Department of Conservation
Te Papa Atawhai

19-E-0503 – DOC 6041941

21 August 2019

[redacted]
Email: [redacted]

Dear [redacted]

I refer to your official information request of 24 July 2019 for information relating to takahē in Kahurangi National Park.

Kahurangi permission documentation

> *Please can you also provide copies of any Wildlife Act permits, HSNO Act s95A permits or any other permits or authorities that DoC has issued for its 2019 aerial poisoning operation to kill Takahe, Kea or any other wildlife in Kahurangi National Park.*

My letter of 25 July 2019 advised that this information is available online.

Takahē translocation to Kahurangi National Park

Before responding to your remaining questions, I would first like to provide some background information.

As a result of years of sustained effort, the takahē has been recently downgraded from a 'Nationally Critical' to 'Nationally Vulnerable' species. The population is increasing at 10% per year, with most breeding taking place at the Burwood Takahē Centre. Prior to 2018, the only wild population of takahē (where takahē exist within their natural range) was in the Murchison Mountains, Fiordland. With an estimated population of approximately 130 birds, the Murchison Mountains were nearing capacity. One of the primary goals of the 2015-2028 Takahē Recovery Plan, therefore, was to establish a second wild takahē recovery site, which would give the national takahē population much greater security.

Gouland Downs in Kahurangi National Park was chosen for the new takahē habitat, due to the suitability of the plant species, breeding habitat, topography, climate, availability of water, and low numbers of predators.

The number of predators was an important factor because takahē are very susceptible to predation by introduced mammals. Trapping alone has provided insufficient protection for the Murchison Mountains population in years when beech and tussock seeding leads to a surge in stoat numbers; in 2007 up to 40% of the adult population were lost. Chick and juvenile deaths from predation are likely to be much higher than adults.

Conservation House - *Whare Kaupapa Atawhai*
PO Box 10 420, Wellington 6143
Telephone (04) 471 0726, Fax (04) 381 3057

While takahē and many other native species in the Murchison Mountains would benefit from the use of aerial 1080 for predator control, it cannot be used there, because the susceptibility of takahē to 1080 is unknown.

Gouland Downs has benefitted from regular 1080 operations since the 1990s, and the trapping network has recently been upgraded. This predator control has ensured the protection of vulnerable species at this site. Before Gouland Downs was chosen as the new takahē habitat, it was determined that this area could be partially excluded from the next 1080 operation to help mitigate any negative impact on takahē. This would also allow further time for the Takahē Team to investigate the susceptibility of takahē to 1080, and to seek effective repellents.

Assessment and mitigation of risks to takahē from 1080 in Gouland Downs

> *Please can you urgently advise what steps have been taken by or on behalf of DoC to assess the risk to Takahe of using 1080 poison baits and/or to to protect Takahe and Tahake food and habitat from 1080 poison during DoC's 2019 Kahurangi 1080 poison operations.*
>
> *Please can you also provide copies of any assessment of effects prepared by or on behalf of DoC for its 2019 Kahurangi poison operation.*

As takahē susceptibility to 1080 is not currently known, measures have been put in place to avoid the risk that takahē will be exposed to 1080 during the 2019 Tiakina Ngā Manu operations in Kahurangi National Park.

An area will be excluded from the treatment area, encompassing at least 80% of the Gouland Downs takahē population. This zone will be as small as possible to ensure protection from predators for other threatened native species in the area – some of which have a higher threat classification than takahē. An exclusion zone of about 500 ha is currently planned.

Where possible, the takahē outside this exclusion zone will be relocated into the excluded area. During the last week of July, three takahē were relocated back into the core protected area and appeared to remain in place. Further attempts to capture remaining takahē outside the exclusion zone will be carried out ahead of the drop, but it is likely a small number of the takahē will remain outside the exclusion zone given it can be difficult to catch wild birds.

Temporary enclosures have been constructed in which to hold relocated birds during the drop. These birds will be released following sufficient degradation of monitored 1080 baits.

All of the takahē are wearing radio transmitters, enabling those outside the exclusion zone to be close approached. These birds will be monitored visually and aurally, as much as is practical, as it is critical that we understand the level of risk posed by 1080 to takahē to enable informed future decision-making.

DOC undertakes pest control operations for the overall benefit of native species populations. Given the measures being put in place to avoid risk to most of the Gouland Downs takahē, and takahē population growth of more than 10% annually, exposure of a small number of takahē to 1080 will not affect the security of the species.

Rat numbers will be monitored following the prefeed drop in Gouland Downs. If rat densities exceed 50%, the threat to other native species in the area will require the plan for the exclusion zone to be reconsidered. Instead, the takahē will be captured and housed in temporary enclosures for the duration of the drop. It is considered unlikely that rat densities will reach this level in Gouland Downs.

Documents we are providing to you

We are providing you with three documents within scope of your request. The first, titled *2019 Kahurangi 1080 operation: takahē mitigation and monitoring plan*, describes in further detail the exclusion plan outlined above.

The documents *Captive takahē 1080 trial* (draft) and *1080 bait monitoring 2019: Gouland Downs, Kahurangi National Park v2*, relate to two trials that aim to provide insight into the risk to takahē of 1080, without putting takahē at risk.

We have withheld the names of individuals from these documents under sections 9(2)(a) and 9(2)(g) of the Official Information Act 1982 to protect their privacy and to prevent any improper pressure or harassment of officials or employees. In making this decision, I have taken into account the public interest considerations set out in section 9(1) of the OIA.

You have the right to seek an investigation and review by the Ombudsman of this decision. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

If you wish to discuss this decision with us, please feel free to contact me at this email address.

Please note that this letter (with your personal details removed) and enclosed documents will be published on the Department's website.

Yours sincerely

Martin Kessick
Deputy Director-General, Biodiversity

Item	Date	Document description	Decision
1	31 July 2019	2019 Kahurangi 1080 operation: takahē mitigation and monitoring plan	Released in full
2	30 July 2019	Captive takahē 1080 trial (draft)	Released in part
3	4 July 2019	1080 bait monitoring 2019: Gouland Downs, Kahurangi National Park v2	Released in part

2019 Kahurangi 1080 operation: takahē mitigation and monitoring plan.

For all information regarding the upcoming Kahurangi BFOB 1080 operations:

Kahurangi BFoB 2019 Operational Plan DOC-5593075

For full context and key messages around takahē and the upcoming 1080 drop in Kahurangi National Park, see the Communications Plan:

Takahe and 1080 Communications Plan DOC-5708988

For a summary of takahe and 1080 research undertaken to date:

Takahe bait repellent DOCDM list DOC-5950758

2019 Kahurangi BFoB Operations

There are four 1080 operations planned for Kahurangi National Park in 2019 (image 1). Gouland Downs sits within the Aorere block, which, of the four, is the lowest priority in terms of relative predator numbers. However, if weather conditions were right for the northern Aorere block, and not for one of the others, then the weather window would be utilised, and the drop for this block would go ahead of the others. Originally there were 14,000 ha of alpine exclusions (image 1), these have recently been scrapped due to high alpine rodent numbers. The only planned exclusion zone is for takahē at Gouland Downs.

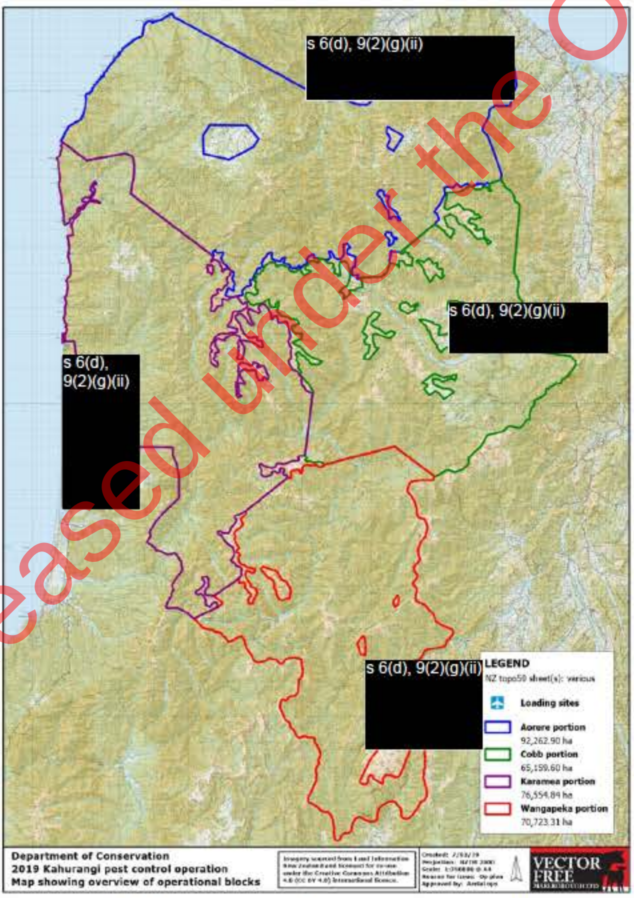

Image 1. 2019 Kahurangi BFoB operational blocks

1080 mitigation at Gouland Downs for takahe will consist of three main components:

- 1080 drop exclusion zone
- Captive Enclosures
- Close approach monitoring

Exclusion zone

A 1080 exclusion zone is the preferred method for limiting takahē exposure to 1080, in terms of infrastructure and staff time required, as well as stress to the birds. This is the least preferred option in terms of reducing the effectiveness of the drop, and the protection of other species inside the exclusion zone. In 2018, an exclusion zone of ~3400ha was originally tabled (Image 1. Blue polygon), which, at the time, encompassed most of the birds. Due to recent bird dispersal, and concerns over the lack of 1080 protection for such a large area, the exclusion zone is under revision and has been greatly reduced in size; somewhere between 600-1,000ha (Image 2. Red polygon- ***as a rough indication***).

The exact shape and size of the final exclusion zone is yet to be determined, it will depend on bird movements and rodent tracking results in the coming months.

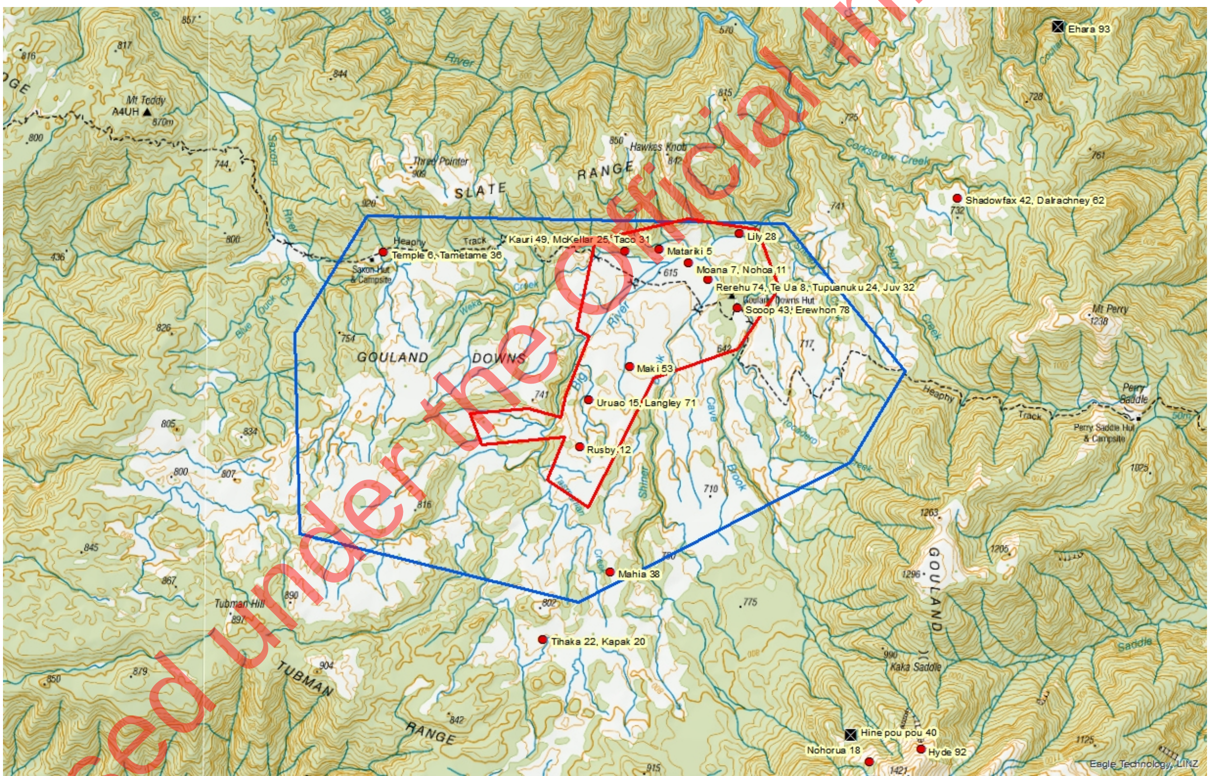

Image 2. Recent takahe locations, and 1080 exclusion zones; original (blue) and revised (red).

A smaller, more targeted exclusion zone will encompass the core takahē area between Weka Creek and Gouland Downs Hut, and birds just to the South, which have been stable in pairing and location for some time now. Birds outside of this exclusion zone are either wandering and not settled, or the required extension of the zone is unsatisfactory.

The Takahe Recovery Team (TRT) will continue to monitor bird locations at least monthly either by foot or by fixed-wing tracking. When notification of the prefeed for the Aorere Block is received, the TRT will fly a fixed wing tracking flight, to provide an immediate indication of bird locations, and a last draft of the exclusion zone. After which the TRT will undertake another last-minute round of monitoring by foot, to finalise the exclusion zone boundary for the toxic drop.

Captive Enclosures

Following the conclusion of the prefeed operation; the TRT will endeavour to capture takahē that are outside of the exclusion zone prior to the toxic drop. However, it is expected that we will not be able to catch all the birds, due to location (near thick scrub) or individual wariness (running long before we get close enough). Takahē will be targeted for capture in order of genetic value & age (table 1); Although Catlin is highly ranked, she is reaching breeding retirement age.

The aim is to have at least 80% of the Gouland sub population protected from exposure to 1080. To give this 80% figure context; in the Murchison Mountains, annual adult mortality rates average 20% during stoat plague years (following a mast year). For the 2017 calendar year; the mortality rate for adult takahe in the Murchison Mountains was 18.5%, modelled at 24 birds out of ~128.

The TRT intend to construct four captive pens onsite at Gouland Downs. These will be inside the exclusion zone, out of public view. These will be approximately 10x10m in size and be far enough away from each other so neighbouring pairs are not trying to get at each other. Internal partitions can be installed to house single birds. Construction of the pens is planned to be completed before the prefeed operation begins.

Table 1. Takahē priority list (genetics)

BAND	House Name	Sex	MKRank	Age (years)
R32990	RUSBY	Female	21F	10
R54562	CATLIN	Female	26F	13
R32987	SHADOWFAX	Male	38M	10
R60811	TACO	Male	72M	2
R60540	TIHAKA	Male	80M	6
R60510	LANGLEY	Male	99M	8
R60771	MAKI	Female	105F	2
R60852	MCKELLAR	Female	122F	3
R32958	LILY	Female	129F	9
R60850	KAURI	Male	137M	2
R60720	KAPAKAPAPANU	Female	142F	3
R54854	URUAO	Female	143F	7
R32559	MATARIK	Male	143M	12
R60777	DALRACHNEY	Female	145F	2
R60790	MOANA	Male	145M	2
R60737	EREWHON	Female	146F	2
R60502	TE UATORIKIRIKI	Female	153F	7
R60731	SCOOP	Male	154M	2
R54578	HYDE	Female	156F	8
R54851	TAMETAME	Male	167M	8
R31565	REREHU	Male	171M	9
R60846	EHARA	Female	173F	2
R60524	NOHORUA	Male	176M	8
R60890	MAHIA	Female	177F	3
R60778	MULLER	Female	183F	2
R60555	HINE POU POU	Female	185F	7

R60528	NOHOA	Female	187F	7
R60719	TUPUANUKU	Female	188F	2
R60740	TEMPLE	Female	192F	2
R60801	Juvenile	Unknown	---	0

Pens will be constructed using steel waratahs in each corner, with plastic waratahs in between and top and bottom strainer wires running around the pen. The pen wall will be heavy duty, close-weave windbreak or shade-cloth. This will be 1800mm high; 1200mm high wall with a 600mm ground skirt. The wall will be clipped to the strainer wires, the skirt will be pegged down. Waratahs will be tightened with guys ropes (image 3). Most materials will be sourced through Mitre10 and the "Official Supplier" relationship. A trial pen has been constructed and tested at Burwood takahē centre (image 4)

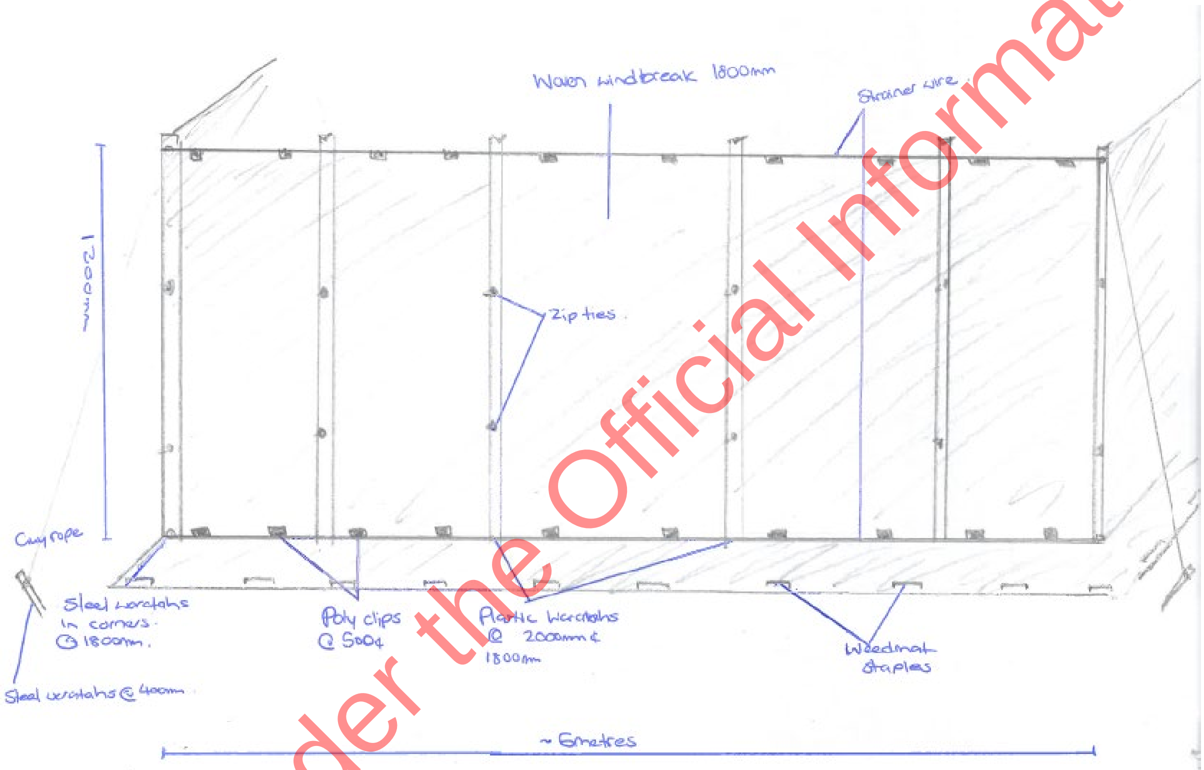

Image 3. Takahē holding pen design

Image 4. Test pen constructed at Burwood Takahē Centre

Table 2. Required materials for a captive pen (*per pen*).

ITEM	QTY	SOURCE
Steel waratahs	4	Mitre10
HT Wire	100m	PGG Wrightson
Plastic waratahs 1800mm	8	Kiwireco & Advanced Landscapes.
Steel Rebar pegs 300mm	24	Mitre10
Light weight tie downs	4	Mitre10
Gripples	2	PGG Wrightson
Windbreak woven	50m	Mitre10
Windbreak U pegs (packet of 20)	4	Mitre10
Wind break clips (packets of 50)	2	Mitre10
Hopper stand	1	Burwood
Hopper	1	Burwood
Water trough	1	Mitre10
Bird pellets (bags)	1	Burwood
Plywood takahe box	4	Burwood
TOOLS		
Safety glasses		Mitre10

Waratah post rammer		Mitre10
Hammer		Mitre10
Fencing pliers		Mitre10
Stanley knife		Mitre10
Pliers		Mitre10
Gripple tool		PGG Wrightson
Drill		Mitre10
Driver		Mitre10
Drill bits		Mitre10
Check at hut?:		
Spade		
Scrub bar		

A sweep of the pens will be made to ensure there are no baits inside immediately after the drop.

Takahē housed in pens will be supplementary fed from hoppers with pellets from Burwood, all takahē on Gouland Downs have come from Burwood and are used to feeding from hoppers. The captive takahē may have to be there for up to a month if there are no significant rain events that reduce the toxicity of the baits. This will put significant strain on the captive takahe, the shorter the time they are in the pens the better. The TRT will be conducting a bait toxicity & degradation trial at Gouland downs during this drop, to assess the danger period to takahē.

1080 bait monitoring plan Gouland Downs 2019 DOC 6001471

Once deemed safe, the penned takahē will be released between Saxon & Gouland Downs Huts.

Loss of exclusion zone

In the event of rat tracking reaching over 50% on Gouland Downs, the 1080 exclusion zone will be scrapped in order to maximise 1080 protection for the area. If this scenario occurs, then all takahē will be attempted to be caught and penned. The Takahē Team will need to construct up to 12 pens, and ensure they have adequate roofing protection on the day of the drop. This would require significant resources and staff time. Also enough warning in order to procure all the equipment and supplementary food needed.

Close approach monitoring

All takahē, in exclusion zones, pens, and any outside of the exclusion zones (exposed to 1080), will be monitored daily.

Takahē inside the exclusion zone will not be close approached, but their position inside the exclusion zone confirmed with telemetry.

An attempt to close approach the takahē outside of the exclusion zone will be made daily, in order to determine their levels of activity, and hence possible bait consumption and resulting illness. Fresh faecal samples from the immediate area will be collected to test for both traces of 1080, and wheat/corn DNA (evidence that baits have been consumed). These faecal samples will be stored in the 12V freezer at the hut and transferred to the freezer in Te Anau for longer term storage until they are processed.

> *Weka fitted with activity level transmitters were followed through 2 operations. Most of the weka's activity levels dropped in the days following the drop, and then returned to normal after approximately 7 days, with low levels of mortality (1.8%). This indicated that there was a high level of bait consumption, after which the weka became ill and activity dropped, until the 1080 was metabolised and they recovered.*
>
> Tinnemans et al 2018. Costs and benefits of aerially applied 1080 poison to western weka (Gallirallus australis australis.)

Activity level transmitters were not fitted to takahē at the time of release into Gouland Downs, as the TRT had experienced reliability issues with them in the past, and it was not known which birds could potentially be exposed to 1080 in the future. A conservative approach of fitting trusted transmitters was taken.

In the event of any takahē death in the three month following the operation, the body will be sent for Necropsy and toxicology.

Following veterinary advice; In the event of discovery of a very sick takahē (immobile) that has consumed a sub lethal, dose of 1080 the bird will be sent for immediate veterinary treatment. There is no antidote for 1080 poisoning, but treatments such as acetamide or glycerol monoacetate can help.

> Goh et al, 2005. Sodium Monofluoroacetate Compound 1080 Poisoning in Dogs. Australian Veterinary Journal

Staffing & Timeframes

The TRT has no expectation of any local DOC staff time for monitoring during the drop, and will cover this either with it's own staff, or contractors.

Trip Type	When	Staff	Timeframe
Takahē pen construction	ASAP following notification of prefeed operation.	2	2 days
Pre-drop Monitoring	ASAP following notification of Prefeed operation. Fixed wing flight for immediate indication of bird locations, followed by ground truthing trip to confirm exclusion zone.	2	3 days
Takahe capture	Completion of Prefeed, ASAP following notification of toxic operation.	6	5 days
Post-drop monitoring 1080 bait trial.	From notification of toxic operation.	2-3	Fortnightly roster until baits degraded. 3rd person required if there are far-flung outlier birds.
Loss of exclusion zone	*Rat tracking >50% on Downs*		
Pen construction for all takahē (12 pens)	ASAP following notification of prefeed zone	4	5 days
Takahē capture (all takahē)	Completion of Prefeed, ASAP following notification of toxic operation.	12	5 days

1080 bait monitoring 2019: Gouland Downs, Kahurangi National Park V.2

Background:

The aerial pest control operation (0.15% wt/wt 1080 6g cereal RS5 baits) due to take place over Gouland Downs, Kahurangi National Park, provides the Takahē Recovery Team with the opportunity to further their knowledge around the risks posed to takahē from such an operation. As part of this, it is proposed that trials investigating 1080 persistence in cereal baits in a tussock environment, and bait availability over time will be run. These will add to the information already gained from captive takahē bait trials and will help to inform the team of the likely risk period duration should takahē be exposed to an aerial 1080 pest control operation using 6g cereal baits.

Trial 1: Bait weathering trial

Aim:

To investigate the toxicity across time of green dyed 0.15% (wt/wt) 1080 6g RS5 cereal baits under natural conditions in takahē habitat/tussock environment concurrently with an aerial pest control operation utilising the same bait type. It is hoped that this will ultimately help inform the Takahē Recovery Team of the risk period during which takahē may be exposed to potentially lethal levels of 1080 in baits. N.B this trial is dependant on s 9(2)(a), 9(2)(g) [redacted] having received her Certified Handler's Certificate and Controlled Substance Licence by the operation date, the application is currently being processed.

- **Location:** s 6(d), 9(2)(g) [redacted] Gouland Downs
- **Start date:** Exact date unknown at present: from day before 1080 aerial operation day (between June 2019 and February 2020) onwards.
- **Trial length:** Until bait has disintegrated or assays come back with negligible levels of 1080 content. Expected to be 1 – 3 weeks.
- **Equipment required:** 2 x rodentproof bait cages
  1 x weka, possum, and kea proof dog crate
  130 x green dyed 0.15% (wt/wt) 1080 6g RS5 cereal baits
  Spade (for digging in the dog crate)
  Tent pegs (for holding cages down)
  4 x small waratahs
  2 x strops
  Spoon (for bait sampling when bait is mushy)
  Davis Vantage Vue weatherstation
  4 x sealed containers (for storing/posting samples)
  4 x polystyrene containers (for posting samples)
  Parcel tape
  4 x iceblocks (for sending with samples)
  30 x ziplock bags
  Gloves
  Spill kit
  1 x tag pen
  1 x 12v freezer (for samples)

2 x padlocks

- **Documentation required:** JSA
  Correct labels for bait sample freezer
  4 x Correct labels for bait samples during transport
  1 x warning sign for weathering cages
  6 x Safety Data Sheet (1 for storage freezer, 1 for emergency response plan, 4 to send with samples)
  Tracking sheet - DOCDM 22761
  4 x Transfer of tracked substance form (for sending samples to Landcare) DOC-3224543
  Emergency response plan
  Safe handling sheet – DOCDM 22712 (Aerial baits), DOCDM 22715 (Ground based baits)

Method:

Before the day of the bait drop

- Move equipment to s 6(d), 9(2)(g) [redacted]
- Pick a secluded position for weathering cages, s 6(d), 9(2)(g) [redacted].
- Set up weathering cages, ensure they are well secured with pegs, waratahs and strops.
- Set up warning sign on/next to weathering cages.
- Set up Davis Vantage Vue weather station and console (station can be 60 – 120m from console).
- Set up 12V freezer (MUST NOT BE USED FOR FOOD). Freeze iceblocks.
- Identify a good location for Emergency Response Plan folder and Spill Kit; ensure other members of team know where these are located.

Day 0 (1080 operation day)

- Place approx. 130 baits in the weathering cages, spread out evenly on ground, ensure not all clumped together (baits ideally brought in with us beforehand and just put out on drop day OR if that is not possible, collected from track clearing).
- Take sample of 6 baits in a ziplock bag; label it Sample 1, day 0 (drop day), date, contents and location on outside and on a piece of waterproof paper inside the bag. Freeze in separate 12V freezer.
- Ensure weathering cages are padlocked.
- Fill in bait tracking sheet.
- Record bait degradation state (1 = fresh, intact. 5 = completely disintegrated)
- Record weather.

Days 1 (the day after the 1080 operation) to 7, then every 2 days i.e. day 9, day 11, day 13 etc.

- Each day take a sample of 6 baits in a ziplock bag; label it Sample 1, day e.g. day 0 = drop day, date, contents and location on outside and on a piece of waterproof paper inside the bag. Ensure correct PPE is worn and you have a copy of the Safety Data Sheet.
- Freeze in separate 12V freezer
- Ensure weathering cages are padlocked.
- Fill in bait tracking sheet.
- Record bait degradation state (1 = fresh, intact. 5 = completely disintegrated)
- Record weather.

Assays:

- Prior to sending samples: e-mail s 9(2)(a), 9(2)(g) [redacted] a copy of the 'Transfer of tracked substance' form (DOC322543). Include in the e-mail details of what you would like the samples tested for and who to contact with the results and invoice.
- Ensure the frozen samples are individually well labelled, with a Safety Data Sheet and packed in sealed ziplock bags in a sealed container in a polystyrene box with ice blocks to keep them cool.
- Include clear instructions on what you wish the baits to be tested for, and who to contact with the results and invoice.
- Update bait tracking sheet: keep a record of what samples you have taken and what you sent off, when.
- Ensure that you use a suitably licenced courier company who is aware of the contents of the package, and that any associated paperwork necessary for safe transport is completed.

- Send samples via next day delivery courier to: s 9(2)(a), 9(2)(g) [redacted] (Laboratory Manager),
  Toxicology Laboratory,
  Landcare Research,
  Gerald St,
  Lincoln 7640.
  Phone: s 9(2)(a), 9(2)(g) [redacted]

Trial 2: Bait availability and degradation; daily monitoring areas

Aim:

To investigate how the availability of green dyed 0.15% (wt/wt) 1080 6g RS5 cereal baits to takahē changes across time following an aerial 1080 pest control operation. It is hoped that this will help inform the Takahē Recovery Team how bait encounter rate and so risk changes over time, although it is recognised that this will be influenced by many variables (weather, temperature, rodent numbers, rodent hunger, weka numbers, weka hunger) to differing degrees in each operation. This trial involves baits being monitored within defined 20 x 20m areas of the drop zone in tussock habitat. The number of baits seen in each Area may therefore vary but will give an indication of spread and potential encounter rate under normal aerial pest control operation protocol.

- **Location:** s 6(d), 9(2)(g) [redacted]. Ideally representative of takahē territories.
- **Start date:** Exact date unknown at present: from day before the 1080 aerial operation day (between June 2019 and February 2020) onwards.
- **Trial length:** Until bait has disintegrated or assays come back with negligible levels of 1080 content. Expected to be 1 – 3 weeks.

- **Equipment required:**
  1 x GPS
  190 x 1.8m bamboo stakes
  800m light rope/twine
  Flagging tape
  Waterproof notebook
  Clipboard
  Area bait record sheet
  Pencil
  Tape measure (or 20m long rope)

- **Documentation required:** JSA
  Safety Data Sheet
  Safe handling sheet – DOCDM 22712 (Aerial baits),
  DOCDM 22715 (Ground based baits)

Method:

A few days prior to the 1080 bait drop

- Choose up to 10 sites for 20 x 20m monitoring areas: should be representative of the site, but not too time consuming to access.
- Name transects (Area 1 – Area 10)
- Mark out each 20 x 20m area with four bamboo stakes, rope and flagging tape.
- Position 15 individually marked bamboo stakes at random within the area (to address initial weka interest). Stakes should be marked with Area Number and Bait Number i.e. A1:B1, A1:B2 etc.
- GPS each area, and name it in the GPS.

Day 0 (1080 operation day)

- Remove the 15 bamboo stakes from the Area.
- Thoroughly search the Area for 1080 baits. It is not essential o find all baits in an area, but it is better if you do.
- When a bait is found, place a bamboo stake **in the ground one metre to the North of the bait** (this is to try and reduce weka or other species attention being drawn to baits).
- Fill out Area Bait Record Sheet
- Record bait degradation state (1 = fresh, intact 5 = completely disintegrated)
- Record weather.
- Repeat with as many of the 10 Areas as time allows.

Daily

- Walk all Areas, looking carefully at/for each marked bait.
- If the bait seems to be missing, search the general area in case bait has been moved.
- Fill out the Area Bait Record Sheet
- Record bait degradation state (1 = fresh, intact. 5 = completely disintegrated)
- Record weather.

Trial 3: Control Areas

Aim:

To compare the availability of green dyed 0.15% (wt/wt) 1080 6g RS5 cereal baits over the study period in areas that are not walked daily with that of our bait monitoring areas. This is to check that our activity has not affected bait predation, either by increasing weka interest, or by putting off rodent activity through frequent human presence.

- **Location:** Sites across Gouland Downs, accessible from the Heaphy Track. Ideally representative of takahē territories.
- **Start date:** Exact date not known at present: Day before the 1080 aerial operation day (between June 2019 and February 2020) onwards.
- **Trial length:** Until bait has disintegrated or assays come back with negligible levels of 1080 content. Expected to be 1 – 3 weeks.
- **Equipment required:** 1 x GPS
95 x 1.8m bamboo stakes
400m light rope
Flagging tape
Waterproof notebook
Clipboard
Control Area bait record sheet
Pencil
Tape measure (or rope marked at 20m)
- **Documentation required:** JSA
Safety Data Sheet

Method:

A few days prior to the 1080 bait drop

- Choose 5 sites for 20 x 20m Control Areas: should be representative of the site, but not too time consuming to access
- Name Control Areas (Control Area 1 – Control Area 5)
- Mark each 20 x 20m Control Area with a bamboo stake in each corner and rope.
- Position 15 individually marked bamboo stakes at random within the area (to address initial weka interest). Stakes should be marked with Control Area Number and Bait Number i.e. CA1:B1, CA1:B2 etc.
- GPS the Control Area, and name it in the GPS.

Day 0 (1080 operation day)

- Remove the 15 bamboo stakes from the Control Area.
- Thoroughly search the Control Area for 1080 baits. It is not essential to find all baits in an area, but it is better if you do.
- When a bait is found, place a bamboo stake **in the ground one metre to the North of the bait** (this is to try and reduce weka or other species attention being drawn to baits).
- Fill out Control Area Bait Record Sheet
- Record bait degradation state (1 = fresh, intact. 5 = completely disintegrated)
- Record weather.
- Repeat with as many of the 5 Control Areas as time allows.

On the last day of the Daily Bait Monitoring trial

- Walk all 5 Areas, looking carefully at/for each bait.
- If the bait seems to be missing, search the general area in case bait has been moved.
- Fill out the Control Area Bait Record Sheet
- Record bait degradation state (1 = fresh, intact. 5 = completely disintegrated)
- Record weather.

Trial 4: Trail camera trial

Aim:

To investigate which species are actually eating the baits in a tussock environment. This will be a limited trial as we do not want to end up with thousands of hours of footage to sort through.

Location:	s 6(d), 9(2)(g) [redacted], Gouland Downs.
Start date:	The day of the 1080 drop.
Trial length:	Whilst Takahē Recovery Team staff are based a s 6(d), 9(2)(g) [redacted]
Equipment required:	6 x trail cameras 6 x short waratahs 6 x angled attachment devices (as used in bare bait trial) 48 x AA batteries (plus spares??) 12 x 16GB SD cards 6 x bamboo stakes Flagging tape Laptop Hard drive GPS

Method:

Day 0 (1080 operation day)

- Set up each of the 6 trail cams so that they have a good view of a 1080 bait.
- If needed set up a bamboo stake with flagging tape on it near to the camera to show camera location.
- It is useful to trigger the camera and point to the bait into show its location on the first recorded file.
- Record each camera location using a GPS.

Throughout trial

- Check cameras occasionally to ensure they do not need battery/SD card changes
- Record bait presence or absence, and state of degradation.
- If bait has gone then remove camera and set it up with a view of another bait.
- Replace the SD card with a new card and save the files from the card removed to the hard drive.

On the last day of the Daily Bait Monitoring trial

- Bring in all the cameras
- Record whether the bait is present or absent.
- Save all files from SD cards to hard drive.

Document 3

Captive takahē 1080 bait trial

s 9(2)(a), 9(2)(g) [redacted]

[1] *Takahē Recovery Programme, Department of Conservation*

1 Abstract

The impacts of sodium fluoroacetate (1080) on takahē are unknown, so this toxin is not currently used in areas of takahē habitat. With the planned introduction of takahē to at least one new wild site which receives aerial 1080 applications, assessing the likely impact of 1080 on takahē is urgently required. In this study 24 captive takahē were exposed to non-toxic RS5 cereal baits of the type used in aerial rodent control. Bait interaction was monitored using videos from motion-triggered cameras, and the likelihood of consumption with takahē sex, age class and bait age was assessed using Bayesian generalised linear mixed models. There was a strong effect of increased consumption with increasing bait age, and juvenile takahē were more likely to consume baits. Consumption was moderately correlated with the behaviour of other birds in the same pen, and strongly correlated with other interactions by each individual. It is estimated that up to 4-6 (16-25%) of the subjects would have received a lethal dose of 1080, although this is prone to considerable uncertainty in consumption amounts, and the unknown toxicity of 1080 to takahē.

2 Introduction

Aerially-applied 1080 is not used at sites that hold takahē due to the presumed risk to this species. This currently only applies to the Murchison Mountains, where there is an extensive trap network for stoat control. However, with the imminent establishment of a new large wild site for takahē in the South Island (Gouland Downs), there is increasing need to assess and mitigate the impact of 1080 on takahē.

Several trials have been recently conducted to investigate repellents to deter takahē from eating 1080. These were:

- D-pulegone and anthraquinone. A captive trial in 2014 showed that these were a promising repellent for takahē, but these were not pursued due to concerns around stability and cost of d-pulegone, and reduced bait consumption by rats with anthraquinone.

- Tannic acid. A large trial on 59 takahē in 2015 showed that this had limited success as a repellent. Some individuals did not eat treated baits when presented on the ground or in hoppers, but other birds readily ate fragmented or weathered disintegrated baits (Digby et al., 2018a,b).

*Corresponding author. Email: s 9(2)(a), 9(2)(g) [redacted]

- ACP repellent. A small trial on 5 individual captive takahē in April 2017 showed that this repellent (provided by Animal Control Products Ltd; of uncertain contents due to confidentiality clauses) was ineffective in takahē.

With no suitable repellent identified, there is a need to assess the risk to takahē from a standard 1080 operation. As with kea, the net benefit to a takahē population from using 1080 may be positive, even with some mortality from 1080 poisoning. This document describes a trial to test the palatability to captive takahē of standard 6 g RS5 baits without repellent, of the type used in an aerial 1080 operation for rodent control.

3 Methods

3.1 Baits

3.1.1 Bait type

Non-toxic 6g RS5 baits with 0.15% cinnamon were used: as typically employed in most rat-control operations, but with no 1080 added (Figure 1). Toxic bait drops usually use green dye to deter consumption by birds (Cowan and Crowell, 2017), but non-toxic green-dyed baits could not be manufactured due to cross-contamination risk, so brown baits were used instead. These are typically used in pre-feed drops. Baits were provided by Pest Control Research Ltd.

Figure 1: Non-toxic 6g RS5 baits used in the trial (top), and takahē food pellets (bottom).

3.1.2 Bait presentation and monitoring

Baits were hand-laid in small areas cleared of tussock, and monitored by motion-triggered cameras (Bushnell Trophy Cam model #119425C, Bushnell Trophy Cam HD, Bushnell Trophy Cam HD Aggressor, Ltl Acorn mobile scouting camera models 5310 and 5210A, KG780NV KEEPGUARD Wildlife Camera) mounted on 1.8 m stakes, allowing height adustment up to 1.5 m above the ground (Figure 2). Cameras were set to record 20 second videos, set to 0 (Ltl Acorn) or 1 second (Bushnell and KeepGuard cameras) interval between consecutive videos. 8 GB and 16GB Sandisk Ultra SDHC cards with a video speed of C10 were used in the cameras. Bushnell Aggressor and Trophy Cameras were set to 640X360 video resolution, 8MP, medium LED and night vision control, high sensor level. Ltl Acorn cameras were set to 640x480 video resolution, 5MP, high sensor level. KeepGuard cameras were set to 848x480 video resolution, 8MP, low LED control, and sensor level high.

Baits were laid at a density comparable with the highest density expected in an aerial 1080 operation: 2kg/ha if rat tracking when greater than 50%, with 20% sowing overlap. This equates to a density of approximately 400 baits per 1ha pen, or 5m between baits. Since each bait was monitored by a camera, it was not feasible to populate the entire pen with baits, so 12 baits were laid around a high-use area within the pen, approximately 5 m apart. High-use areas were identified by the highest quantities of recent faeces, and mostly were around the water supply (pond or stream) in the pen. Baits were not laid near to food stations, to avoid takahē associating them with food. With only a small part of the pen covered with baits, the trial could not assess the likelihood that takahē would encounter baits, but would determine the chance of them eating baits that they encountered.

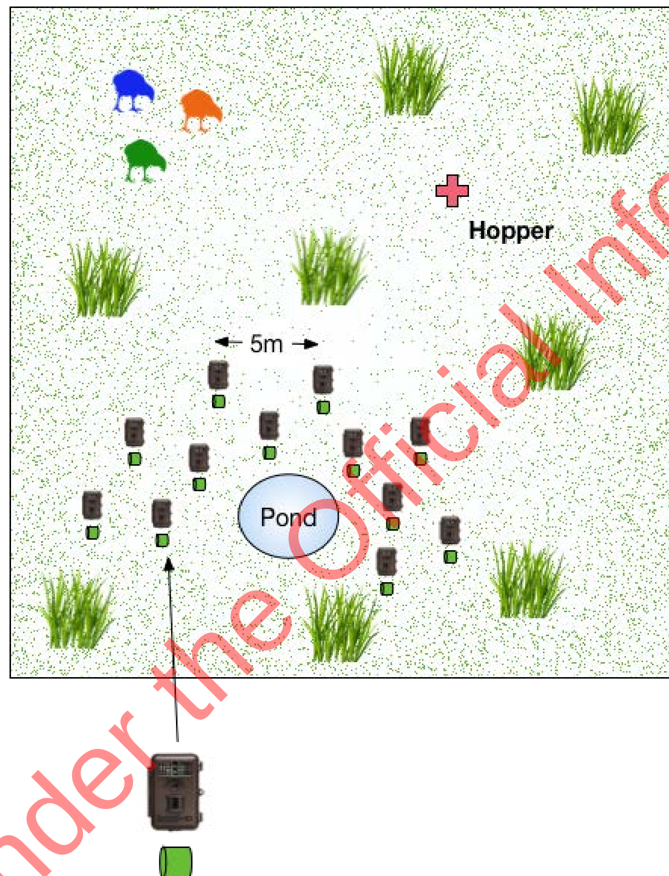

Figure 2: Bait presentation

3.2 Subjects and schedule

Twenty-four captive takahē in six 1ha pens at the Burwood Takahē Centre were used in the trial. Each pen contained either an adult pair, or a family group, with up to three juveniles.

The takahē in each pen were presented with 1080 baits for up to 7 days. Due to equipment limitations and schedule constraints, the pens were tested in groups of three in separate weeks. Pens 1-3 were tested from 17-23 July 2017 and Pens 4-6 from 14-18 August 2017.

Each pen was visited twice per day, in the morning and afternoon, to check baits, and replenish memory cards and batteries in the cameras. Each bait was checked for consumption and decomposition, which was measured each morning on a scale of 1 (intact) to 5 (disintegrated). Baits were replaced with a pre-weathered bait if it had been eaten entirely (by takahē or other species). At the start of the trial 84 baits were placed on an area of grass under a rodent-proof cage close to the trial site, and these were used as replacements, so that all baits in each pen were of the same age and similar decomposition. These baits were used to assess general weathering for each day.

During the first week of the trial it was noticed that the takahē in some pens followed the observer, and so may have biased interactions towards consumption, since staff usually enter the pens to provide supplementary food. In the second week a second person was used to first feed the takahē at their feeding station, to distract them from the observer checking the baits and cameras.

To compare weathering between trial weeks, a weather station was installed at the site (between 1-2 km from the pens). This recorded hourly temperature, humidity and precipitation.

3.3 Video analysis

The video files from the trail cameras were reviewed by two observers with experience of observing takahē behaviour. For each file, the species seen was noted, and bait interaction recorded in one of six categories for each bait encounter: no reaction, scented, touch, bite/gape, taste and consumption. For takahē, the individual was identified from leg band combinations if possible. On several occasions the leg bands were obscured by grass, or the colours were not visible in greyscale video in low light. When consumption was noted, the amount of bait consumed was estimated as low, medium or high. The presence of bait during each encounter was also noted from the camera and from bait checks each day (crumbs, bait present, bait not present).

There were often multiple video files for each encounter, so these were 'merged': encounters within 10 minutes of each other for the same individual were combined, with the interaction and consumption amount taken to be the maximum for the encounters that were combined.

All results were stored in Microsoft Excel spreadsheets and analysed in Tableau Desktop Professional 10.5 (Tableau Software, Seattle, WA, USA), and R 3.3.2 (R Core Team, 2016).

3.4 Statistical analyses

All encounters where no bait was present were excluded from analyses of interactions. If only bait crumbs were present, it was assumed that consumption was still possible and so baits were classed as being present. Encounters with indeterminate interactions were treated as definite: so 'possible consumption' was classed as 'consumption', for example. This had the tendency of exaggerating interactions, with more adverse interactions being reported than actually happened. Conclusions derived from the results will therefore be pessimistic, assuming more interactions.

Factors influencing interactions were analysed using generalised linear mixed models in a Bayesian framework. Consumption was the interaction of most importance, so a binary response variable of consumption/no consumption was used, with fixed factors for sex, age class, bait age and trial week number (one or two). Data exploration indicated that consumption varied by bait age differently within age class for each week, so a three-way interation of age class, bait age and week number was included, and the two-way interactions of these covariates. No interactions with sex were included. Random effects were included for pen, and takahē identity nested in pen. Models without a random effect, and with a random effect with pen, were also constructed, and compared with leave-one-out information criterion tests (LOOIC; Vehtari et al., 2016). Models were run using the R package rstanarm (Stan Development Team, 2016). Mixing of chains and autocorrelation was assessed graphically, and model validation was assessed graphically with residual plots. The significance of factors was assessed with coefficient plots: if the 95% confidence intervals for a coefficient did not intersect zero, then that factor was deemed to have a significant impact on consumption.

4 Results

4.1 Video analysis

More than 3082 video files were recorded by 12 cameras per pen, over 6 pens for a total of 13 days (**Figure 2**). Due to time limitations, not all camera footage was analysed. However, effort was made to obtain video footage of all takahē encountering baits, and this was achieved.

Figure 3: Video files analysed

4.2 Weather

During the trial 35 mm of rain fell during the first week, and 21 mm during the second week (Table 1). Baits were very degraded by the 4th or 5th day of each trial period.

Table 1: bait degradation scores (1-5) and weather conditions for each day of the trials.

Date	Bait age (days)	Bait degradation	Description	Precip (mm)	Mean humidity (%)	Mean temperature
17/7/17	0	1	Dry, intact	0.4	95	6.6
18/7/17	1	1	Damp on outside	0.0	89	3.9
19/7/17	2	1	Damp on outside	0.0	79	6.2
20/7/17	3	2-3	Bait swollen; outside crumbling inside hard	0.2	84	7.0
21/7/17	4	3-4	Bait swollen and damp, crumbles easily	25.8	94	4.1
22/7/17	5	4-5	Bait very swollen and wet, falls apart easily	8.6	96	2.8
23/7/17	6	5	Bait fallen apart, or falls apart when touched	0.2	92	2.0
14/8/17	0	1	Dry, intact	0.2	91	2.1
15/8/17	1	1	Damp on outside, and crumbles a little	0.0	88	2.1
16/8/17	2	1	Damp on outside, and crumbles a little	0.2	77	5.7
17/8/17	3	4	Bait very swollen and damp, falls apart easily	17.8	87	7.8
18/8/17	4	5	Bait fallen apart, or falls apart when touched	3.0	86	7.0

4.3 Bait interactions

4.3.1 Overall consumption

A total of 635 encounters interactions were analysed from the video footage. All 24 takahē in the trial were seen on video encountering baits. Baits were eaten in all pens, but in one (G7) this was solely due to mice - evident since no day time consumption occurred (Figure 4), and from the trail camera footage.

Figure 4: number of baits missing (presumed eaten) for each twice-daily bait check during the trial. Nearly all overnight consumption (resulting in missing baits during the morning check) was due to mice; day time consumption was mostly due to takahē.

Takahē consumed or probably consumed baits in 39% of encounters, with 55% resulting in no interaction (Figure 5). The likelihood of consumption across all age and gender groups combined increased during the second week of the trial, but not the first (Figure 5).

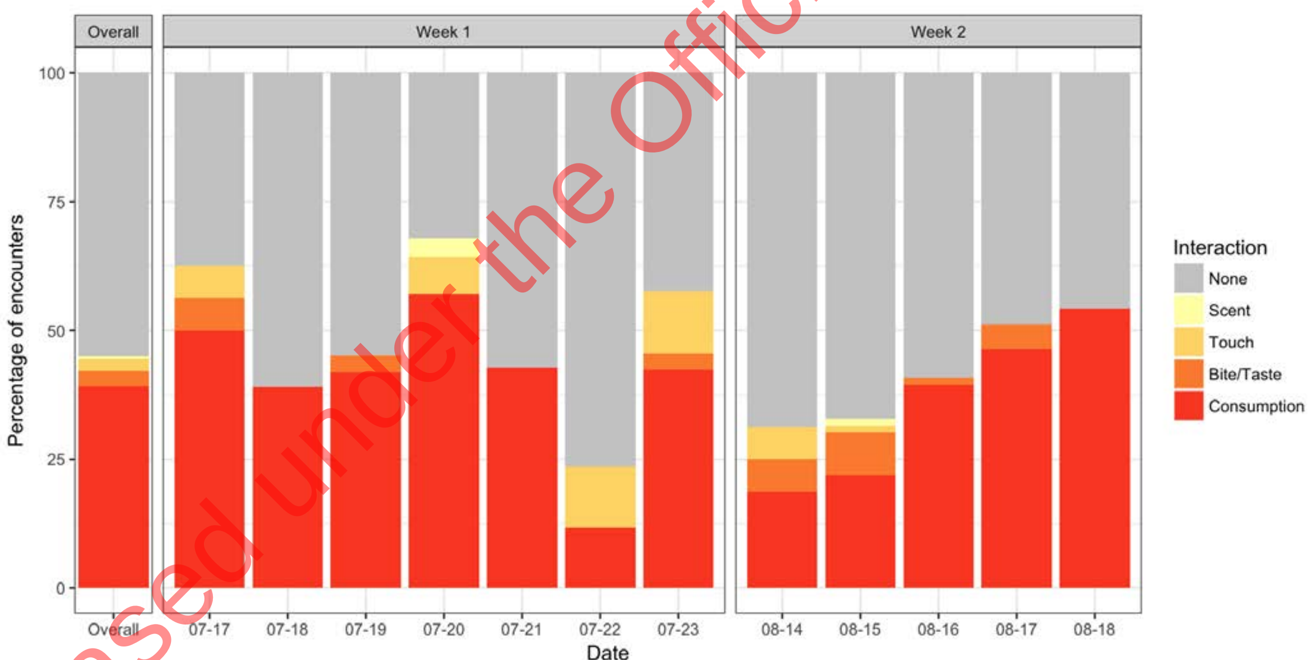

Figure 5: interaction proportion across all age groups and both genders for all encounters (left panel), and for each date during the two weeks of the trial (centre and right panels).

4.3.2 Predictors of interaction behaviour

The model with a random effect of takahē nested in pen provided the best fit to the data, as measured by LOOIC. The final model specification and results were as shown in Listing 1.

```
stan_glmer
 family:       binomial [logit]
 formula:      Consumption ~ Sex + Age.Class * weekno * Bait.Age + (1 | Pen/Band)
 observations: 363
------
                                      Median MAD_SD
(Intercept)                           -3.32   1.35
SexM                                   0.06   0.77
Age.ClassJuv                           1.96   1.08
weeknoWeek 2                          -0.40   1.64
Bait.Age                               0.63   0.17
Age.ClassJuv:weeknoWeek 2             -0.09   1.51
Age.ClassJuv:Bait.Age                 -0.61   0.25
weeknoWeek 2:Bait.Age                  0.24   0.39
Age.ClassJuv:weeknoWeek 2:Bait.Age     0.35   0.45

Error terms:
 Groups   Name        Std.Dev.
 Band:Pen (Intercept) 1.39
 Pen      (Intercept) 2.17
Num. levels: Band:Pen 24, Pen 6

Sample avg. posterior predictive distribution of y:
         Median MAD_SD
mean_PPD 0.43   0.03
```

Results from the generalised linear mixed model. MAD_SD is an estimate of the standard deviation based on the median absolute deviation (MAD) from the posterior medians.

The optimal model showed that there was no significant difference in the proportion of interactions in which takahē consumed baits with sex. There was an increased likelihood of juveniles eating baits compared to adults. (Figure 6) . There was a strong effect of bait age on consumption, with older baits more likely to be consumed when age classes were combined (Figure 6. However, the significant interaction of age class and bait age indicated that the effect of bait age was less strong for juveniles. Juveniles were more likely to eat baits with increasing bait age in week two, but not in week one (Figure 7).

4.3.3 Consumption per takahē

Of the 24 takahē which did encounter baits, 18 ate at least some bait (Figure 8). Six ate no baits; 6 ate at most only estimated low quantities (crumb consumption), 3 ate at most moderate amounts, and 9 ate high quantities. Of the takahē which ate high quantities, all but one did so on multiple days (Figure 9).

Fifteen (63%) of the 18 takahē which consumed bait did so on at least 25% of encounters (Figure 10). Three takahē in pen G7 ate no baits; in S8 and G3 nearly all takahē either ignored the baits or ate them - there were very few scent/touch/bite interactions. The ICC for pen was 0.616 and for each takahē (nested within pen) was 0.869. Interaction behaviour was therefore moderately correlated within each pen, and strongly correlated within each takahē: the behaviour of other takahē was a moderate influence on interaction, and previous behaviour had a strong influence.

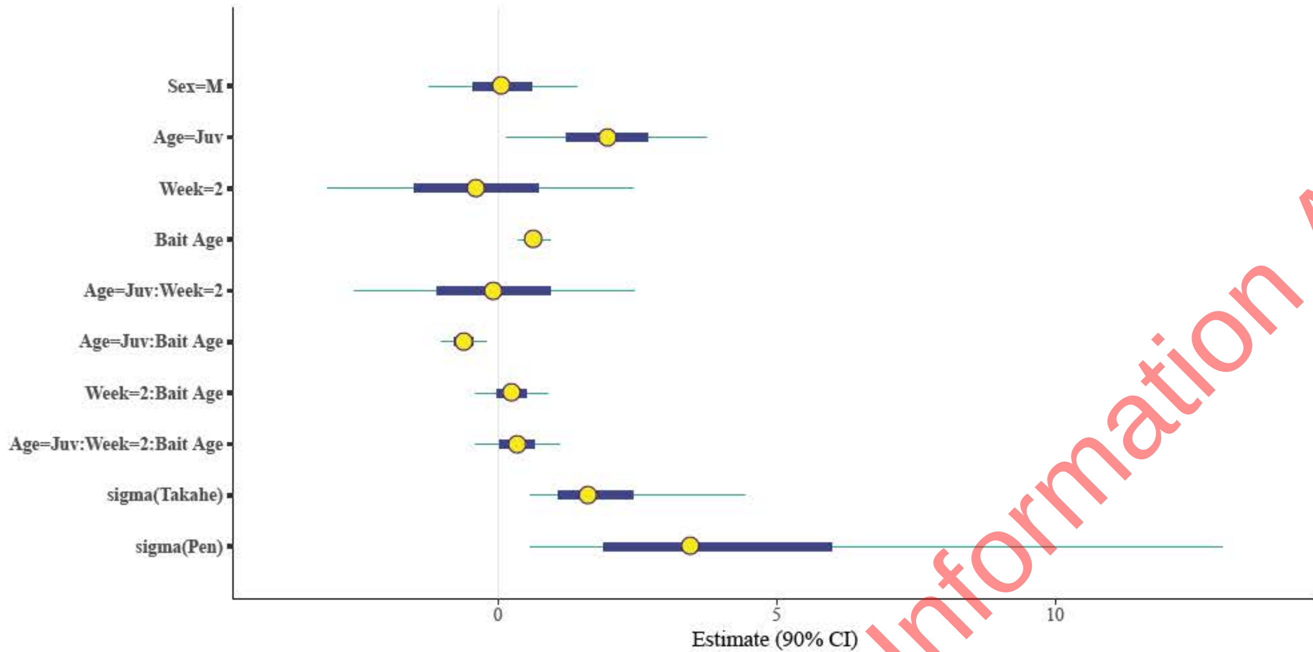

Figure 6: model coefficients for fixed and random effects, showing medians (yellow circles), 50% confidence intervals (thick bars) and 90% confidence intervals (thin bars). Effects were considered significant if the 90% confidence intervals did not intersect zero.

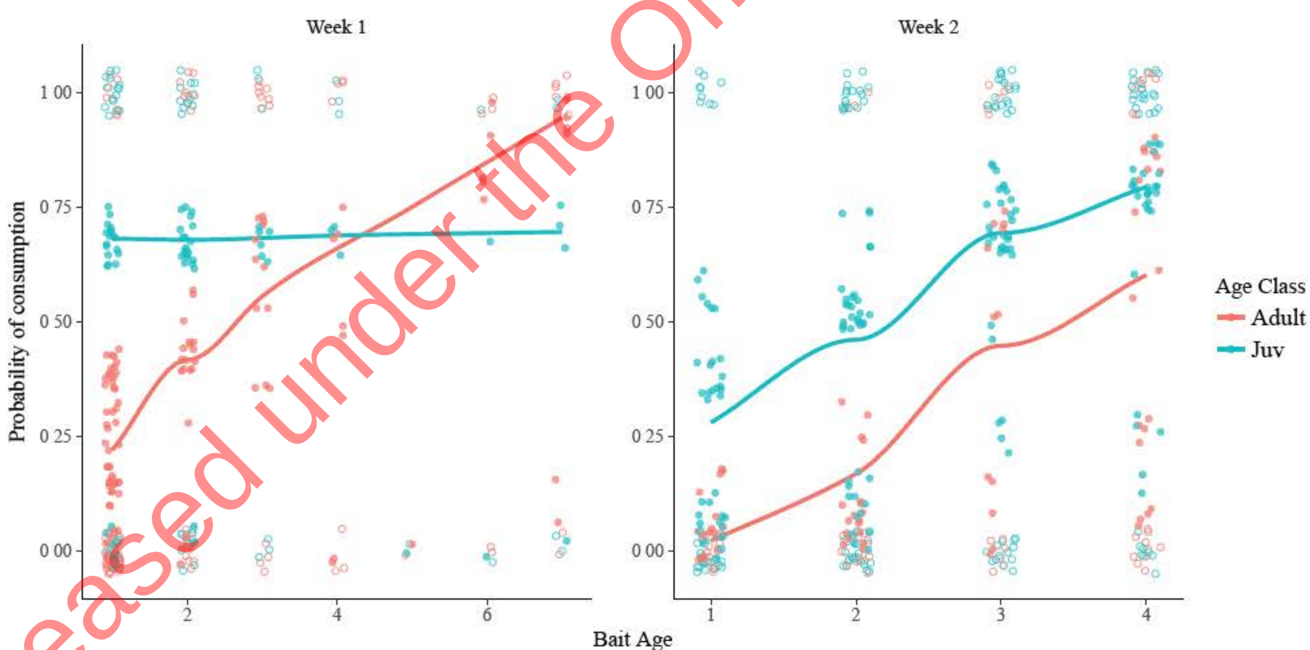

Figure 7: Marginal effects of the final model, showing predicted probability of consumption with bait age by week number and age class, conditioned on random effects of pen and takahē. Sex is not shown, and is held at its reference level (male). Raw (binary) values of consumption are shown as open circles; filled circles are model predictions, with lines showing a smoothed fit (symmetric loess) to these predictions. Points are jittered both horizontally and vertically to avoid overlap.

Figure 8: maximum consumption amount for each takahē for each day of the trial, and over the whole trial. For each interaction, the amount of bait eaten was estimated as 0 = none, 1 = low, 2 = moderate, and 3 = high. Missing values are where takahē were not seen near baits. The highest score over all interactions was then used as a summary for each day.

						Week 1							Week 2				
Band	Name	Pen	Age class	Sex	Total	17 Jul	18 Jul	19 Jul	20 Jul	21 Jul	22 Jul	23 Jul	14 Aug	15 Aug	16 Aug	17 Aug	18 Aug
BM-GY	Nuinea	G5	Adult	M	4										2	1	1
BM-OY	Hossack	G4	Juv	M	2								1				1
BM-RG	Molesworth	G5	Juv	M	1												1
BM-YO	Motatapu	S8	Juv	F	15	3	8	1	3								
BY-WM	Braemar	G5	Juv	M	16									5	3	6	2
GO-YM	Erewhon	S8	Juv	F	12	3	5	1	1			2					
KB-OM	Waiorua	S8	Adult	F	9	1		3	3			2					
KB-RM	George	G3	Adult	F	1												1
KM-GB	Buscot	G4	Juv	M	24								1	4	8	5	6
OG-OM	Manaaki	S8	Juv	M	8		4	1	2			1					
OG-WM	Wal	G3	Adult	M	11										2	4	5
OR-OM	Waireinga	G1	Adult	F	14	1	1	5	2	1	1	3					
RM-RB	Wheko	G5	Juv	M	15									3	4	1	7
RM-WO	Navi	G4	Adult	F	2										1		1
WB-WM	Pahi	S8	Adult	M	8		3		2			3					
WO-BM	Walter	G3	Juv	M	1												1
YB-OM	Hawkeye	G1	Adult	M	7			2	1	2	1	1					
YM-KG	Cecil	G3	Juv	M	7										2	2	3

Max (Consumption): 0, 1, 2, 3, #Missing

Figure 9: number of consumption events on each day for takahē which consumed baits.

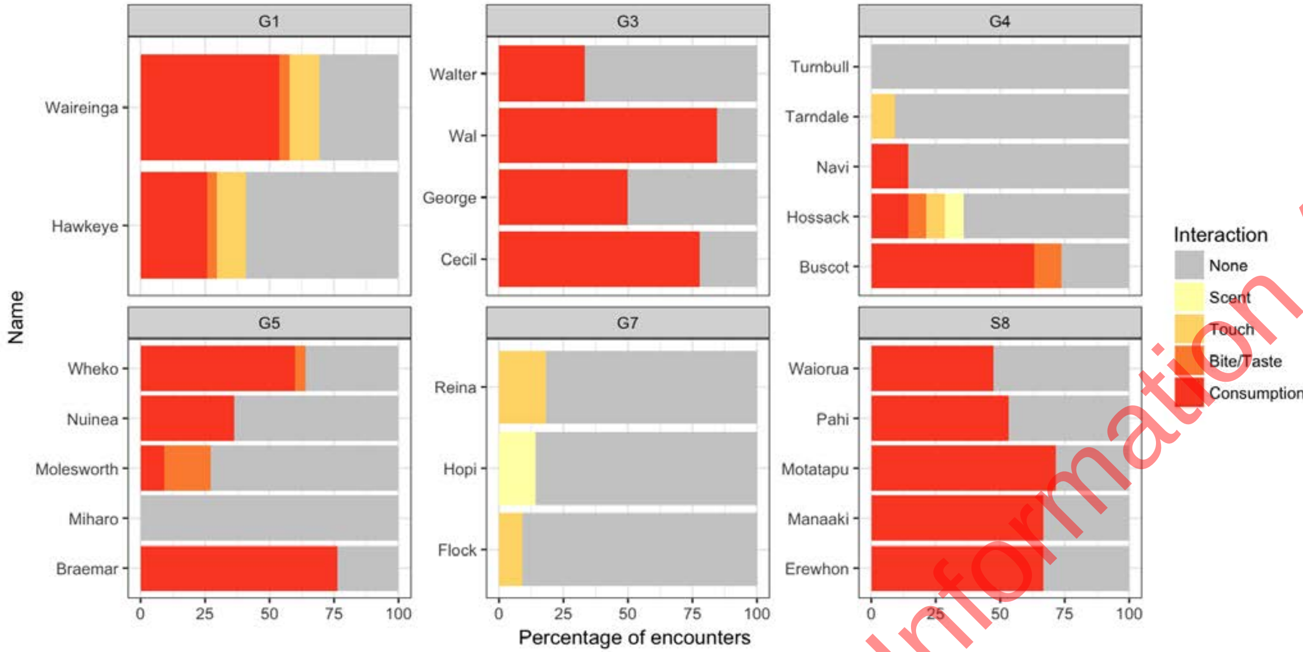

Figure 10: proportion of each interaction type for each takahē for which encounters were observed.

5 Discussion

Captive takahē exhibit a strong tendency to consume the 6 g RS5 cereal 1080 pellets used in most aerial rat control operations. Two-thirds of 24 takahe in this trial consumed baits, and nine ate large quantities, many on multiple occasions. Estimating the number that would have received a lethal dose if the baits had been toxic is difficult, since the exact quantities consumed are unknown, as is the LD50 for 1080 for takahē. Assuming that takahē have the same 1080 LD50 as weka (McIntosh et al., 1966), then a 2kg takahē would need to eat 9g of 0.15% wt/wt 1080 baits to receive an LD50. Assuming that the 9 takahē which consumed large quanti ies ate at least this quantity (1.5 baits), then at least 4 would be expected to die. If the 12 takahē which consumed at least moderate amounts of baits ate more than 1.5 baits, then at least 6 would receive a lethal dose. Therefore from estimated consumption amounts, 4-6 takahē (16-25% of the subjects) would have died had they been exposed to toxic baits.

This estimate is likely to be pessimistic. On some occasions during the first week takahē were attracted to the trial area of the pen by the observer checking baits and cameras. This was mitigated in the second week of the trial by a 'decoy' observer first taking a small amount of food to the food hoppers. The takahe in the trial also have a predilection for bait consumption, since they are trained to consume cereal baits. However, with supplementary-fed birds from the Burwood Takahē Centre comprising the m jority of those used for establishing or supplementing wild sites, these are typical of takahē which will encounter 1080.

The largest uncertainties in the estimate of takahē which would have received a lethal dose were in the amount of bait consumed, and in the takahē LD50. In the extreme case of takahē being extremely sensitive to 1080, then an upper limit of 18/24 (75%) of individuals which consumed some bait could have died if exposed to toxic baits. It is also possible that takahē could consume a non-lethal dose of 1080 which would make them sick and inhibit further consumption, as appears to occur in weka (van Klink and Tansell, 2003; Spurr and Powlesland, 2004; Veltman and Westbrooke, 2011).

These estimates also do not account for bait weathering. The increased likelihood of consumption with bait age was likely due to a combination of habituation to baits - from knowledge that they were edible, and where they would be - and from baits becoming softer and more palatable. However, this weathering would have reduced the likelihood of receiving a lethal dose. This likelihood could not be quantified since quantities of baits consumed was not measured, and a planned simultaneous weathering trial at the same site of toxic 1080 baits could not be undertaken due to logistic reasons. However, published values of 1080 leaching rates (Bowen et al., 2010) can be used to estimate concentrations in baits. Precipitation totals were 35mm and 21mm for the first and second weeks of this trial, at which stage RS5 baits with an initial 1080 concentration of 0.15% would have reduced to approximately 0.05% and 0.08% respectively, assuming the same weathering rates as in Bowen et al. (2010). This suggests that a takahē would need to eat 32.4g (5.4 baits) and 20.25g (3.4 baits) at the end of week 1 and 2 respectively to receive an LD50. Without estimates of bait consumption it is not possible to estimate which takahē exceeded these doses, but the effect of bait weathering would further reduce the number which would have died from the 4-6 estimated.

That there were no significant differences in bait consumption with sex suggests that there is no elevated risk by gender. However, juveniles had a higher likelihood of consumption than adults, and so are more at risk. This may be due to juveniles being more likely to copy feeding behaviour. In one case, an adult was seen feeding baits to a juvenile.

The increase in the likelihood of consumption by juveniles during week 2, but not week 1, cannot be explained by bait weathering. It is likely to have been due to individual variation in behaviour of the takahē groups.

6 Conclusion

Up to 16-25% of captive takahē exposed to RS5 1080 baits would have been expected to die from bait consumption, assuming a lethal dose equivalent to that in weka. Juvenile takahē were more likely to consume baits. This is an upper limit that does not take into account the effects on toxicity of bait weathering. Bait consumption was influenced by previous exposure to baits, and by consumption by other individuals in the same pen. Wild takahē, which have not been trained to eat cereal pellets and live in smaller groups, may have lower levels of consumption, although this may be mitigated by greater hunger levels and fewer novel items in their habitat. Care should be taken in extrapolating the results of this study to wild populations, although all populations do comprise tahakē with experience of supplementary pellets.

Future trials should attempt to measure bait consumption, although this is difficult due to bait degradation, scattering and consumption by non-study species. The largest uncertainty in this work is the lack of knowledge of the lethal dose of 1080 for takahē. This should be addressed.

7 Acknowledgements

This work would not have been possible without the support of the entire Takahē Recovery Programme, and particularly [redacted] and the rangers and volunteers at the Burwood Takahē Centre. The authors also wish to thank Pest Control Research for providing the RS5 pellets.

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