PEST ANIMAL MANAGEMENT PLAN FOR THE LOWER ASHLEY/RAKAHURI RIVER

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PEST ANIMAL MANAGEMENT PLAN FOR THE LOWER ASHLEY/RAKAHURI RIVER

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Project Team:
Vikki Smith – Report author
Des Smith – Report author and project manager

Prepared for:
Environment Canterbury
Ashley-Rakahuri Rivercare Group Inc
200 Tuam Street
Christchurch 8011

CHRISTCHURCH OFFICE: 7A VULCAN PLACE, MIDDLETON, CHRISTCHURCH 8024;
P.O. BOX 9276, TOWER JUNCTION, CHRISTCHURCH 8149; Ph 03-338-4005

HEAD OFFICE: 99 SALA STREET, P.O. BOX 7137, TE NGAE, ROTORUA
Ph 07-343-9017; Fax 07-343-9018, email ecology@wildlands.co.nz, www.wildlands.co.nz

EXECUTIVE SUMMARY

The Ashley/Rakahuri River is an important nesting ground for indigenous braided river birds, many species of which are threatened. The Ashley-Rakahuri Rivercare Group (ARRG) have been trapping and monitoring predators to protect native birds, and Environment Canterbury (ECan) wishes to work with the ARRG to increase the predator control effort in the Ashley/Rakahuri River.

Current predator control is extensive, with lines of Timms, DOC, Trapinator, run-through, and rat traps either side of the river and within the river bed in response to nesting locations. However, predator numbers remain high and nest predation is still a significant issue for birds on the Ashley River.

Current bird monitoring includes nest counts, walking surveys, and continuous nest observation throughout the breeding season. Predators are monitored with camera traps by nests, and by calculating catch-per-unit-effort from trap-catch data.

The following plan recommends an increased number of traps, incorporating ground-set Sentinels and modified Timms traps to catch cats, in addition to DOC 150 and DOC 200 traps. The proposed new trapping regime expands upon the current lines and incorporates new lines suggested by the ARRG, filling in gaps in the current regime, and running a line along the centre of the river bed. Additionally, Philproof bait stations containing Double Tap (alternating with Feracol) are recommended for rat control. Alphachloralose poisoning, and luring and shooting operations, are recommended for controlling black-backed gull and swamp harrier. River diversions are a possible experimental short-term solution to help restrict the access of predators (particularly hedgehogs) to river islands.

Recommended additional predator monitoring includes more targeted catch per unit effort calculations, additional camera traps, and tracking tunnels. Avian monitoring, including monitoring of avian predators, is currently sufficient.

CONTENTS

Reviewed and approved for release by:

W.B. Shaw
Director/Lead Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

Braided rivers and their associated gravel beds have been identified as a historically rare ecosystem type and are naturally uncommon on a national basis (Williams *et al.* 2007). Braided river ecosystems are therefore classified as Threatened-Endangered (Holdaway *et al.* 2012). Sixty-four percent of New Zealand's braided rivers occur in Canterbury.

The Ashley/Rakahuri River is a braided river that is approximately 95 kilometres long and is located on the Canterbury Plains, north of Ōtautahi/Christchurch. It flows from its headwaters in the Puketeraki Range, through Lees Valley and the Ashley Gorge, before crossing the Canterbury Plains and reaching the coast near Waikuku, c.25 kilometres north of Christchurch.

The Ashley/Rakahuri Rivercare Group (ARRG) have developed an extensive predator control programme on the lower Ashley/Rakahuri river bed to protect indigenous ground-nesting braided river birds. The trapping programme is implemented by volunteers. Trapping is focused in the 21-kilometre stretch between the Okuku River junction and the upper estuary (the 'project area', Figure 1). A large database has been developed by the ARRG to track the numbers of predators caught in traps, and the abundance and breeding success of indigenous braided river birds.

Environment Canterbury wishes to improve pest animal control operations on the Ashley/Rakahuri River, so that they are more effective at protecting indigenous braided river birds. Environment Canterbury commissioned Wildland Consultants Ltd to prepare this plan.

2. BRAIDED RIVER BIRDS ON THE ASHLEY/RAKAHURI RIVER

Indigenous bird species known to nest in the Ashley/Rakahuri River include tarapuka/black-billed gull (*Larus bulleri*, At Risk-Declining), tarapirohe/black-fronted tern (*Chlidonias albostriatus*, Threatened-Nationally Endangered), tūturiwhatu/banded dotterel (*Charadrius bicinctus*, At Risk-Declining), tōrea/South Island pied oystercatcher (*Haematopus finschi*, At Risk-Declining), ngutu-pare/wrybill (*Anarhynchus frontalis*, Threatened-Nationally Increasing), karoro/southern black-backed gulls (*Larus dominicanus*, Not Threatened), and poaka/pied stilt (*Himantopus himantopus*, Not Threatened). Refer to Table 1.

Table 1: Indigenous bird species known to nest in the bed of the Ashley/Rakahuri River.

Species	Status	Conservation Status
Banded dotterel (*Charadrius bicinctus*)	Endemic	At Risk-Declining
Black-billed gull (*Larus bulleri*)	Endemic	At Risk-Declining
Black-fronted tern (*Chlidonias albostriatus*)	Endemic	Threatened- Nationally Endangered
Pied stilt (*Himantopus himantopus*)	Indigenous	Not Threatened
Southern black-backed gull (*Larus dominicanus*)	Indigenous	Not Threatened
South Island pied oystercatcher (*Haematopus finschi*)	Endemic	At Risk-Declining
Wrybill (*Anarhynchus frontalis*)	Native	Threatened-Nationally Increasing

[1] Source: Robertson *et al.* 2017.
[2] Source: http://nzbirdsonline.org.nz/

Records of these species in 2020-2021 are shown in Figure 1. Banded dotterel, wrybill, black-billed gull, black-fronted tern, and South Island pied oystercatcher are endemic species that have evolved to live in braided river habitats. Pied stilt have breeding populations throughout the tropics and warmer temperate regions of the world.

Southern black-backed gulls breed in a wide variety of habitats throughout Aotearoa New Zealand and are considered to be unnaturally 'superabundant' due to increased food supply from human sources (Miskelly 2013). They are serious predators of other braided river birds and on some rivers (e.g. the Waimakariri) they take up extensive areas of favourable breeding habitat, and are therefore considered to be a threat to the Threatened and At Risk species listed in Table 1. However, although black-backed gulls nest around the Ashley estuary, they are rare further upstream on the lower Ashley/Rakahuri River, with only one nest found in the last 15 years (ARRG 2021). Only 14 black-backed gulls were counted in the Ashley/Rakahuri River during the 2020-2021 breeding season.

3. KEY PREDATORS AND THREATS THEY POSE

The most common predators in the Ashley/Rakahuri River project area are hedgehogs (*Erinaceus europaeus*), rats (*Rattus* spp.), mustelids (stoats, weasels, and ferrets), and feral cats (*Felis catus*) (ARRG 2021). Brushtail possums (*Trichosurus vulpecula*) will also be present in the riparian berms of the river, but do not feature strongly in the ARRG data. Table 2 lists the main predators and describes the threats they pose to indigenous braided river birds.

Avian predators include southern black-backed gull and swamp harrier (*Circus appproximans*) (Table 2).

Table 2: Key predators of focal bird species on the Ashley/Rakahuri River.

Predator Species	Notes on Behaviour	Threats Posed
Feral cat (*Felis catus*)	Feed on rabbits; rabbit control may increase cat predation of birds. Rising stoat and rat populations may cause cat populations to increase.	Nocturnal predation of adults and chicks; predation of lizards and invertebrates (Murphy *et al*. 2004).
Ferret (*Mustela furo*)	Heavily dependent on rabbits as a food source. Ferrets mainly inhabit pastoral habitat, but will be found in other habitats that border farm margins.	Ferrets are known to kill ground nesting shorebirds such as banded dotterel, wrybill and black-fronted tern (Clapperton and Byrom 2005).
Weasel (*Mustela nivalis*)	Mostly near the estuary. Difficult to monitor and control due to small size, particularly of the females (Haworth 2018).	Predation of eggs and chicks. Diurnal and nocturnal predation. (Haworth 2018; Strang *et al.* 2018).
Stoat (*Mustela erminea*)	Widespread but commonly caught near the estuary (ARRG, pers. comm.). Climb and swim; easily reinvade areas. Kills usually hidden in dens or under cover (ARRG, pers. comm.).	Significant bird predator, particularly of eggs and chicks but also adults (Steffens *et al*. 2012); major contributor to bird decline in braided rivers. (J. Dowding *et al*. 2015; Murphy *et al.* 2004).
Norway/brown rat (*Rattus norvegicus/ rattus*)	Norway rats tend to be terrestrial. Brown rats are arboreal and terrestrial. All rats are excellent swimmers. Primarily nocturnal. Rat	Egg and chick predation (J.E. Dowding and Murphy 2001). Norway rats appear to have been the major cause of black-fronted

Predator Species	Notes on Behaviour	Threats Posed
	kills identified by rats gnawing close to the bone (ARRG, pers. comm.).	tern nesting failure in the 2021-2022 breeding season (Davey 2021 pers. comm.).
Hedgehog (*Erinaceus europaeus*)	Upstream from the weasel and stoat populations (ARRG, pers. comm.). Prefer not to cross water.	Major predator of eggs and chicks (Sanders and Maloney 2002).
Australasian harrier (*Circus approximans*)	Native avian predator; primarily scavenger but opportunistic.	Diurnal predator of chicks and eggs (Bell 2017; Cameron *et al*. 2005).
Southern black-backed gull (SBBG; *Larus dominicanus*)	Native avian predator.	Predator of eggs and chicks (Steffens *et al.* 2012).

Hedgehogs and rats are the predators caught most commonly in the Ashley/Rakahuri River project area, followed by mustelids and feral cats (ARRG 2021, Figure 5). Rat captures have increased in the last five years relative to the other predators.

4. AVIFAUNA BIODIVERSITY GOALS

Predator control on the Ashley-Rakahuri River is undertaken with the primary goal of reducing the number of incidences of nest predation and/or disturbance events by introduced predators.

O'Donnell *et al.* (2016) have noted that it is very difficult to set recruitment targets for indigenous braided river birds in response to predator control. This is because their response to predator control has varied substantially across different braided rivers, and can be substantially influenced by other factors such as flood events and the extent of woody weed infestations, and human disturbance.

However, the goal of pest control on the Ashley/Rakahuri River should be to achieve:

- A reduction in the number of incidences of nest predation or disturbance events caused by introduced predators.
- Greater fledging and recruitment rates for endemic braided river breeding bird species, i.e. an increase in the average breeding rate of black-fronted tern, wrybill and black-billed gulls over the next 10 years, compared with the previous 15 year average.
- An increase in endemic braided river bird numbers within the Ashley/Rakahuri River over the next 10 years, i.e. a consistent positive trend.

This will be achieved by:

- Decreasing the abundance of introduced mammalian predators to a level that reduces most predation events on breeding endemic birds and their nests and chicks.
- Removal of southern black-backed gulls and swamp harriers.

5. REVIEW OF CURRENT MANAGEMENT

5.1 Trapping

As of 13 August 2021, the ARRG had 284 traps within the project area, maintained by 26 volunteers. Both sides of the river are trapped, as is the estuary. A breakdown of the

trap types and trap lines typically used is provided in Table 3 and Figure 2, although this can vary. Throughout the life of the project, the ARRG have caught 3,353 predators since 2004. Predators were caught at a rate of 1.3 per corrected trap nights (C/100TN) over the first six years (2004-2009), but between 2015-2020 the figure has dropped to an average of 0.5 C/100TN. However, it is difficult to discern the extent to which this decrease has resulted from declining abundance of predators, versus increased trap numbers diluting the capture rate.

Table 3: Current typical trap layout in the Ashley/Rakahuri River as per Figure 2. Note the number of traps deployed on the river at any one-time varies.

Trap Type	Target Species	Total Number	Number and Positioning on River	Number and Positioning on Estuary
DOC-series (primarily DOC200)	Mustelids, hedgehogs, rats	226	138 traps positioned up to 100 metres apart on both sides of the river, targeting forest and scrub habitat.	88 traps positioned up to 100 metres apart on both sides of the river, with more traps on the true left than on the true right. True left trap line extends further along the coast than the true right line.
Timms	Cats, mustelids	43	42 traps positioned intermittently on both sides of the river, with some 150 metres apart and others over two kilometres apart.	One trap on the true left of the river, one kilometre from the main channel. Trap positioned in the corner of a paddock, 1.2 kilometres inland, near scrub.
Trapinator	Cats	15	Two traps in scrub habitat on the true right.	13 traps; two on the true right, 11 on the true left. In open, edge, and scrub habitat.
Run-through	Rats, mustelids, hedgehogs	11	11 traps in two clusters, positioned in the middle of the river bed.	None positioned on the estuary.
Rat	Rats	1	One rat trap in the middle of the river bed.	None positioned on the estuary.

The current operation is intensive, with a high trap density and different types of trap targeted at different pest species. However, there are gaps in the trapping network where predators might pass between and along habitat types without encountering traps. Cats, ferrets, and stoats are targeted using DOC200s and Timms traps, but rats and smaller mustelids are not targeted to the same extent. Weasels and rats are not controlled effectively using DOC200 traps, as they are not heavy enough to reliably trigger the mechanism (Haworth 2018), and also the local abundance of rats can be so high that DOC200 traps cannot cull a sufficient amount of them. Trap density will need to be increased in the project area if hedgehog numbers are to be reduced.

Traps are serviced by volunteers, and baited using eggs, meat, peanut butter, cat biscuits, salted meat, venison, or chicken necks (ARRG pers. comm.). Different volunteers use different baits and lures. In October, some rat traps were baited using chocolate spread. It is problematic to use different baits in an unstructured manner and this is discussed further in Section 9.

The trapping area has no buffer zone, meaning that outside of the heavily-trapped river bed, predators are not controlled. A buffer zone would be difficult to establish because of the large number of private landowners that would need to be involved. The surrounding area is a reservoir of predators that will be continually reinvading the river bed. The long, thin shape of the project area increases the length of perimeter in contact with untrapped habitat, increasing reinvasion risk.

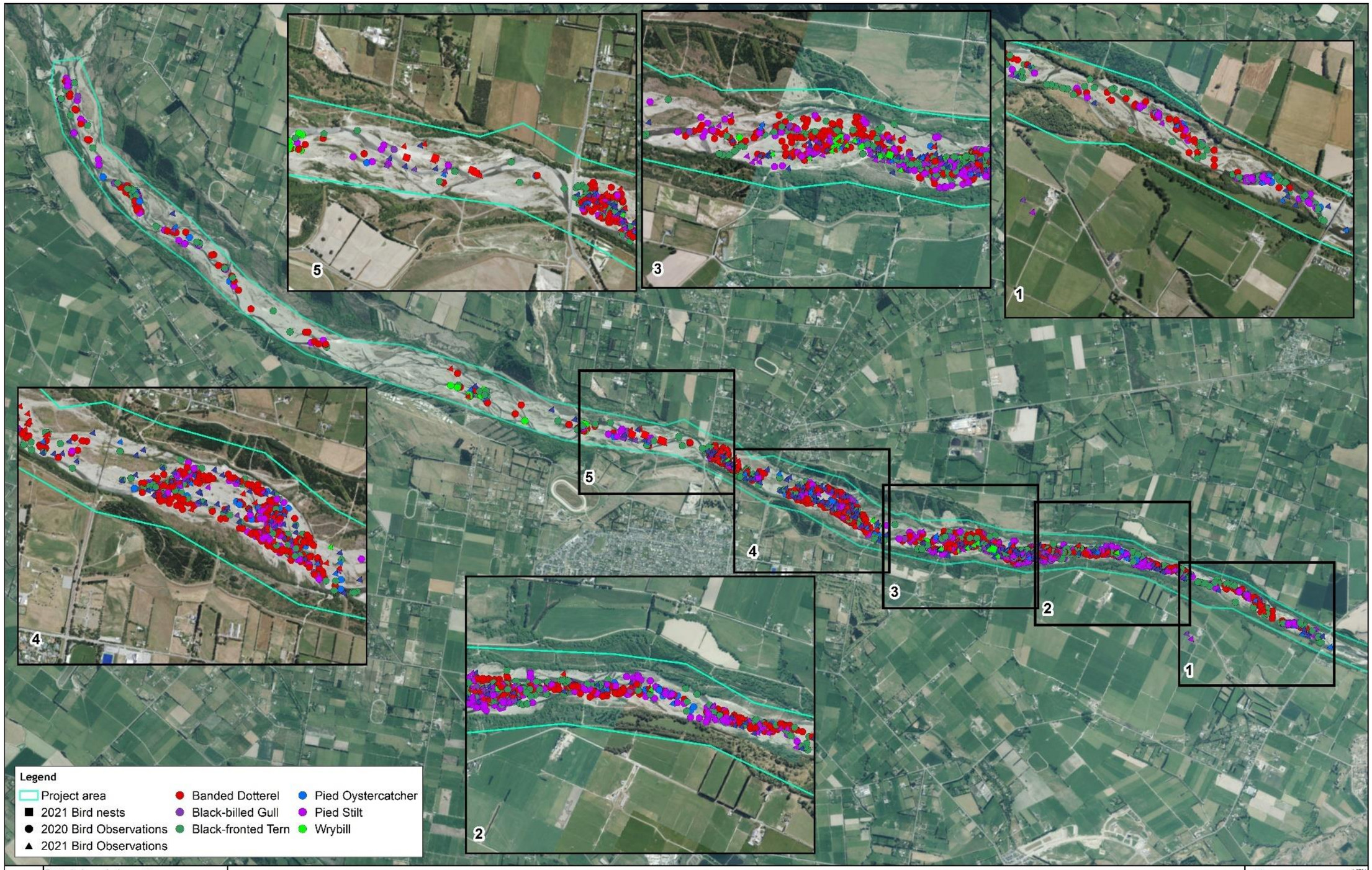

Figure 1. Project area and 2020-2021 bird observations in the Ashley/Rakahuri River

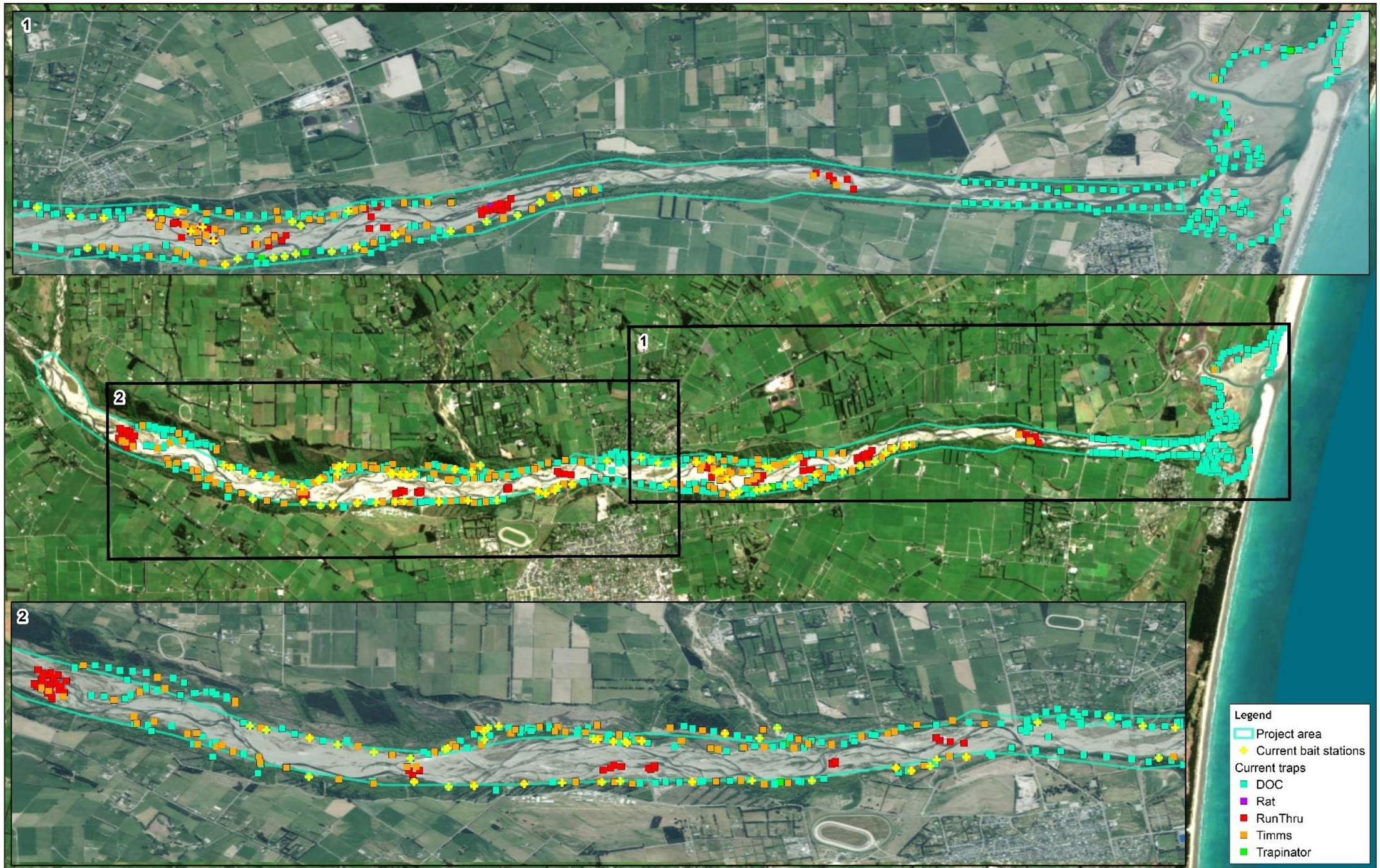

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Figure 2. Current control implemented by the ARRG along the Ashley/Rakahuri River

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Cartographer: LD
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5.2 Toxins

Over 100 bait stations along both sides of the river were previously filled with Brodifacoum, however this has been stopped recently. Brodifacoum is not to be used long-term, due to its persistence in the environment and the food chain (Mosterd and Thijssen 1991). Currently, no poisoning is being implemented in the project area.

6. REVIEW OF CURRENT MONITORING

6.1 Avifauna monitoring

The ARRG undertake intensive and thorough monitoring of focal birds within the project area during the breeding season, including:

- An annual bird count along 21 kilometres of the river, from Okuku to the estuary.
- Drone surveys of black-billed gull colonies.
- Monitoring of nest success of wrybill, black-billed gull, and black-fronted tern (including the use of trail cameras at nests).
- Monitoring of banded dotterel nests (2020-2021 breeding season).

Relative bird abundance had a positive trajectory between 2000 and 2014, but declined in 2015 and 2016 and has not recovered to the 2014 levels. Wrybills have a 15 year breeding success average of 0.8 per pair. black-billed gull breeding success has varied over the years, but the 2020-2021 breeding season saw a large colony (1,278 nests) have an average breeding success per pair of one. Black-fronted tern average breeding success in 2020-2021 was 0.6 but, overall, there were low numbers of black-fronted tern nesting in the river.

6.2 Predator monitoring

One of the strengths of the current operation is data collection, with records dating from project inception in 2004, including detailed annual reports. ARRG mainly use catch per unit effort calculated from their trap-catch data to monitor the abundance of predators and the effectiveness of control. This is done by calculating catches per 100 trap nights (C/100TN, c.f. Nelson and Clark 1973). C/100TN can provide good data on predator numbers in an operation, but it can be influenced by the following:

- Inconsistent lure use may affect the results. For example, because more predators are caught with a certain lure type compared with another.
- Variation in the number of traps. For example, if one year's trapping effort catches 50 predators using 100 traps, and the following year 50 predators are caught with 400 traps, then C/100TN would be 0.14 in the first year and 0.03 in the second, assuming no sprung empty traps. The apparent decline in predator abundance is actually an artefact of the increased trapping effort.
- Variation in frequency of trap checks can result in similar effects to variation in the number of traps, because it can affect the rate at which sprung traps are reset and therefore the overall number of trap nights available.

Seven trail cameras have been placed along the river in two clusters 4.7 kilometres apart. These cameras have been instrumental in identifying the pest species responsible for nest predation, and revealing the issue of predators frequently encountering traps without being caught (Ledgard and Davey 2021). Most of the river is not covered by cameras, and no wax tags, tracking tunnels, or other monitoring methods are used.

7. FUTURE MANAGEMENT OF MAMMALIAN PREDATORS

7.1 Overview

O'Donnell *et al*. (2016) reviewed pest control initiatives on braided rivers, concluding that most small-scale or short-term operations have failed to achieve any effect on indigenous bird populations. However, intense long-term control over a large area (rather than a long, narrow area) has shown some success in increasing braided river bird numbers, particularly when a variety of control methods are used (multiple trap types, poison baiting, shooting, and controlling rabbits). They also note that there is some benefit of using water as a barrier to protect birds from predators, by the creation of river islands for colonies to nest on. However, the level of protection provided by water alone is weak and is only effective when used in conjunction with intensive landscape-scale pest control.

7.2 Changes to the trapping operation proposed by the ARRG

The ARRG have proposed expansion of the current trapping regime to include three new lines (Figure 3). One new line of DOC150s will run continuously down the middle of the river bed (the "river line"), active only in the nesting season, starting 400 metres downriver from the Okuku confluence and finishing two kilometres upriver from the estuary. This fairway line will be flanked by two other new lines on each side of the river (the "berm lines"), with a one-kilometre gap between lines on the true right side of the river, and a 1.9 kilometre gap between lines on the true left. The gaps are both near Cones Road and are discernible in Figure 4. Four line-extensions are also proposed by ARRG on each side of the river: two line extensions will be near the Okuku confluence, and two will be adjacent to the estuary. Traps along the new riverbank lines will be spaced 100 metres apart, with either a DOC200 or Timms trap at each site, with 10 DOC200s to every two Timms traps.

Note that new traps are to be placed where there are no traps currently in place. The recommended traps (including DOC 150s) are not suggested to replace current traps.

Some new trap lines will be set up in farmland adjacent to the control zone: 59 lines of four traps will be set roughly perpendicular to the edge of the river bed.

To help prevent hedgehogs from gaining access to nests, Environment Canterbury is planning to dig trenches to temporarily divert river channels during the bird breeding season. While mustelids and rats have no problem crossing water, it is thought that hedgehogs generally avoid river crossings. Water diversion may also be a minor deterrent to cats.

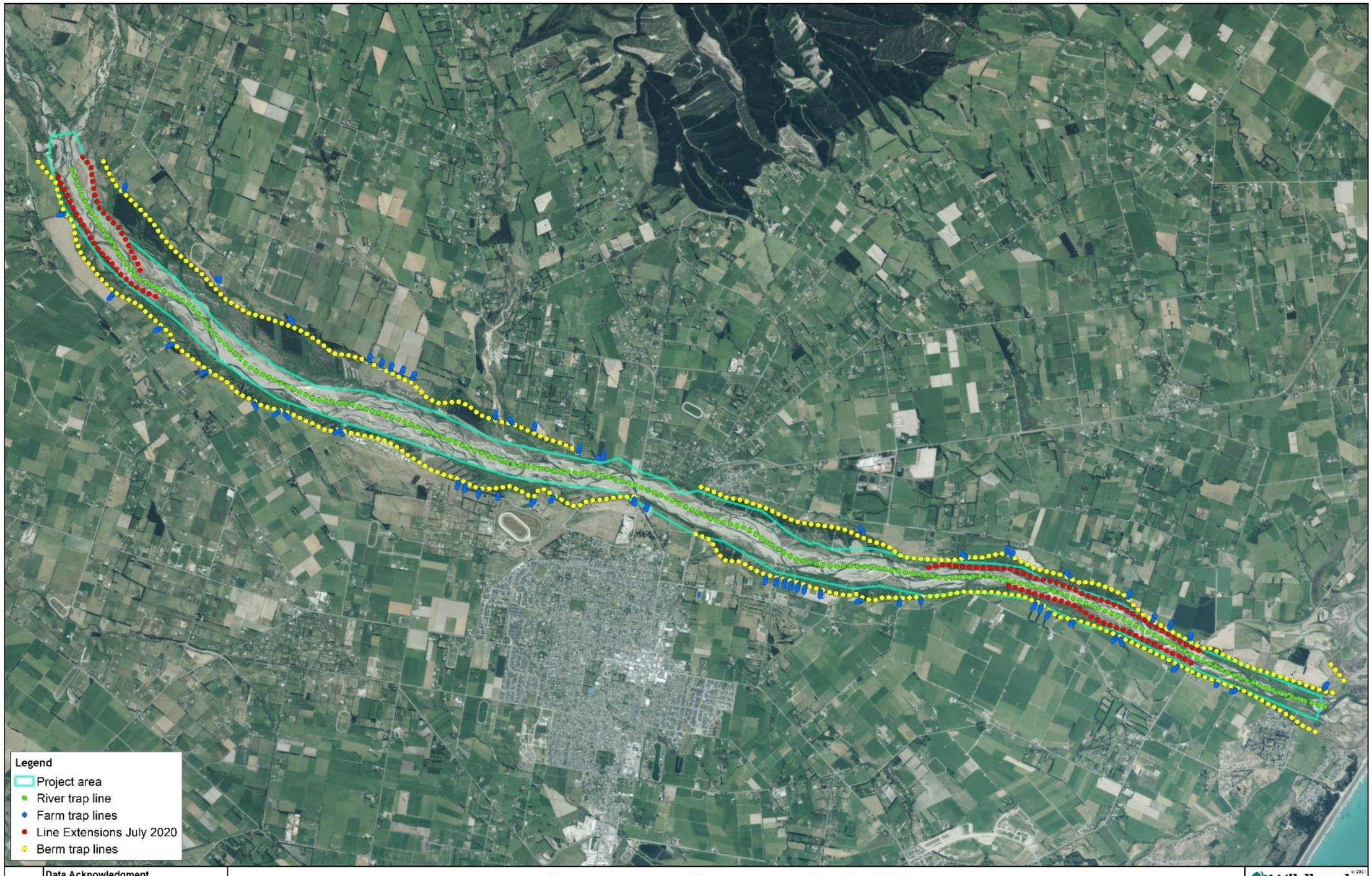

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Figure 3. New trap lines proposed by the ARRG along the Ashley-Rakahuri River control zone

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Figure 4: Bait stations and additional lines proposed for the Ashley/Rakahuri River

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Scale: 1:50,000
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7.3 Evaluation of the new lines proposed by ARRG

The new river and berm lines proposed by the ARRG are a positive initiative. The line down the centre of the river bed will target predators that are active around breeding birds. When considered in isolation, however, this line cannot prevent predators from moving from the berm areas on to the river bed. Predators that do so may prey on nests before being caught in the central line. However, the berm lines will target predators living in or moving through the berm areas. Therefore, the three lines should work in a complementary manner to reduce predator abundance and activity in the project area.

Potential farm trap lines are not necessarily useful as they are very close to existing or planned lines, and additional effort would be better spent implementing the control approach proposed in Section 7.4 below.

The river trap line should be DOC150s as these are light and easy to move around and out of the river bed when fresh floods are predicted. However, the two berm trap lines should follow the layout prescribed in Section 7.4.1.

7.4 Additional pest control

7.4.1 Overview

In addition to the changes proposed by the ARRG, the following key suggestions are provided to further improve the pest control operation:

- Introduce a permanent bait station network (Figure 4), to attempt to substantially reduce the number of rats along the river.
- Several additional trap lines should be added (Figure 4) to:
  - Plug gaps in existing lines in the project area.
  - Infill gaps >600 metres between trap lines in berm areas. This is the minimum spacing between lines required for stoats (c.f. Smith *et al.* 2015).
- An overall trap line configuration aimed at targeting numerous mammalian predators at once. This trap line configuration is described below.

7.4.2 Trap line configuration

The overall trap line configuration should comprise alternating DOC200 traps and DOC150 traps at 100 metre spacings. Every 400 metres along each trap line there should be a paired modified Timms trap and a Sentinel trap. The purpose of the DOC200 traps is to primarily target stoats and hedgehogs, while the DOC150 traps will help target smaller predators such as weasels and rats. Modified Timms traps and Sentinels provide two methods for targeting feral cats, and will also pick up mustelids (which may have avoided DOC-series traps) and brushtail possums.

DOC200s and 150s should be baited with a hen egg and a piece of rabbit, and Timms traps and Sentinels should be baited with a chunk of rabbit or hare. Traps should generally be checked monthly, but fortnightly checks should be undertaken during the braided river bird breeding season if trap saturation is occurring i.e. most traps have caught something during trap checks.

Fenn traps failed National Animal Welfare Advisory Committee (NAWAC) testing. More humane alternatives are suggested here.

Table 4: Traps to be used on trap lines and spacings.

Control Method	Target Species	Distance Between Devices (metres)
Modified Timms trap	Feral cats	400
Ground-set Sentinel	Feral cats	400
DOC200 (alternating with DOC150s)	Mustelids, hedgehogs	200
DOC150 (alternating with DOC200s)	Mustelids, rats, hedgehogs	200

7.4.3 Bait station configuration

Lines of Philproof bait stations spaced 50 metres apart (Figure 4) should be used to target rats (Figure 4), and will also control brushtail possums. The discontinued bait station lines that were previously baited with brodifacoum should be reinstated, to form a continuous line along each berm. If these bait stations are unsuitable for Feracol or Double Tap, or if they are not of a design that is accessible by both rats and possums, they should be replaced with Philproof bait stations.

The bait stations should primarily be baited with Feracol but this should be switched to Double Tap from time-to-time to prevent bait shyness from developing in the population. Switching to Double Tap could either be undertaken systematically or when rat monitoring identifies that rat numbers are persisting despite ongoing use of Feracol. Feracol and Double Tap have been selected for this project due to their ability to effectively target both possums and rats. Neither poison requires a controlled substance licence. Their risk to non-target species, and their potential for environmental contamination, is low when used as intended in bait stations (Eason et al. 2020). However, no poison is perfect from a welfare, bycatch, and environmental contamination point of view. We recommend caution when poisoning, adherence to local laws, toxin label instructions, appropriate public outreach and notification, and a change in toxin use if more suitable toxins become available.

Baits stations should be baited in August before indigenous birds start breeding in the river bed, and run throughout the breeding season. Frequency of bait station checks will depend on the rate at which rodents and possums remove the bait from the stations. The priority is to ensure that bait stations are never empty, as these baits require rats to feed multiple times to receive a lethal dose. Empty bait stations may result in sick rats recovering and becoming bait averse. Pest control operators will soon develop an understanding of how quickly bait is being removed from bait stations, and therefore how frequently bait top ups should be occurring, however this may vary annually in relation to the abundance of rats in the river bed.

7.5 Lagomorph control

Lagomorphs (rabbits and hares) are prey for mustelids, cats, and swamp harriers. Through hyperpredation (Courchamp et al. 2000), lagomorphs may be assisting in maintaining large predator populations and reservoirs of predators either side of the river. Periodic rabbit control may cause an increase in bird predation until rabbit numbers recover. However, long-term lagomorph control through frequent shooting (rabbits and hares) and poisoning (rabbits only) may help to reduce predator numbers

(O'Donnell *et al*. 2016), so long as lagomorph populations are not suddenly dropping before slowly recovering to their previous levels.

7.6 Buffer control

Once all of the control effort described in the previous sections has been implemented, ECan should work with the local community, particularly adjacent landowners to establish a landscape-scale buffer control network. An approximate buffer control area is shown in Figure 5, comprising a 1.5 kilometre radius around the project area. Within this buffer area, perpendicular trap lines should be established along fence lines, wind breaks, roads, streams, and other features, where landowner permission allows. Initially, an attempt should be made to place a perpendicular line every 3-4 kilometres throughout the buffer area, with the focus being on dispersing buffer control around the river. If this is achieved, and there is high landowner uptake and support, then further effort should be made to establish buffer trap lines every two kilometres, where it is practical to do so. The purpose of the buffer control network is to reduce mammalian predator reinvasion of the river bed.

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Figure 5. Buffer zone around the Ashley/Rakahuri River predator control project

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Cartographer: LD
Format: A3R

7.7 River diversion to prevent predators reaching islands

Environment Canterbury and ARRG are interested in the concept of using river diversions to create islands for the focal bird breeding colonies. The purpose would be to reduce or prevent hedgehogs, and potentially other ground-dwelling predators, from accessing key focal bird breeding areas.

Although hedgehogs can swim it is generally considered that they prefer not to. Stoats, weasels and rats are strong swimmers, capable of crossing rivers. However, the rate at which species will cross rivers will be affected by several factors, including:

- Rate of flow: likelihood of a safe crossing.
- Likelihood of reward: food availability on the island compared with the main river bed.
- Territorial pressure: if a pest species is at high density, territorial pressure from conspecifics may encourage individuals to cross rivers.

Consequently, risk from ground-dwelling predators is likely to be lower for focal bird species on islands compared with non-island sites. However, estimating the overall benefit of this in the Ashley/Rakahuri River, compared with other predator control intensification efforts, will need to be carefully evaluated through monitoring. This monitoring would involve a comparative study of breeding success on and off islands created by river diversions, and a camera study of predator visitation rates to nests on and off islands.

The potential of river diversions to discourage predator incursion is unproven and the concept is currently experimental. However, due to the ease with which the river could be diverted, and the lack of alternative hedgehog control options, it could be worth implementing in the short-term. In the long term, natural braiding and island forming should be facilitated through weed control and reduction in the size of berm areas to reduce constriction of the river. This type of braided river habitat enhancement is strongly advocated by the ARRG (ARRG 2021).

8. FUTURE MANAGEMENT OF AVIAN PREDATORS

8.1 Southern black-backed gulls

Southern black-backed gulls are present on all braided rivers in the Canterbury Region and are an immediate and long-term threat to braided river birds during the breeding season (Bell and Harbone 2019).

While black-backed gulls are not abundant in the Ashley/Rakahuri River (Section 2), larger colonies could begin to form and spread if they are not controlled. Alphachloralose poisoning of colonies as they form will help to control their numbers. Luring and shooting, as described in Section 8.2 below, could also be used to control individual problem birds.

8.2 Swamp harriers

Swamp harriers are known to prey on juvenile black-billed gull, particularly in the Smarts section of the project area (ARRG 2021). Harriers should be managed on a case-by-case basis. If particular birds are observed to be a problem for breeding focal birds they should be targeted for control. A permit should be obtained from the Department of Conservation to shoot problematic harriers, luring them in with a rabbit carcass bait. Carcasses of trapped and shot animals should be buried or removed, rather than left where they may attract harriers. Poisoned carcasses should be removed and disposed of in a certified landfill.

9. MONITORING

9.1 Monitoring of pest animal abundance

9.1.1 Catch per unit effort

Catch per unit effort (C/100TN) will continue to play important role in evaluation of the success of the Ashley/Rakahuri River predator control programme. However, for C/100TN to provide an effective monitoring tool there must be consistent bait use and rate of trap checks. If there is an identified need to change the baiting regime, then this should be implemented experimentally on some lines and not others so that the impact of the new bait on C/100TN can be understood. A positive response to bait should lead to an increase in C/100TN compared with other lines, while a negative response to the bait would lead to a decrease in C/100TN.

To avoid a dilution effect on C/100TN of increased trap numbers, subsets of traps should be analysed that reflect the original trapping arrays. Subsets of traps should also be analysed in a manner that will help to understand operational progress, for example:

- Internal lines: to see if there as an overall reduction in predators in the core of the project area.
- Buffer and outer berm lines: to gauge rates of reinvasion and the species that are prevalent on those lines.

Given that several trap lines extend the full length of the project area, rat trap catch data will be extremely useful for the identification of rat hotspots, i.e. locations with high/continual rat captures. This data can be used to better focus bait stations on problem rat infestations.

9.1.2 Camera traps

Camera traps are useful for the following types of monitoring:

- Feral cats, as they are not easily detected in tracking tunnels.
- Determining the overall guild of predators and how they are affected by the control programme, because cameras detect all predators.

- Determining if there is a trap shyness problem. For example, it might be concluded that there is a trap shyness issue if camera traps are detecting numerous stoats, but stoat captures are low in the trap lines.

It is suggested that 4-5 camera trap monitoring lines are established across the project area, placed in representative habitats. Camera trap monitoring of predators should follow best practice methods developed by the Department of Conservation (Gillies 2021), with each line having five camera traps set out for 21 nights. Camera trap monitoring should be undertaken in early September and February.

9.1.3 Tracking tunnels

Tracking tunnels are useful for monitoring of rats, stoats, and hedgehogs in a manner that is independent of trap catch rates. They are also useful for monitoring mice. Tracking tunnels also record lizard footprints and can be used to index lizard responses to pest control. It is suggested that 6-8 tracking tunnel lines are established throughout the project area and run at least three times per year: twice during the focal bird breeding season and once during the winter prior to the breeding season. Tracking tunnel use should follow the methods described in Gillies and Williams (2013).

9.1.4 WaxTags

WaxTags can be used to monitor rats and possums. Sufficient information on rats should be available from C/100TN, camera trapping, and tracking tunnels. WaxTag monitoring should only be included if there is an identified need to monitor possums, e.g. possums are as preying on the nests of indigenous birds within the project area). See NPCA (2020) for information on setting up WaxTag monitoring.

9.1.5 Avian predators

Data to date shows that ARRG are able to satisfactorily count the number of black-backed gulls in the project area during their bird surveys, so long as current monitoring continues no further monitoring will be required. Problematic harriers will be identified during monitoring of focal bird breeding.

9.2 Monitoring indigenous biodiversity abundance

ARRG undertake a laudable level of intensive monitoring of focal bird species in the project area during the breeding season (ARRG 2021). This includes walking surveys and nest monitoring. As a result, ARRG are able to provide detailed information on focal bird numbers and their spatial distribution within the project area, and the nesting success of breeding pairs and colonies. The level of monitoring undertaken by the ARRG, in conjunction with their detailed reporting, should be sufficient to determine whether or nesting success improves due to intensification of predator control.

10. WHEN TO USE VOLUNTEERS AND/OR CONTRACTORS

10.1 Predator control

Contractors should be employed to deploy and maintain the rat bait stations.

Working closely with ECan the ARRG should continue to run and provide oversight of the trapping component of the programme. However, as the programme grows, volunteer capacity and capability will need to be reassessed. If growth in the number of volunteers is slow, and the overall administration of their efforts is onerous, then sections of trap lines could be contracted out.

10.2 Monitoring

ECan and the ARRG should work together to maintain their focus on monitoring the focal bird species. If the increased predator monitoring proposed in Section 9.1 is beyond volunteer capability then contractors should be used to implement this monitoring.

11. CONTINGENCY: PRIORITISING OF CONTROL EFFORT IF RESOURCES ARE LIMITED

11.1 Predator control

If funding is limited, predator control should be prioritised in the following manner (over and above current control effort):

- Deployment of rat bait stations.
- Deployment of the river bed and berm lines proposed by ARRG (but not the farm lines). The highest priority is the berm lines, followed by the river line.
- Deployment of the additional control lines suggested in this report.
- River diversion experimentation.
- Establishment of buffer control (Section 7.4).

Note that trapping around colonies is reactive, protecting current nests in the short-term, while fairway trapping is long-term for population control. If the budget is limited then fairway trapping can be dropped from the programme, and reactive colony trapping effort increased instead.

11.2 Monitoring

If funding is limited, additional monitoring should be prioritised in the following manner.

- Continue the intensive braided river bird counts and nest monitoring.
- Tracking tunnels.
- Camera trap monitoring of predators. However, cameras should not be taken away from nest monitoring for this purpose, and additional cameras should be bought or borrowed for predator monitoring.

It is assumed that changes to C/100TN can be implemented within current capacity.

12. NEW TECHNOLOGY

There are a large number of new predator control tools proposed and being developed, with efforts made to bring them to market. If approached, ARRG should not get involved in the beta testing of new tools. This is because it will be difficult to determine what benefits the new tool brings if it is trialled in the project area, where predator control has already been implemented for some time. This process may therefore result in a costly distraction, with no confirmable results.

If a new tool and what it promises is compelling for ARRG they should trial it further up the Ashley/Rakahuri River, outside the project area, or in another unmanaged section of a Canterbury River with Environment Canterbury's support. After a suitable trial period the ARRG should then evaluate the results of this new tool against their existing data set, to determine what value it can bring to their programme.

13. RESEARCH OPPORTUNITIES

The Ashley-Rakahuri river pest control project presents an opportunity for research into Norway rat ecology on braided rivers. Given the severity of the threat posed by Norway rats to braided river birds, a study on their movements (perhaps using radio tracking) would be extremely useful. The pest control project would also benefit from data showing the types of habitats along the river where rat colonies occur.

14. CONCLUSIONS

ARRG have implemented extensive predator control in the bed of the Ashley/Rakahuri River between the Okuku River and the estuary over the past two decades. They also undertake extensive and thorough monitoring of indigenous braided river birds and their nests. Trap data suggests that rat numbers have increased and that hedgehogs are probably not under control.

Predator control should be intensified, with the highest priorities being implementation of bait stations to knock down rat numbers, followed by intensification of berm trapping, and intensification of river bed trapping. In the longer-term, extensive buffer control should be established to reduce recruitment of predators onto the river bed.

Catch per unit effort monitoring should be refined, by evaluation of subsets of the data to determine relative densities in different sections of the project area, and how they are tracking over time. Establishment of tracking tunnels and camera monitoring of predators will provide monitoring independent of the trap catch data, and will help with monitoring of the overall composition of the predator guild, and whether there are trap shy residual populations, that may need to be targeted using other tools.

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APPENDIX 1

THREE-YEAR WORK PLAN

Year	Tasks	Timing
1	Deployment of the berm lines proposed by the ARRG (Section 7.2).	July-August.
	Deployment and prefeeding of rat bait stations (Section 7.4.3).	July. Prefeed until August, then fill with poison bait.
	Establishment of camera trap monitoring lines.	Establish and run for the first time in September of Year 1. Then run every year in September and February.
	Establishment of tracking tunnel lines.	Establish and run for the first time in October of Year 1. Then run in October, December, and June every year.
	Southern black-backed gull poisoning.	October-November every year.
	Swamp harrier control (lure and shoot).	Throughout the braided river bird breeding season, where necessary to remove problem individuals.
2	Deployment of the river bed lines proposed by the ARRG.	July-August.
	River diversion experimentation.	August.
3	Deployment of the additional trap lines suggested in this report (Section 7.4.2).	July-August.
	Establishment of buffer control (Section 7.4).	Year-round; ongoing.

APPENDIX 2

CONTROL METHODS FOR SPECIFIC PREDATORS

CATS

If modified so that their entrance is wide enough to accommodate a cat's whisker span, Timms traps can be effective in catching cats. Enlarging the entrance hole by 25 millimetres all around the circumference, and baiting the trap with fresh or salted meat, is enough to modify a Timms trap for catching cats (Bay of Plenty Regional Council 2018). Existing Timms traps can be modified rather than new Timms traps being placed.

Ground-set Sentinel traps can also be used to catch cats, if baited by wiring meat to the trigger plate. The wire should be made as tight as possible with pliers so that the cat has to pull at the meat. The traps must be pegged to the ground through the holes in the cover and the metal rings at the top of each trap.

The new pest control regime uses a line of Sentinels and modified Timms traps along the riverbank lines, filling in the gaps around Cones Road.

MUSTELIDS

Larger mustelids can be caught in Timms traps and ground-set sentinels; smaller mustelids are caught in DOC150s. The DOC200 is an excellent trap for catching most mustelids, though smaller weasels will not trigger the traps (Haworth 2018). DOC200s are proposed to fill the gaps in the riverbank lines. They can be baited with two hen eggs (one cracked or pierced, the other whole), or fresh or salted rabbit or hare meat, or a hen egg rabbit combination. Dragging the bait around the entrance can help to entice the animals to investigate the trap. Trap entrances must be kept clear of weeds.

RATS

Where rat population increases are detected by trail cameras, wax tags, or kills in traps, intensive poison baiting should be done in that portion of the river, using Feracol and Double Tap. All bait stations should also be filled with poison before the start of each breeding season, and kept full until all chicks have fledged. The bait stations should be left out year-round, and pre-fed at least three times before poison is laid.

HEDGEHOGS

No poisoning or baiting method is known to control hedgehogs effectively in an open system where they can continually reinvade. Possum leghold traps and DOC-series traps baited for cats and mustelids frequently catch hedgehogs, so should be relied upon to catch them in the Ashley/Rakahuri river.

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