PROJECT RIVER RECOVERY INTERNAL REPORT 2023/01

Godley Delta River Braids. Photo: Dave Murray

Project River Recovery Annual Report

01 July 2022 to 30 June 2023

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Department of Conservation
Te Papa Atawhai

New Zealand Government

Contents

Summary

- This report summarises Project River Recovery's (PRR) progress towards its six key objectives as identified in its strategic plan for the period from the 1st of July 2022 to 30th of June 2023.
- PRR continues to give highest priority to preventing weed invasions of the near-pristine upper rivers above the hydro lakes of the upper Waitaki basin.
  - Due to Te Manahuna Aoraki (TMA) changing some of its priorities, PRR funded over 2087 hours of contractor time spraying mainly Russell lupins in the Tasman River and lower Fork Stream. An extra $21,400 was spent on aerial spray control in the Tasman to pick up late germination of Russell lupins. PRR continued its ongoing programme of weed control in other areas including removal of all vegetation from Tern Island (to benefit nesting black-fronted terns), ongoing wilding pine, alder, and willow control around Lake Poaka, as well as doing just under $60,000 of aerial control of willows in the Ahuriri River. Nearly $41,000 was contributed to ongoing joint programmes in the Tekapō and Dobson Rivers.
- This marked the nineteenth year of trapping results from the Tasman River Predator Control Project, a joint programme between TMA, PRR and DOC's kakī management programme.
  - Over the year, 245 hedgehogs, 20 rabbits, 228 stoats, 47 cats, 37 ferrets, 35 weasels, 7 rats, 67 possums and 4 mice were caught. An additional 5 cats were located and destroyed over four nights of spotlighting.
- The programme of intensive predator trapping around the black-fronted tern colony in the upper Ōhau River continued for the fourteenth year (the seventh year since trapping was reduced to 500m radius).
  - Over the year, a total of 72 hedgehogs, 193 rabbits, 94 ferrets, 24 cats, 33 rats, 18 possums, 4 stoats, and 2 weasels were caught in kill traps.
  - As many as 184 black-fronted terns/tarapirohe returned to the island for breeding this year. Norway rat and stoat predation occurred early October and caused the loss of 170 eggs and the colony abandoning Tern Island. Pindone was hand laid on the island in November. Terns returned to nest on the island in December. Over the season, 314 nest attempts with a total 502 eggs monitored. A range of 69-84 chicks were estimated to have fledged this season. A total of 25 chicks were flag banded.
- Walk-through riverbed bird counts were completed on the Tasman, Dobson, and Hakataramea Rivers (lower section only). This year was the final of three consecutive years of surveys in these rivers. The Hopkins and Hakataramea (upper section) rivers were not completed for a third year due to staff and weather constraints.
- PRR continued to support a nation-wide bittern/matuku hūrepo study by deploying 15 Acoustic Recording Devices in locations across the basin in December 2022. Of those locations, four returned positive detections of bitterns across the Mt Gerald and McGregor wetlands.
- Ongoing threatened fish (galaxiid) monitoring, checking and/or trout/kōaro removal was carried out above nine constructed and two natural trout barriers at Fraser stream, Corbies Creek, Fork Stream, Hunter Hills, Waterwheel Wetland, Otamatapaio River, and the Ahuriri River in Omarama Station.
- Annual monitoring of robust grasshoppers was conducted by PRR across six key populations. PRR also conducted a survey of the entire length of the lower Ōhau River (below Lake Ruataniwha) for the second year and the Pūkaki River for the first year. High counts of *B. robustus* were found in the Pūkaki River.
- At the beginning of the year PRR commenced a project aimed at determining if standard rabbit-proof fences act as effective hedgehog barriers. This project is in the eradication phase, with hedgehogs currently being removed from four large (38 – 160 ha) fenced areas of Public Conservation Land and monitored for reinvasion within four small (~1 ha) fenced areas.

- PRR continued to monitor five populations of *Lepidium solandri* across the basin to better understand population trends.
- Wetland management has included weed control and water-level manipulation at Waterwheel and Ruataniwha wetlands. Our focus is to benefit threatened ephemeral plants that occur in these habitats.
- PRR spent $656,000 in the 2022-23 financial year.

1 Introduction

Project River Recovery (PRR) commenced operations in 1991 following the establishment of a compensatory funding agreement with energy providers in the upper Waitaki River which recognised the adverse impacts of hydroelectric power development on braided river and wetland ecosystems. A key focus of the programme over its 32 years of operation has been to maintain integrity of braided river ecosystems, particularly from the impacts of invasive plants. The programme has also invested considerable effort into assessing the impacts of mammalian predators on riverbed fauna and developing effective methods for their control in riverbed environments.

These and other goals are set out in the current interim strategic plan (Nelson, Maloney & Gale, 2020) which replaces the 2012 – 2019 plan. This interim strategic plan covers the renegotiation period of the compensatory funding agreement as part of the renewal of the Resource Consents for water takes for Meridian and Genesis.

This annual report summarises progress toward the six key objectives identified in the strategic plan, describes staffing, and presents financial statements for the year from the 1st of July 2022 to 30th of June 2023.

2 Staff

Dean Nelson continues to manage the project as Senior Ranger for Biodiversity and PRR. Samantha Turner continued her role as a PRR ranger for the second year.

Tom Goodman joined PRR as a ranger in December. He is a graduate of Otago University's Postgraduate diploma of Wildlife Management programme. He conducted his MSc research on modelling the feasibility of using current hedgehog control tools for landscape-scale control in tussock grassland and adjacent to braided rivers. This research is being continued by PRR, where staff will soon be testing novel landscape-scale hedgehog control tools and contributing to DOC's "Best Practice for Hedgehog Control".

Anna Porter led the black-fronted tern outcome monitoring in the Tasman River and co-monitored Tern Island with PRR rangers. Connor Hines led the DOC weed team which controlled PRR priority weeds outside of the TMA area.

Tayla Hooker, Twizel's biodiversity ranger and plant expert extraordinaire, lead PRR's threatened plant work this year, and supported PRR's river bird surveys, robust grasshopper surveys, and trout removal from streams including the Forks and Fraser.

Jen Schori took up a year's secondment with Environment Canterbury in September 2022 and will be back with the team in October 2023.

Predator control traps and bait stations in the Upper Ōhau River were serviced by Mainland Vector this year. Mainland Vector also serviced about half of the kill trap lines in the Tasman while DOC staff and volunteers maintained the rest. The 10-day period of leg-hold trapping was undertaken by Ecological Contracting Services Ltd.

3 Strategic plan

The strategic plan outlining the work objectives of PRR normally spans consecutive seven-year cycles, allowing regular review, reporting, and realignment. The previous strategic plan from 2012 to 2019 (Rebergen & Woolmore, 2015) has now expired, and an interim strategic plan outlining the work for the next few years has been prepared (Nelson, Maloney & Gale, 2020). Once a mitigation agreement as part of the Meridian and Genesis water re-consenting process has been agreed to, a new strategic plan will be prepared.

4 Progress toward objectives of the strategic plan

PRR's progress towards achieving the objectives of the current interim strategic plan is summarised below. Detailed reports of seasonal results and outcomes from trials and analyses of data are recorded through PRR's internal report series and are available on request.

4.1 Objective 1: Maintain indigenous biodiversity; protect and restore terrestrial and aquatic river and wetland habitat and the ecological communities within it by controlling and where possible, eradicating invasive weeds

Ongoing riverbed and wetland weed control programme

The total area of braided-river habitat in the large rivers of the upper Waitaki basin is approximately 32,000 hectares. PRR gives the highest priority to preventing new incursions of invasive weeds and removing newly established infestations at priority locations. Priority sites are generally still relatively 'clean' in terms of the number of weed species and the extent of their distribution.

As a result of several years of additional funding from Land Information New Zealand (LINZ), Te Manahuna Aoraki (TMA) carried out a large part of the weed control within its core operational area. This included some of the key riverbeds where PRR has traditionally used contractors to control weeds that pose a threat to the habitats of native species. However, this year due to TMA changing priorities for its spending, PRR stepped in and funded over 2087 hours of contractor time spraying mainly Russell lupins in the Tasman River and lower Fork Stream. An extra $21,400 was spent on aerial spray control in the Tasman to pick up late germination of Russell lupins.

Additionally, PRR continued its ongoing programme of weed control in other areas including removal of all vegetation from Tern Island (to benefit nesting black-fronted terns), ongoing wilding pine, alder, and willow control around Lake Poaka, as well as doing just under $60,000 of aerial control of willows in the Ahuriri River. Some of this work was follow-up control of the willow regrowth from the PRR operation to remove willows from the active riverbed which began in 2004.

$20,000 was contributed to the Environment Canterbury (ECan) led multi-year, landscape scale weed control project in the Dobson Valley. It aims to control elderberry, cotoneaster, buddleia, willows, and Russell lupin, as well as some miscellaneous garden escapees (raspberry, gooseberry, currant, and flowering cherry). PRR has been doing some work in this area as weeds like buddleia have always been priority weeds to keep out of the Mackenzie Basin. Also, the long-term aim is to remove Russell lupins from the mid part of the valley and progressively push them down valley toward Lake Ōhau. PRR will continue to help fund this project as it will concentrate on willows and Russell lupins in the Dobson riverbed and associated wetlands.

PRR and ECan continue to joint fund an integrated weed-control programme in the upper Tekapō River targeting gorse, broom, Russell lupin and willows. ECan contractors carry out this weed control work and this season, PRR's contribution amounted to just over $21,000.

4.2 Objective 2: Test and where possible, improve the effectiveness of and implement experimental predator control for population recovery of braided river and wetland fauna

Tasman River

The Tasman project's goal is to reduce predation of braided river birds to a level where depleted populations are recovering, and large populations are in a stable state. The project takes a large-scale approach, using a wide variety of control methods that are applied throughout the year. Success of the project is assessed on achieving target increases in fledging success and population growth for a range of river birds. PRR and the Kakī Management Programme continue to implement an extensive predator control project in the Tasman Valley supported by the Te Manahuna Aoraki (TMA) partnership who have extended trap lines throughout the area.

Predator control

The 2022-23 season was the nineteenth year of operation at the site, with a total of 700 DOC-150s, 311 DOC-250s, 310 Conibear traps, and 77 Timms traps run by PRR. PRR's trapping network is supplemented by an additional 715 traps that are run and maintained by the TMA project (Figure 1). Between 1 July 2022 and 30 June 2023, PRR's trapping network removed 245 hedgehogs (*Erinaceus europaeus occidentalis*), 20 rabbits (*Oryctolagus cuniculus*), 228 stoats (*Mustela erminea*), 47 cats (*Felis catus*), 35 weasels (*M. nivalis vulgaris*), 37 ferrets (*M. furo*), 7 rats (*Rattus* spp.), 4 mice (*Mus musculus*) and 67 possums (*Trichosurus vulpecula*) from the 2,104 traps in the Tasman Valley.

The annual 10-day period of opening 530 leg-hold traps took place during April/May. This work specifically targets cats that may have become shy of entering the kill trap tunnels. Once again this was a successful operation, catching 36 cats, 42 stoats and 37 hedgehogs. An additional nine cats were located and destroyed over 11 nights of spotlighting during July to September.

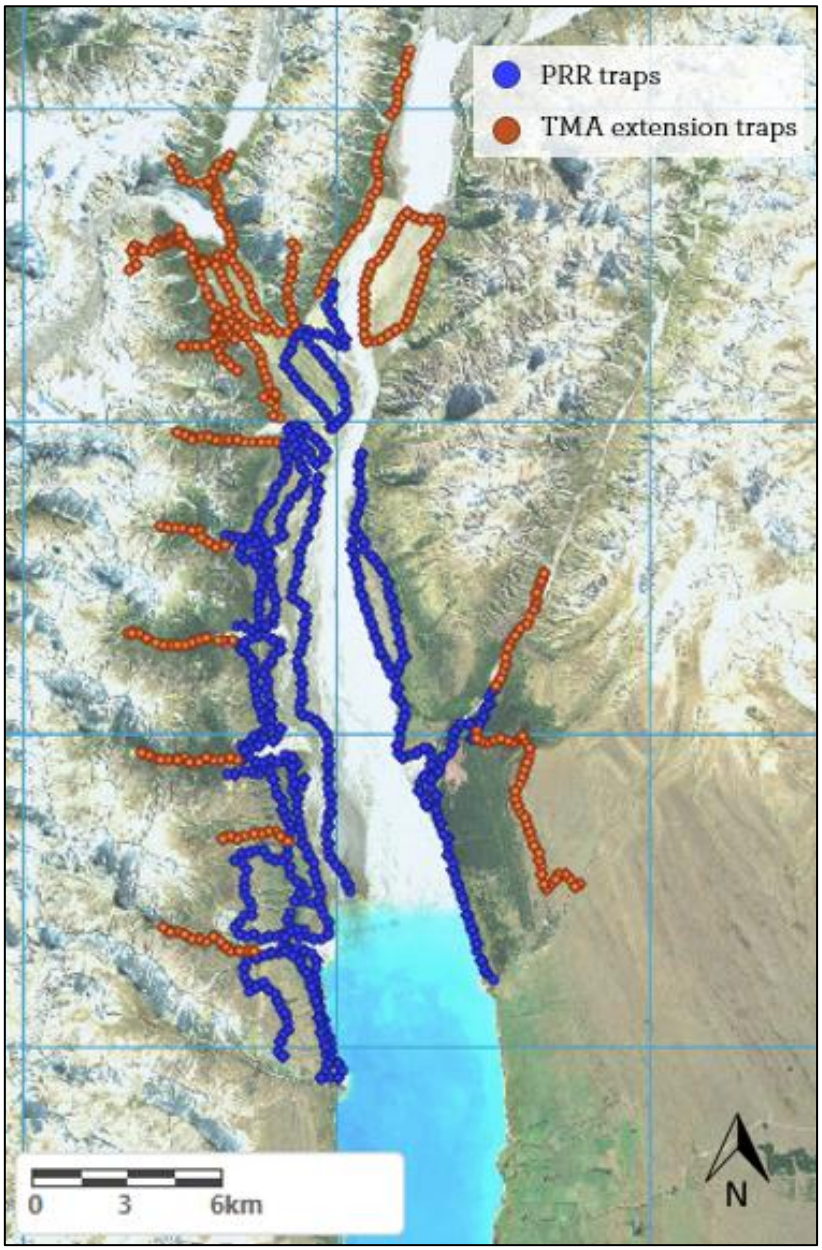

Figure 1. The trapping network in the Tasman Valley consists of traps managed by Project River Recovery (PRR; *n* = 1,389 traps) and the Te Manahuna Aoraki Project (TMA; *n* = 715).

Outcome Monitoring

Black-fronted terns

The species selected for monitoring this year was black-fronted tern/tarapirohe and outcome monitoring this season followed the breeding success of 92 nests over five colonies (Figure 2) .

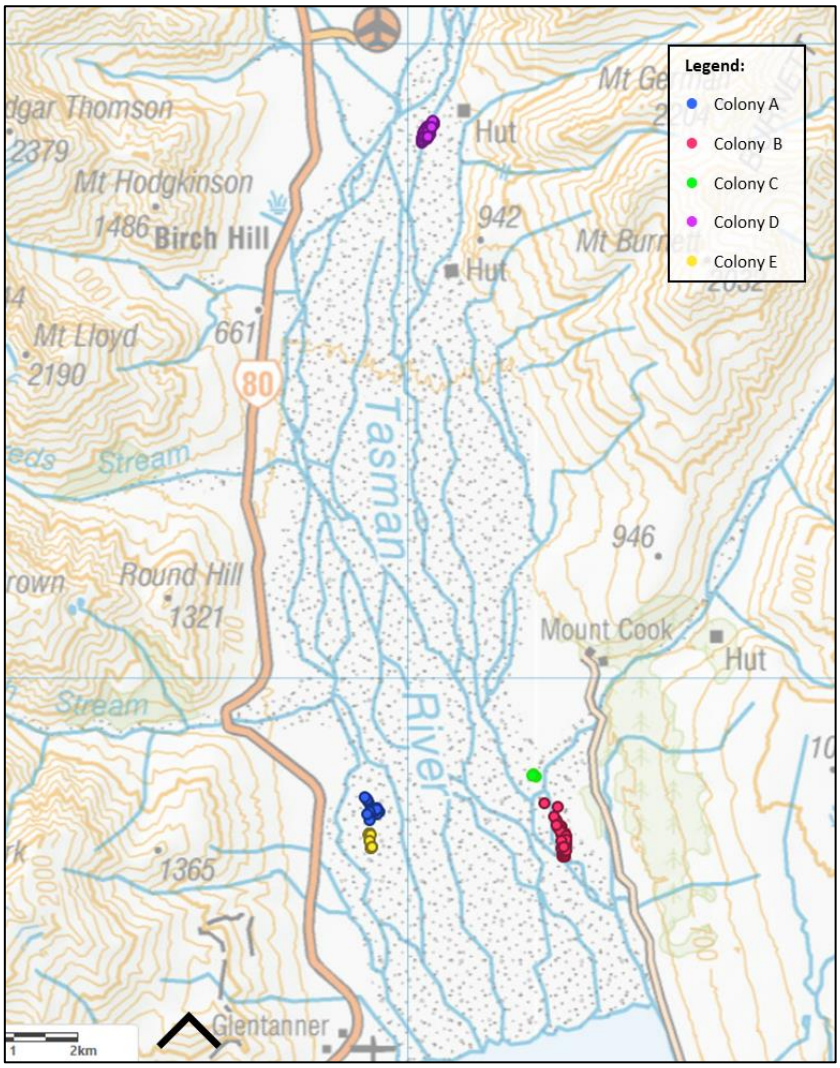

Figure 2. The locations of the black-fronted tern/tarapirohe nests and colonies monitored in the Tasman River in 2022-23. Image reproduced from Porter 2023.

Of the monitored nests, 73% hatched at least one chick (Figure 3). The 2022-2023 season had the highest total number of nests and eggs laid since the 2019 breeding season however the hatching success was lower than the previous two seasons which was largely due to predation and abandonment (Porter, 2023). Between 0 and 104 chicks fledged. Mean fledging success this season showed similar results to 2019 and 2020 (0.46 fledglings per chick; Figure 3).

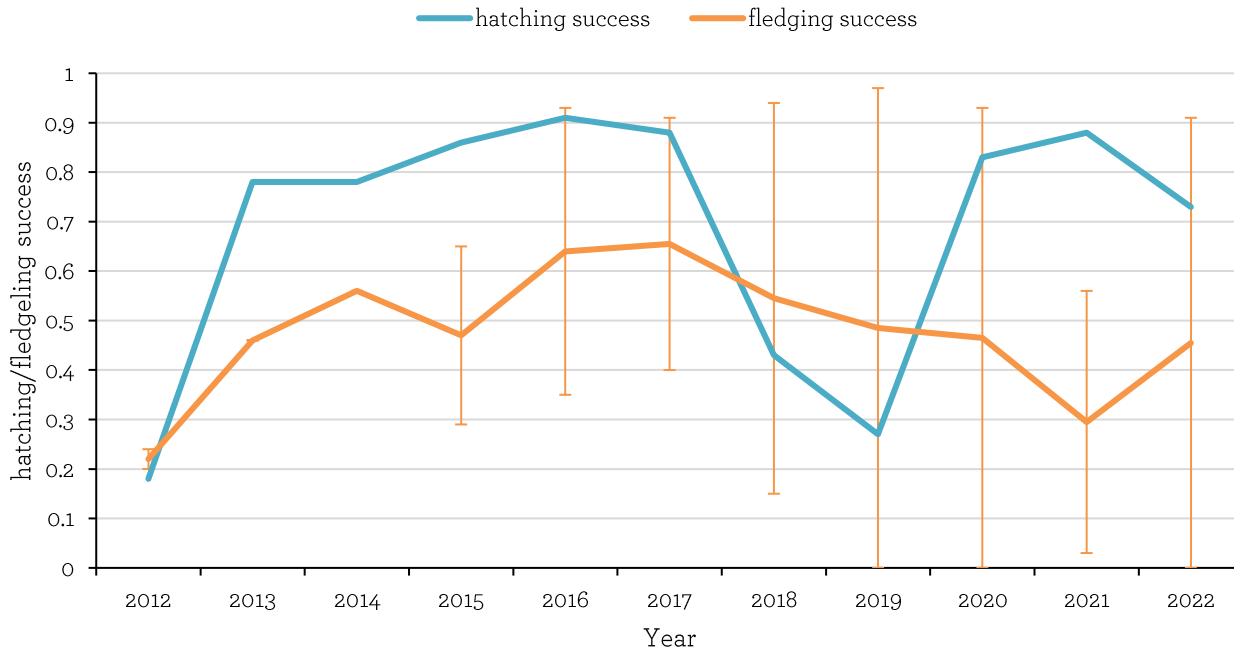

Figure 3. The hatching success (chicks hatched per nest with known outcome) and mean fledging success (number of fledglings per nest, error bars show estimated minimum and maximum) of black-fronted terns/tarapirohe nesting on the Tasman River between 2012 and 2022.

Braided river bird survey

The Tasman River bird survey is completed each year and is used as an indicator of the success of the Tasman River Predator Control Project. PRR contributes to the project by organising the survey and providing staff. The results for this season's survey conducted in December are compared with previous seasons in Table 1.

Table 1. Results of river bird surveys on the Tasman River between 1992 and 2022. Results from the three-year cycle from 1992 to 1994 and first 11 years of following commencement of the Tasman predator control project (2004-2014) are averaged. Results from the current 2022 season are highlighted in bold.

Species, threat ranking*		1992-1994 (Range)	2004-2014 (Range)	'17	'18	'19	'20	'21	**'22**
Banded dotterel/tūturiwhatu,	NV	565 (523-599)	658 (395-858)	741	946	710	568	641	**729**
Black stilt/kakī,	NC	2 (1-5)	11 (2-32)	17	8	7	2	6	**11**
Black-backed gull/karoro,	NT	585 (537-609)	240 (95-413)	64	53	60	29	51	**51**
Black-billed gull/tarāpuka,	NC	13 (7-25)	25 (5-113)	135	218	160	60	72	**226**
Black-fronted tern/tarapirohe,	NE	121 (79-175)	137 (47-217)	648	245	464	192	393	**539**
Caspian tern/taranui,	NV	2 (2-2)	1 (0-3)	2	0	2	3	2	**5**
Hybrid stilt,	n/a	4 (1-9)	4 (0-10)	0	3	0	0	4	**0**
Pied stilt/poaka,	NT	17 (12-21	11 (0-54)	1	8	8	5	2	**7**
South Island pied oystercatcher/tōrea,	D	60 (46-76)	72 (52-109)	81	115	62	65	123	**108**
Spurwing plover,	NT	19 (17-23)	20 (5-37)	6	25	10	14	19	**16**
Swamp harrier/kāhu,	NT	5 (0-11)	3 (1-3)	0	4	9	0	2	**3**
Waterfowl and shags,	n/a	366 (334-407)	406 (177-842)	310	494	260	154	214	**249**
White-faced heron/matuku,	NT	2 (1-2)	1 (0-3)	1	7	0	1	3	**5**
Wrybill/ngutuparore,	NV	133 (120-151)	110 (32-165)	126	133	148	122	207	**192**

*Threat rankings, from most to least threatened: Nationally Critical (NC), Nationally Endangered (NE), Nationally Vulnerable (NV), Declining (D), Not Threatened (NT).

Upper Ōhau River/Tern Island

Black-fronted tern/tarapirohe is a small, nationally endangered tern species endemic to New Zealand (Robertson et al., 2021). Braided river specialists, black-fronted terns breed only in the eastern and southern South Island, with recent population estimates of only 10,000 birds. The Ōhau River is one of the many braided rivers in the Upper Waitaki Basin which supports breeding colonies of black-fronted tern/tarapirohe during the summer months. They face a complex variety of interacting threats including introduced pests (Keedwell, 2005; Keedwell et al., 2002), weed encroachment of their habitat (Schlesselmann, 2018) and environmental factors such as flooding risk (Cruz et al., 2013).

Predator and Weed Control

The upper Ōhau predator control programme commenced in 2009 (Anderson, 2010) and aims to improve the breeding success of a large black-fronted tern/tarapirohe colony that nests each year on an island in the upper Ōhau River (known locally as "Tern Island"). This project has historically involved intensive predator control using a kill trap grid spanning a 1km radius from the tern colony at the core of the trapped area, targeted Norway rat (*Rattus* norvegicus) control using poison, and rabbit (*Oryctolagus cuniculus cuniculus*) control within a 1.2km radius of the same area using a mixture of night shooting and patch poisoning. The project was reviewed in 2016 with a recommended scaled down approach to management of this area (Maloney, 2016). This approach would test if black-fronted tern/tarapirohe breeding success can be maintained at the high levels seen since the project commenced while reducing operational costs (Maloney, 2016). The control area was reduced to approximately a 500m radius area surrounding the island. The number of traps, frequency of trap checks was also reduced, and rabbit night shooting was discontinued due to excessive growth of vegetation making shooting very difficult.

The 2022-23 season marks the fourteenth year of predator control operations in the upper Ōhau River. The kill trap network currently consists of 128 DOC-150s (replaced with double sets), 118 DOC-250s, 54 Twizel cat traps, 21 Belisle Super X 220 traps, 20 modified Timms, 18 Warrior traps (replaced with Trapinator traps), and 12 Goodnature A24 traps (Turner et al. 2022c; Figure 4). Traps were checked weekly-fortnightly during the tern breeding season (October 2022 until mid-February 2023) and monthly for the remainder of the year. Kill traps were run continuously throughout the year except for traps on Tern Island which were shut down for five months after black-fronted tern/tarapirohe started nesting to avoid catching their chicks. During the trapping period from 1 March 2022 to 28 February 2023, 72 hedgehogs, 193 rabbits, 94 ferrets, 24 cats, 33 rats, 18 possums, 4 stoats, and 2 weasels were caught in kill traps.

Pindone 0.5g/kg cereal baits were used again this season to control Norway rats within the trapping area. Toxin was laid in 140 bait stations and was later than previous seasons (started in October vs August) due to contractor unavailability. The stations were checked weekly, and a supply maintained through to late-February when terns had left the colony (Figure 4). Consent was gained to lay additional Pindone on the island after rats were discovered nesting in situ in November. This was laid in 51 rock crevices spread across the island in the hope of poisoning rats which were unlikely to be exposed to Pindone off the island.

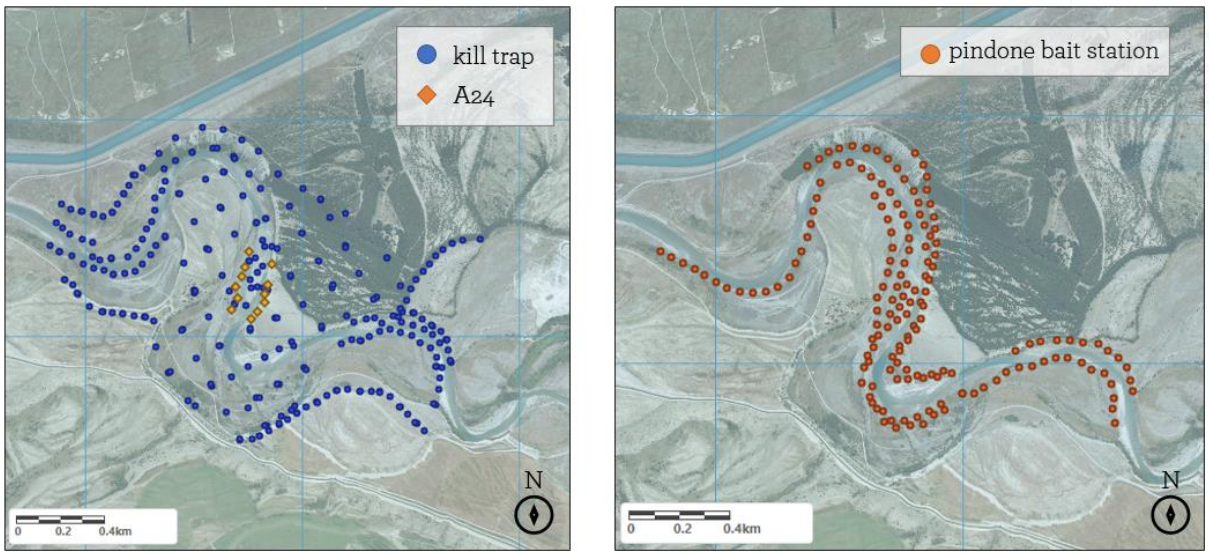

Figure 4. The network of kill traps (blue dots, left), A24s (orange diamonds, left) and bait stations (orange dots, right) established in the Upper Ōhau River to protect a population of Nationally Endangered tarapiroe/black fronted terns. Basemap imagery sourced from the LINZ Data Service and licensed for re-use under the Creative Commons Attribution 4.0 New Zealand licence.

Additional predator control operations targeted feral cats and Norway rats. Spotlighting from September to October resulted in six feral cat kills. The rodent detection dog team searched the island and river edges up and down stream on two occasions (two days per visit). The first visit occurred when the Terns just starting nesting which coincided when rats were also detected on the island. The second visit occurred end of October, when mass egg predation occurred, and a rats nest was discovered on the island in boulder terrain where the dogs could not access them. The use of a detection dog again proved extremely useful in detecting weak points in the control network and the likely cause of the colony failing. Multiple egg caches with 30+ eggs were discovered on the island, suggesting that the resident rats were the likely culprits (Figure 5). No black-backed gull control was conducted this season.

Weed control targeting any regrowth was conducted twice on the island last year, before the terns arrived on the island, and at the end of the season. Weed control was conducted before the terns arrived for the 2022-23 season and after the season ended. Vegetation removal from the island using an excavator was last completed in 2019.

Figure 5. ***Left:*** **Locations of dog detections of Norway rat nests (rat symbol) and all the black-fronted tern nests (orange) lost to predation or abandonment.** ***Top right*****: an egg cache found by dogs on Tern Island October 2022.** ***Bottom-right:*** **Detection dogs digging out a rat nest on the upper end of Tern Island. Photos: Leona Kirk (Handler, Wildlife Protection Services).**

Black-fronted tern/ tarapirohe monitoring

This was the seventh season of nest monitoring on Tern Island since the trapping network scaled down in 2016 (Turner et al., 2023c). Monitoring was conducted by one person with multiple visits in a week. Colony size was estimated by doubling the maximum number of active nests per nest check after the season. Nest monitoring involved thorough searches of the island where an observer walked the island (downstream to upstream) to find new nests and monitor each nest from eggs until hatching. Nests with guano present were considered as hatched. Six cameras also monitored active nests with eggs for predator surveillance and nest outcome.

The colony size fluctuated during the season due to predation events. Peak colony size was in mid-October with 184 adults (92 nests). By mid-November, the colony abandoned Tern Island after Norway rats and stoats destroyed all the nests (~170 eggs) on the island. At this time, some black-fronted terns began to nest on the true right mainland next to Tern Island. Then at the end of November, a colony of up to 40 terns renested 1km downstream from the island (true right) on the edge of the trapping network. All off-island nests were wiped out via hedgehog predation. Some terns then returned to the island in mid-December and renested in a smaller colony which peaked in January with 144 adults.

A total of 321 nests with 502 eggs were monitored this season. Hatching success of nests with known outcomes (n=303), was 21% which is much lower than the previous two seasons (Figure 6). Despite significant predation events, it was the third season since 2016 where chicks fledged. Once chicks began to crèche, associating chicks and fledglings to nests was difficult. The number of chicks estimated to fledge ranged from 69 to 84. At least 24 large chicks are assumed to have fledged from (Turner et al., 2023c).

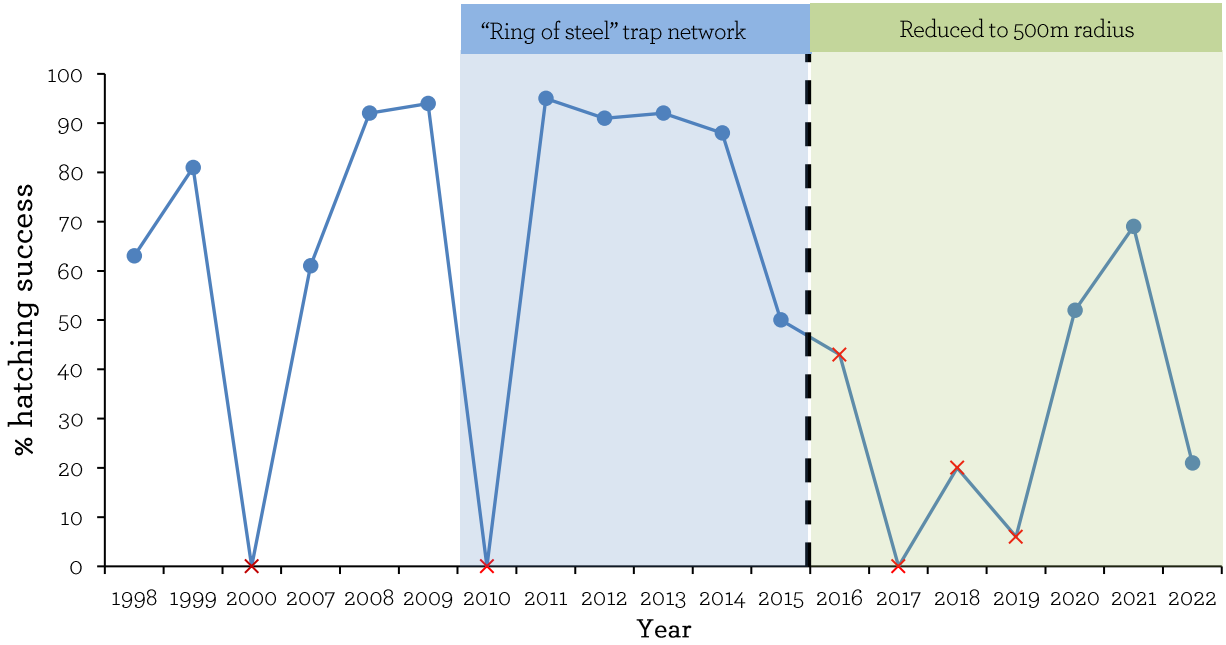

Figure 6. Hatching success of black-front terns nesting on Tern Island in the upper Ōhau river from 1998-2022. *Blue:* From 2010 to 2015 an intensive trapping network "Ring of steel" was set up in a 1-km radius of Tern Island. *Green:* In 2016 the trap network reduced 500m. *Red crosses* = colony failures. Note that monitoring effort has varied over the years.

Flag banding

Over 2 days at end of January, a total of 25 chicks were captured by hand then given a metal band on the right tarsus and a green flag band (white numerical text) on the left tarsus for future identification (Figure 6).

Figure 6. *Left:* Anna Porter (left) and Sam Turner (right) flag banding a black-fronted tern chick. *Right:* A black-fronted tern chick with its new bands. Photos: Tom Goodman

Lakes Skink Monitoring

Lakes skinks (*Oligosoma* aff. *chloronoton* "West Otago") are a Nationally Vulnerable taxonomically indeterminate, large-bodied lizard that inhabit the area from the Eyre Mountains in the south to the Pūkaki River in the north (Hitchmough et al., 2021). They were discovered along scree terraces in the Upper Ōhau River in 2013. Population monitoring began in 2016-17 to determine whether the population benefited from predator control established for protection of a nearby black-fronted tern colony (Lettink, 2016; Haultain 2017a). This year was the seventh year of population monitoring of Lakes skink at the site. Very few studies of lizard populations in New Zealand follow individuals in such detail and for this many years.

The population is monitored using an established line of 41 pitfall traps (spaced approximately 5m apart). This year, pitfall trapping was carried out over seven days in January/February. Traps were made of 4L plastic containers dug into the ground and baited with pieces of pear. To reduce thermal stress, a wet sponge and a handful of dampened moss was added to each pitfall. A wooden lid with spacers was placed on top of each trap, leaving a 2-3cm gap. Traps were opened during optimal weather windows (>12°C, no rain) and checked daily. This season, traps were closed a day early due to poor weather (243 trap nights). All captured skinks were given a temporary identification mark using a non-toxic permanent marker. This meant recaptured individuals could be easily identified. Morphological measurements were recorded and photographs of key features of each individual captured. An assessment will be made of whether natural markings can be used to identify individuals over multiple years.

A total of 66 Lakes skink captures were made over the trapping period, consisting of 55 unique individuals and 11 recaptures (of 7 individuals; Table 2). McCann's skinks (*Oligosoma maccanni*; 13 individuals) and one southern alps gecko (*Woodworthia "Southern Alps"*) were also caught in the pitfall traps this season. Capture rates have varied dramatically in short time frames (2-4 years) while management and trapping effort has not.

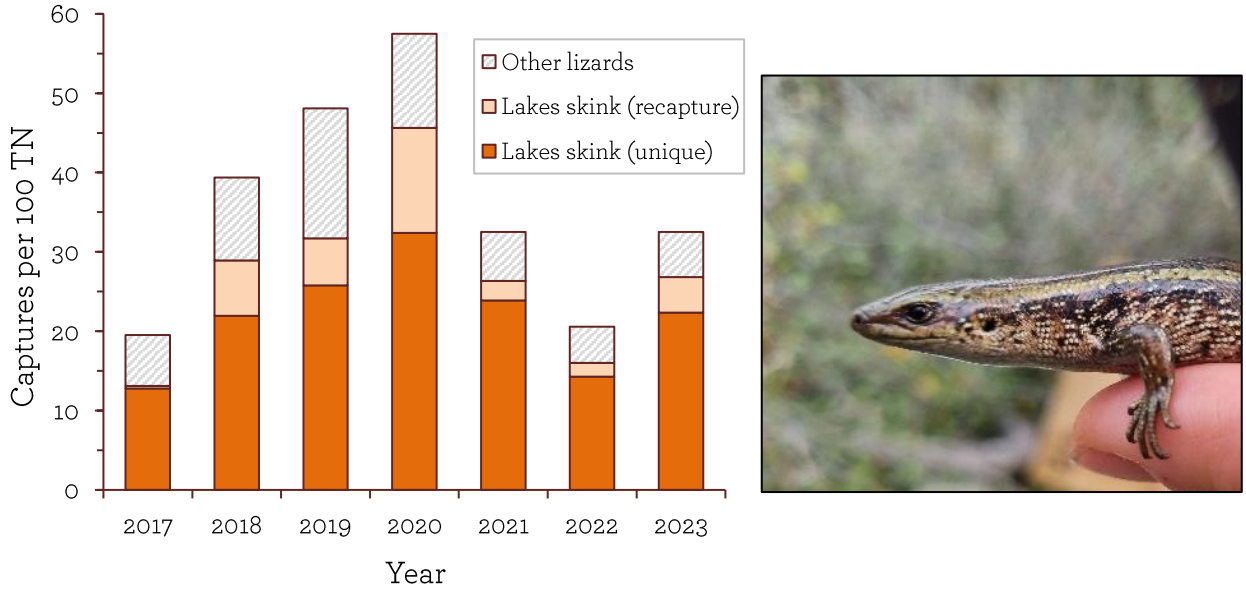

Figure 7. Left: The capture rates of unique lakes skinks (dark orange), recaptures (light orange) and other lizards (grey stripes) per 100 trap nights (TN) during pitfall trap monitoring since 2017 at the Upper Ōhau Lakes skink monitoring site. Total monitoring days were 6 in 2023, 7 for 2018-22 and 8 in 2017. Right: A lakes skink. Photo: PRR

It was intended that the monitoring of the lakes skink population at this site would reveal whether predator control benefits this species (Haultain, 2017a; PRR, 2022). However, the lakes population now occurs on the perimeter of the predator control grid (rather than near the core) following the downscaling of the Upper Ōhau

River trapping network in 2016 (Turner et al., 2023a). It's possible that predator control may still be providing some suppression of predation as there doesn't appear to be a steep decline in the population.

Table 2. Summary table of annual monitoring details from lizard pitfall surveys in the Upper Ōhau terrace site from 2017-2023 (DOC-5987394). McC = McCann's skink, SaG = Southern alps gecko.

	2017	2018	2019	2020	2021	2022	2023
Total monitoring days	8	7	7	7	7	7	6
Total trap nights	328	287	287	287	243	287	246
Max temp(˚C)	17.3	22.7	36.5	37.7	39.6	38.2	48.2
Min temp (˚C)	6.9	8.9	10.2	1.1	4.2	5.4	11.1
Species captured	Lakes skink McC	Lakes skink McC SaG	Lakes skink McC Cryptic/ Grass skink	Lakes skink McC Cryptic skink	Lakes skink McC SaG	Lakes skink McC	Lakes skink McC SaG
Total captures and recaptures: All Lizards	64	114	145	167	79	60	78
Total unique captures: All Lizards	63	93	121	127	73	54	66
Total unique captures: Lakes skink	42	63	74	93	58	41	55
Total recaptures: Lakes skink	1	20	17	38	6	5	11
Other lizards	21	30	47	34	15	13	14
Average unique Lakes skink captures (per day)	5.3	9	10.6	13.3	10.3	5.9	9
Other lizards (per 100TN)	6.4	10.5	16.4	11.8	6.2	4.5	5.7
Lakes skink (recaptures) (per 100TN)	0.3	7.0	5.9	13.2	2.5	1.7	4.5
Lakes skink (recaptures) (%)	2.4 %	31.7 %	23 %	40.9 %	10.3 %	12.2 %	20 %

Hedgehog fence project

Hedgehogs are one of the key predators of ground-nesting birds, lizards, and invertebrates on and adjacent to braided rivers in Te Manahuna/the Mackenzie Basin. Learning to effectively control hedgehogs will benefit many of the populations of threatened species that PRR and other national projects are working to protect. Hedgehog eradication is currently being carried out within five rabbit fenced sites within Tū Te Rakiwhānoa Drylands Public Conservation Land (PCL) to test the efficacy of standard rabbit-proof fences as effective barriers to hedgehog reinvasion (Goodman, 2023).

Determining the role of rabbit-proof fences as a barrier to hedgehog movement may provide opportunities to use existing infrastructure as it is to eradicate hedgehogs from areas and prevent reinvasion, make low-cost modifications to existing infrastructure to eradicate hedgehogs (and potentially other predators) from areas and prevent reinvasion, and create new lower-cost infrastructure to exclude hedgehogs (and potentially other mammalian predators) from high-priority threatened populations or ecosystems.

The hedgehog fence project is in its first year of three. The fenced areas selected for this study are between 38 and 160 ha (Figure 8) providing a realistic scale to undertake eradication using trapping (DOC250 traps), night searches (thermal imaging and spotlighting), and detection dogs. These same tools and motion-sensor cameras are being used to determine eradication at each site and monitor for reinvasion.

Between February and June 2023, 22 hedgehogs were killed at Pūkaki Scientific Reserve (n=4) and Upper Ruataniwha Wetlands (n=18). Twin Peaks has had its fence fixed by the LINZ team at DOC Twizel and has 50 DOC250 traps inside the perimeter of the fence. An adjacent site to Upper Ruataniwha Wetlands has been established (called 'Lower Ruataniwha Wetlands'). These sites share one fence line and are similar in size. Between them there are 81 DOC250 traps set for knocking down the hedgehog population to low numbers before eradication is achieved through thermal imaging and the use of a detection dog if necessary. Lower Ruataniwha Wetlands has replaced Pūkaki Scientific Reserve due to the recent fire sweeping through and destroying the fence and vegetation within the reserve.

Motion-sensor cameras are set up at all established sites (1 per 4-9 ha) to determine hedgehog presence before, during, and after eradication. Eradication will be considered successful at each site once there are no hedgehog detections on camera or in traps for three months during hedgehogs' active season (mid-September to mid-April). Fences are checked regularly by the DOC Twizel threats team, LINZ team, and PRR staff when traps are being serviced. It is paramount to this study that any damages caused to the fences or substrate around them must be fixed before hedgehogs are able to exploit them.

There are four additional smaller sites being monitored by PRR in this study. Four ~1 ha rabbit-proof fences were set up last year at Maryburn and Patersons Terrace to protect invertebrates from hedgehog predation (Figure 8). These fences are checked monthly and monitored by DOC250 traps in each corner and a motion-sensor cameras in each to ensure that no hedgehogs are getting inside. Only mustelids and feral cats have been caught in these traps to date.

Across all sites there will be outcome monitoring taking place to measure the response of invertebrate communities in the absence of hedgehogs. This is already happening at Maryburn and Patersons Terrace and will be established at all sites with control sites to match.

The next phase of this study is setting up Ben Dhu Scientific Reserve as a site (installing traps and cameras) and completing eradication at the other three sites in the upcoming summer-spring period. Additionally, an application for the use of alpha-chloralose for landscape-scale hedgehog control is being compiled and, subject to ethics approvals, will be tested by PRR for its feasibility to control hedgehogs within ecosystems adjacent to braided rivers (tussock grassland terraces/plains).

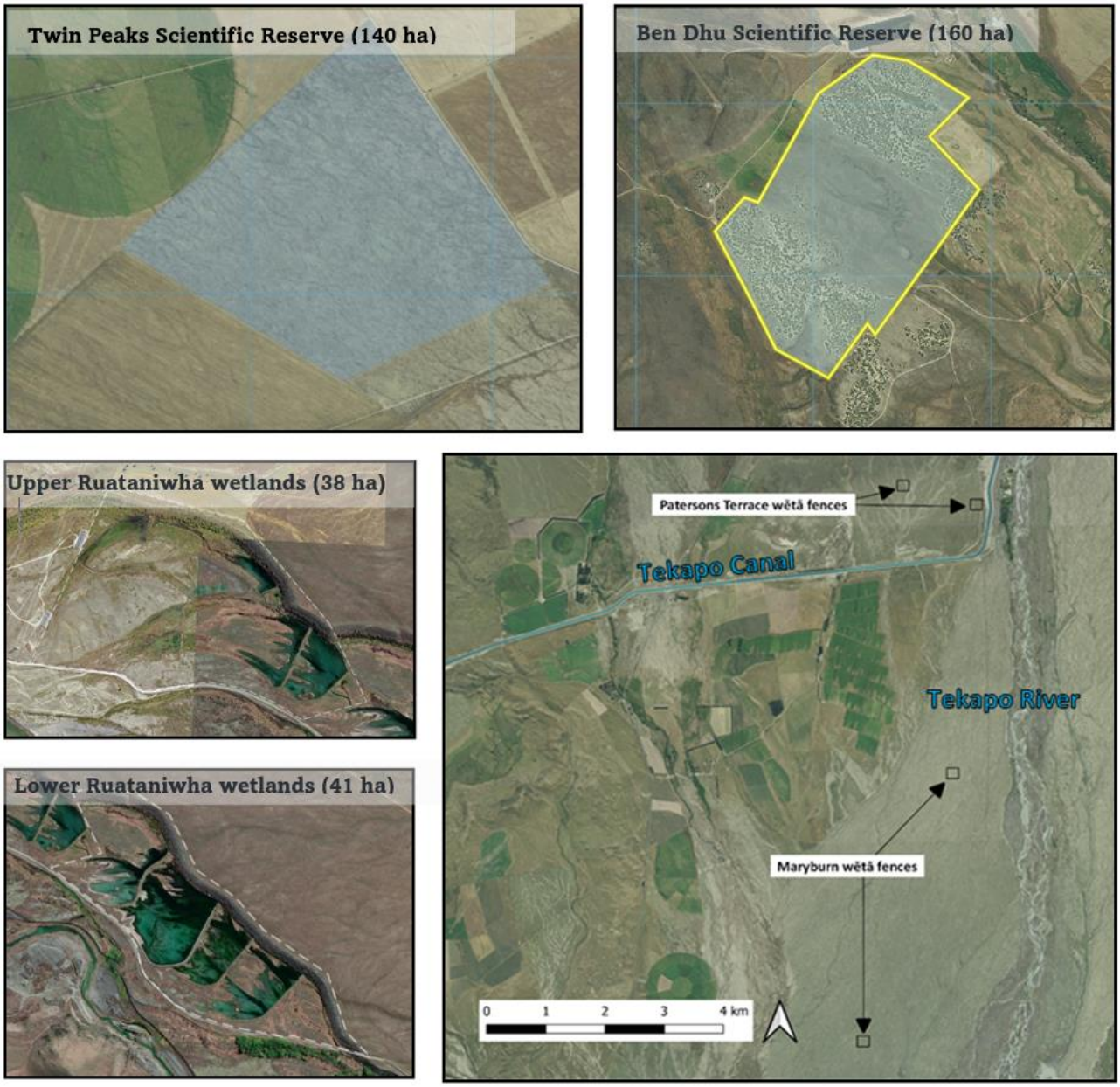

Figure 8. ***Left:*** **Site locations within Te Manahuna/the Mackenzie Basin for rabbit-proof fence study as a barrier to hedgehog reinvasion.**

Lake Alexandrina Southern Crested Grebe/kāmana

Lake Alexandrina is known as a stronghold for the Southern crested grebe/kāmana (*Podiceps cristatus*; Nationally Vulnerable). Crested grebe/kāmana generally make nests scattered around the lake and the nearby Lake McGregor on floating or semi-floating nests made of aquatic weeds and sticks, however in the 20/21 season, an unusual occurrence took place in the Lake Alexandra outlet stream. Possibly because of strong early season winds making nesting attempts unsuccessful, later in the season virtually all the population (peak of 40 nests) started breeding in a short 50 metres section of the outlet stream (Figure 9). With active nests sometimes only one metre apart in this small area, this made for an interesting visual spectacle with territorial disputes and breeding displays in regular evidence.

Once again, this season, the same behaviour took place, but it was even busier with a maximum number of 66 nests in mid-December 2022. PRR supplied the Lake Alexandra Conservation Trust volunteer trapping group with bait and that group serviced traps around the site. Due to concerns about people's behaviour disturbing

the birds, PRR again put up a temporary fence around the area to keep people at a suitable distance. Feedback from local people was that this helped manage behaviour and although formal monitoring did not take place, numerous chicks appeared to fledge.

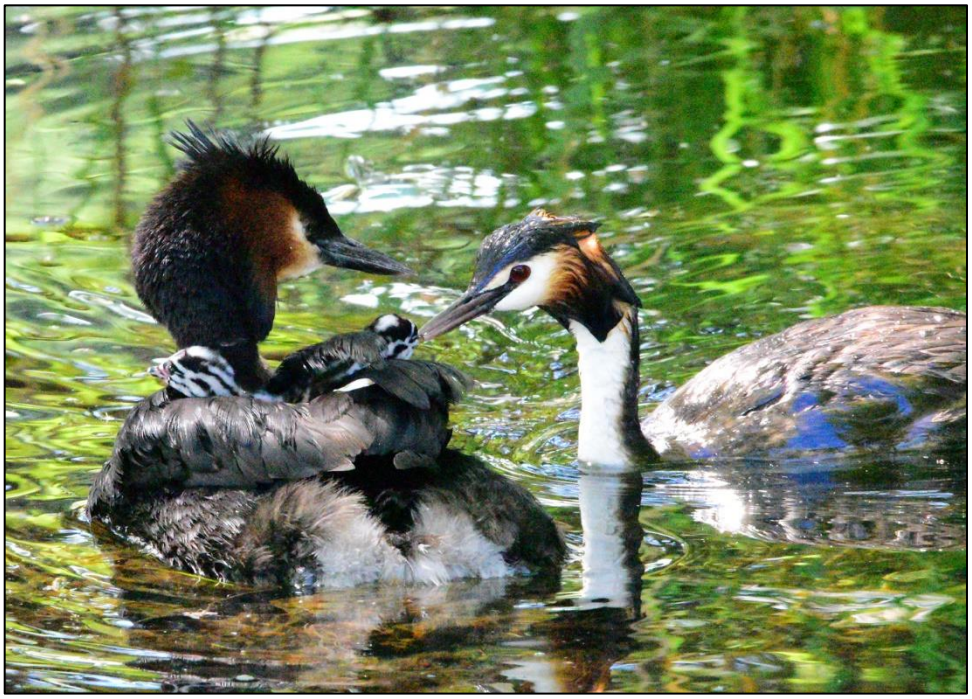

Figure 9. Crested Grebe/kāmana parents with young chicks. Photo: Dean Nelson

4.3 Objective 3: Increase public awareness of braided rivers and associated wetlands within a changing environment.

PRR's information resources continue to be updated and reprinted as necessary and distributed to schools, and other community groups, with the braided river multi-species poster and braided river field guide still proving to be popular.

PRR continued to support University of Otago Wildlife Management students. The students visited in April 2023 and PRR gave them practical exercises associated with threatened species management at Patersons Terrace and the Tasman River. Throughout the year, PRR met with various stakeholders including Fish and Game, ECan and various private landholders.

Dean was interviewed in the Tasman Valley for the TVNZ 1 Sunday programme about feral cats. He also did some filming for a threatened species television series with hosts Pax Assadi and Nicola Toki in February 2022. This was based around threatened galaxiid management in the Fraser Stream trout barrier site. The series, called Endangered Species Aotearoa aired in early July 2023. Tom also featured on this programme, working with kea at Aoraki and other DOC staff featured with kakī.

Copies of the book *Rivers Rare*, written by Neville Peat in 2016 to celebrate the first 25 years of operation for PRR, are on sale in the Twizel and Tekapo bookstores and the Aoraki/Mt Cook Visitor's Centre. Due to the limited distribution of the book commercially, it is now regularly used as an advocacy tool by giving it to appropriate visitors and associates.

4.4 Objective 4: Gain ecosystem knowledge in upper Waitaki rivers and wetlands through research and monitoring

Braided River Bird Surveys

PRR has continued its programme of riverbed bird counts. This is as part of a regular cycle of repeated surveys aimed at long-term monitoring of population trends in threatened, as well as more common braided river birds. In the early 1990s, PRR completed surveys of all the upper Waitaki rivers over three years. Currently, PRR sequentially re-surveys the rivers over three consecutive years on a rotational basis.

PRR uses standardised walk-through methodology to record counts of native (e.g., black-fronted terns, banded dotterels, wrybill) and non-native (e.g., Canadian geese) braided river birds and record GPS locations of nesting colonies and rare birds (e.g., kakī/black stilts). The standardised methodology allows the data collected to be compared directly with historic surveys, as well as other nation-wide braided river bird surveys. In the upcoming season PRR will additionally adopt the "KM" method being developed by Miles Burford and Jean Jack (ECan science team). Each "section" (the current method) will be split into kilometres to allow a higher resolution of river bird distribution whilst still allowing future data to be compared to past data. This work allows PRR to improve the understanding of bird population changes over time in upper Waitaki rivers, as well contributing to information on species-wide dynamics at a national scale. At the end of 2022, PRR surveyed the Dobson River and lower of the Hakataramea River for the third and final year (Goodman et al., 2023; Table 3). The third year of the Hopkins River survey was unable to be completed due to staff shortages. The Hopkins River will be completed this year and results for the three rivers will be analysed and presented in next year's annual report. The Pūkaki, Ōhau, and Cass Rivers will be surveyed for the next three-year cycle (2023-25).

Table 3. Braided river bird species recorded in walkthrough surveys of the Hakataramea, Hopkins and Dobson Rivers during the 2020 survey compared to the last time the river was surveyed. Data shows the minimum and maximum number of birds observed during the survey years.

Species, threat ranking*		Hakataramea River				Dobson River				Hopkins River		
		1982-83	2020	2021	2022[1]	1992-94	2020	2021	2022	1992/93	2020	2021
Australasian shoveler/kuruwhengi	NT	11-20	0	0	2	0	0	0	0	0-3	0	0
Banded dotterel/tūturiwhatu	NV	80-92	6	2	0	9-82	51	86	55	1-63	38	42
Black-billed gull/tarāpuka	NC	568-1056	0	20	0	0	20	0	0	0	4	7
Black-fronted tern/tarapirohe	NE	42-97	7	52	6	2-55	30	79	47	1-21	52	81
Black shag/kawau	NU	4-6	9	3	1	0-1	1	0	0	0-3	2	1
Black stilt/kakī	NC	0	0	0	0	0	0	0	0	0-2	4	0
Black swan/kakīānau	NT	0	0	0	0	0	0	0	0	0-22	1	1
Canada goose	I/N	0-9	79	47	5	6-47	28	15	9	0-175	49	55
Caspian tern/taranui	NV	0	2	0	0	0-2	0	0	0	0-2	4	2
Grey duck/pārera	NC	0-6	2	1	0	0-4	0	0	0	0-22	1	0
Grey teal/tētē	NT	0	0	0	0	0	0	0	0	0-4	9	0
Hybrid stilt	n/a	0	0	0	0	0-1	0	0	0	0-1	0	0
Indeterminate duck species	n/a	0-20	52	48	0	0-5	3	1	0	0-41	14	6
Little shag/kawau paka	NT	2-3	0	1	0	0	0	0	0	0-1	1	0
Mallard	I/N	140-89	9	16	0	0-6	12	2	0	0-3	0	15
New Zealand scaup/ pāpango	NT	0	0	0	0	0	0	0	0	0-4	0	0
Paradise shelduck/pūtakitaki	NT	49-120	56	50	3	4-52	36	12	26	5-61	26	25
Pied stilt/poaka	NT	90-171	80	112	6	0-2	1	2	2	0-12	3	4
South Island pied oystercatcher/tōrea	D	78-145	46	41	1	0-22	32	38	23	5-22	28	48
Southern black-backed gull/karoro	NT	22-84	304	100+	1	3-63	56	76	15	5-70	284	280
Spur-winged plover	NT	55-66	17	43	2	1-23	9	8	3	0-104	72	67
Swamp harrier/kāhu	NT	0	9	6	1	0-1	4	0	0	0-5	3	0
White-faced heron/matuku	NT	7-13	10	12	1	0	0	0	1	0	0	1
Wrybill/ngutuparore	NV	0	0	0	0	0-17	28	36	6	0-54	23	34
Total number of species		16	15	17	11	16	14	11	10	23	19	16

*Threat ranking, from most to least threatened: Nationally Critical (NC), Nationally Endangered (NE), Nationally Vulnerable (NV), Declining (D), Naturally Uncommon (NU), Not Threatened (NT), Introduced and Naturalised (I/N). [1] Only the lower section was surveyed.

Australasian Bittern/matuku hūrepo (*Botaurus poiciloptilus*)

The Australasian bittern/matuku hūrepo is a large, brown bird that is found throughout Australasia, including New Zealand, Australia, and New Caledonia. They inhabit wetlands and raupō-fringed lakes, feeding on fish, eels, frogs, lizards, and freshwater invertebrates including worms, spiders, insects, and molluscs. In recent decades, populations of Australasian bittern/matuku hūrepo have steeply declined, primarily because of habitat destruction but also due to pressure from predatory mammals. Up to 90% of their wetland habitat in New Zealand has been destroyed to develop farmland, and remaining wetlands are often of poor habitat quality because of water pollution or reduced food sources. Currently, Australasian bittern/matuku hūrepo are ranked as 'Nationally Critical' by the New Zealand Threat Classification System (Robertson et al., 2021; Townsend et al., 2008).

In the Mackenzie Basin, historic records from the 1930s-1970s show Australasian bittern/matuku hūrepo occurring on the shores of Lakes Benmore, Ōhau and Pūkaki, Alexandrina and Tekapō, and in the Ahuriri, Dobson and Pūkaki Rivers. Very little is known about the distribution and breeding of bitterns in the Mackenzie Basin today. Because visual observations are uncommon, the PRR team use ARDs (**A**coustic **R**ecording **D**evices;) to detect where breeding male bitterns were present. During the mating season, male bitterns produce a distinctive 'boom' (a sequence of between 1 and 10 '*wooooooom*' sounds in a row). This boom can be detected on a sound recording using specialised software. The PRR team deployed 15 ARDs to wetlands and raupō fringed lakes across the upper Waitaki Basin in December 2023. The acoustic recordings were processed by contractors. In December 2022, successful detection of bittern booms was made across four ARDs at two wetlands, Mt Gerald, and McGregor (Figure 10).

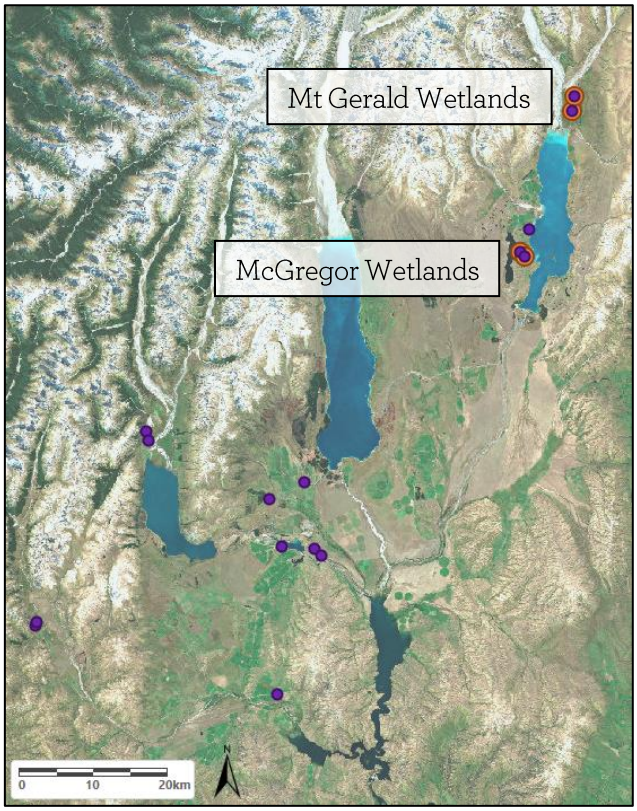

Figure 10. The locations where Acoustic Recording Devices (ARDs) were deployed (purple dot), and the four locations where bittern booms were detected (large orange dot with purple centre) across the Mackenzie Basin in 2022. Basemap imagery sourced from the LINZ Data Service and licensed for re-use under the Creative Commons Attribution 4.0 New Zealand licence.

Freshwater Fish

Objectives four and five include assisting with DOC's freshwater fish distributional surveys, monitoring fish populations and protection of fish species by appropriate installation of trout barriers and removal of invasive fish species. There are three threatened fish species in the Te Manahuna Twizel district, and they are the focus of all work carried out (Nelson et al., 2023). The non-migratory, "pencil" galaxiid species are *Galaxias* aff. *cobitinis* "Waitaki", the Nationally Endangered lowland longjaw galaxias (hereafter referred to as 'lowland longjaw'); *Galaxias macronasus*, the Nationally Vulnerable bignose galaxias (referred to as 'bignose'); and *Galaxias* aff. *prognathus* "Waitaki", the Nationally Vulnerable upland longjaw galaxias (referred to as 'upland longjaw') (Dunn et al., 2017). Other species found in the district include *Anguilla dieffenbachii* (longfin eel, Declining), *Galaxias brevipinnis* (kōaro, Declining), *Galaxias vulgaris* (Canterbury galaxias, Declining), *Galaxias paucispondylus* (alpine galaxias, Naturally Uncommon) and the Not Threatened *Gobiomorphus breviceps* (upland bully) and *Gobiomorphus cotidianus* (common bully). Galaxiids, particularly "pencil" species and juveniles, are prey of introduced species such as trout. PRR continues to maintain nine trout barriers to protect threatened native fish species across the basin. The spring-fed tributary of Fraser Stream is one site where populations of lowland longjaw and bignose galaxias are protected by a downstream trout-barrier.

Two staff from the National Freshwater Team staff assisted local staff with fish work for four days in April 2023. Work completed included the annual monitoring of the two Fraser Stream sites as well as setting up a new monitoring site in Waterwheel Wetland Spring, and some re-surveying of Tasman River upland longjaw sites and Edward Stream lowland longjaw sites (Figure 11). Annual monitoring shows that lowland longjaw and bignose galaxias continue to thrive in the Fraser spring-fed stream with the highest numbers of each (169 lowland longjaw galaxias and 277 bignose galaxias) caught across the two sites since monitoring began in 2007. This was despite a small presence of trout although it appears that the last trout was caught in late August 2022. A new monitoring site was set up in the Waterwheel Wetland barrier site and this produced a very healthy number of 346 bignose galaxias (Figure 12).

The Rūnanga work in the true left spring-fed stream tributary of Fork Stream as part of a Te Manahuna Aoraki (TMA) funded project didn't occur this year for various reasons. However, DOC/PRR and ECan staff stepped in again in December 2022 to ensure that all the previous effort was not wasted. In a combined elapsed time of 499 minutes electric fishing, only 37 brown trout and 25 rainbow trout were caught. This is a clear indication that progress toward complete trout elimination above the barrier is working if follow-up removal continues.

A massive, localised flood event in Corbies Creek in July 2022 washed through the trout barrier site causing some minor damage to the barrier however the positive result was that all the macrophyte and vegetation growth within the stream was completely cleaned out. Follow up electric fishing in September revealed that a handful of lowland longjaws had survived and spawned. Consequently, follow up inspections in October and December found large numbers of juvenile fish so it appears that the population has bounced back quickly.

Figure 11. ***Left:*** **Canterbury galaxiid at waterwheel, June 2023. Photo: Tom Goodman.** ***Right:*** **Sjaan electrofishing at Waterwheel Wetland, June 2023. Photo: Tom Goodman.**

Figure 12. The team of netters from University of Canterbury and Department of Conservation setting up a galaxiid monitoring site at Waterwheel in April 2023. Photo: Sjaan Bowie.

Robust grasshopper (*Brachaspis robustus*)

The Nationally Endangered robust grasshopper (*Brachaspis robustus*) is a braided river specialist, found only on the gravels of riverbeds and their associated terraces in the Mackenzie Basin. This large, flightless grasshopper occurs in shades of greys and browns that blend in well to the rocks of the braided rivers (Figure 13). It is a generalist herbivore that feeds on lichens, mosses, and other leafy vegetation of the braided riverbeds.

Figure 13. A female robust grasshopper basks on a rock in Snow River. Photo: Tom Goodman.

The robust grasshopper has been observed and monitored at various intensities by PRR and associated researchers since the 1990s (Turner et al., 2023b). In 2017, an annual monitoring protocol was developed. It was first implemented in a collaborative effort between University of Canterbury researchers and students and Twizel DOC staff. The monitoring is conducted across six key populations of robust grasshopper, located in the Ōhau River, Forks Stream (incorporating the gravel pits and military land), Patersons Terrace, Pūkaki River, Snowy River, and Tekapō River.

This year, the Patersons Terrace site yielded the highest mean count of adult female *B. robustus* (31.5 ± 3.18 SE) and total individuals (51 ± 1 SE; Figure 14). Forks yielded the second highest counts but was only surveyed once and excluded the military road. Fewer than six individuals were found on average across the remaining sites. The highest count of adult females at Ōhau, Snowy and Pūkaki Rivers on a single day was four. No females were found at Tekapō River, which was also only surveyed once, in cloudy conditions.

This year yielded some low population and adult female counts of *B. robustus* in each of the braided river sites, Snowy, Tekapō, Ōhau and Pūkaki Rivers (<1 adult females per km). The two least natural sites, Patersons Terrace and Forks, yielded the highest counts in 2021 (3.3 ± 0.3 SE and 2.3 ± 0.1 SE adult females per km, respectively), and have generally done so in previous years (Figure 14).

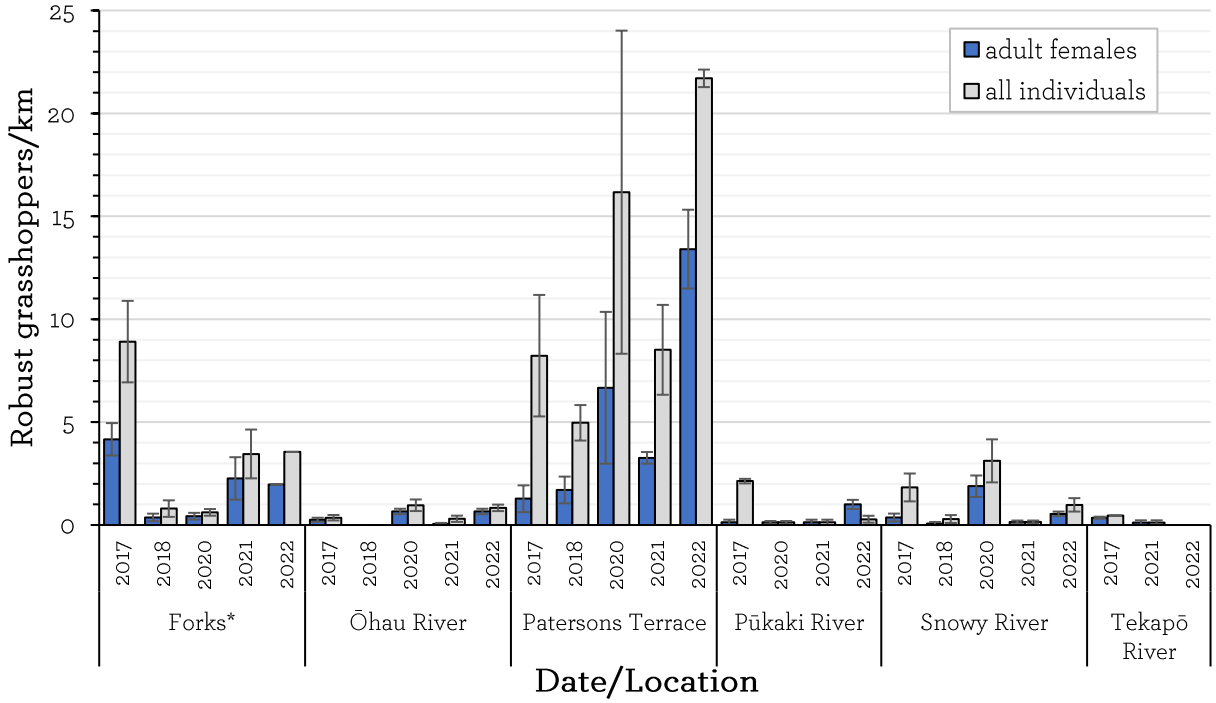

Figure 14. The mean number (±SE) of adult female and total robust grasshoppers per km at the Ōhau River, Forks (*including gravel pits and military land), Patersons Terrace, Pūkaki River and Snowy River between 2017 and 2022.

Distribution surveys were conducted in the Ōhau and Pūkaki Rivers in March 2023. These surveys involve observers walking the whole length of the river searching for robust grasshoppers to better understand distribution and how it may have changed over time. Five grasshoppers were found in the Ōhau River, their distribution matching that of the historic known range. The Pūkaki River distribution survey had abundant robust grasshopper sightings, 59 individuals. Most were found in the mid-sections in good clear habitat with mostly clear gravel islands with Epilobium. Recent records show a similar distribution to historic intensive searches carried out from spillway to the confluence with the Tekapō River, Sep-Dec 1992 (Figure 15; White, 1994).

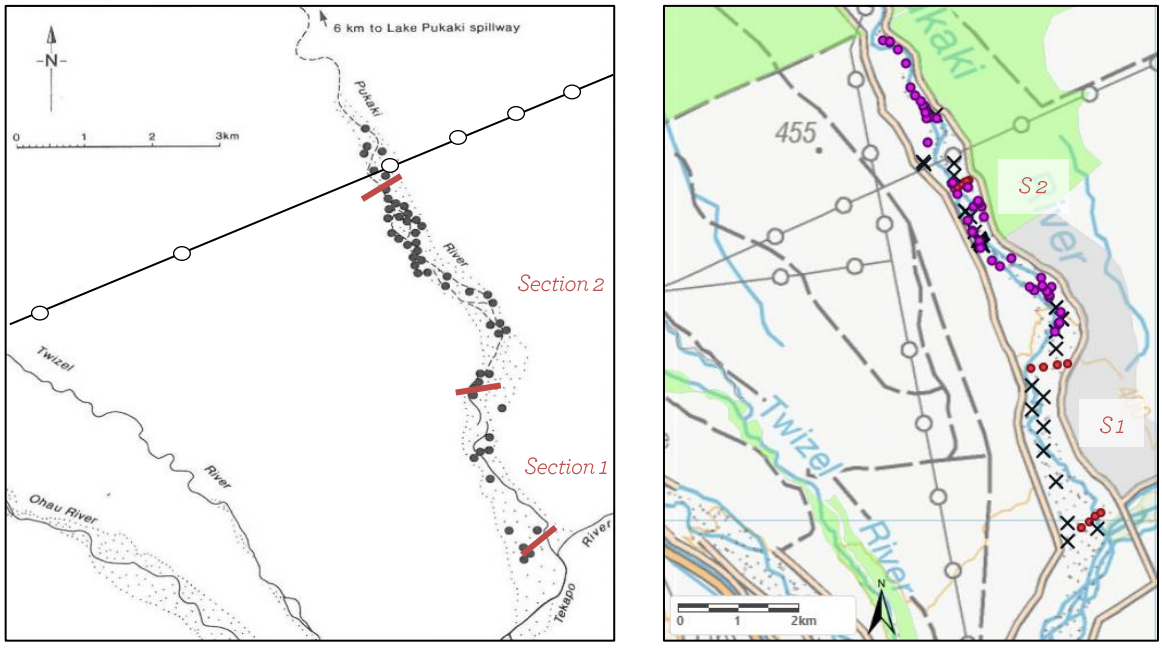

Figure 15. *Left:* Robust grasshopper sightings from surveys (n=74) in Sep-Dec 1992 (dots). *Right:* The same section of river 31 years later during the 2023 distribution river survey (purple dots = sightings; black crosses = historic sightings).

Maniototo peppercress (*Lepidium solandri*)

Lepidium solandri, commonly known as Maniototo peppercress, is a unique species of dryland plant: it is dimorphic meaning that individuals are either male or female (Soza, 2014). *L. solandri*, and the closely related *Lepidium sisymbrioides*, are the only species to be dioecious in the Brassicaceae family (Soza, 2014).

In 2017, a notable decline in population sizes of *Lepidium solandri* (Maniototo peppercress) across the South Island led to a re-evaluation of its threat status to Nationally Critical (de Lange, 2017). Populations are threatened by competition from introduced weeds, browsing by mammals, and a large proportion of populations experience negative effects from the surrounding intensification of land-use, including irrigation (Allen, 2000). The largest remaining populations of *L. solandri* occur in the Mackenzie Basin, and PRR undertakes monitoring, seed collection, and propagation of this species to understand what is needed to secure its survival.

Monitoring of several key *L. solandri* populations throughout the Mackenzie Basin commenced in 2021. Five dryland sites were chosen for monitoring, based on known *L. solandri* occurrence. These sites included Ruataniwha Wetlands, Pūkaki Flats, Maryburn, Tekapō Military Reserve and Tekapō Scientific Reserve. These sites vary in their ecological composition, management, and proximity to heavily modified landscapes.

The monitoring plots were set up as 3m x 10m plots, divided into 1m x 1m quadrats (Figure 16). In each quadrat, the percentage cover, sex, and locations of *L. solandri* plants were recorded. Percentage cover of other species and substrate types was also noted. *L. solandri* plants were counted individually to give a sum of individuals present within each plot. Overall, this study will provide us with a better understanding of *L. solandri* populations trends, and what key environmental factors are driving change.

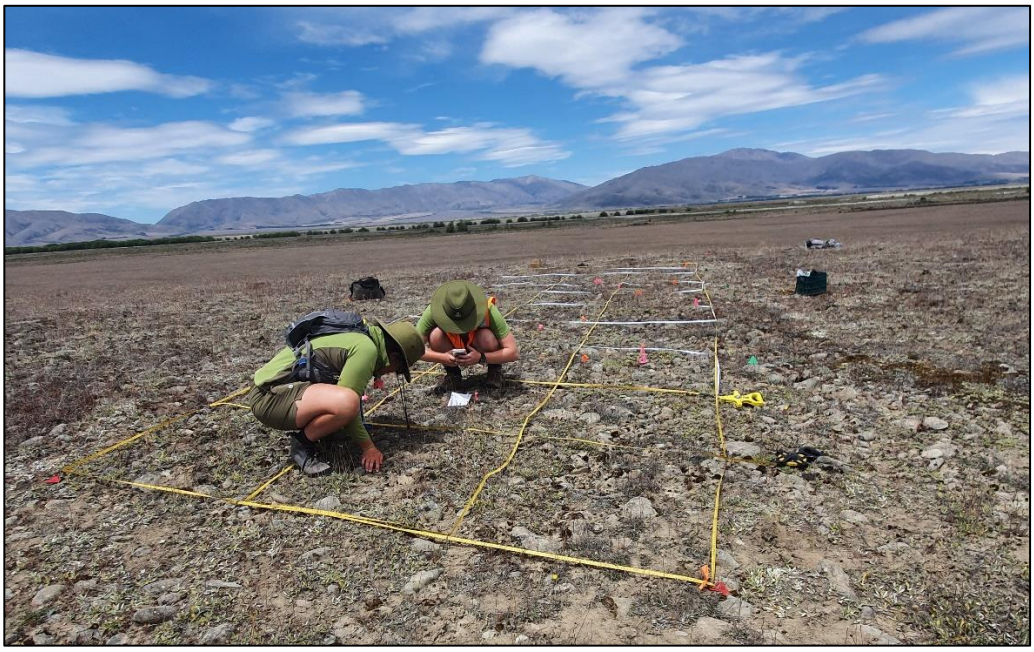

Figure 16. Tayla Hooker and Serena O'Brien monitoring one of the *Lepidium solandri* plots at Maryburn.

Additionally, this study provides an insight into the population dynamics of other threatened dryland plant species that occur within the plots. Other threatened species occurring across the five locations include the

Nationally Vulnerable species *Convolvulus verecundus*, *Muehlenbeckia ephedroides* and *Raoulia monroi*, and the At Risk – Declining species *Colobanthus brevisepalus* and *Rytidosperma exiguum* (Figure 17).

Figure 17. Top: a male *Lepdium solandri* in flower. Bottom, left to right: *Convolvulus verecundus*, *Raoulia monroi* and *Colobanthus brevisepalus*. Photos: Tayla Hooker.

In 2022, a full plant inventory including percentage cover was recorded across all sites. It showed that all the sites varied greatly in their composition of native and non-native species, as well as substrate types. Observing the population trends of these native species will be important for understanding the threats, not only to *L. solandri* but the dryland ecosystem that hosts these rare plants.

Overall, populations have increased by 8 individuals from 2021 to 2023. Most of this increase is seen in Maryburn as the population has risen by 7 individuals from 2021. Most other populations have fluctuated in their population size, showing signs of individual mortality but also recruitment. Both Pūkaki flats and Ruataniwha have increased in population size, whilst Takapō scientific has decreased by two individuals, and Takapō military has fluctuated but resulted in the same size population since monitoring began in 2021 (Figure 18).

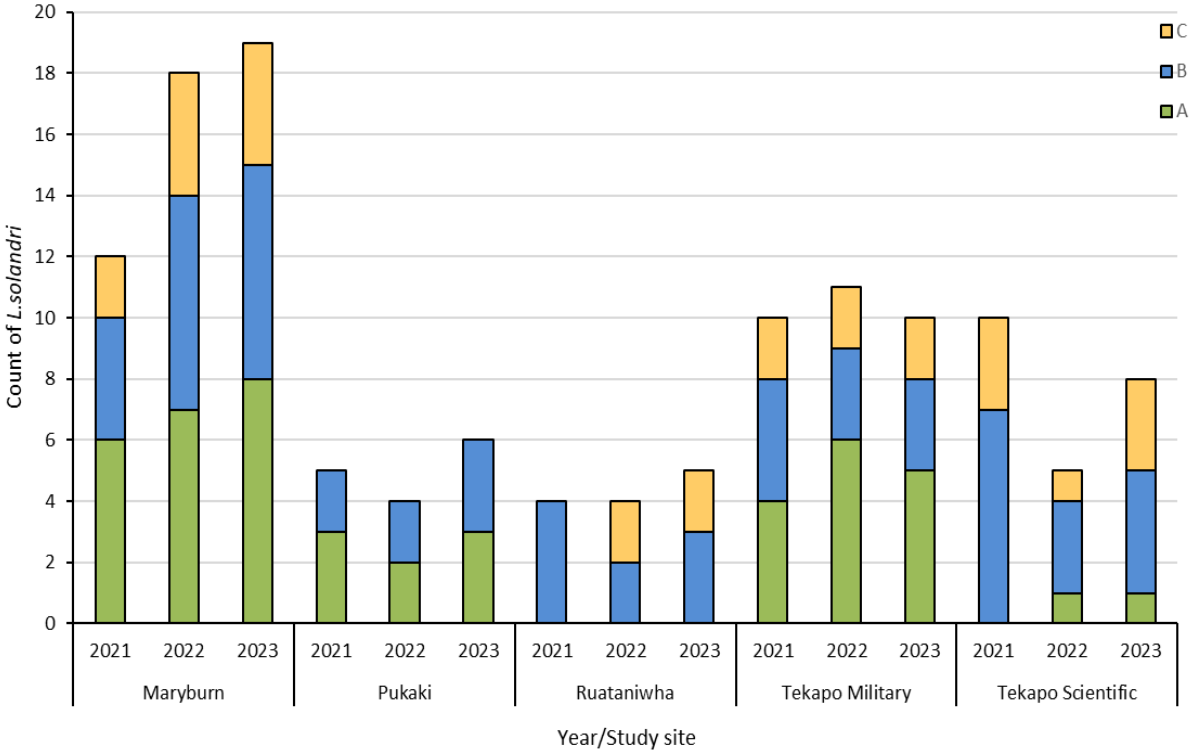

Figure 18. The number of *Lepidium solandri* individuals that were found in each plot (A, B, and C) at Maryburn, Pūkaki Flats, Ruataniwha Wetlands, Tekapō Military, and Tekapō Scientific Reserve in 2021, 2022 and 2023.

Alongside monitoring, seed collection has also been undertaken with the help of Susan Walker (Manaaki Whenua) and independent ecologist Mike Harding. Some of this seed has gone to Manaaki Whenua for the study of *Albugo*, a rust that has spread to some populations. Other seed has been collected and successfully propagated in a DOC Twizel nursery for future seed and planting trials.

4.5 Objective 5: Protect and manage upper Waitaki wetlands

Originally, the ponds at Ruataniwha wetlands were created to provide habitat for kakī (*Himantopus novaezelandiae*) and other bird species, but management now focuses on benefiting several Nationally Threatened ephemeral plant species. Ephemeral plants are specialised to live in habitats that cycle through being dry and inundated with water, e.g., on the margins of ponds where water levels fluctuate throughout the year. Water levels within the Ruataniwha ponds are controlled by PRR: By adjusting the height of weirs at the outlet of each of pond we can manipulate the water level in each pond and manage the duration of drying and flooding events on the pond margins.

The species *Dysphania pusilla* is one of three threatened vascular plant species that occurs in the ephemeral zones at Ruataniwha wetlands. It was regarded as extinct until it's re-discovery at Ruataniwha wetlands and in parts of Marlborough in 2015 and 2016 (Clayton-Greene, 2015). It is now regarded as Nationally Endangered because most populations exist in habitats that are heavily grazed or that are susceptible to weed incursion. The population that occurs at Ruataniwha wetlands is an anomaly because the habitat is fenced off from grazing mammals, and weed incursion is managed by the fluctuating water levels.

The same year *D. pusilla* was re-discovered, the liverwort *Riccia cavernosa* was also discovered (Rebergen et al., 2017). This species had never been recorded in New Zealand and is currently accepted as a recent natural arrival from Australia where it resides in similar habitats to Ruataniwha wetlands (Rebergen et al., 2017). Currently, the population at Ruataniwha wetlands is the only known occurrence of this species in New

Zealand. The other threatened species occurring in the ephemeral habitats of Ruataniwha are *Centipeda minima subsp minima* (Nationally Endangered) and *Isolepis basillaris* (At Risk – Declining).

In 2021, PRR began monitoring plants in the ephemeral zones at Ruataniwha wetlands to better understand how the changing water levels affects their distribution and abundance. Two transects were established on the wetland margins, and a third was added in 2022. At each transect, three strata (at low-, middle- and high-water levels) were monitored. The vegetation cover along each stratum was surveyed using quadrats, recording the surface cover (%), plant species cover (%), and total count of threatened plants plant species (vascular and non-vascular), water depth and/or moisture index and soil pH (where possible). Photo points were set up in strategic locations to capture a visual record of how water levels were changing in each of the monitoring sites each month (Figure 19). Our aim is to determine the optimal water level regime (i.e., the duration and timing of flooding and drying periods) in the ephemeral zones to benefit native threatened plant species.

Figure 19. An example of an image captured from one of the photopoints established at Ruataniwha wetlands in 2021 (photopoint 5).

Transect three has the highest native flora of all the three transects. The highest amount of bare ground (or 'substrate') is found on transect 1, making it the most suitable habitat for *D. pusilla*. Transect 2 is consistently the weediest of the transects, has the lowest substrate and native cover of the three transects (Table 4).

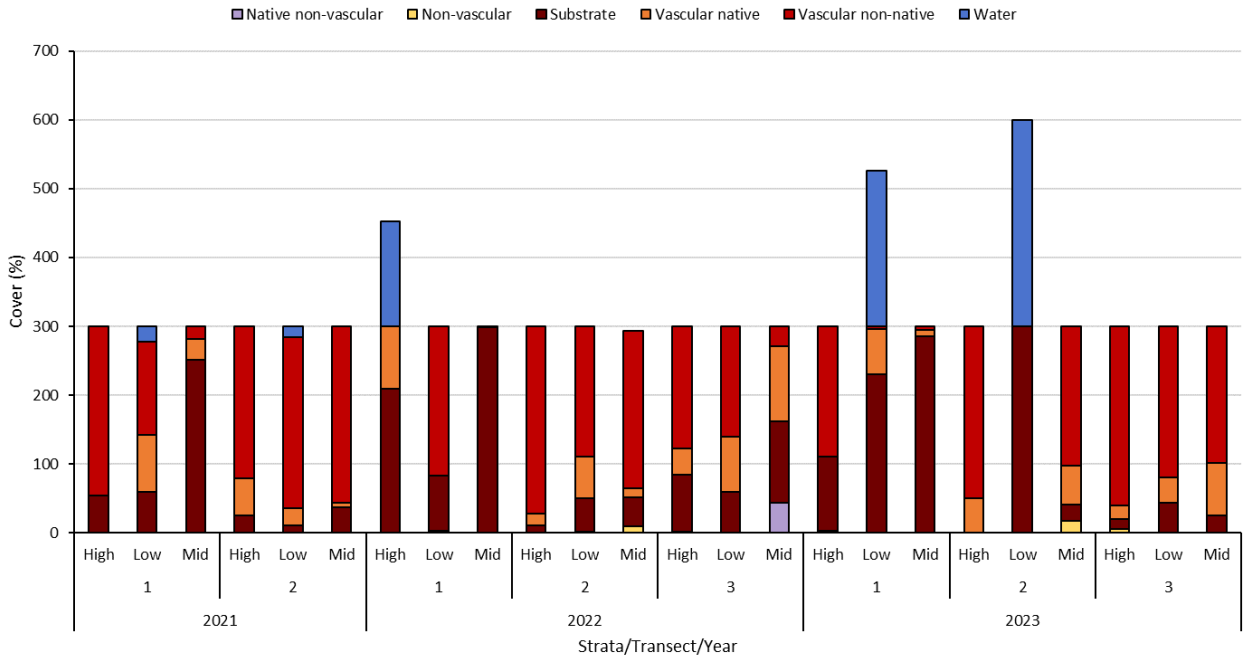

Figure 20. The mean percentage cover type (n = 3) recorded at each strata (low, mid, high) within each transect (T1-3) in 2021, 2022 and 2023. The third transect was added in 2022. The mean percentage of water cover during each survey is stated above each bar but substrate and plant cover was still recorded if under water.

The highest native diversity within the three transects was found in Transect 3, with a total of nine species, followed by Transect 1 (four species) and Transect 2 (three species; Table 4). Identification of *Centipeda aotearana* and *Centipeda minima* subsp. *minima* is difficult, so some work needs to be done in clarifying where the species are in Ruataniwha. The highest number of threatened taxa were present on Transect 3 (namely, *C. aotearana,* Naturally Uncommon; and *I. basilaris*, Declining).

This year, *D. pusilla* and *I. basilaris* were absent from Transect 1 despite being recorded in 2021 (Gale and Hooker, 2021) and observations of *D. pusilla* elsewhere in Ruataniwha wetlands (Tayla Hooker, pers. obs.). These changes can be mainly attributed to the variations in water levels. If water levels are left too high for too long, some species may not have the chance to appear, but weed cover will be very low. On the other hand, if water levels are left low for too long, ephemeral species will develop earlier but weeds will be able to establish and will be dominant when the survey is conducted. Weed incursion is the primary threat to the ephemeral taxa at Ruataniwha, and as we continue this study, we will better understand what water management regime will result in the lowest density of weeds and the highest density of bare substrate and native flora.

Table 4. The mean percentage cover of native vascular and non-vascular plant species recorded at each stratum (low-, mid- and high-water levels) at the three transect monitoring sites (T1, T2, T3) at Ruataniwha wetlands in 2022.

Species/threat ranking*		% Cover								
		Transect 1			Transect 2			Transect 3		
		Low	Mid	High	Low	Mid	High	Low	Mid	High
Argentina anserinoides,	NT	-	-	-	2.3	-	3.7	3.3	0.3	0.7
Azolla rubra,	NT	-	-	0.3	-	-	-	-	-	-
Carex maorica,	NT	-	-	-	-	-	-	-	-	-
Carex secta,	NT	-	-	-	17.3	-	-	-	-	-
Centipeda aotearoana,	NU	-	-	-	-	-	-	1.7	2.8	0.3
Crassula sinclarii,	NT	-	-	-	-	-	-	0.3	3.0	-
Dysphania pusilla,	NE	-	-	-	-	-	-	-	-	-
Glossostigma elatinoides,	NT	-	-	-	-	-	-	-	-	-
Hydrocotyle sulcata,	NT	-	-	-	-	-	-	13.3	18.3	6.7
Isolepis basilaris,	D	-	-	-	-	-	-	6.7	-	5.3
Lemna disperma,	NT	-	-	0.5	-	-	-	-	-	-
Limosella lineata,	NT	-	0.5	0.2	-	-	-	0.3	8.3	-
Myriophyllum propinquum,	NT	-	-	-	-	-	-	-	-	-
Myriophyllum triphyllum,	NT	-	-	29.0	-	-	-	0.7	1.7	-
Pseudognaphalium luteoalbum,	NT	-	-	-	0.7	7.0	2.0	0.3	-	-
Riccia cavernosa,	†	-	-	-	-	-	-	-	14.3	0.3
Total % cover of native species		0.0	0.5	30.0	20.3	7.0	5.7	26.7	48.8	13.3
Total number of native species		0	1	4	3	1	2	8	7	5
Total number of threatened species		0	0	0	0	0	0	2	1	2

*Threat ranking, from most to least threatened: Nationally Critical (NC), Nationally Endangered (NE), Nationally Vulnerable (NV), Declining (D), Naturally Uncommon (NU), Not Threatened (NT), Introduced and Naturalised (I/N).
† Threat status not published.

4.6 Objective 6: Facilitate research by various agencies, including universities, to improve our understanding of the ecology of braided river systems

In 2016, PRR determined that funding should be used to facilitate research by University students or other researchers into relevant management issues associated with braided rivers and wetlands. To support decisions on how best to use this research fund, PRR staff are working towards developing a database of research ideas in collaboration with Richard Maloney, the DOC technical advisor for braided riverbeds. This will be a working document of approximately 50 projects which align with PRR's six strategic goals and investigate relevant management issues associated with braided rivers and wetlands or the ecology of their fauna and flora. Projects will be prioritised, allowing PRR to easily determine the most critical research to be conducted which can then be advertised to universities and independent researchers. They will vary in size and required expertise to target a range of different research levels (undergraduate through to post-doctoral).

Last year, PRR contributed to costs of one ongoing project. Student Katie Gray started a GPS tracking study of the movements and breeding ecology of tarapirohe/black-fronted tern and pohowera/banded dotterel (Figure 21). Some interesting data came out of the first season with evidence that the partners of nesting tarapirohe often roost for the night many kilometres away from the nesting colony (Figure 21). This potentially

has implications for increasing the spread of predator control in the future. PRR will completely fund this research for the next season.

Figure 21. Left: GPS transmitter attached to an adult tarapirohe/black-fronted tern for research on the species movements. Right: Locations of activity from an adult tern from the Tekapo River. Photo: Katie Gray.

5 Project River Recovery's relationship with the Te Manahuna Aoraki Project

November 2018 saw the official launch of the Te Manahuna Aoraki (TMA) Project – a landscape scale conservation project focusing on restoring the natural landscapes and threatened species of the upper Mackenzie Basin and Aoraki/Mt Cook National Park. The project will enhance biodiversity across 310,000 ha of land including braided river systems and alpine habitats. As such, there is some overlap with PRR on the rivers, wetlands, and lakeshores in the project area from the Ben Ōhau Range in the West to the Two Thumb Range in the East. This includes some of our major lakes and rivers including Lakes Pūkaki and Tekapō and the Tasman, Cass, Godley and Macaulay Rivers and Fork Stream. PRR continues to work in collaboration with TMA to gain ecosystem knowledge in overlapping areas. This year, PRR ranger Sam Turner supported TMA with conducting lizard surveys at the Upper Cass and Round Hill sites in February and March 2023.

6 Project River Recovery's financial support for the Kakī programme

Traditionally kakī have not been part of the PRR programme; however, over recent years, PRR has become more involved by funding the operational cost of the Tasman Predator Control programme which was fundamentally driven by the need to secure and increase the kakī population. Results of the Tasman Predator Control programme is reported in the PRR Annual Reports. Kakī are seen as the flagship species for the protection and recovery of braided rivers in the Mackenzie Basin and if kakī are increasing in the wild, this reflects better survival of other populations of braided river bird, lizard, and invertebrate species.

In 2017, following consultation with Meridian and Genesis, PRR contributed $60,000 from its Trust Account towards the construction of a new kakī brooder facility. The new eight bay brooder facility was built to remove the current bottleneck in brooder facilities by doubling the brooder capacity and maximising the production of chicks to fully utilise the capacity of the new aviary. This new facility has been key to improved efficiency in the whole captive breeding programme. A total of 152 chicks were hatched this season from eggs gathered from wild breeding pairs or laid in captivity.

7 Project River Recovery's financial statements 1st July 2022 – 30th June 2023

Project River Recovery spent $656,060 in the 2022-2023 financial year. PRR's revenue and expenditure for the 2022-2023 financial year is itemised in Table 5.

Table 5. Project River Recovery statement of financial performance for year ending 30th June 2023.

	2023 ($k)	2022 ($k)	2021 ($k)	2020 ($k)	2019 ($k)	2018 ($k)	2017 ($k)	2016 ($k)	2015 ($k)	2014 ($k)	2013 ($k)	2012 ($k)	2011 ($k)	2010 ($k)
REVENUE														
Stakeholder Transfers from revenue in advance	656	588	465	554	544	539	513	528	495	516	492	499	485	472
Other revenue		0	16	0	0	0	0	0	10	18	37	0	0	0
TOTAL REVENUE	655	588	481	554	544	539	513	528	505	534	529	499	485	472
EXPENDITURE														
Personnel costs														
Salaries	132	139	104	113	83	44	80	125	117	138	138	140	129	119
Wages	33	37	13	57	15	50	51	48	39	3	0	2	1	12
Other Personnel	3	3	0	0	0	0	0	-3	0	1	0	-3	-2	6
Total personnel costs	168	179	117	170	98	93	132	170	156	141	138	139	128	137
Administration costs														
Accommodation	0	20	0	20	20	22	20	20	27	27	27	27	26	26
Total administration costs	0	20	0	20	20	22	20	20	27	27	27	27	26	26
Operating costs														
Professional fees/contracts	0	7	32	5	8	5	1	11	1	6	5	1	9	2
Travel	1	0	2	2	1	3	1	1	3	2	1	1	1	7
Vehicle expenses	2	28	4	36	34	35	36	36	35	39	40	41	42	38
Field operations	480	351	325	319	382	371	321	289	281	316	306	278	273	260
Information and publicity	0	3	1	2	1	1	2	1	2	1	2	1	4	6
Grants and miscellaneous	5	0	0	0	0	8	0	1	0	3	10	11	2	3
Total operating costs	488	390	364	363	426	424	361	338	322	367	364	333	331	316
TOTAL EXPENDITURE	656	588	481	554	544	539	513	528	505	535	529	499	485	479
NET SURPLUS (DEFICIT)	0	0	0	0	0	0	0	-1	0	-1	0	0	0	-7

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