PROJECT RIVER RECOVERY INTERNAL REPORT 2024/01

Godley Delta River Braids. Photo: Dave Murray

Project River Recovery Annual Report

01 July 2023 to 30 June 2024

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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 2023 to 30th of June 2024.
- 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 $70,000 of contractor spraying - mainly of Russell lupins - in the lower Tasman River and lower Fork Stream. Most of the Tasman River Russell lupin control was done by aerial spot spraying as this is an efficient control method over large areas and can target late germination. 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 alder, and willow control around Lake Poaka; and just over $25,000 of aerial control of willows in the Ahuriri River. PRR also contributed $55,000 to ongoing joint weed control programmes with Environment Canterbury and LINZ in the Tekapō and Dobson Rivers.
- This year was the twentieth year of trapping for the Tasman River Predator Control Project, a joint programme between TMA, PRR and the Department of Conservation's (DOC) kakī management programme.
    - For consistency with previous reporting, trapping data is recorded from March to February each year. Over the year, 73 Cats, 34 ferrets, 492 hedgehogs, 17 mice, 61 possums, 63 rabbits, 28 rats, 421 stoats and 67 weasels were caught. An additional 10 cats were located and destroyed over ten nights of spotlighting.
    - The annual Tasman River walk-through bird survey took place in November. No outcome monitoring of black-fronted terns occurred due to staff constraints.
- The programme of intensive predator trapping around the black-fronted tern colony in the upper Ōhau River continued for the fifteenth year (the seventh year since trapping was reduced from a 1 km radius).
    - For consistency with previous reporting, trapping data is recorded from March to February each year. Over the year, a total of 59 cats, 135 ferrets, 129 hedgehogs, 47 Norway rats, 15 possums, 26 stoats, and 7 weasels were caught in kill traps.
    - This year was the most successful breeding season since the trap network reduced with no predators detected on Tern Island. It's estimated that a minimum colony size of 600 adult black-fronted terns/tarapirohe returned to the island for breeding this year. A total of 365 nest attempts (693 eggs) were monitored and hatching success was high with 75% of nests hatching at least one chick. A range of 127-277 chicks were estimated to have fledged. A total of 52 chicks were flag banded.
    - An additional 20 nests (37 eggs) were monitored in two smaller mainland colonies. Hatching success was low with 36% and no chicks survived to fledge due to feral cat predation.
- Walk-through river bird surveys were completed on the Hopkins/Te Awa Aruhe, Pūkaki, Cass/Te Awa-a-Takatamira, Upper and Lower Ōhau Rivers. This year was the final of three years of surveys for the Hopkins River, and the first of three years in the remaining rivers.
- Ongoing threatened fish (galaxiid) monitoring, checking and/or trout and kōaro removal was carried out in trout barrier protected sites in Fraser Stream, Waterwheel wetland, Corbies Creek, un-named spring on Omarama Station (Ahuriri River), Cabbage Tree Gully and Nessing Stream spring.
- Annual population monitoring of robust grasshoppers was conducted across six key populations for the 7th year as part of a long-term study to better understand population trends.

- Robust grasshopper distribution surveys were conducted in the Pūkaki River for the second year, and in the Snowy River for the first time as part of a study to understand how distribution has changed over time.
- A project aimed at determining if standard rabbit-proof fences act as effective hedgehog barriers 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.
- Research into the conservation requirements of *Lepidium solandri* continued this year, with both seed and cage trails starting, and monitoring of populations continuing for its 4th year.
- Wetland management has included weed control and water-level manipulation at Waterwheel and Ruataniwha wetlands. PRR's focus is to benefit threatened ephemeral plants that occur in these habitats.
- PRR supported an MSc research project that used GPS transmitters to reveal movements of black-fronted tern/tarapirohe and banded dotterels/pohowera in the Mackenzie Basin.
- PRR spent $647,000 in the 2023-24 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 Basin which recognised the adverse impacts of hydroelectric power development on braided river and wetland ecosystems. A key focus of the programme over its 33 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 2023 to 30th of June 2024.

2 Staff

Dean Nelson continues to manage the project as Senior Ranger for Biodiversity and PRR.

Samantha Turner and Jennifer Schori continue their roles as PRR Biodiversity Rangers, leading the project's biodiversity work for lizards, birds and invertebrates.

Tom Goodman continues his role testing novel landscape-scale hedgehog control tools and developing best practice methodology for hedgehog control.

PRR utilises the DOC weed team of Connor Hines, Leon Meewezen and Brent Mander to control key weeds that occur that occur outside of the Te Manahuna Aoraki Project core operational area (see page 36).

Tayla Hooker, DOC Twizel's Biodiversity Ranger, leads PRR's threatened plant work this year, and supported several of PRR's biodiversity surveys.

DOC threats ranger, Glen Currall, and volunteers serviced half of the kill trap lines in the Tasman Valley. Mainland Vector serviced the rest. The 10-day period of leg-hold trapping was undertaken by Ecological Contracting Services Ltd.

Glen also delivered cat control in the Upper Ōhau River while predator control traps and bait stations were serviced by Mainland Vector this year.

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 spanned 2012 to 2019 (Rebergen & Woolmore, 2015), and PRR is currently working to an interim strategic plan (Nelson, Maloney & Gale, 2020) prepared to lead the project through until the expiry of the current mitigation agreement (June 2025) with Meridian and Genesis.

A new mitigation agreement between Meridian, Genesis and DOC has been created as part of the power companies' re-consenting process. DOC are currently working with our Treaty Partner and the two Energy Companies to prepare a Strategic Plan for the new agreement. The new mitigation agreement takes effects July 2025.

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

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.

Tasman River and Fork Stream weed control

As a result of several years of additional funding from Land Information New Zealand (LINZ), the Te Manahuna Aoraki (TMA) Project 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, for the last couple of years, due to TMA changing priorities for its spending, PRR has picked some of the work back up, particularly spraying Russell lupins in the Tasman River and lower Fork Stream.

Due to the scattered nature of Russell lupins, new areas of germination that occur following flooding, and the late germination of some lupins, most of the spraying was done aerially this season as this was considered a more efficient way to cover the large areas of riverbed involved. Consequently, over $67,000 was spent on aerial spot spraying, however this aerial coverage allowed the identification of several new areas of Russell lupin infestation. One was in the lower reaches of Black Birch Stream which appears to come from a small seed source near the Red Tarns Track and may have been exacerbated by heavy machinery working in the streambed on flood protection work.

The other site was an island in the Hooker River above the Tasman Valley Road bridge which due to it being away from any tracks or roads, hadn't been noticed previously. This infestation had become a source of seed for the lower Hooker River where there hadn't been any Russell lupins observed previously.

PRR and ECan continue to joint fund an integrated weed-control programme in a portion of the Takapō River targeting gorse, broom, Russell lupin and willows. ECan contractors carry out this weed control work and this season, PRR's contribution was $35,000 as per the agreed contract.

Pine control at Simons Pass

Project River Recovery has been working towards clearing pines from an area of high value lizard habitat on the edge of the Pūkaki River. Lizard species known to be present in this area include two Nationally Vulnerable species; the Mackenzie skink (*Oligosoma prasinum*) and the scree skink (*Oligosoma waimatense*). PRR, with support from the wider Twizel DOC team and other agencies, have been manually removing pines to ensure minimal damage to the habitat which is sensitive to disturbance (Figure 1. Before (left) and after (right) wilding pine control at Simons Pass Conservation Area.Figure 1).

Figure 1. Before (left) and after (right) wilding pine control at Simons Pass Conservation Area.

Other weed control

Additionally, PRR continued its ongoing programme of weed control in other areas including removal of all vegetation from Tern Island using a drone spray unit (to benefit nesting black-fronted terns); ongoing alder and willow control around Lake Poaka; broom, gorse, willow and Russell lupin control on the shore of Lake Ōhau; as well as just over $25,000 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.

PRR contributed $20,000 to the 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 (such as raspberry, gooseberry, currant, and flowering cherry). The project outcomes align well with PRR's weed management objectives which include removing priority weeds from Mackenzie Basin rivers, eradicating Russell lupins from the Hopkins Valley, and improving wetlands through willow control. LINZ and the Glen Lyon lease also contribute funding to this project.

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 Project

The Tasman River 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) Project partnership who have extended trap lines throughout the area.

Predator control

The 2023-24 season was the twentieth year of operation at the site, with a total of 499 DOC-150s, 252 DOC-250s, 298 Conibear traps, and 75 Timms traps run by PRR. PRR's trapping network is supplemented by an additional 512 DOC-150s and 197 DOC-250s that are run and maintained by Aoraki volunteers and the TMA Project (**Error! Reference source not found.**). For consistency with previous reporting, the trapping data is reported between 1 March 2023 and 29 February 2024. Over this period, the trapping network removed 492 hedgehogs (*Erinaceus europaeus occidentalis*), 63 rabbits (*Oryctolagus cuniculus*), 421 stoats (*Mustela erminea*), 73 cats (*Felis catus*), 67 weasels (*M. nivalis vulgaris*), 34 ferrets (*M. furo*), 28 rats (*Rattus* spp.), 17 mice (*Mus musculus*) and 61 possums (*Trichosurus vulpecula*) from the 1,833 traps in the Tasman Valley and side

valleys. An additional ten cats were located and destroyed over 10 nights of spotlighting during June to August.

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 work shows its value by catching 31 cats, 24 stoats, 24 possums and 12 hedgehogs. Interestingly, following very successful pindone and 1080 rabbit control operations in recent years on the Tasman riverbed and flats around the Aoraki airport, very few cats were caught in this area. The fence beside the road to Aoraki Mount Cook (SH80) has been completely rabbit netted and ongoing night shooting in the poisoned areas has kept rabbits to low levels. Rabbit numbers tend to drive cat numbers so ongoing rabbit control which PRR will support in these areas will hopefully keep numbers of this top predator low in the key breeding sites for riverbed birds.

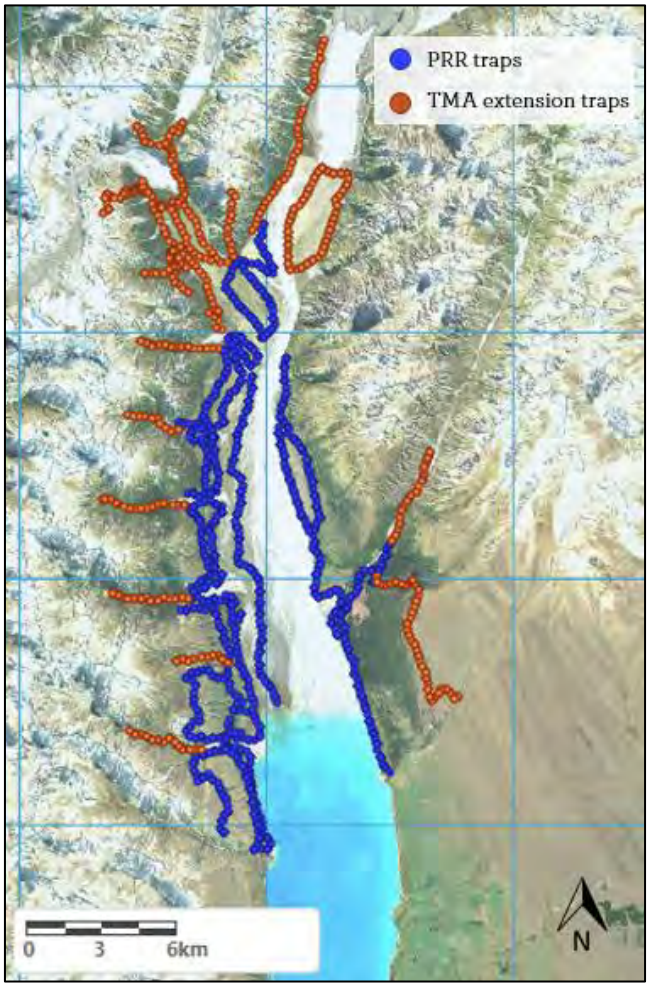

Figure 2. The trapping network in the Tasman Valley consists of traps managed by Project River Recovery (PRR; *n* = 1,124 traps) and the Te Manahuna Aoraki Project (TMA; *n* = 709).

Outcome Monitoring

Outcome monitoring this season consisted of the annual braided river bird survey. Monitoring of nesting outcomes for birds in the Tasman River was not conducted this year due to staff capacity shortages.

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 organises and provides staff for the survey. The results for this season's survey conducted in November are compared with previous seasons in Table 1ble 1.

Table 1. Results of river bird surveys on the Tasman River between 1992 and 2023. Results from the three-year cycle from 1992 to 1994 and the first 11 years following commencement of the Tasman predator control project (2004-2014) are averaged, as is the 5-year period between 2017 and 2021. Results from the current 2023 season are highlighted in bold.

Species, threat ranking*		1992-1994 (range)	2004-2014 (range)	2017-2021 (range)	'22	**'23**
Banded dotterel/tūturiwhatu,	NV	565 (523-599)	658 (395-858)	721 (568-946)	729	**785**
Black stilt/kakī,	NC	2 (1-5)	11 (2-32)	8 (2 -17)	11	**23**
Black-backed gull/karoro,	NT	585 (537-609)	240 (95-413)	51 (29 – 64)	51	**13**
Black-billed gull/tarāpuka,	NC	13 (7-25)	25 (5-113)	129 (60 – 218)	226	**505**
Black-fronted tern/tarapirohe,	NE	121 (79-175)	137 (47-217)	388 (192 -648)	539	**598**
Caspian tern/taranui,	NV	2 (2-2)	1 (0-3)	2 (0 – 3)	5	**2**
Hybrid stilt,	n/a	4 (1-9)	4 (0-10)	1 (0 – 4)	0	**6**
Pied stilt/poaka,	NT	17 (12-21	11 (0-54)	5 (1 – 8)	7	**2**
South Island pied oystercatcher/tōrea,	D	60 (46-76)	72 (52-109)	89 (62 – 123)	108	**128**
Spurwing plover,	NT	19 (17-23)	20 (5-37)	15 (6 – 25)	16	**19**
Swamp harrier/kāhu,	NT	5 (0-11)	3 (1-3)	3 (0 – 9)	3	**1**
Waterfowl and shags,	n/a	366 (334-407)	406 (177-842)	286 (154 – 494)	249	**269**
White-faced heron/matuku,	NT	2 (1-2)	1 (0-3)	2 (0 – 7)	5	**1**
Wrybill/ngutu pare,	NV	133 (120-151)	110 (32-165)	147 (122 – 207)	192	**129**

*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

The black-fronted tern/tarapirohe is a small, Nationally Endangered tern species endemic to New Zealand (Robertson et al., 2021). Recent population estimates indicate there are only 10,000 birds currently in existence. They spend most of their life at the shoreline but move inland each spring to nest in colonies on the braided rivers of the eastern and southern South Island. The Ōhau River is one of the many braided rivers in the Upper Waitaki Basin that support breeding colonies of black-fronted tern/tarapirohe during the summer months. At their nesting sites, they are threatened by a complex variety of interacting threats including introduced mammalian and native avian predators (Keedwell, 2005; Keedwell et al., 2002), and weed encroachment (Schlesselmann, 2018) and seasonal flooding (Cruz et al., 2013) of their nesting sites.

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 started with the installation of an intensive predator kill trap grid spanning a 1km radius around the tern colony located at its core. This "ring of steel" was supplemented with poison control targeting Norway rats (*Rattus norvegicus*). Rabbits (*Oryctolagus cuniculus cuniculus*) were also controlled within a 1.2km radius of the island using a combination of night shooting and patch poisoning. In 2016, a review of the project recommended scaling down the management approach to test if high levels of black-fronted tern/tarapirohe breeding success could be maintained at reduced operational costs (Maloney, 2016). The control area decreased to c. 500m radius around the colony, and the total number of traps and frequency of trap checks were reduced. Rabbit night shooting was discontinued due to establishment of vegetation making shooting very difficult.

The 2023-24 season marks the fifteenth year of predator control operations in the upper Ōhau River. The kill trap network has been added to this season with the addition of a line around the upper shoreline of Lake Ruataniwha (originally serviced by Meridian staff) and some more traps to fill the gap between this lakeshore line and the existing network. Traps currently include 263 DOC-150s, 170 DOC-250s, 65 Twizel cat traps, 20 F-bomb traps, 19 modified Timms traps, and 18 Trapinator traps (for targeted possum control; Figure 3). Much more emphasis has been placed on targeting Norway rats around the island as there has been strong evidence over the last few seasons (from detection by dogs and trail cameras) that Norway rats are a significant problem as they are easily able to swim to the island.

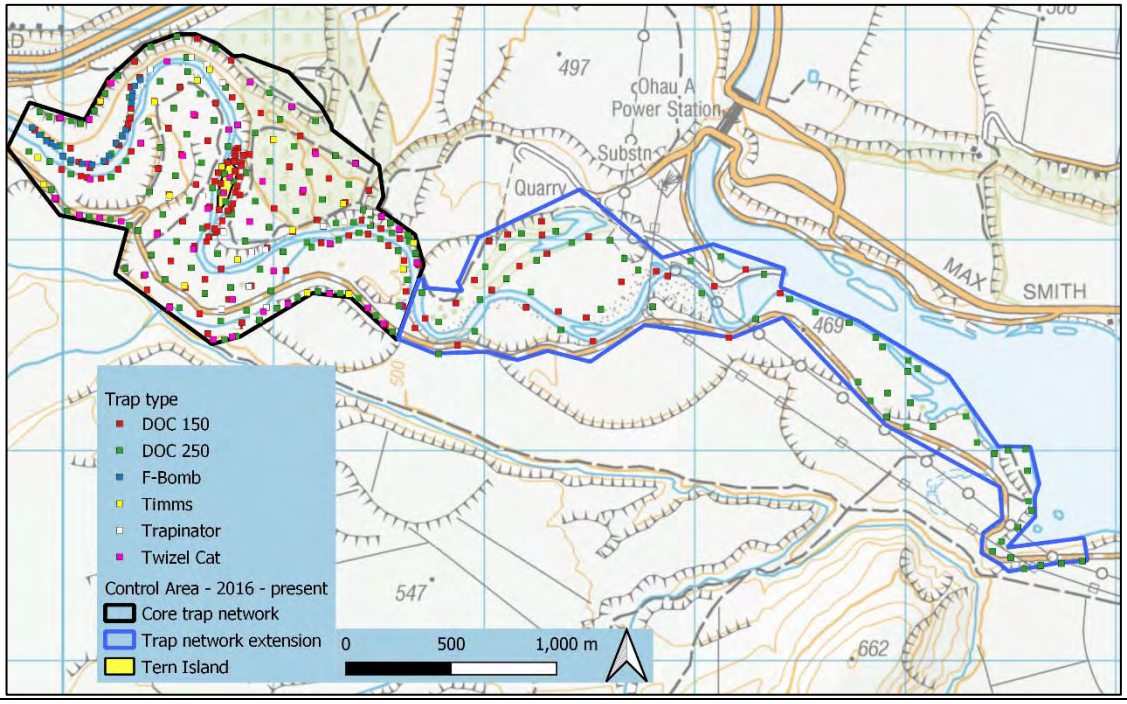

Figure 3. The current network of kill traps (*n*=475) in the Upper Ōhau River to target mammalian predators for the protection of a nesting colony of Nationally Endangered tarapirohe/black fronted terns.

Traps were checked weekly to fortnightly during the tern breeding season (October 2023 until mid-February 2024) 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 during black-fronted tern/tarapirohe nesting to avoid catching their chicks. During the trapping period from 1 March 2023 to 29 February 2024, 129 hedgehogs, 124 rabbits, 135 ferrets, 59 cats, 47 Norway rats, 15 possums, 26 stoats, and 7 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 153 bait stations on 21st August (Figure 4). The stations were checked weekly, and a supply maintained through to late-February when terns had left the colony.

Tern Island was sprayed for weeds by High Country contracting using drones for the first time in April 2024 (Figure 5).

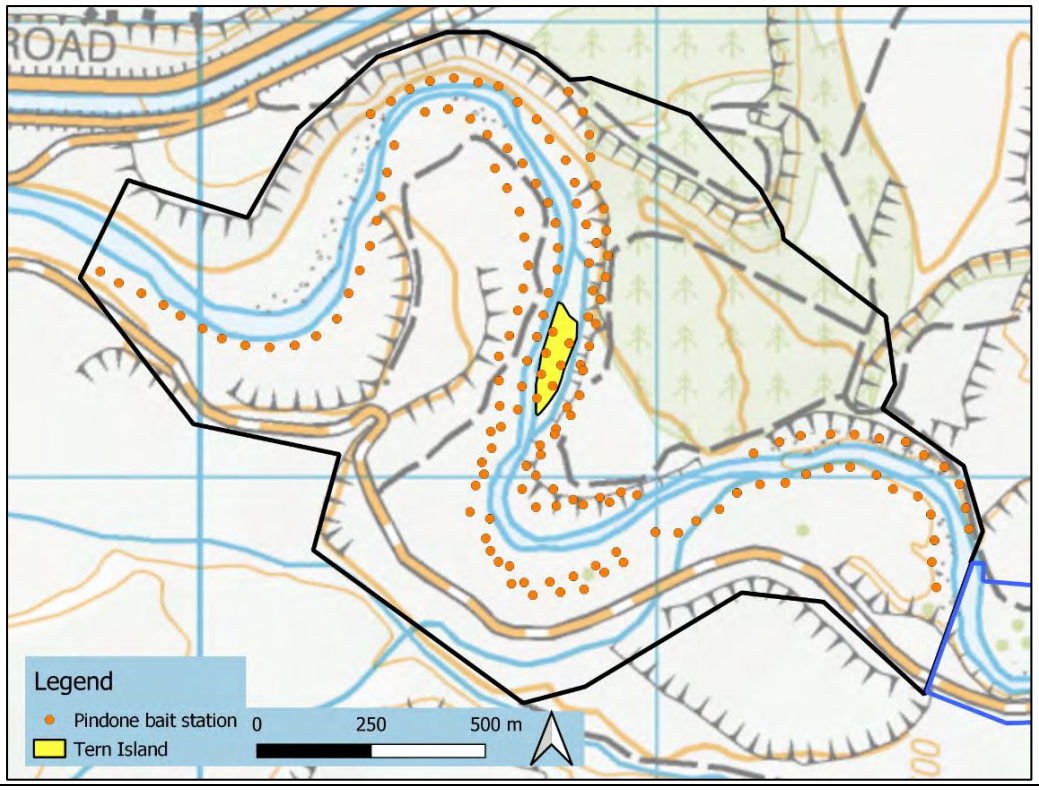

Figure 4. The current network of pindone bait stations (*n*=158) in the Upper Ōhau River to target Norway rats for the protection of a nesting colony of Nationally Endangered tarapirohe/black fronted terns.

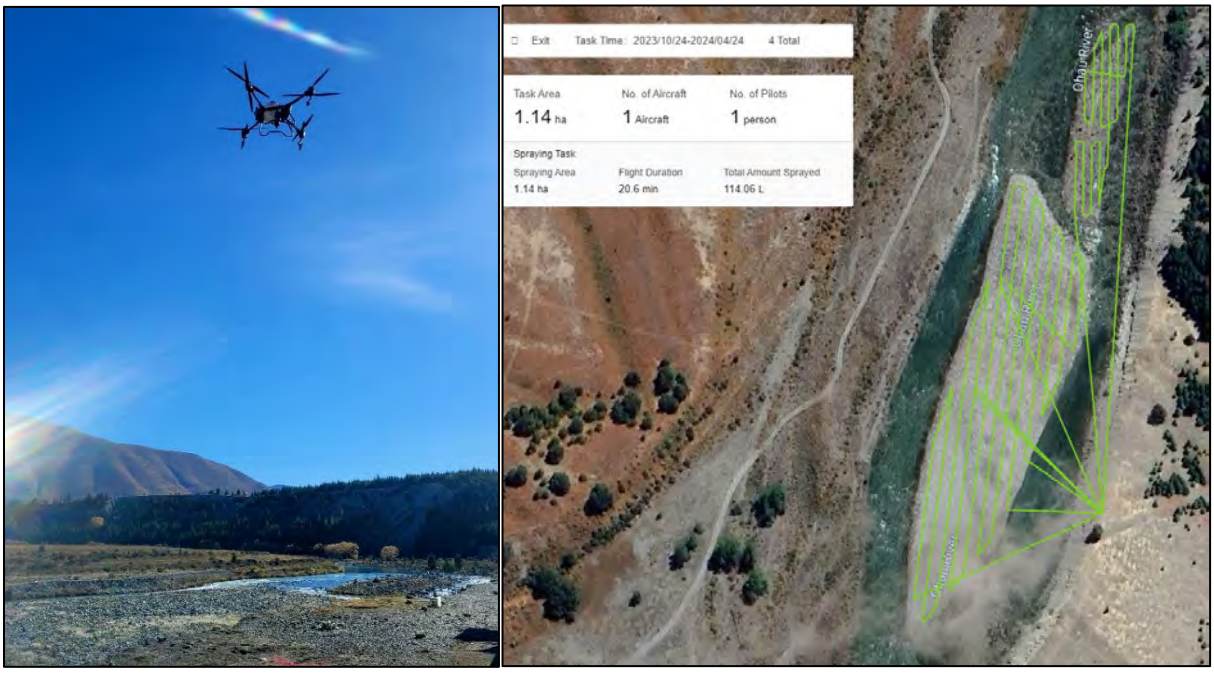

Figure 5. Tern Island weed control spray drone in action in April 2024 (left), and the drone's flight path covering 1.14 ha on Tern Island and the island immediately upstream (right).

Black-fronted tern/ tarapirohe monitoring

This was the eighth season of nest monitoring on Tern Island since the trapping network was scaled down in 2016, and the 20th year overall (Turner et al., 2024c). Monitoring was carried out by two PRR rangers visiting Tern Island once a week. Colony size was estimated by doubling the maximum number of active nests per nest check after the season. Nest monitoring involved thorough systematic searches of the island where observers walked the island (downstream to upstream) to find new nests and monitor each nest status from eggs until hatching. Nests with guano present were considered as hatched. Eight trail cameras also monitored active nests with eggs for predator surveillance and nest outcome.

Estimated colony size peaked in early November with 590 adult terns (295 active nests). By the end of November, the island was full of crèching chicks and by mid-December most eggs had hatched. A second smaller colony of 30 terns began nesting upstream on the true right mainland (about 400m from Tern Island) and a smaller 10 tern colony nested on the mainland adjacent to the island (Figure 6).

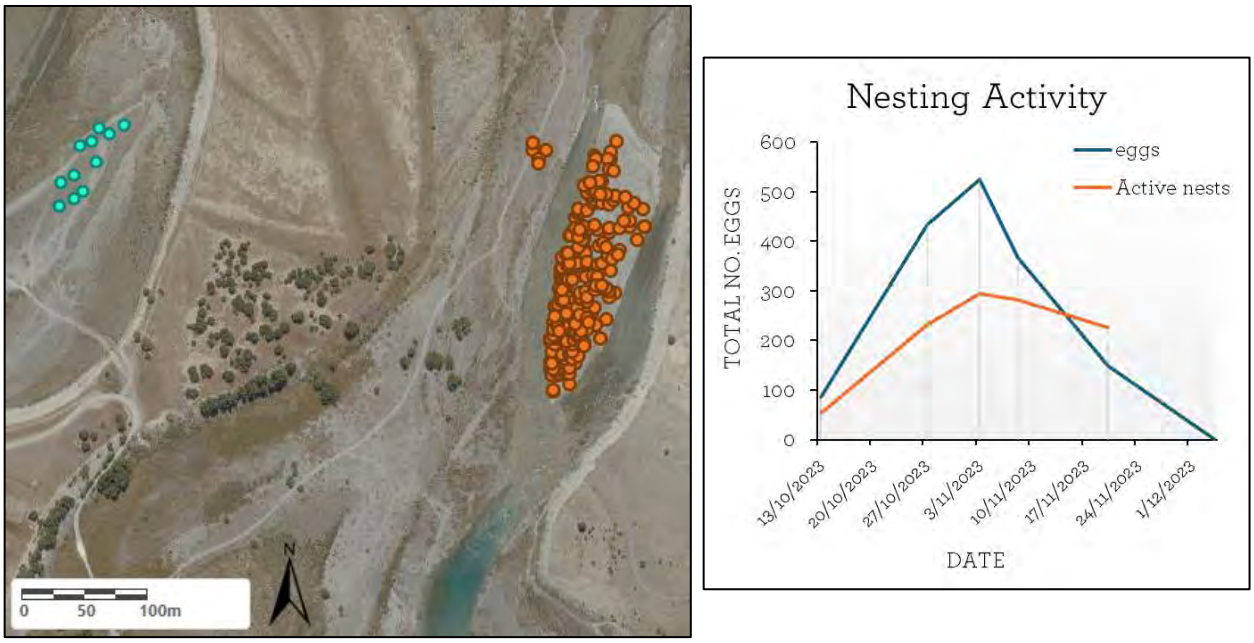

Figure 6. Black-fronted tern nest locations during the 2023-24 season including the upstream mainland colony (15 nests, blue circles), the true right mainland colony (5 nests, orange circles) and Tern Island (365 nests, orange circles; left). Total eggs and number of active nests during each nest check from October to December 2023 (right).

A total of 365 nests with 693 eggs were monitored on Tern Island this season. Hatching success of nests with known outcomes (n = 220) was 75%, the highest hatching success over the last eight years (Figure 7). This was the fourth season in a row where chicks fledged. The estimated number of chicks fledged ranges from 127 to 277. During a visual count of chicks and fledglings on Tern Island in mid-December 2023, PRR rangers counted 78 fledglings, 3 of which were banded. This count was conducted after the additional chicks were banded, indicating high fledgling success.

An additional 20 nests (37 eggs) were monitored on the true right in the two smaller mainland colonies. Hatching success of the upstream colony was 36%, however no chicks survived to fledge due to cat predation (camera evidence) and possibly hedgehogs. Similarly, the smaller colony close to Tern Island failed with desertion the main cause.

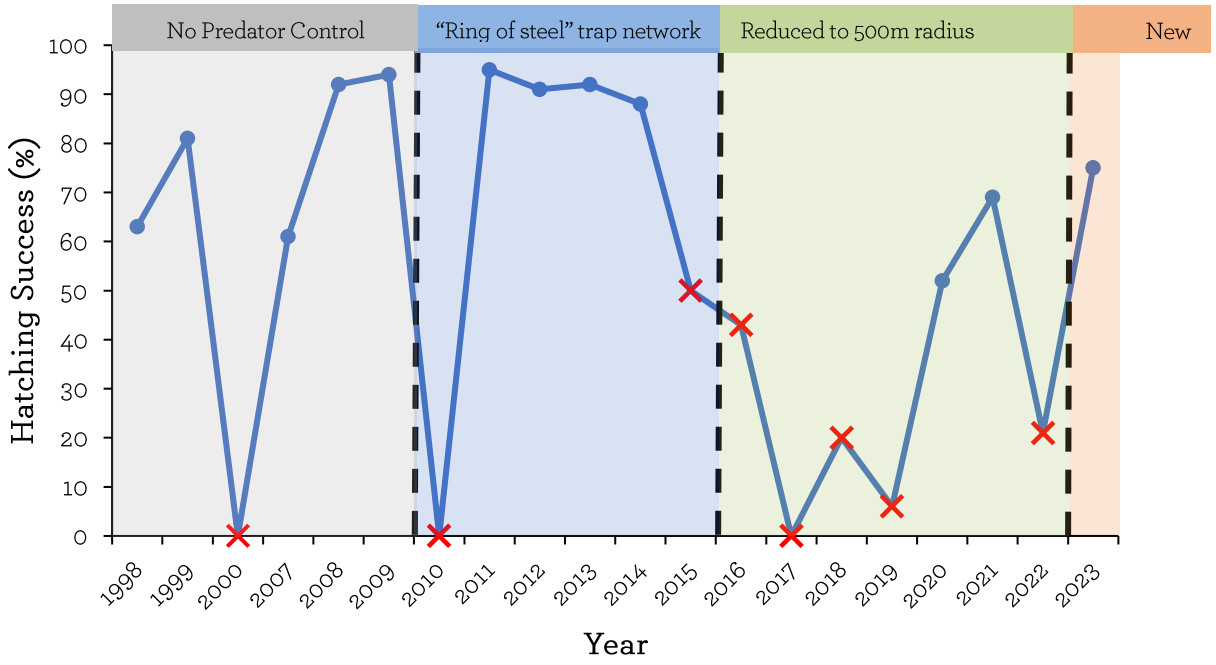

Figure 7. Hatching success of black-fronted terns nesting on Tern Island in the upper Ōhau river from 1998-2023. *Red crosses* indicate when the colony abandoned Tern Island. Before 2010 no predator control was in place (*grey shading*). From 2010 to 2015 an intensive trapping network "Ring of steel" was set up in a 1-km radius of Tern Island (*blue shading*). In 2016 the trap network reduced 500m (*green shading*) and in 2023 additional trap lines were added downstream in the river margin habitat of Norway rats and stoats (*orange shading*). Note that monitoring effort has varied over the years.

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; Figure 8). They were discovered along scree terraces in the Upper Ōhau River in 2013. Population monitoring began in 2016-17 to determine whether the population benefits from predator control established for protection of a nearby black-fronted tern colony (Lettink, 2016; Haultain 2017). It was intended that the monitoring of the lakes skink population at this site would reveal whether predator control benefits this species (Haultain, 2017; PRR, 2022). However, the lakes skink 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 (Turner & Nelson, 2024a).

Figure 8. A lakes skink, *Oligosoma* aff. *chloronoton* "West Otago".

The population is monitored each season using an established line of 41 pitfall traps (spaced approximately 5m apart). Traps were opened during optimal weather windows (>12˚C, no rain) and checked daily for seven days. All captured skinks were given a temporary identification mark using a non-toxic permanent marker which allowed for easy identification of recaptured individuals. We recorded morphological measurements and photographs of key features for each skink. Current research is being undertaken to determine whether natural markings can be used to identify individuals over multiple years.

This year was the eighth year of population monitoring of Lakes skink at the site. A total of 76 Lakes skink captures were made over the trapping period, consisting of 53 unique individuals. and 23 recaptures (of 13 individuals; Figure 9; Table 2). McCann's skinks (*Oligosoma maccanni*; 20 individuals) and six Southern Alps gecko (*Woodworthia "Southern Alps"*) were also caught in the pitfall traps this season.

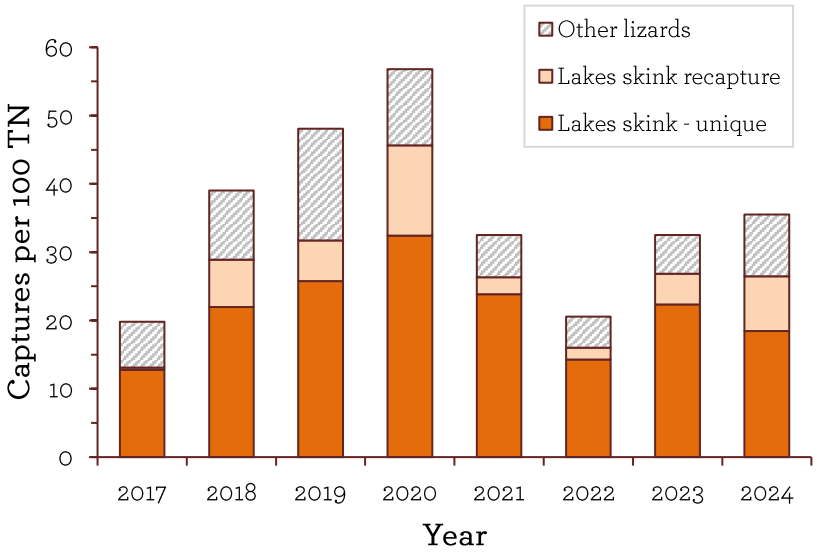

Figure 9. Annual pitfall trap lizard captures per 100 trap nights (TN) at the Upper Ōhau site of unique lakes skinks (*dark orange*), recaptures (*light orange*) and other lizards (*grey stripes*) from 2017 to 2024. Total monitoring days were 7 days except for 2017 (8 days) and 2023 (6 days).

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). An additional four ~one hectare rabbit-proof fences are being monitored for hedgehog incursions and the response of invertebrate communities in the ongoing absence of hedgehogs.

Determining the role of rabbit-proof fences as a barrier to hedgehog movement may (1) provide opportunities to use existing infrastructure to exclude hedgehogs from areas and prevent reinvasion, (2) make low-cost modifications to existing infrastructure to exclude hedgehogs (and potentially other predators) from areas and prevent reinvasion, and (3) create new lower-cost infrastructure to exclude hedgehogs (and potentially other mammalian predators) from high-priority threatened populations or ecosystems. To date, 74 hedgehogs have been removed from four of the larger fenced sites. Elimination at the fifth site, Ben Dhu Scientific Reserve, will begin in late 2024. Trap shy hedgehogs will be targeted with a certified hedgehog detection dog.

Table 2. Summary table of annual monitoring details from lizard pitfall surveys in the Upper Ōhau terrace site from 2017-2024 (DOC-5987394). Lakes = Lakes skink, McC = McCann's skink, SaG = Southern alps gecko.

	2017	2018	2019	2020	2021	2022	2023	**2024**
Total monitoring days	8	7	7	7	7	7	6	**7**
Total trap nights	328	287	287	287	243	287	246	**287**
Max temp(˚C)	17.3	22.7	36.5	37.7	39.6	38.2	48.2	**35.0**
Min temp (˚C)	6.9	8.9	10.2	1.1	4.2	5.4	11.1	**5.4**
Species captured	Lakes McC	Lakes McC SaG	Lakes McC Cryptic /Grass skink	Lakes McC Cryptic skink	Lakes McC SaG	Lakes McC	Lakes McC SaG	**Lakes McC SaG**
Total captures and recaptures: All Lizards	64	114	145	167	79	60	78	**103**
Total unique captures: All Lizards	63	93	121	127	73	54	66	**79**
Total unique captures: Lakes skink	42	63	74	93	58	41	55	**53**
Total recaptures: Lakes skink	1	20	17	38	6	5	11	**23**
Other lizards	21	30	47	34	15	13	14	**26**
Other lizards (per 100TN)	6.4	10.5	16.4	11.8	6.2	4.5	5.7	**9.1**
Lakes skink (recaptures) (per 100TN)	0.3	7.0	5.9	13.2	2.5	1.7	4.5	**8.0**
Lakes skink (recaptures) (%)	2.4 %	31.7 %	23 %	40.9 %	10.3 %	12.2 %	20 %	**43%**

Hedgehog Toxin Trials

Project River Recovery have teamed up with the Department of Conservation Threatened Species Research Workstream (TSRW) and Manaaki Whenua/Landcare Research to develop an approved hedgehog-specific toxin for broadscale use. Alphachloralose has been identified as the most promising candidate amongst trialled existing toxins. The final pen trial is currently underway at Manaaki Whenua's research facility in Lincoln before field trials are conducted in Te Manahuna/the Mackenzie Basin at the beginning of 2025. The goal for the project is to achieve a >80% kill rate of marked hedgehogs to seek a label change of alphachloralose to a formula that targets hedgehogs. Tom Goodman is leading the field aspect of this research and will be catching and fitting VHF tags to 90 hedgehogs (n = 30/site, two treatments and one control site). A positive result for this project will help PRR and other conservation groups around Aotearoa control hedgehogs more effectively.

Robust Grasshopper Predator Exclusion Fence

In 2018, the Te Manahuna Aoraki Project installed a mammal exclusion fence around a portion of the robust grasshopper habitat at Patersons Terrace with the aim of understanding whether excluding mammalian predators results in a population increase relative to unprotected populations (Murray 2022). Although the fence is short, no mammals have been recorded to breech the fence since it was installed. Project River Recovery has supported outcome monitoring for the trial since it began. After observing a large increase in skink numbers inside the fence in 2019-20, DOC Science Advisor, Dr Tara Murray advised evicting skinks from the fenced area to further reduce predation pressure on the robust grasshopper. The first eviction occurred in 2020-21 and removed 348 skinks from inside the fence (Lettink 2021). However, skink neonates were small enough to move relatively freely through the fence's mesh, and skinks re-established inside the

fenced area. To prevent skink reinvasion, the fence required addition of a polyethylene membrane at ground level. This material has been used in other parts of the country to prevent mouse incursions to protected areas. PRR rangers undertook the task of adding the membrane to all 465m of fence in autumn (Figure 10) and will begin evicting skinks next spring. PRR will continue to monitor the robust grasshopper population inside the fence and compare it to unprotected populations outside the fenced area to determine whether excluding both mammals and skinks provides a benefit. This predator fence is one of the few in New Zealand that is dedicated to protecting a threatened invertebrate.

Figure 10. Project River Recovery rangers preparing the existing predator fence for polyethylene membrane installation (top), DOC Twizel back filling soil around the installed membrane (bottom left), the completed membrane installation (bottom right).

Lake Alexandrina Southern Crested Grebe/ pūteketeke

Lake Alexandrina is known as a stronghold for the Nationally Vulnerable Southern crested grebe/pūteketeke (*Podiceps cristatus*; Figure 11). Pūteketeke generally create floating or semi-floating nests made of aquatic

weeds and sticks located around the lake's edge. Since the 20/21 season, a large proportion of the population of pūteketeke on Lake Alexandrina has nested in a short 50 metre section of stream at the lake's outlet. With active nests sometimes only one metre apart in this small area, territorial disputes and breeding displays occur in abundance.

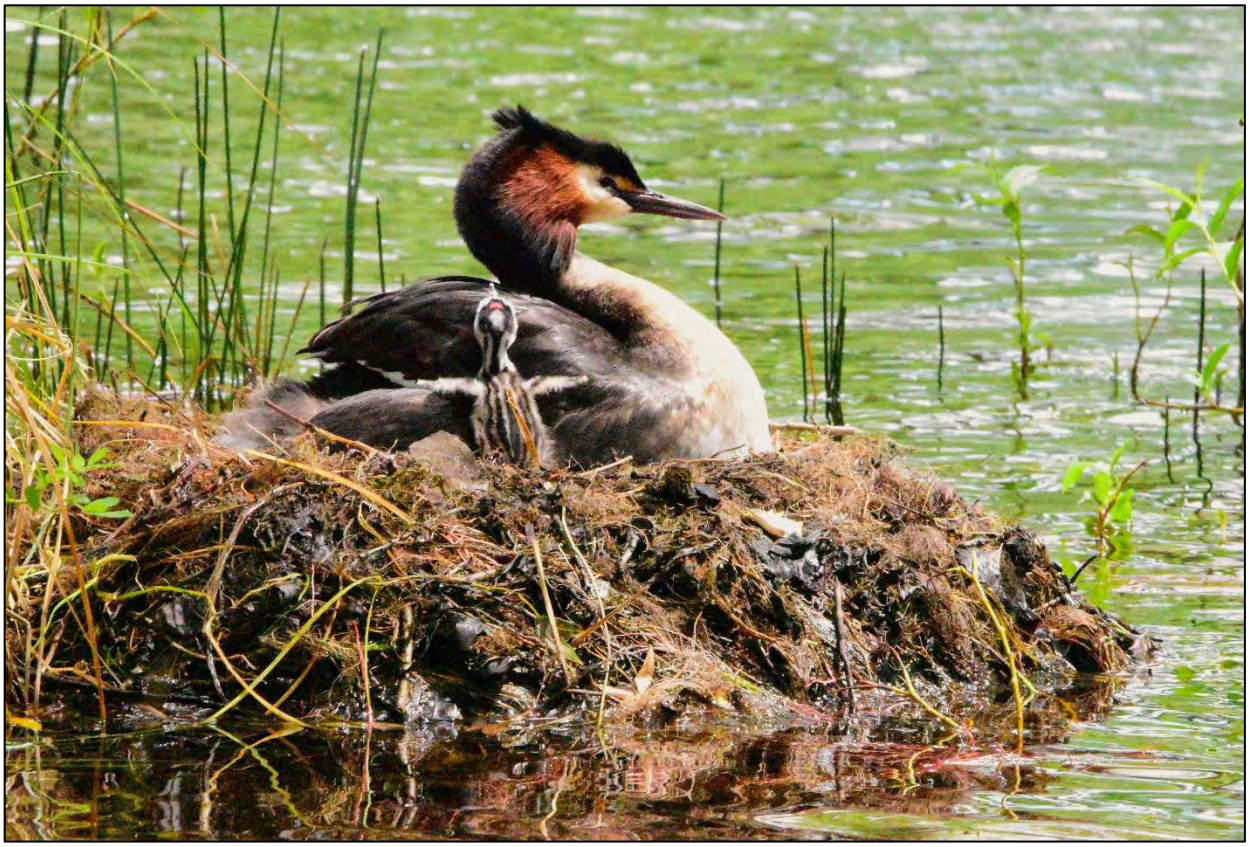

Figure 11. Crested Grebe/ pūteketeke parent with young chick on the nest. Photo: Dean Nelson

PRR supplied the Lake Alexandrina 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.

Following concerns raised by bach owners about high lake levels and flooding due to willow root build-up in the outlet creek, the Mackenzie District Council got a contractor to remove several large willows and dig out their root systems once the pūteketeke breeding season had finished. Some Carex plants have been planted in the affected area to try to create some suitable habitat for pūteketeke to nest in. The work has lowered the water level in the lake and enables pūteketeke to swim under the small footbridge without having to dive. However, the modifications in the streambed have changed the flow slightly and it will be interesting to see if pūteketeke continue to nest there en masse.

Bird of the Century

Pūteketeke was the winner of Forest and Bird's "Bird of the Century" competition in 2023. The win attracted many visitors to the Lake Alexandrina outlet, most of whom were respectful of the nesting birds. Despite the additional attention, 49 active nests were counted on 29th January 2024.

National Census 2024

Forest and Bird coordinate a national pūteketeke census every ten years and on 27th January 2024, four PRR staff contributed to the most recent census by counting pūteketeke on Lake Alexandrina, Lake Ruataniwha

and the Wairepo Arm of Lake Ruataniwha. The Mackenzie Basin and Waitaki hydro lakes along with Central Otago hold the largest populations for this South Island based species. The census indicated that Pūteketeke numbers are increasing. Numbers for each site counted by staff (with 2004 and 2014 numbers in brackets) were: Lake Alexandrina – 142 (13, 93), Lake Ruataniwha – 12 (0, 10) and Wairepo Arm – 47 (6, 14).

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 2024 and PRR gave them practical threatened species management exercises at Patersons Terrace and the Tasman River, including sessions on monitoring technique for invertebrates and trapping for introduced mammalian predators.

Throughout the year, PRR met with various stakeholders including Fish and Game, ECan, various private landholders and volunteer groups and braided river managers from other districts.

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 Tekapo bookstore 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 seeks to better understand river bird distributions in the Upper Waitaki Basin, and how they are changing over time. In the early 1990s, PRR completed surveys of all the upper Waitaki rivers over three years. PRR sequentially re-surveys the rivers over three consecutive years on a rotational basis to record trends of threatened as well as more common braided river birds.

PRR uses standardised walk-through methodology to record counts of native (e.g., 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., black-fronted terns, 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. This season, PRR adopted the "KM survey" method. Each "section" (the current method) was divided into the nearest number of full kilometres to allow a higher resolution of river bird distribution whilst still allowing future data to be compared to past data.

Figure 12. PRR rangers survey the gorge section of the Cass River for braided river birds in November 2023.

This year was the final survey of the 3-year cycle for the Hopkins River (Table 3) and the first survey of the 3-year cycle for the Cass (Figure 12), Ōhau and Pūkaki Rivers (Table 4; Schori et al. 2024a). In the Hopkins River, the total number of species recorded across this cycle was comparable to past survey cycles indicating that species diversity has not substantially changed since surveys began in the 1960s. However, the abundance of some species has declined since the 1960s including banded dotterels/pohowera, black shags/kawau, Canada geese/kuihi, grey ducks/pārera and paradise shelducks/pūtangitangi. Only banded dotterels/pohowera and grey ducks/pārera are threatened and have undergone nation-wide declines. For the other species, the decline appears to be localised to the Hopkins River. Three of the species are dabbling waterfowl which might indicate a change in quality and/or availability of preferred feeding or breeding microhabitats. Conversely, black-backed gulls/karoro have increased in abundance since the 1960s. This species has increased in abundance nationwide in recent decades mostly as a result of land use intensification and increased availability of organic waste associate with human activities (Miskelly 2013).

Table 3. The bird species and number of individuals observed during the 1960s, 1992-93 and the recent cycle (2020, 2021, 2023) of surveys of the Hopkins River/Te Awa Aruhe. For years 1960s and 1992-1993, the minimum and maximum number of birds observed during those surveys are presented. For the recent cycle, the adult bird count is presented for each year. Threat status: *Threatened*, inclusive of Nationally Critical (NC), Nationally Endangered (NE) and Nationally Vulnerable (NV); *At Risk*, inclusive of Declining (D) and Naturally Uncommon (NU); Not Threatened (NT); Introduced and Naturalised (I/N).

Species	Threat status	1962, '65 & 68	1992, '93	2020	2021	2023
Australasian crested grebe/pūteketeke	NV	0-2	0- 1	0	0	0
Australasian shoveler/kuruwhengi	NT	2-13	0- 3	0	0	0
Banded dotterel/pohowera	NV	124-136	1- 63	38	42	58
Black shag/kawau	NU	19-32	0- 3	2	1	4
Black stilt/kakī	NC	1-12	0- 2	4	0	1
Black swan/kakīānau	NT	12-15	0- 22	1	1	0
Black-billed gull/tarāpuka	D	74-107	0- 0	4	7	105
Black-fronted tern/tarapiroe	NE	133-149	1- 21	52	81	84
Canada goose/kuihi	I/N	120-197	0- 175	49	55	0
Caspian tern/taranui	NV	0-1	0- 2	4	2	3
Grey duck/pārera	NV	22-37	0- 22	1	0	0
Grey teal/tētē	NT	0	0- 4	9	0	0
Hybrid stilt	n/a	0-1	0- 1	0	0	0
Indeterminate duck species	n/a	3-8	0- 41	14	6	6
Little shag/kawaupaka	NT	0	0- 1	1	0	0
Mallard/rakiraki	I/N	28-30	0- 3	0	15	2
New Zealand scaup/pāpango	NT	0	0- 4	0	0	2
Paradise shelduck/pūtangitangi	NT	130-373	5- 61	26	25	19
Pied stilt/poaka	NT	12-16	0- 12	3	4	0
South Island pied oystercatcher/tōrea	D	31-79	5- 22	28	48	41
Southern black-backed gull/karoro	NT	57-86	5- 70	284	280	181
Spur-winged plover	NT	0-3	0- 104	72	67	33
Swamp harrier/kāhu	NT	0	0- 5	3	0	0
White-faced heron/matuku	NT	0-2	0	0	1	1
Wrybill/ngutu pare	NV	10-36	0- 54	23	34	28
Total number of species		21	23	19	16	15

Table 4. Braided river bird species recorded in the current round of walkthrough surveys of the Cass, Pūkaki, Upper and Lower Ōhau Rivers compared to the most recent previous round of surveys. Data shows the minimum and maximum number of birds observed during the previous survey rounds.

Species, threat ranking*		Cass River		Pūkaki River		Upper Ōhau River		Lower Ōhau River	
		2013-15	2023	1992-94	2023	2008 /10	2023	2008-10	2023
Australasian crested grebe/pūteketeke	NV	0-2	0	0	0	0-1	0	0	0
Australasian shoveler/kuruwhengi	NT	0	0	0	0	0	0	0-9	0
Banded dotterel/tūturiwhatu	NV	203-412	325	28-60	18	0	7	51-91	14
Black-billed gull/tarāpuka	NC	66-79	415	0-2	0	0	0	0-3	0
Black-fronted tern/tarapirohe	NE	77-201	161	3-43	41	124-125	474	40-108	9
Black shag/kawau	NU	1	3	0-2	0	1-2	0	1-3	0
Black stilt/kakī	NC	0	0	0	0	0	0	0	0
Black swan/kakīānau	NT	0-2	18	0	0	0	0	0	0
Canada goose	I/N	4-21	15	5-20	20	0-2	0	46-86	51
Caspian tern/taranui	NV	0	1	0	0	0-1	1	0-5	0
Grey duck/pārera	NC	0	0	0-2	0	0-2	0	0-9	0
Grey teal/tētē	NT	0	0	0	0	0	0	0	0
Hybrid stilt	n/a	0-1	0	0-1	1	0	0	0	0
Indeterminate duck species	n/a	0-3	1	0	2	0-4	5	0-25	4
Little shag/kawau paka	NT	0-1	0	0	0	0-2	0	0-8	0
Mallard/rakiraki	I/N	0	34	0-2	0	0-16	0	1-10	14
New Zealand scaup/ pāpango	NT	0	0	0	0	0	0	0	0
Paradise shelduck/pūtakitaki	NT	15-37	90	0-3	7	2	16	6-8	0
Pied stilt/poaka	NT	5-17	7	3-11	1	0	0	11-16	0
South Island pied oystercatcher/tōrea	D	0	51	3-4	7	0	0	3-11	1
Southern black-backed gull/karoro	NT	209-234	15	6-50	0	1-3	1	3-32	3
Spur-winged plover	NT	0	46	0-5	2	0	4	1-11	2
Swamp harrier/kāhu	NT	0-4	0	1-19	0	1-4	2	1-5	0
White-faced heron/matuku	NT	0-3	0	0-3	2	0-1	3	5-13	6
Wrybill/ngutu parore	NV	23-36	48	0-1	0	0	0	0	0
Total number of species		**16**	**15**	**16**	**10**	**13**	**9**	**18**	**10**

Black-fronted tern / tarapirohe natal site fidelity study

Project River Recovery seeks to better understand natal site fidelity of black-fronted terns. This is important for understanding whether investment in predator control at one colony can contribute to an increase in total population size for the species. If protected colonies are productive, but their offspring nest elsewhere in unprotected rivers and fail to produce offspring of their own, that indicates that more widespread predator control is required to benefit the species as a whole. PRR began flag banding birds in the Tasman (blue flag/white text), Cass (black flag/white text) and Ōhau Rivers (green flags/white text) in 2018, and continues to band and observe for banded birds at these and other sites. In the 2023-24 season, PRR rangers banded an additional 52 chicks to the 25 that were banded last season in late January (Figure 13).

Figure 13. PRR rangers banding black-fronted tern chicks that hatched from Tern Island in the Ōhau River in late spring/early summer 2023.

Australasian Bittern/matuku hūrepo distribution study (*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. In recent decades, populations of Australasian bittern/matuku hūrepo have steeply declined, primarily because of habitat loss but also due to pressure from predatory mammals and birds. Up to 90% of their wetland habitat in New Zealand has been destroyed, and the remaining wetlands are often of poor quality because of water pollution or reduced food sources. Currently, Australasian bittern/matuku hūrepo are ranked as 'Nationally Critical'.

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. PRR seeks to understand the current distribution of Australasian bitterns in the upper Waitaki Basin by monitoring their occupancy of wetlands during the breeding season. This will inform which wetlands are still providing habitat for bittern and allow us to consider where protection could best be implemented.

During the mating season, male bitterns produce a distinctive 'boom' that is used to attract a mate. This boom can be detected on a sound recordings using specialised software. PRR deploys ARDs (**A**coustic **R**ecording **D**evices) in wetlands in the Upper Waitaki basin during the breeding season to detect where breeding male bitterns were present. In October 2023, PRR deployed 18 ARDs to wetlands and raupō fringed lakes across the upper Waitaki Basin (Figure 14). No bittern were detected this season, however, due to time constraints PRR was unable to deploy the recorders for their second round in December and the booming period may have been missed if it occurred later this season.

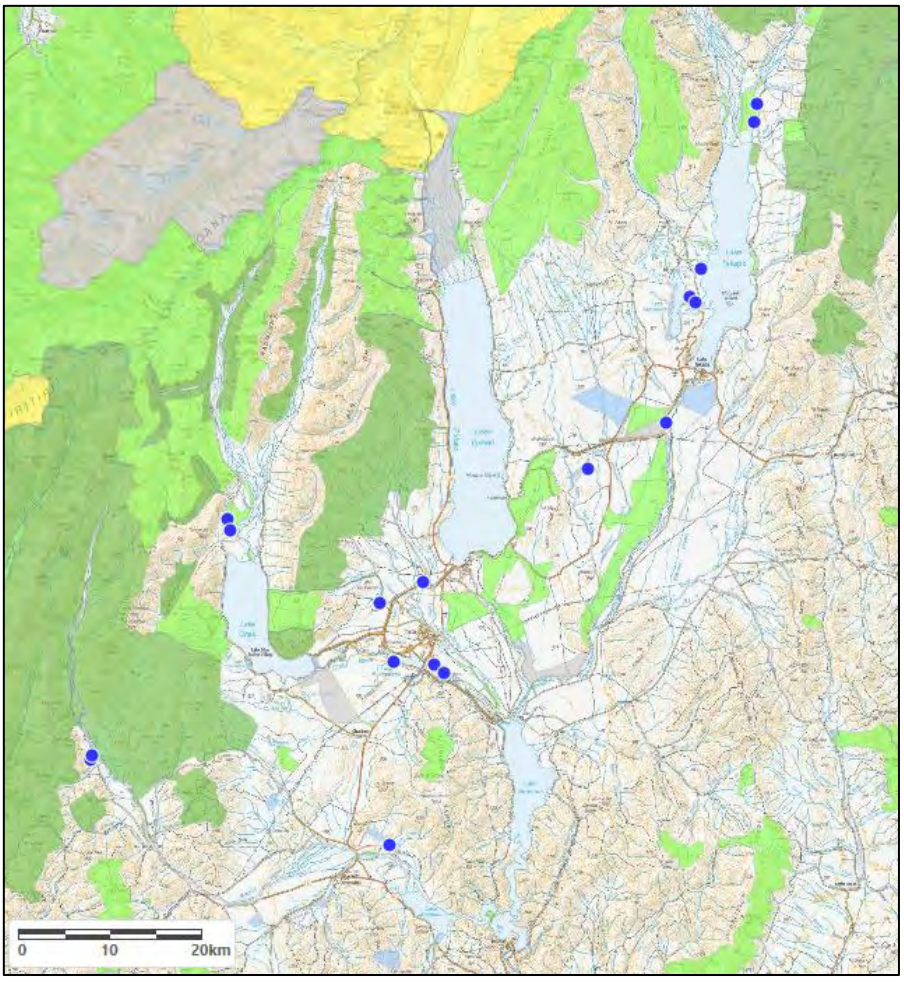

Figure 14. The wetlands where Acoutic Recording Devices were deployed to detect Australasian bittern in October 2023.

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 and maintenance 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., 2024). 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 built trout barriers and monitor two natural waterfall barriers to protect threatened native fish species across the basin (Figure 15).

Figure 15. Monitoring the Waterwheel Wetland spring site with electric fishing machine.

Despite the presence of mostly small trout above the Fraser Stream barrier, (large floods overtop this barrier sometimes enabling trout access) annual monitoring in March found the most lowland longjaw galaxias (316 individuals) and bignose galaxias (646 individuals) ever recorded in 17 years of monitoring at this site. Most of the trout removed were from the last spawning season (40 – 50mm long) and at this size, present little threat to the galaxiids, however one 300mm brown trout was removed which may have been the trout that spawned. eDNA samples collected in June confirmed that all trout had been removed.

The annual monitoring site above a barrier constructed in 2021 in the Waterwheel Wetland springs continues to show the benefit of trout removal with 562 bignose galaxias recorded. A successful application to the

Environment Canterbury's Fish Habitat Fund will enable the construction of a second trout barrier in this valuable site in early 2025.

The Corbies Creek site had a large flood through it in 2022. Since then, lowland longjaw galaxias appeared to have recovered well. However, lower than expected numbers of lowland longjaw galaxias were found when a full survey was undertaken in March 2024, and two brown trout (330 and 98mm) were subsequently removed. Hopefully the lowland longjaw galaxias will now bounce back as eDNA samples collected in June confirmed the absence of trout.

The spring site in Omarama Station continues to hold good numbers of lowland longjaw galaxias with 169 recorded during a full survey in March 2024. This stream is quite hard to electric fish so numbers are likely to be higher than this.

Robust grasshopper (*Sigaus robustus*) population and distribution trend study

The Nationally Endangered robust grasshopper (*Sigaus robustus*) is a braided river specialist, found only on the gravels of riverbeds and their associated terraces in the Mackenzie Basin (White 1994). This large, flightless grasshopper camouflages among the rocks of the braided rivers (Figure 16). It is a generalist herbivore that feeds on lichens, mosses, and other leafy vegetation of the braided riverbeds. PRR seeks to understand the population dynamics of the threatened braided river invertebrate, and how its distribution has changed over time.

Figure 16. A juvenile robust grasshopper at the Pūkaki River during the distribution survey, 2024.

In 2017, PRR began annually monitoring population density at six key populations of robust grasshopper located in the Ōhau River, Forks (incorporating the gravel pits and military land), Patersons Terrace, Pūkaki River, Snowy River, and Takapō River. Population density monitoring occurs each spring and focusses on monitoring the breeding population, recording only large adult females (Schori et al. 2024b). Some intriguing trends have been revealed in the first six years of monitoring: Large fluctuations of adult females occur in the densest populations, namely Forks and Patersons Terrace. In the smaller populations fluctuations are dampened. Almost consistently a total of 1 or 2 females are seen each year in surveys of the Takapō, Ōhau and Pūkaki Rivers. The past four years of surveys at Forks and Patersons Terrace show a biennial cycle emerging, with every second year being a 'good' year, and the in between years being 'poor' (Figure 17). Such a cycle might be expected when considering the 2-year life cycle of the species (in which individuals reach maturity in their second and final summer) but does not align with the observed trends pre-2019. Continued monitoring will be important for understanding the long-term population trends of the robust grasshopper at these sites.

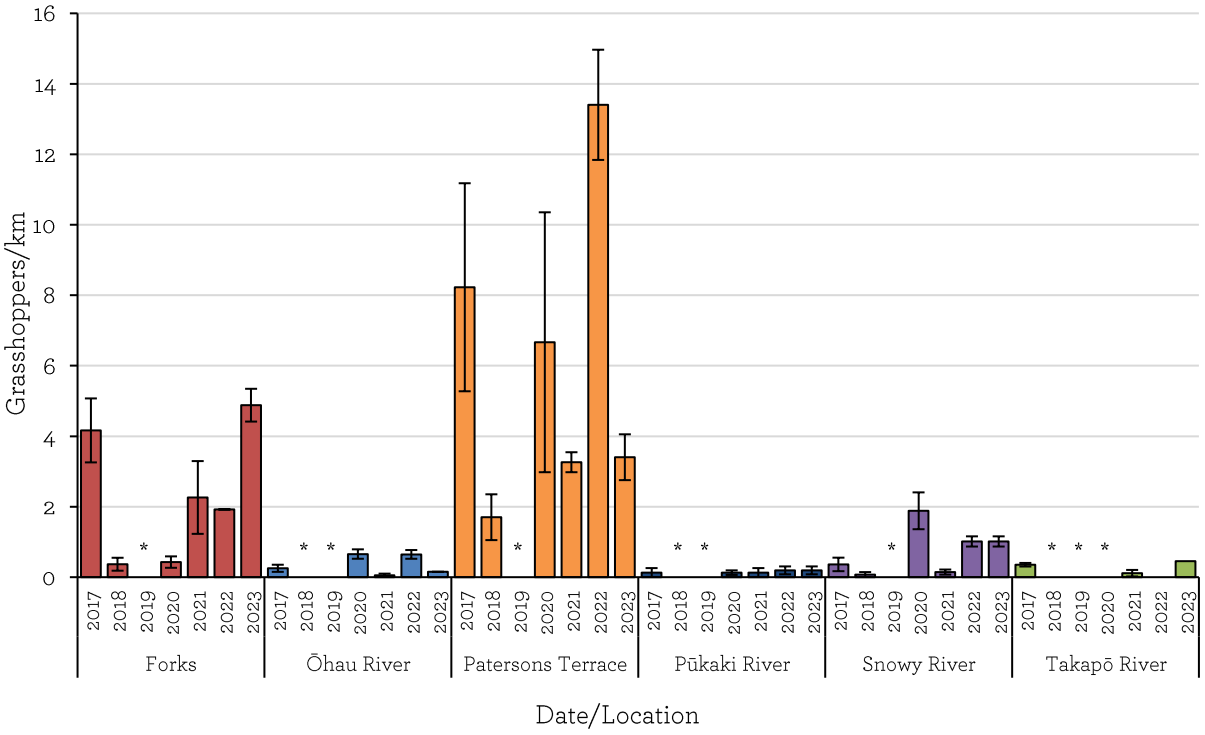

Figure 17. The mean (± SE) number of adult female *Sigaus robustus* grasshoppers per kilometre (km) during surveys of six populations from 2017 to 2023. Data from 2017 sourced from van Eyndhoven and Murray 2017. Data from 2018 sourced from surveys conducted by Murray and McIver (DOCCM-6704288). Data from 2018 sourced from surveys conducted by Murray and McIver (DOCCM-6704288). Forks includes data from Forks Gravel Pits and Forks Military Road. * Indicates that site was not monitored in that year.

Distribution monitoring was introduced in 2021 to compare current distributions to historic records in 4 key rivers systems: Ōhau, Pūkaki Takapō and Snowy. Distribution monitoring occurs in autumn to coincide with a relatively high abundance of medium sized juvenile grasshoppers which emerged that spring. Two rivers are surveyed each year, each for two consecutive years on a rotational basis.

The Snowy River was surveyed for the first time this season (Schori et al. 2024b). The survey area followed historic records and included the riverbed and a portion of the sparsely vegetated habitat north of the river. In Section 1, grasshoppers were largely absent and only found in the area immediately adjacent to Section 2 (Figure 18). Most of Section 1 did not look favourable for robust grasshoppers: Rocks tended to be jagged (versus rounded) and there was substantial cover of small herbs and woody vegetation including willows and briar rose. Throughout Sections 2 and 3, grasshopper observations aligned well with historic records indicating that the distribution has not contracted through these sections. Section 3 of the survey was in sparsely vegetated outwash plain habitat. Observations of robust grasshoppers in this type of habitat are somewhat common and indicate that this species is not strictly bound to rocky braided river habitat. Whether observations in this habitat are of individuals dispersing from braided rivers, or of individuals persisting in the environment is unknown. However, it does reinforce how important sparsely vegetated habitats are for this species.

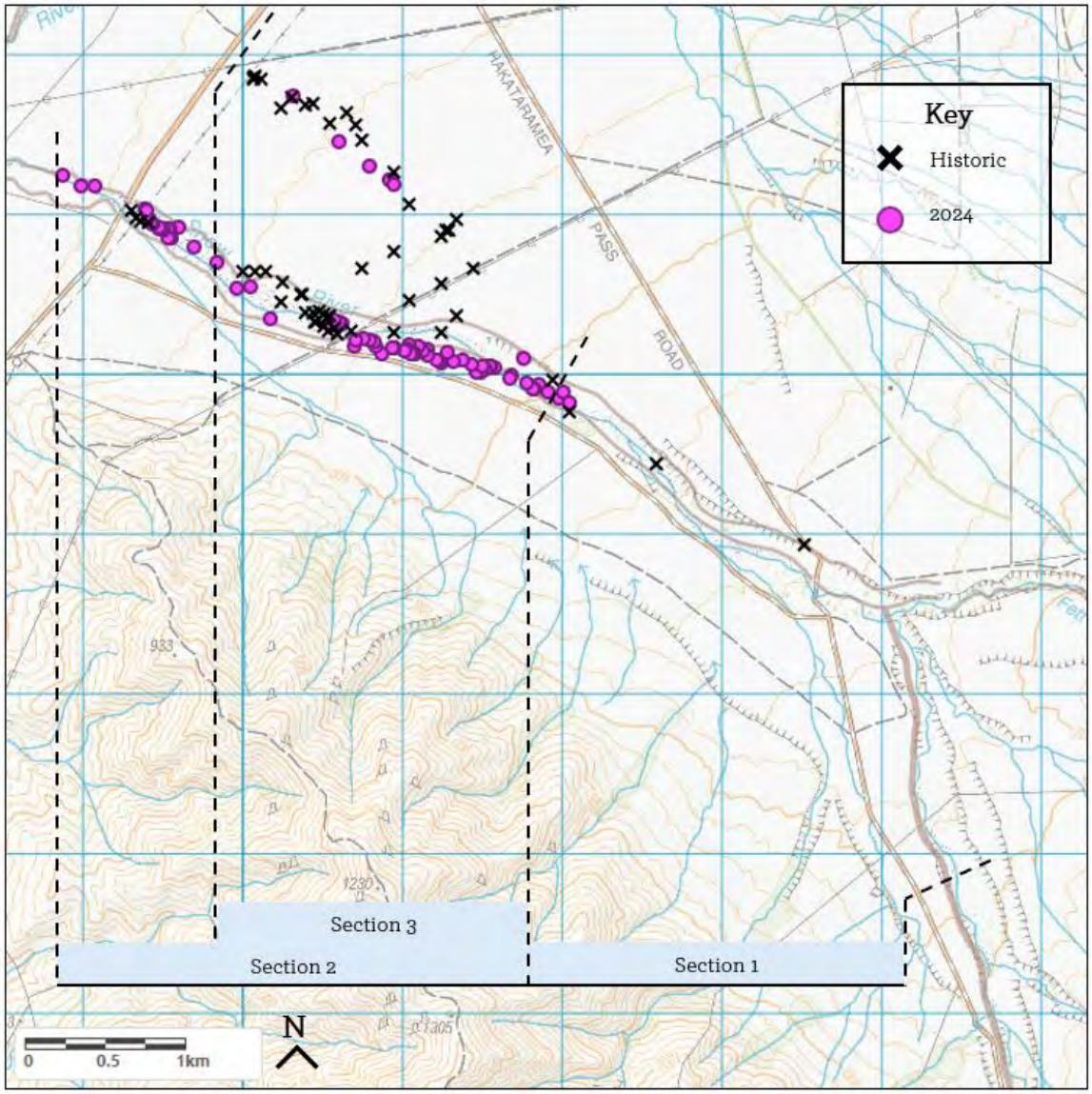

Figure 18. Records of *Sigaus robustus* in the Snowy River in the 2024 (magenta circle) distribution surveys and historically (black cross). Sections indicate how the river was divided for the recent distribution surveys.

Sigaus robustus distribution was surveyed for the second time in the Pūkaki River this year. In 2023, no grasshoppers were observed in Section 4 at the lower end of the river (Turner et al. 2023b). This season, grasshoppers were observed throughout Section 4 and Sections 1-3, indicating that the distribution of robust grasshoppers aligns with historic recordings and that their distribution has not contracted in this river over recent years (Figure 19).

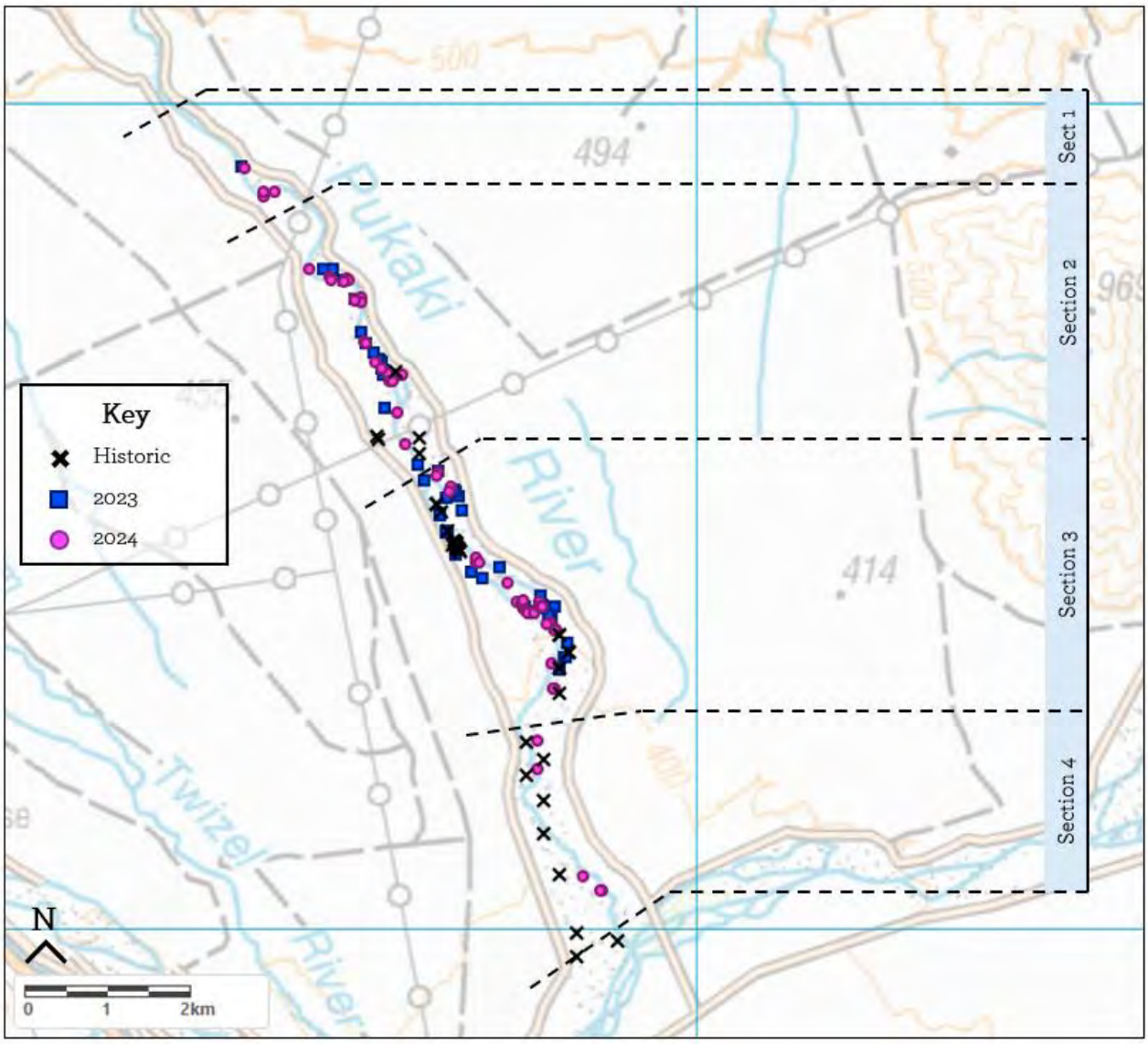

Figure 19. Records of *Sigaus robustus* in the Pūkaki River in the 2023 (blue square) and 2024 (magenta circle) distribution surveys and historically (black cross). Sections indicate how the river was divided for the recent distribution surveys.

Maniototo peppercress (*Lepidium solandri*) conservation requirements study

Maniototo peppercress (*Lepidium solandri*; Figure 20) is a unique species of dryland plant: it is dioecious meaning that individuals are either male or female (Soza, 2014). Maniototo peppercress and the closely related *Lepidium sisymbrioides* are the only dioecious species in the Brassicaceae family (Soza, 2014). In 2017, a notable decline in population sizes of *L. solandri* 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 and browsing by mammals, but the biggest threat appears to be proximity to land-use intensification including irrigation (Allen, 2000). The largest remaining populations of *L. solandri* occur in the Mackenzie Basin. PRR seeks to understand how to secure the survival of this rare plant, and undertakes monitoring, seed collection, and propagation.

Figure 20. A male *Lepidium solandri* in flower. Photo: Tayla Hooker.

Monitoring to understand population trends and the key environmental factors driving trends began in 2021. Five key *L. solandri* populations were selected, namely Ruataniwha Wetlands, Pūkaki Flats, Maryburn, Takapō Military Reserve and Takapō Scientific Reserve. These sites vary in their ecological composition, management, and proximity to heavily modified landscapes. At each population 3-5 monitoring plots of 3m x 10m, divided into 1m x 1m quadrats, were established. In each quadrat, the percentage cover, sex, and locations of *L. solandri* plants were recorded. Percentage cover of other species and substrate types were also noted. *L. solandri* plants were counted individually to give a sum of individuals present within each plot.

An additional benefit of this study is that it provides an insight into the population dynamics of other threatened dryland plant species that occur within the plots including the Nationally Vulnerable species *Convolvulus verecundus*, *Muehlenbeckia ephedroides* and *Raoulia monroi*, and the At Risk – Declining species *Colobanthus brevisepalus* and *Rytidosperma exiguum*.

Monitoring of *Lepidium solandri* has shown that populations across the five sites are fluctuating, including recruitment occurring in some populations (Table 5). The Takapō Scientific Reserve and Maryburn populations have increased by 4 and 5 individuals respectively since 2021, resulting in an overall increase of 9 individuals since monitoring began. Other populations still fluctuate but in smaller numbers. Monitoring for a longer period is necessary to determine whether this recruitment trends towards a sustained overall increase in population size.

Table 5. The count of *Lepidium solandri* in each monitoring grid (A, B, C; and D, E for Pūkaki only) at five populations in the Mackenzie Basin: Maryburn, Ruataniwha Wetlands, Takapō Military, Takapō Scientific Reserve and Pūkaki Flats shown as a heat map. Colour intensity increases with population size at the time of monitoring: lightest = 0, light = 1-2, medium = 3 - 5 and dark = 6< individuals.

		Year/Population																			
		Maryburn				Ruataniwha Wetlands				Takapō Military				Takapō Scientific				Pūkaki Flats			
		2021	2022	2023	2024	2021	2022	2023	2024	2021	2022	2023	2024	2021	2022	2023	2024	2021	2022	2023	2024
Monitoring Grid	A	6	7	8	7	0	0	0	0	4	6	5	2	0	1	1	1	3	2	3	3
	B	4	7	7	4	4	2	3	2	4	3	3	4	7	3	4	10	2	2	3	2
	C	2	4	4	6	0	2	2	1	2	2	2	4	3	1	3	4	0	0	0	0
	D																	0	0	0	0
	E																	2	2	2	2
Total		12	18	18	17	4	4	5	3	10	11	10	10	10	5	8	15	7	6	8	7

Seed collection has also been undertaken for *L. solandri* 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 the DOC Twizel nursery. Seed trials and cage trials also began in 2024, with cages set up around individuals at Pūkaki Flats, Maryburn, Ruataniwha Wetlands and Takapō Scientific Reserve. Both trials will be continued in the summer 2024/25 (Figure 21).

Figure 21. *Lepidium solandri* within the DOC Twizel nursery grown from seed collected at nearby monitoring plots (left), a cage installed over a *Lepidium solandri* (centre), and an example of a seed trial set up (right).

4.5 Objective 5: Protect and manage upper Waitaki wetlands

The Ruataniwha wetlands (Figure 22) were created in the 1990s to mitigate for wetland habitat lost during the development of the hydro-electric scheme. The intention was to provide habitat for kakī (*Himantopus novaezelandiae)* and other wetland bird species. However, management now focuses on benefiting several Nationally Threatened ephemeral plants (Gale & Hooker 2021.). Ephemeral plants are specialised to live in habitats that cycle through being dry and inundated with water, such as the margins of ponds where water levels fluctuate throughout the year. Water levels within the Ruataniwha ponds are controlled by PRR who adjust the height of weirs at the outlet of each of pond to manipulate its water level, thus manipulating the duration of dry and wet events at pond margins.

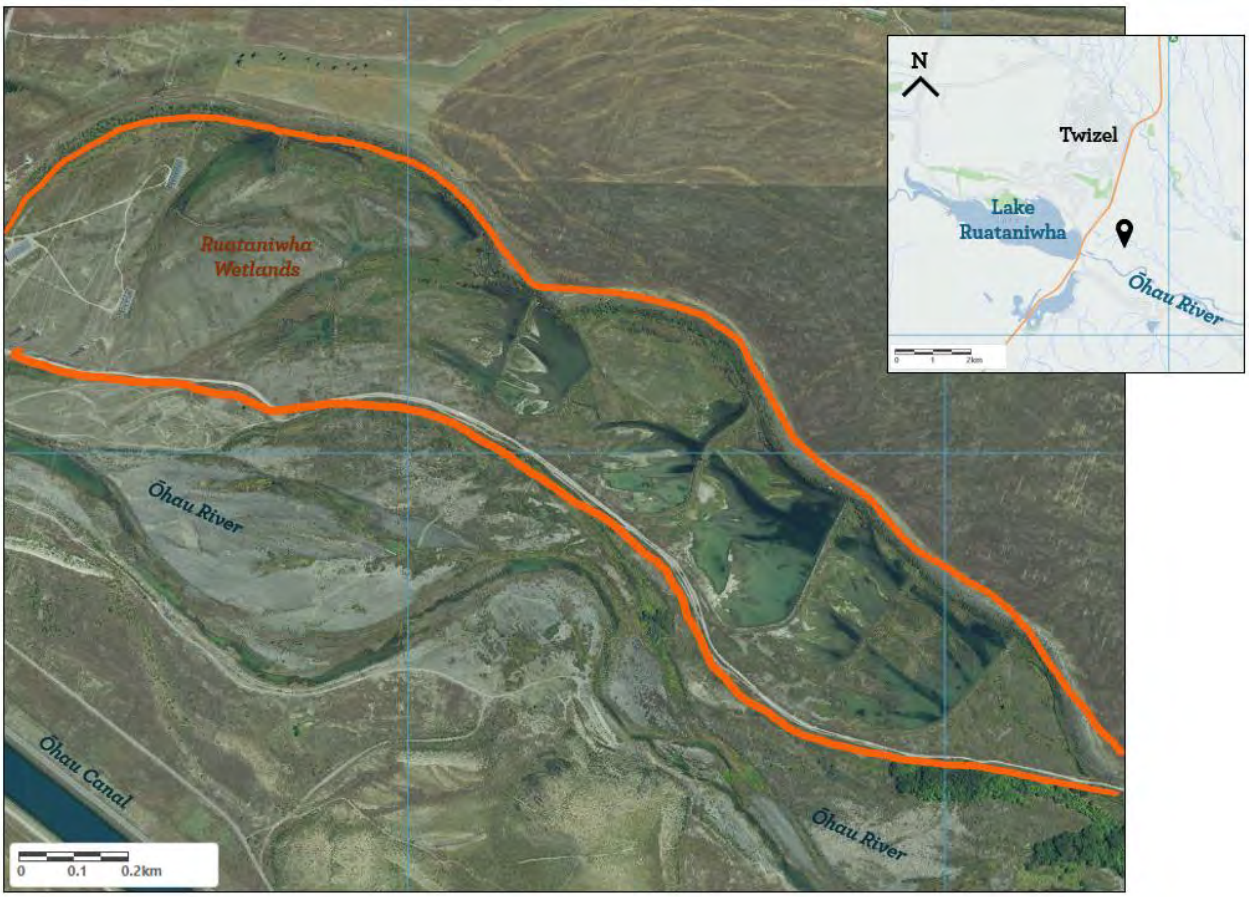

Figure 22. Satelite imagery of the Ruataniwha Wetlands (circled in orange) located adjacent to the lower Ōhau River.

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 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 (Table 6). 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**Error! Reference source not found.**. 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.

Table 6. 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 over 2021 – 2024.

Species/threat ranking*		% Cover								
		Transect 1			Transect 2			Transect 3		
		Low	Mid	High	Low	Mid	High	Low	Mid	High
Centipeda aotearoana,	NU	0.9	-	-	0.25	0.1	-	2.1	4.1	0.83
Crassula sinclarii,	NT	-	-	-	-	0.1	-	0.6	0.4	0.25
Dysphania pusilla,	NE	-	3.9	-	-	-	-	-	-	-
Elatine gratioloides,	NT	-	-	-	-	-	-	-	0.1	-
Eleocharis gracilis,	NT	-	-	-	-	0.7	-	0.25	-	-
Glossostigma diandrum,	NT	-	-	-	-	-	-	-	1.67	0.5
Glossostigma elatinoides,	NT	0.25	-	-	0.1	1	-	0.1	0.4	-
Hydrocotyle sulcata,	NT	1.75	-	-	0.1	-	-	11.6	15.2	5.8
Isolepis basilaris,	D	0.75	-	-	-	-	-	1.33	1.7	-
Limosella lineata,	NT	1.67	0.25	-	-	-	-	1.25	1	1.1
Riccia cavernosa,	†	-	-	-	-	-	-	0.1	1.7	1.9
Total % cover of native ephemeral species		4.32	4.15	0	0.45	1.9	0	17.33	26.27	10.4
Total number of native ephemeral species		5	2	0	3	4	0	8	9	6
Total number of threatened species		2	1	0	1	0	0	3	3	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 to investigate relevant management issues associated with braided rivers and wetlands or the ecology of their fauna and flora. Research topics that are selected for support must align with PRR's six strategic goals.

Black-fronted tern/tarapirohe and banded dotterel/pohowera tracking study

Project River Recovery has been supporting MSc student, Katie Gray's research into the movements of black-fronted tern/tarapirohe and banded dotterel/pohowera in the Mackenzie Basin, which aligns with PRR's fourth objective to gain ecosystem knowledge. In 2022/23, PRR partially funded solar-powered GPS tracking devices to attach to the birds. The GPS units continuously record location data and store it locally on the device. When the birds come into range of 'HUBs' - deployed at strategic locations around key breeding sites – the data is automatically downloaded from the device and uploaded to the DRUID website. The solar panel theoretically keeps the device's battery powered continuously and allows birds to be tracked for long periods of time providing they fly near a 'HUB' at some point for the data to be downloaded. Katie had issues with the devices in her first season, and the manufacturer (Druid Technology Ltd) replaced the whole batch free of charge, providing her with an opportunity to repeat the study for a second season which PRR funded her to undertake. Her preliminary results are reported here, with her thesis due to be published next financial year.

Black fronted terns/tarapirohe

Katie's GPS tracking of black-fronted terns in 2022-23 revealed that the non-incubating partner would often fly long distances to overnight at communal roosting sites at the lower Takapō River or the Cass delta. In Katie's second season, she aimed to find out more about these overnight roosting sites. She did an overnight trip and a dawn visit to each roost site. Over 350 birds were seen roosting on the Lower Takapō River and >450 birds on the Cass delta. At dawn, birds departed in groups, and often towards different directions. Birds roosting at the Lower Takapō River included GPS-tagged birds from the Ahuriri and Ōhau Rivers. There are potential implications for having large numbers of birds roosting together in one place at night, including vulnerability to mammalian predators - particularly in the lower Takapō River where there is currently no predator control.

Figure 23. Trail camera imagery shows black-billed gulls depredating black-fronted tern chicks on the Tasman River, November 2023.

This season, Katie was able to resight and recapture birds that she had attached trackers to the previous summer. Most tagged birds looked generally healthy and were able to forage, fly and swoop defensively with agility. However, many of the tracked birds spent a considerable amount of time preening around the tracker's harness which could indicate discomfort or irritation. Tagged birds were very trap-shy and difficult to recapture with spring traps. Only one tagged bird was successfully recaptured. It had some feather wear and feather loss in the vicinity of the harness and GPS-tracker, but there were no signs of rubbing or sores. It is possible that some feather loss was caused by excessive preening around the harness. The bird weighed less at recapture than at initial capture, and this is something that should be closely monitored in future tracking studies. Other options for recapturing tagged birds also need to be explored to ensure that a reliable method for recapture is available in future studies.

Figure 24. A recaptured black-fronted tern with solar powered GPS transmitter attached (left), feather wear underneath the transmitter (top right) and feather loss around the harness (bottom right). Photos: Katie Gray.

This year, 30 GPS trackers were deployed on black-fronted terns captured in the Tasman (18 transmitters), Upper Ahuriri (9 transmitters) and Takapō Rivers (3 transmitters); 20 transmitters were deployed on each bird of 10 nesting pairs, and the remaining 10 on individuals. The nests of all tagged birds were monitored using trail cameras until end of December 2023 (n = 21), and an additional 23 nearby nests were also monitored for nesting success. Across all sites, 27% of nests hatched, 36% failed and 32% had unknown outcomes (Table 7). One nest failed because of rat predation (Ahuriri River), and 3 nests were abandoned (one in the Tasman River, and two in the Ahuriri River). For 75% of nests, the cause of failure was unknown (n = 12). Of the 20 chicks that hatched (15 chicks in the Tasman, 2 in the Ahuriri and 3 in the Takapō River), only 2 survived until the end of monitoring, and 60% of losses were from an unknown cause. In the Tasman River, the only known cause of tern chick death was predation by black-billed gulls (n = 4 chicks; Error! Reference source not found.).

Table 7. Black-fronted tern/tarapirohe nesting success in three rivers in the Mackenzie Basin in spring 2023. Hatching ≥1 chick was considered successful. Unknown outcomes includes nests that were still at the egg stage when monitoring ended in December 2023.

Location	Total nests monitored	Successful	Failed	Unknown
Tasman River	27	9	10	8
Ahuriri River	10	1	3	6
Takapō River	7	2	3	2

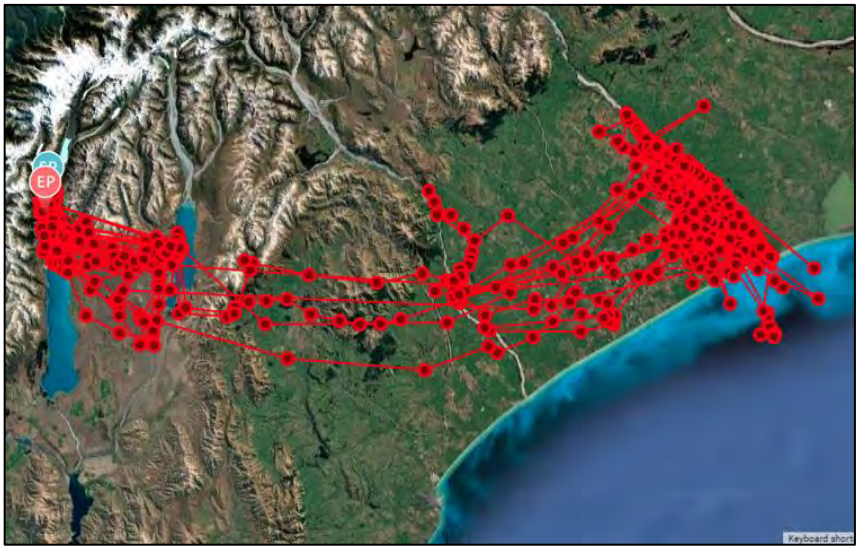

Figure 25. Breeding season and typical off-season movement of a GPS tagged black-fronted tern/tarapirohe.

With the arrival of birds for the new breeding season, data has been obtained for some of the GPS tracked birds during the off-season. Mostly they seem to move to the Canterbury Plains and coast (Figure 25). However, one bird also made a flight down to the Southland area.

Banded dotterels /pohowera

Katie deployed both HUB-reliant and 5G GPS transmitters for banded dotterels this season. The 5G transmitters (deployed for the Max Planck Institute) upload data to DRUID over the CAT-M1 (also called LTE-M, or 5G) network, rather than being uploaded via a HUB. They are slightly heavier than the HUB-reliant trackers, and hence few birds were large enough to be suitable for deployment. Many birds were also too light for the HUB-reliant transmitters, resulting in a total of 5 birds being tagged this season: three at Maryburn (2 x HUB-reliant, 1 x 5G) and two at the Tasman River (1 x HUB-reliant, 1 x 5G). Katie tested the reliability of the 5G tags to upload data across the Mackenzie Basin and found often the coverage indicated by the providers (e.g., Spark) did not often match her experience on the ground. Data could be uploaded in locations that shouldn't have coverage, and couldn't be in some locations that should have coverage.

Two nests of tagged birds were monitored using trail cameras, but because banded dotterels were slow to return to the nest after tagging, trail camera monitoring was discontinued. It was thought that the trail cameras might further contribute to their reluctance to return, and that they may even cause nest abandonment. However, 23 banded dotterel nests were visually monitored until end of December 2023. Of these, 13% successfully hatched ≥1 chick, 39% failed to hatch any chicks, and 52% had unknown outcomes (Table 8, Table 9). Preliminary results from the winter data from tracked birds shows that one bird over-wintered in Australia, making half the trip then returning to New Zealand, before making the trip again (successfully) and then returning back to New Zealand (Figure 26Figure 25).

Table 8. Banded dotterel/pohowera nesting success at five locations in the Mackenzie Basin, October-December 2023. Hatching ≥ 1 chick was considered successful.

Location	Habitat type	Total nests monitored	Successful	Failed	Unknown
Maryburn	Outwash	6	0	5	1
Ruataniwha Wetlands	Dryland	1	1	0	0
Takapō River and margins	Braided River	6	1	3	2
Tasman River	Braided River	5	1	1	4
Cass River	Braided River	5	0	0	5

Table 9. Causes of nesting failure of banded dotterels/pohowera in the Mackenzie Basin, October-December 2023.

Location	Cause of failure				
	Cat	Ferret	Harrier	Hedgehog	Unknown
Maryburn	1	1	1	1	1
Takapō River and margins	0	0	0	0	3
Tasman River	0	0	0	0	1

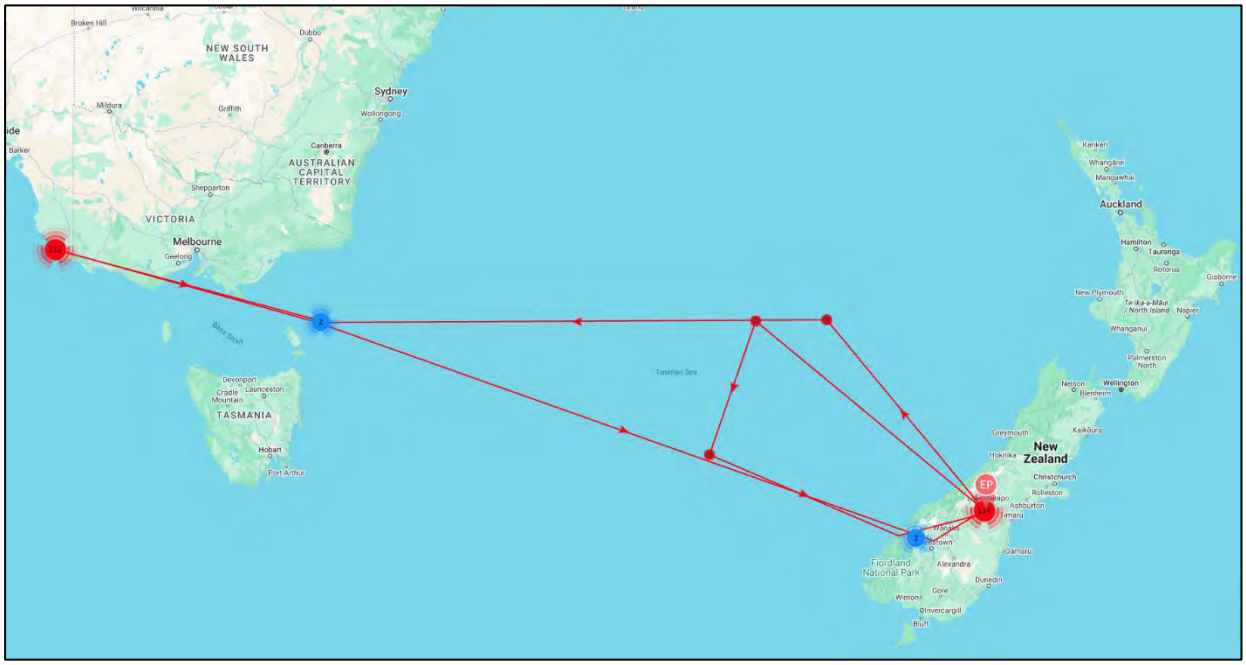

Figure 26. The tracks of a banded dotterel's flight to Australia in winter 2024.

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

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, officially launched in 2018. The project aims to 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 works in collaboration with TMA to gain ecosystem knowledge and maintain weed and predator control in overlapping areas.

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 are 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.

7 Project River Recovery's financial statements 1st July 2023 – 30th June 2024

Project River Recovery spent $647,000 in the 2023-2024 financial year. PRR's revenue and expenditure for the 2023-2024 financial year is itemised in Table 10.

Table 10. Project River Recovery statement of financial performance for year ending 30th June 2024.

	2024 ($k)	2023 ($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	**647**	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	**647**	655	588	481	554	544	539	513	528	505	534	529	499	485	472
EXPENDITURE															
Personnel costs															
Salaries	**129**	132	139	104	113	83	44	80	125	117	138	138	140	129	119
Wages	**17**	33	37	13	57	15	50	51	48	39	3	0	2	1	12
Other Personnel	**0**	3	3	0	0	0	0	0	-3	0	1	0	-3	-2	6
Total personnel costs	**146**	168	179	117	170	98	93	132	170	156	141	138	139	128	137
Administration costs															
Accommodation	**20**	0	20	0	20	20	22	20	20	27	27	27	27	26	26
Total administration costs	**20**	0	20	0	20	20	22	20	20	27	27	27	27	26	26
Operating costs															
Professional fees/contracts	**2**	0	7	32	5	8	5	1	11	1	6	5	1	9	2
Travel	**0**	1	0	2	2	1	3	1	1	3	2	1	1	1	7
Vehicle expenses	**6**	2	28	4	36	34	35	36	36	35	39	40	41	42	38
Field operations	**472**	480	351	325	319	382	371	321	289	281	316	306	278	273	260
Information and publicity	**1**	0	3	1	2	1	1	2	1	2	1	2	1	4	6
Grants and miscellaneous	**0**	5	0	0	0	0	8	0	1	0	3	10	11	2	3
Total operating costs	**481**	488	390	364	363	426	424	361	338	322	367	364	333	331	316
TOTAL EXPENDITURE	**647**	656	588	481	554	544	539	513	528	505	535	529	499	485	479
NET SURPLUS (DEFICIT)	**0**	0	0	0	0	0	0	0	-1	0	-1	0	0	0	-7

8 References

Allen, R.B. (2000). Inland *Lepidium* recovery plan 2000-2019. Threatened Species Recovery Plan 32. Department of Conservation.

Anderson, S. J. (2010). Upper Ōhau black-fronted tern predator-control project. Project River Recovery Internal Report 2010/03, Department of Conservation, Twizel, DOCCM-2516039.

Clayton-Greene, J., Courtney, S., Rebergen, A. and Head, N. 2016. A rediscovery of the presumed extinct *Dysphania pusilla*. Trilepedia, New Zealand Plant Conservation Network 139: 1 – 3.

Cruz, J., Pech, R. P., Seddon, P. J., Cleland, S., Nelson, D., Sanders, M. D., & Maloney, R. F. (2013). Species-specific responses by ground-nesting Charadriiformes to invasive predators and river flows in the braided Tasman River of New Zealand. Biological Conservation, 167, 363–370.

de Lange, P.J., Rolfe, J.R., Barkla, J.W., Courtney, S.P., Champion, P.D., Perrie, L.R., Beadel, S.M., Ford, K.A., Breitwieser, I., Schönberger, I., Hindmarsh-Walls, R., Heenan, P.B., Ladley, K. (2017). Conservation status of New Zealand indigenous vascular plants. The New Zealand Threat Classification Series. Department of Conservation.

Dunn, N., Allibone, R., Closs, G., Shannan, C., David, B., Goodman, J., Griffiths, M., Jack, D., Ling, N., W, J., & Rolfe, J. (2017). Conservation Status of New Zealand Freshwater Fishes, 2017. The New Zealand Threat Classification Series. Department of Conservation.

Gale, S. and Hooker, T. (2021). Towards understanding the man-made pond-shore plant habitat at Ruataniwha wetlands. Department of Conservation Internal Report. DOC-6697051.

Goodman, T. (2023). Hedgehog exclusion fence trial annual report. Department of Conservation Internal Report. DOC-7367579.

Gray, K. (2024). Report on black-fronted tern and banded dotterel tracking in the Mackenzie Basin, October – December 2023. DOC-7765302.

Haultain, S. (2017a). Lakes Skink, *Oligosoma* aff. *chloronoton* "West Otago", monitoring in the Upper Waitaki Basin, 2017. Project River Recovery Internal Report 2017/03, 38p.

Hitchmough, R., Barr, B., Knox, C., Lettink, M., Monks, J., Patterson, Geoff., Reardon, J., van Winkel, D., Rolfe J., and Michel P. (2021). Conservation status of New Zealand reptiles, 2021. Department of Conservation, Wellington.

Keedwell, R. J. (2005). Breeding biology of Black-fronted Terns (*Sterna albostriata*) and the effects of predation. Emu, 105, 39–47.

Keedwell, R. J., Sanders, M. D., Alley, M., & Twentyman, C. (2002). Causes of mortality of Black-fronted Terns *Sterna albostriata* on the Ōhau River, South Island, New Zealand. Pacific Conservation Biology, 8(3), 170–176.

Lettink, M. (2016). Lizard monitoring and management recommendations for two sites in the Mackenzie Basin, Canterbury. Prepared for the Department of Conservation (Twizel/Te Manahuna Office).

Lettink, M. (2021). Analysis of skink footprint tracking and capture data from the robust grasshopper enclosure, Mackenzie Basin. Unpubl. Report prepared for the Department of Conservation, 12 pp.

Maloney, R. (2016). Upper Ōhau River Predator Control Programme: Review of progress and recommendations for future work. Internal Report. Department of Conservation, Twizel.

Murray, T. (2022). Te Manahuna Aoraki Project 2 Final Report: Outcomes of the Robust Grasshopper Predator Exclusion Fence. DOC-7108215

Nelson, D., Maloney R. & Gale, S. (2020). Project River Recovery Interim Strategic Plan 2020. Department of Conservation Internal Report, DOCCM-6471079.

Nelson, D., Schori, J., Hooker, T., and Turner, S. (2024). Twizel Freshwater Fish Work Summary 2023/24. Department of Conservation Internal Report, DOCCM-7756097.

PRR (2022). PRR Strategy Meeting Minutes 2022, DOC-7138110.

Rebergen, A. L., & Woolmore, C. B. (2015). Project River Recovery Strategic Plan 2012-2019. Project River Recovery Report 2015/01, Department of Conservation, Twizel.

Rebergen, A., Glenny, D.S., Frogley, K., Rolfe, J.R., and de Lange, P. (2017). *Riccia cavernosa*: A new addition to the liverwort flora of New Zealand. New Zealand Journal of Botany 56: 84-90.

Robertson, H.A., Baird, K.A., Elliott, G.P., Hitchmough, R.A., McArthur, N.J., Makan, T.D., Miskelly, C.M., O'Donnell, C.F., Sagar, P.M., Scofield, R.P and Taylor, G.A. (2021). Conservation status of birds in Aotearoa New Zealand, 2021. New Zealand Threat Classification Series 36. 43 p. Department of Conservation, Wellington.

Schlesselmann, A. K. V. (2018). Linking science and management for effective long-term conservation: A case study of black-fronted terns/tarapirohe (*Chlidonias albostriatus*). PhD thesis, University of Otago.

Schori, J., Turner, S. & Nelson, D. (2024a). Braided river bird surveys of the Hopkins, Ōhau, Pūkaki and Cass Rivers. Project River Recovery Internal Report 2024/03. DOC-7762952.

Schori, J., Turner, S., Murray, T. and Nelson, T. (2024b). Robust grasshopper population surveys and monitoring. Project River Recovery Internal Report 2024/04. DOC-7759601.

Soza, V.L., Huynh, V.L., Di Stilio, V.s. (2014). Pattern and process in the evolution of the sole dioecious member of Brassicaceae. EvoDevo (5) 42. doi: 10.1186/2041-9139-5-42.

Turner, S., & Nelson, D. (2024a). Lakes skink (*Oligosoma* aff. *chloronoton* "West Otago") monitoring in the Upper Ōhau River, February 2024. Project River Recovery Internal Report 2024/05.

Turner, S., Goodman, T., Schori, J.C., Murray, T. and Nelson, D. (2023b). Robust grasshopper (*Brachaspis robustus*) population surveys and monitoring 2021-22. Project River Recovery Internal Report 2023/03.

Turner, S., Goodman, T., Schori, J., & Nelson, D. (2024c). Upper Ōhau black-fronted tern predator control project and population monitoring. Project River Recovery Internal Report 2024/02.

White, EG. 1994. Ecological research and monitoring of the protected grasshopper *Brachaspis robustus* in the Mackenzie Basin. Department of Conservation Science and Research Series 77, 1-48.