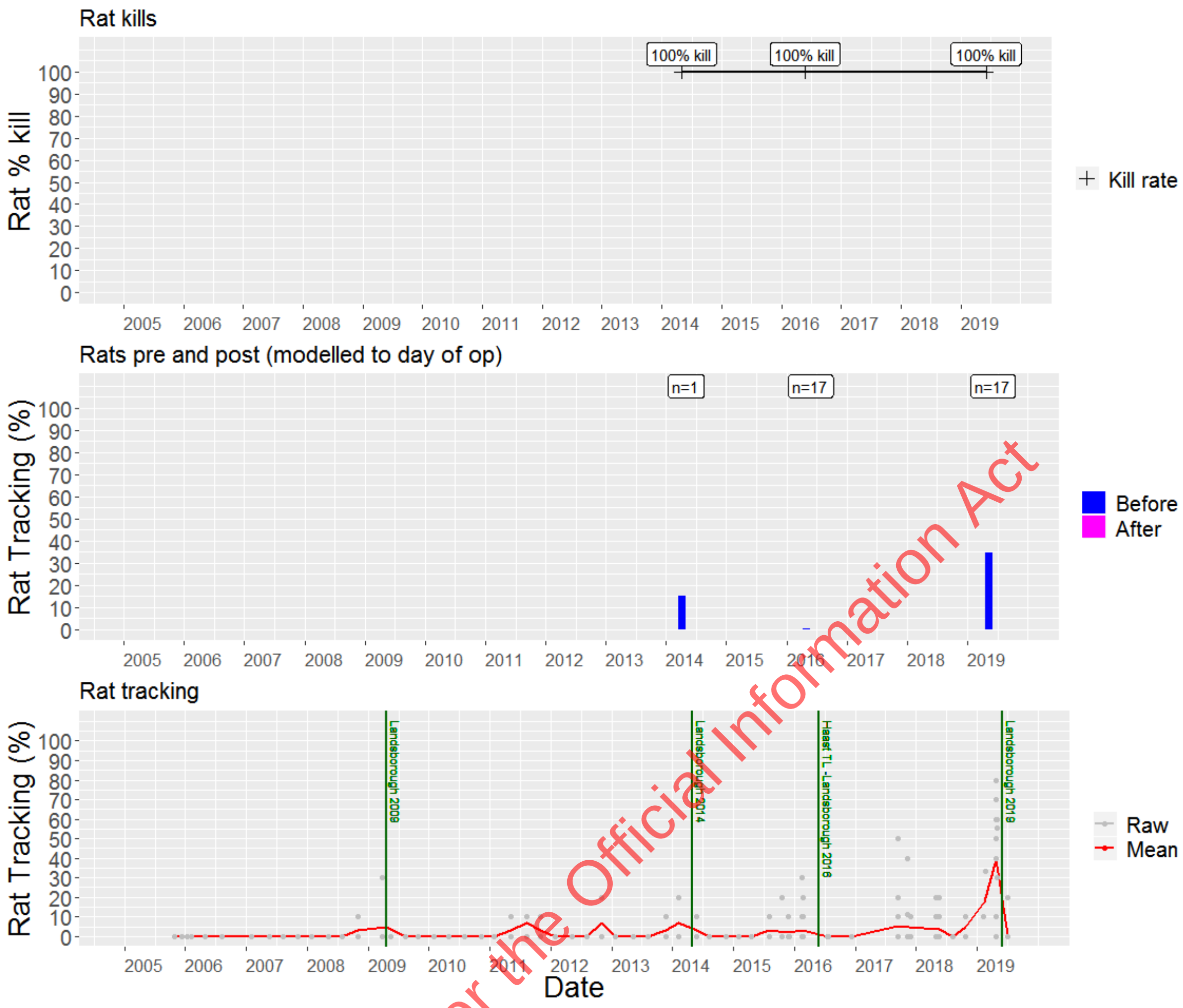
More case studies

I made these charts today for two sites with an alternative control tool – cold winters without food – and without so much 1080 use in adjacent lands (the Catlins and the Landsborough). These sites are sites where genetic resistance should theoretically take longer to emerge or might not ever emerge, especially the Landsborough. I haven't written any text yet but can't bear to delete them. Enjoy.

Catlins


Rat kills
Rat % kill
94% kill
100% kill
100% kill
88% kill
69% kill
Kill rate
Rats pre and post (modelled to day of op)
Rat Tracking (%)
n=15
n=17
n=18
n=13
n=23
Before
After
Rat tracking
Rat Tracking (%)
Catlins 2009
Catlins 2013
Catlins 2014
Catlins 2016
Catlins 2019
Raw
Mean
Date

Landsborough



Department of Conservation
Te Papa Atawhai

Our File: R191691

20 November 2020

Dr Keith Morfett
Chairperson
West Coast *Tai Poutini* Conservation Board
Private Bag 701
HOKITIKA

Dear Keith

Cycleway Proposal: Punakaiki Township to Truman Track.

My understanding is that the Board has been kept aware of the Dolomite Point Redevelopment Project (DPRP), an initiative being managed by the Department of Conservation. A significant project within the overall DPRP is the construction of a cycleway from Punakaiki to the Truman Track. Waka Kotahi are a key partner in this project and are managing the construction of the cycleway along the side of SH6. The new cycleway is intended to be exclusively located on legal road.

The existing formed road already encroaches onto Paparoa National Park (Areas 3 & 4 on the attached plan), and a stock-resting reserve held under the Reserves 1977, (Area 2 on the plan). Site photos are also enclosed. The construction of the cycleway will extend the road a few more metres into the adjoining land. Waka Kotahi have therefore sought consent for the land already occupied by road, plus the few extra metres required for the cycleway, to be excluded from the park and reserve to legalise the existing situation. These three sections of land are located near the Truman Track. Resolving the long-standing matter of the existing formed road occupying part of the park, will also resolve the additional narrow strip required for the cycleway.

The land sought is shown on the attached plan as Areas 2, 3 & 4 and are based on a 10-metre offset from the centre line of the road. The areas are as follows;

Area 2. Land required for road is 180 m^2 and the additional land for the cycleway is 18 m^2.
Area 3. Land required for road is 750 and the additional for the cycleway is 101 m^2.
Area 4. Land required for road is 254 m^2 and the additional land for the cycleway is 26 m^2.

The exclusion of this land from the park will have minimal impact on the park. The land required for the cycleway is small and only totals 145 m^2 across the three areas.

Area 1 on the plans was also sought in the initial Waka Kotahi proposal, but this area of land is already approved for exclusion from the park under a previous roading proposal. The earlier proposal includes other national park land required for road and road no longer required for road within the township. This process is almost complete and is currently awaiting the passing of the Reserves and Other Lands Disposal Bill. Once enacted, the land containing Area 1 will be excluded from the park.

Context:
The DPRP shared pathway involves either upgrading existing paths or forming a new path immediately adjacent to State Highway 6 in the vicinity of Punakaiki. All construction work has been designed to minimise adverse environmental impacts and in accordance with conditions specified in Section 4.4 Nikau Place: Outcomes, policies, and milestones of the National Park Management Plan. The shared pathway will provide safety improvements for users along the length of Punakaiki. Implementing the pathway will involve some disturbance to and removal of some vegetation, and the impacts of which have been documented and consented under the RMA approvals process (RC-2020-0074) including conditions relating to earthworks and vegetation clearance associated with the pathway. As a part of that process, extensive stakeholder consultation has occurred, and concluded;

"Any environmental effects form the earthworks that will occur during the construction of the shared pathway are considered less than minor for the reasons discussed above. It is noted that the establishment of the shared pathway will benefit users of the road network such as the local community and visitors to the area."

Ecological Values:
The ecological value of the land required for road is minimal. As mentioned earlier in this letter, 1184 ^{2} of the land required for road is already formed. The additional 145m^2 required for the cycleway is strip, a metre or two from the edge of the existing seal along the length of cycleway that will adjoin the park.

The impact on the national park adjoining the road will be minimal. The physical disturbance required has already been assessed to have less than minor impacts as part of the shared pathway.

The attached photos give a good indication of the values present on the land that is required for the cycleway.

Benefits:
The Pedestrian/cycle path at Punakaiki is a specific workstream within the broader Dolomite Point Redevelopment Project. The workstream involves constructing a shared pedestrian and cycle path connecting key attractions along a 4km section of State Highway 6. By using the pathway, visitors and residents will benefit from the opportunity to move between attractions and localities in a safer and more sustainable manner and spend more time in the Punakaiki area. This will lead to improvements in visitor experience, visit duration (by making it easier and more attractive to visit other sites), and visitor/resident safety.

Exclusions of land from national parks requires legislative approval via a Reserves and Other Lands Disposal Bill. Before this can occur the New Zealand Conservation Authority (NZCA) must recommend to the Minister of Conservation that the land be excluded from national park. NZCA will only consider the exclusion of land when the local conservation board has been consulted and recommends the land be excluded. The process of excluding land from the stock resting reserve is a much simpler process and is determined at a local river.

I would appreciate the Board considering this request for consent to national park required for road, be excluded from the park as soon as is convenient. I would also appreciate any comments you may have on the section of stack resting reserve required for road.

Should any further information be required, please do not hesitate to contact me.

Yours faithfully

Ron Hazeldine
Senior SLM Advisor
Hokitika Shared Service Centre

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Cell: 0272033707
Email: rhazeldine@doc.govt.nz

Encl:
Plans and photos.

LAND PLAN - TRUMAN TRACK AREA

SCALE 1:1,000 (A1) 1:2,000 (A3)

LEGEND

(black line)	EXISTING BOUNDARIES
(red line)	PROPOSED BOUNDARIES
(hatched)	LAND REQUIREMENT
(blue)	PROPOSED PUNAKAIKI CYCLEWAY

NOTES

1. AERIALS FROM NZTA 2016
2. CO-ORDINATES IN TERMS OF BULLER 2000

LAND REQUIRED FROM PAPAROA NATIONAL PARK

REFERENCE NO.	APPELLATION	OWNER	AREA REQUIRED (ha) FOR BOUNDARY ADJUSTMENT	AREA REQUIRED (ha) FOR WALK AND CYCLEWAY
2	STOCK RESERVE NEW ZEALAND GAZETTE 1944 P 1074	CROWN LAND	0.0180	0.0018
3	NATIONAL PARK [PAPAROA NATIONAL PARK] NEW ZEALAND GAZETTE 1987 p 5361	CROWN LAND	0.0750	0.0101
4	NATIONAL PARK [PAPAROA NATIONAL PARK] NEW ZEALAND GAZETTE 1987 p 5361	CROWN LAND	0.0254	0.0026
			0.1184	0.0145

FOR INFORMATION

Revision	Amendment	Approved	Revision Date
A	FOR INFORMATION	CAL	15.09.2020
B	PATH AREAS ADDED TO TABLE	CAL	21.09.2020
C	REVISED WITH 10m OFFSET	CAL	09.11.2020

NZ TRANSPORT AGENCY WAKA KOTAHI

wsp Greymouth Office +64 3 768 9330 PO Box 365 Greymouth 7840 New Zealand

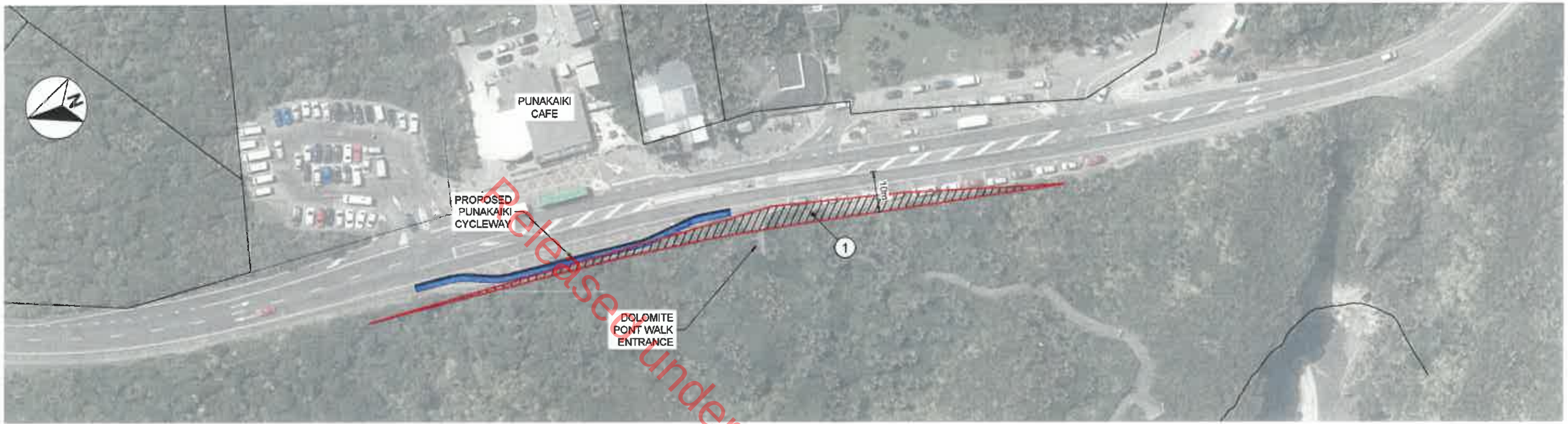
NEW ZEALAND TRANSPORT AGENCY
PUNAKAIKI SH6 RP374/9.6-RP388/0.27
PUNAKAIKI CYCLEWAY

LAND PLAN - TRUMAN TRACK AREA

Designed	Approved	Approved Date
A RALPH	A LUCAS	09.11.2020
Drawn: A RALPH	Scale: AS SHOWN	

6-KM001.00(03) C73 C

1:1000@ A1 1:2000@ A3 0 10 20 30 40 50 60 70 80 90 100 m



LAND PLAN - DOLOMITE POINT

SCALE 1:500 (A1) 1:1,000 (A3)

LEGEND

- EXISTING BOUNDARIES
- PROPOSED BOUNDARIES
- LAND REQUIREMENT
- PROPOSED PUNAKAIKI CYCLEWAY

LAND REQUIRED FROM PAPAROA NATIONAL PARK

REFERENCE NO.	APPELLATION	OWNER	AREA REQUIRED (ha) FOR BOUNDARY ADJUSTMENT	AREA REQUIRED (ha) FOR WALK AND CYCLEWAY
1	NATIONAL PARK [PAPAROA NATIONAL PARK] NEW ZEALAND GAZETTE 1987 p 5361	CROWN LAND	0.0397	0.0007

NOTES

1. AERIALS FROM NZTA 2016
2. CO-ORDINATES IN TERMS OF BULLER 2000

FOR INFORMATION

Revision	Amendment	Approved	Revision Date
A	FOR INFORMATION	CAL	15.09.2020
B	PATH AREAS ADDED TO TABLE	CAL	21.09.2020
C	REVISED WITH 10m OFFSET	CAL	09.11.2020

NZ TRANSPORT AGENCY WAKA KOTAHI

wsp Greymouth Office +64 3 769 9030 PO Box 365 Greymouth 7840 New Zealand

Designed: A RALPH | Approved: A LUCAS | Approved Date: 09.11.2020
Drawn: A RALPH | Scales: AS SHOWN

Project: NEW ZEALAND TRANSPORT AGENCY
PUNAKAIKI SH6 RP374/9.6-RP388/0.27
PUNAKAIKI CYCLEWAY

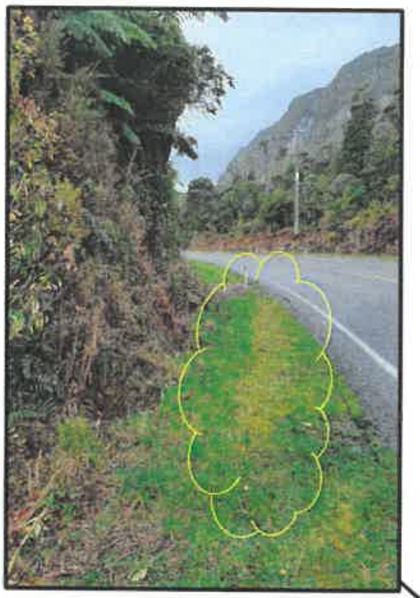
Sheet: LAND PLAN - DOLOMITE POINT

Project No.: 6-KM001.00(03) | Sheet No.: C72 | Revision: C

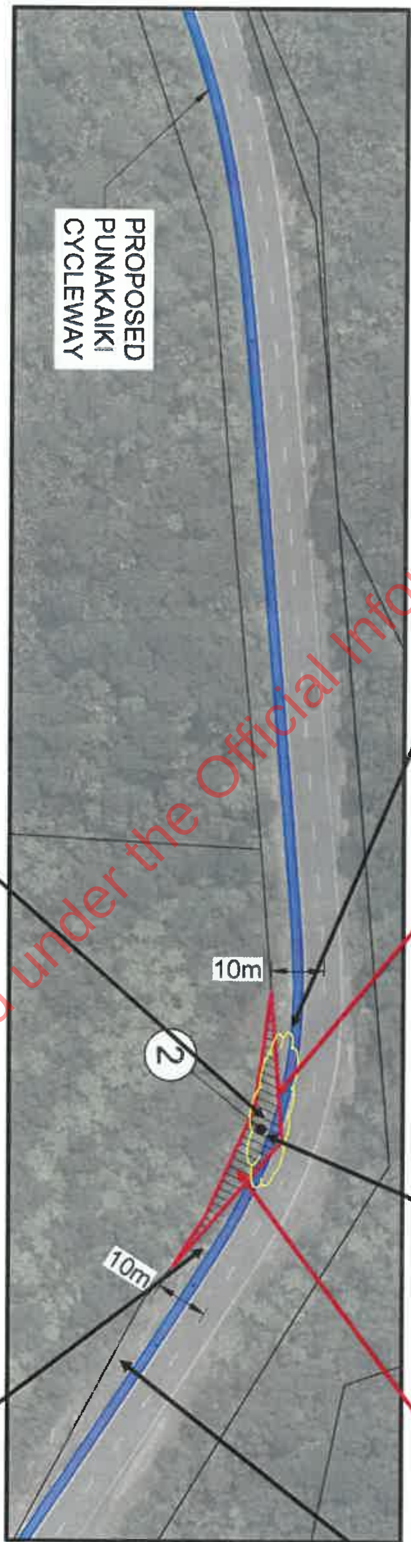
1:500@ A1 1:1000@ A3 0 5 10 15 20 25 30 35 40 45 50 m

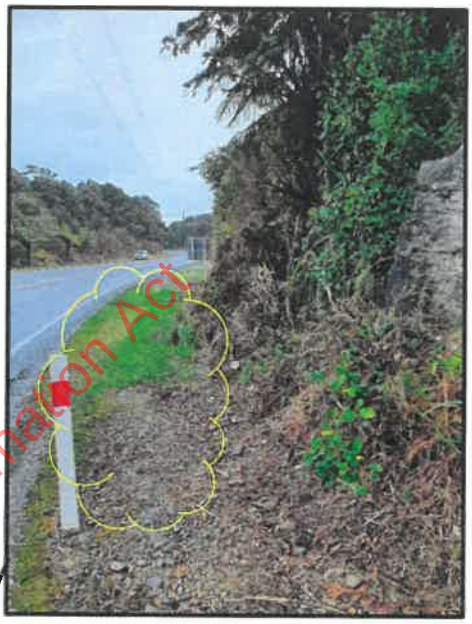
Original Sheet Size A1 [841x594] Plot Date 2020-11-09 at 12:44:46 PM Path G:\Opus\4 Projects\6-KM001.00 (NZTA Miscellaneous)\365GG (Punakaiki Cycleway)\Drawings\(C) Civil-Civil3D\6-KM001.00(03)_C71-C73 Land Plans.dwg C72

Section 2 - STOCK RESERVE NEW ZEALAND GAZETTE 1944 P 1074 CROWN LAND



Section 2 3 Looking north, bluff to left





Section 2 4 looking south, bluff to right

Existing land boundary angles into road reserve

Section 2 2 Looking across SH6 to bluff

Section 2 1 just before Section 2, note the water services

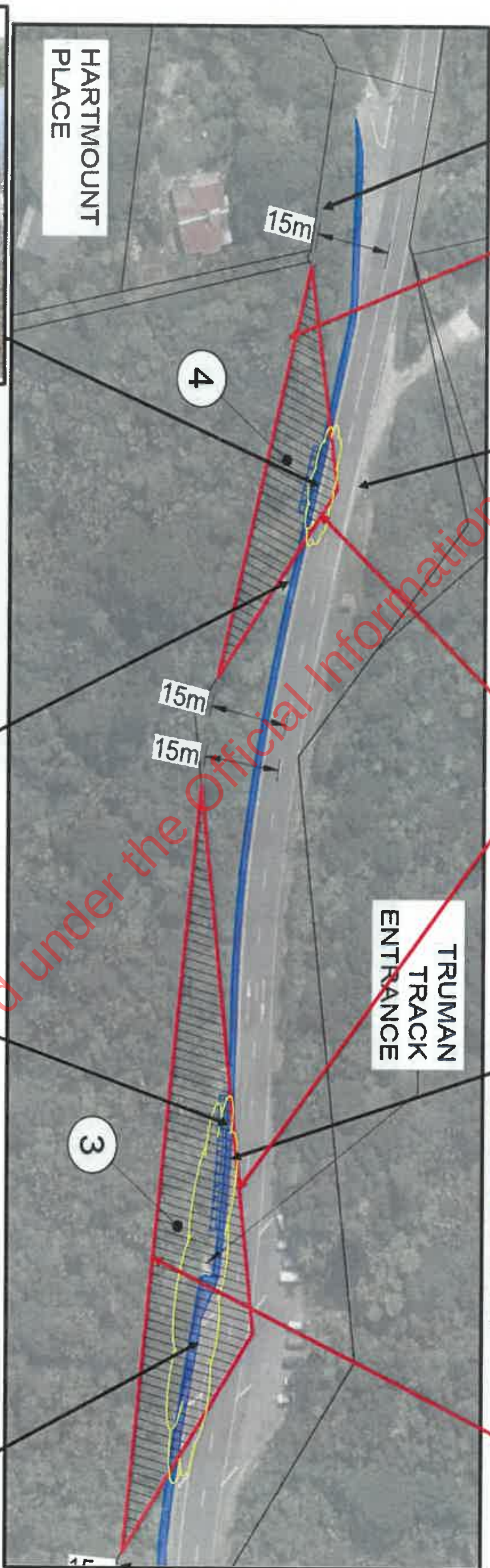
Indicative location of proposed new boundary offset to road centreline by 10m

Existing land boundary

Section 3 and 4 - NATIONAL PARK [PAPAROA NATIONAL PARK] NEW ZEALAND GAZETTE 1987 p 5361 CROWN LAND

Section 4 1 looking north along SH6

Section 4 2 Looking north along SH6

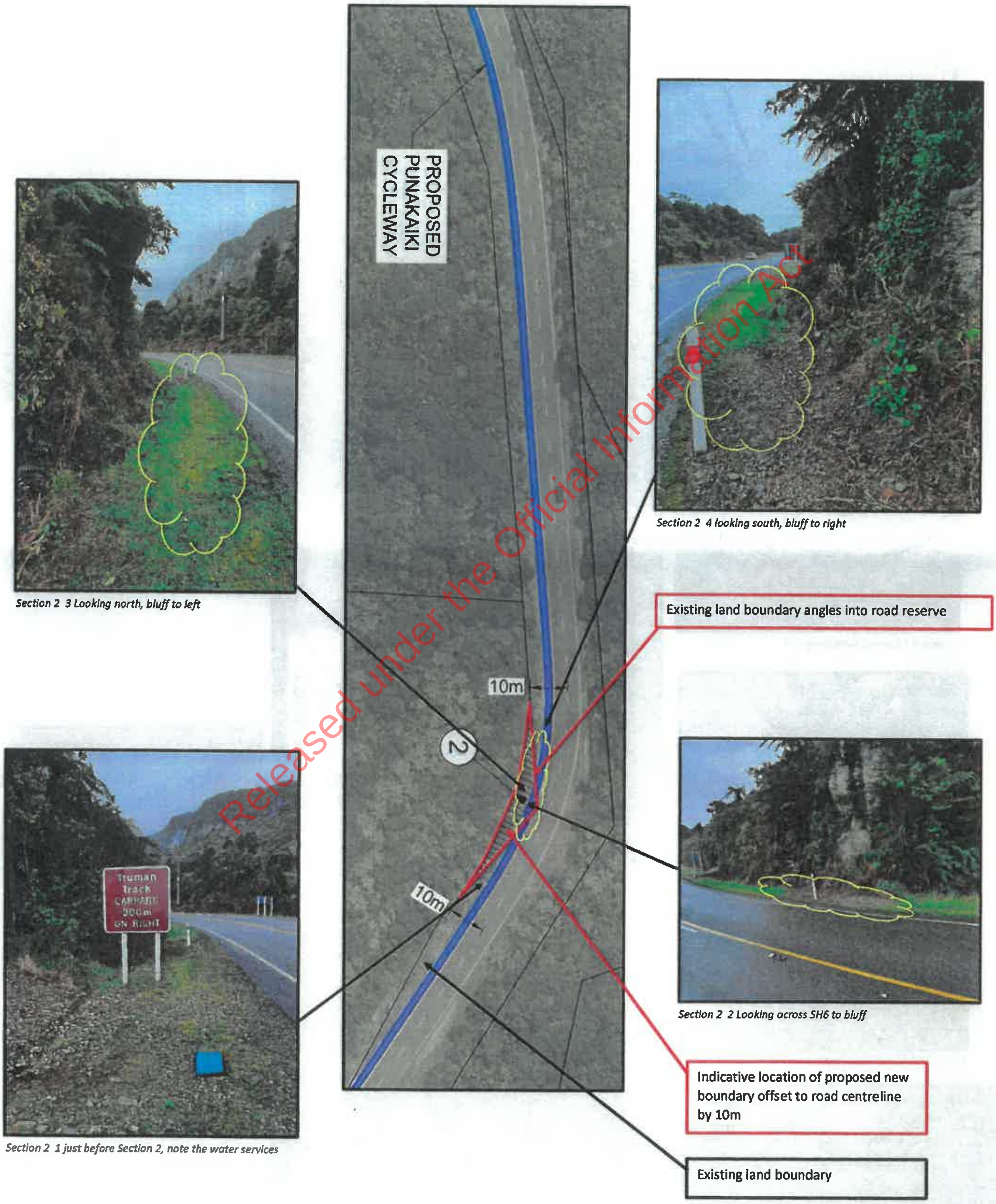


Section 4 3 Looking across SH6

Section 3 2 looking south along SH6, Truman Car Park to left

Section 3 3 Indicative vegetation

Section 2 - STOCK RESERVE NEW ZEALAND GAZETTE 1944 P 1074 CROWN LAND



Section 2 3 Looking north, bluff to left

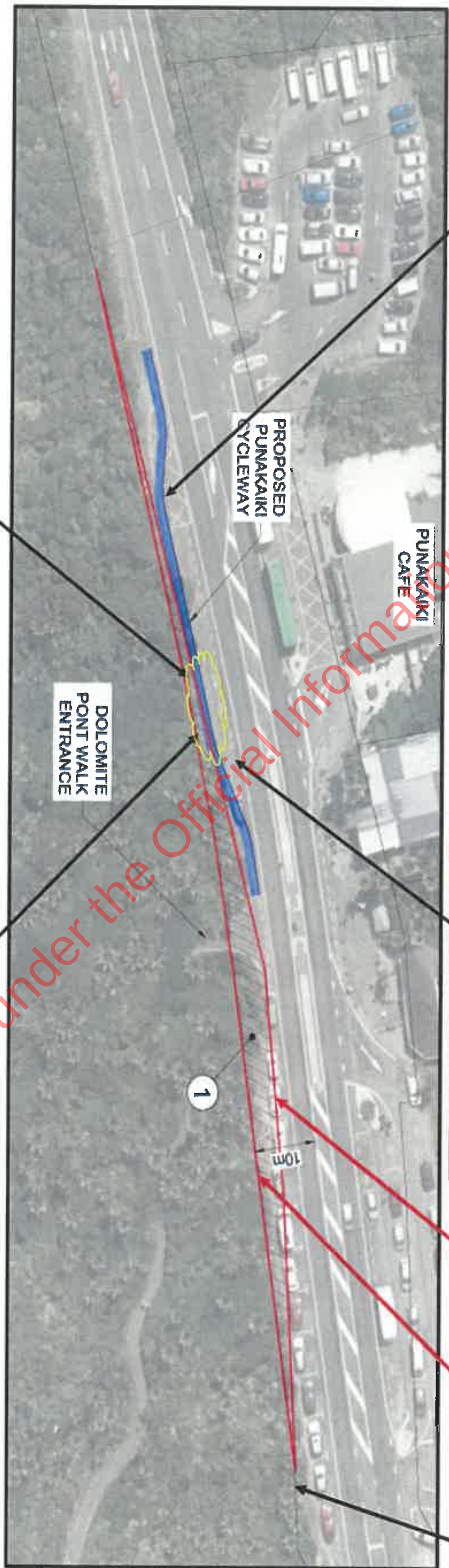
Section 2 4 looking south, bluff to right

Section 2 2 Looking across SH6 to bluff

Section 2 1 just before Section 2, note the water services

Section 1 - NATIONAL PARK [PAPAROA NATIONAL PARK] NEW ZEALAND GAZETTE 1987 p 5361 CROWN LAND

Section 1 3 Looking south behind the bus stop



Section 1 1 Looking across from Punakaiki VC

Section 1 4 Looking north behind the bus stop

Section 1 2 Looking across from SH6 to the bus stop

Existing land boundary angles in towards road

Indicative location of proposed new boundary offset to road centreline by 10m

Existing land boundary

Note: Area is already being excluded from National Park. In current RoLD Bill.

Bathurst Resources Community Information Session

Ngakawau Hall 26th November 2020.

Conservation Board report – Keith Morfett

100% of all coal mined on the coast by Bathurst Talley's (BT) is exported and is used in steel making.

Stockton mine – there is a 10 year supply of coal reserves on Stockton.

Cascade mine has finished mining and rehabilitation is taking place.

Escarpment mine is in care and maintenance. Consents will need renewal soon. The best coal is not within the current footprint of the access agreement and a variation will be sought to extend the area to be mined.

Sullivans mine site is still under investigation and there are no immediate plans to seek consents. The only consents required will be from the regional council and a wildlife permit from DOC. An access agreement with DOC is not required. The current licence expires in 2027. The initial plan would be to truck the coal mined from Sullivans out by road via the highway and then up to Stockton for treatment. Some local residents are not happy with this option because of the increased truck movements. The haul road from Denniston to Stockton via the upper Waimangaroa remains a long-term option but is not being contemplated for the initial development and did not figure at all on the BT displays. Sullivans coal will make a good replacement for the coal currently mined at Millerton which is nearing the end of its viability.

The **Cypress mine** will expand to the south within its consented footprint.

Deep Creek and the Upper Waimangaroa are long term options, in 20-30 years' time, and are not being considered now.

Acid Mine Drainage (AMD). Currently AMD is being treated by dosing in two plants, the original of which was initially installed and owned by Solid Energy and the second of which is a new scheme that has just been built by BT to treat the AMD into St Patricks Stream. Both of these plants are owned by the government (much of the AMD is from old underground mines) and operated by BT, who meet 17% of the cost of treatment. AMD is treated in these plants with calcium oxide from lime mined and then treated in Oamaru which is then trucked up to the Coast. Holcim placed a caveat on their abandoned lime quarry at Cape Foulwind so that cannot be used. Treasury are currently looking at various schemes to treat AMD on Stockton, including the HDL scheme that was consented and involved discharge to the ocean via a hydroelectric generation plant and the parallel scheme proposed by Solid Energy. Their review is expected in the new year.

BATHURST
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Dr Keith Morfett
West Coast Conservation Board
C/- Department of Conservation
Private Bag 701
HOKITIKA 7842

Via Email

Dear Keith

BATHURST RESOURCES – COMMUNITY INFORMATION SESSIONS

This letter is to acknowledge and thank you for making the time to attend the Bathurst Resources community information session at Ngakawau last Thursday 26 November.

I trust that the session was worthwhile, and you were able to obtain information on our current and planned operations. As indicated at the meeting, the Conservation Board would be welcome to come to both Stockton and Denniston for a site visit so that everyone can see first-hand our operations, the measures to ensure a safe workplace, how we optimise production, controls in place to manage environmental effects, and the off-site compensation and mitigation work.

Should you have any further questions please do not hesitate to contact me, preferably via email campbell.robertson@bathurst.co.nz.

Yours faithfully

Campbell Robertson
Environmental Manager